2016 Sec 4 Emath

1	Raffles Institution
2	Nanyang Girls' High School
3	Dunman High School
4	CHIJ Saint Nicholas Girls' School
5	Catholic High School
6	Chung Cheng High School
7	Crescent Girls' School
8	Victoria School
9	Anglican High School
10	Methodist Girls' School
11	Tanjong Katong Girls' School
12	St. Margaret's Secondary School
13	Maris Stella High School
14	Holy Innocents' High School
15	Fuhua Secondary School
16	Holy Innocents' High School

Candidate Name______________________( ) Class: Sec 4 /______

S4

Anglican High School
Preliminary Examination 2016
Secondary Four
Mathematics Paper 1
[4048 / 01]

Date of Examination: **5 August 2016** Duration : **2 hours**

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
Calculators should be used where appropriate.
If degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

The number of marks is given in brackets [ ] at the end of each question or part question.
The total of the marks for this paper is 80.

Table of Penalties		
Error	Penalty	Q No.
Significant figures	–1	
Units	–1	
Presentation/ Missing statements/ Not using ink	–1	

/ 80

Parent's Signature : ______________

This document consists of 20 printed pages.

Mathematical Formulae

Compound Interest

$$\text{Total amount} = P\left(1+\frac{r}{100}\right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi rl$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3}\pi r^3$$

$$\text{Area of triangle } ABC = \frac{1}{2}ab\sin C$$

$$\text{Arc length} = r\theta\text{, where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2}r^2\theta\text{, where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

Answer **all** the questions.

1 Calculate $\dfrac{-6.23^2 \div \sqrt[3]{-124.5}}{3.22(-5.003)^2}$.

(a) Write down the first six digits on your calculator display.

Answer *(a)* ………………………… [1]

(b) Write your answer to part (a) correct to 2 significant figures.

Answer *(b)* ………………………… [1]

2 Given that $\dfrac{\sqrt[4]{x^{-3}} \times x^{\frac{1}{2}}}{x^{-2}} = x^{\frac{2}{3}k}$, find the value of k.

Answer.………………………… [2]

3 A class of 30 students was randomly divided into two equal groups, *A* and *B*.
Each group was taught by 2 teachers with different years of experience.
Their marks in a common test are shown in the stem-and-leaf diagram.

Group *A*		**Group *B***
8	2	7
6 0 0	3	2 8
2	4	5 6
5 1	5	5 9
8 8 8 3	6	0 1 9 9
0	7	2 7 8
9	8	0
9 6	9	

Key (Group A)

8 | 2 means 28

Key (Group B)

2 | 7 means 27

(a) Write down the mode of Group B's marks.

Answer (a) ………………………… [1]

(b) Write down the median of Group A's marks.

Answer (b) ………………………… [1]

(c) Explain briefly whether Group A or Group B performed better in the common test.

Answer (c) Group ..………performed better because ……………………………

..……………………………………………………………………

..……………………………………………………………………

..……………………………………………………………………

..……………………………………………………………………

..……………………………………………………………………

...………...…………………………………………………………… [1]

4 **(a)** The population density of Singapore is 7697 people per square kilometre.
The population density in Hong Kong is 17019 people per square mile.
State, showing your working, the country that is more densely populated, given that 1 mile = 1.61 kilometre.

Answer…………………………... [2]

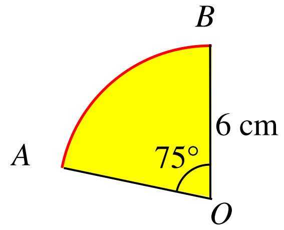
(b) Given that the land space in Singapore is 719 km^2, calculate the total population residing in Singapore, leaving your answer in standard form.

Answer…………………………... [2]

5 A car travelled at an average speed of 80 km/h on a recent journey to Malacca. Along the way, a 15-minute rest stop was taken before continuing on the trip. The ratio of the times of the whole journey is $5:3:7$. Calculate the distance travelled.

Answer..............................km [2]

6 The diagram shows a sector *AOB* with radius 6 cm. Angle *AOB* is $75°$.



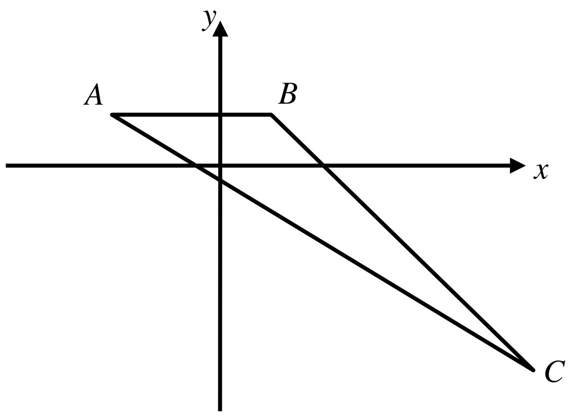
(i) Express $75°$ in radians.

Answer *(i)* .... [1]

(ii) Hence, find the arc length *AB*.

Answer *(ii)* .... cm [1]

7 The diagram shows a triangle ABC, with AB parallel to the x-axis.



A is $(-2, 2)$, C is $(7, -10)$ and the equation of the line BC is $y = -2x + 4$. Find

(i) the length of AC.

Answer (i) .... units [1]

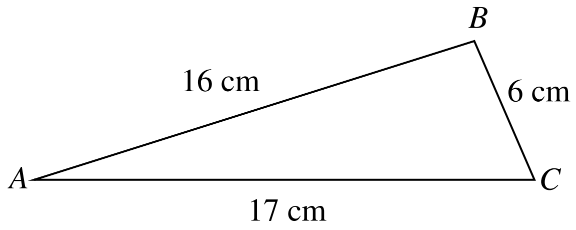
(ii) the x-coordinate of B.

Answer (ii) .... [1]

(iii) the area of triangle ABC.

Answer (iii) .... square units [1]

8 Determine whether triangle ABC is right-angled. [2]



Answer ………………………………………………………………………………………...

……………………………………………………………………………………………

……………………………………………………………………………………………

……………………………………………………………………………………………

9 Peter and Mary competed in a written Mathematics quiz that required them to answer twenty questions.

The table shows the number of questions they have answered correctly, wrongly or did not attempt.

	Correct	**Wrong**	**Did not attempt**
Peter	10	5	5
Mary	12	7	1

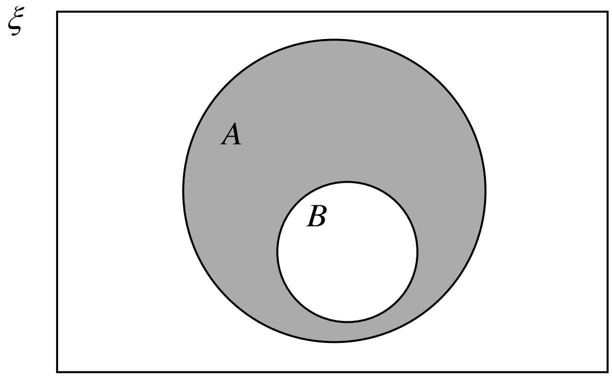
The table shows the number of points they will be awarded if they answer correctly, wrongly or did not attempt.

	Correct	**Wrong**	**Did not attempt**
Points Awarded	2	– 1	0

Using matrix multiplication, find the number of points awarded to Peter and Mary respectively.

Answer
Peter is awarded ……………points and Mary is awarded …………… points. [3]

10 **(a)** Express in set notation, the set shaded in the Venn diagram.



Answer (a) .... [1]

(b) $A = \{\text{letters from the word 'THRONES'}\}$
$B = \{\text{letters from the word 'PHONES'}\}$

(i) State an element x such that $x \in A$ and $x \notin B$.

Answer (b)(i) .... [1]

(ii) List the elements in the set $A \cup B$.

Answer (b)(ii) .... [1]

11 Given that $\dfrac{\frac{1}{x}+\frac{1}{y}}{\frac{2}{x}} = \dfrac{4}{3}$, find the value of $\dfrac{y}{x}$, where $x \neq 0$.

Answer............................... [3]

12 **(i)** If x is directly proportional to y^2, and y is inversely proportional to z.
Prove that xy is inversely proportional to z^3.

Answer (i)

[2]

(ii) Given that when $xy = A$, a particular value of z is obtained. Find the percentage change in z when xy is doubled.

Answer (ii) …………………… % [2]

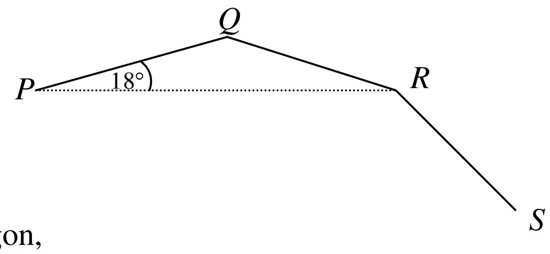
13 Ian has written down six numbers 3, 4, 7, a, 3 and b where $b > a$.
If the mode of these numbers is 3, the mean is 6 and the median is 5,
find the value of a and of b.

Answer a is .... and b is .... [2]

14 Factorise $2x^2 - 8xy + 8y^2 - 18$ completely.

Answer... [3]

15 PQ, QR and RS are adjacent sides of a regular polygon.
Given that $\angle RPQ = 18°$,



(a) calculate

(i) the exterior angle of the polygon,

Answer *(a)(i)* .... [1]

(ii) the number of sides of the polygon,

Answer *(a)(ii)* .... [1]

(iii) angle PRS.

Answer *(a)(iii)* .... [1]

(b) Write down the name of this polygon.

Answer *(b)* .... [1]

16 **(a)** Written as a product of its prime factors

$$2200 = 2^3 \times 5^2 \times 11 \ .$$

(i) Express 5880 as the product of its prime factors.

Answer.................................. [1]

(ii) Hence write down the greatest integer that will divide both 2200 and 5880 exactly.

Answer.................................. [1]

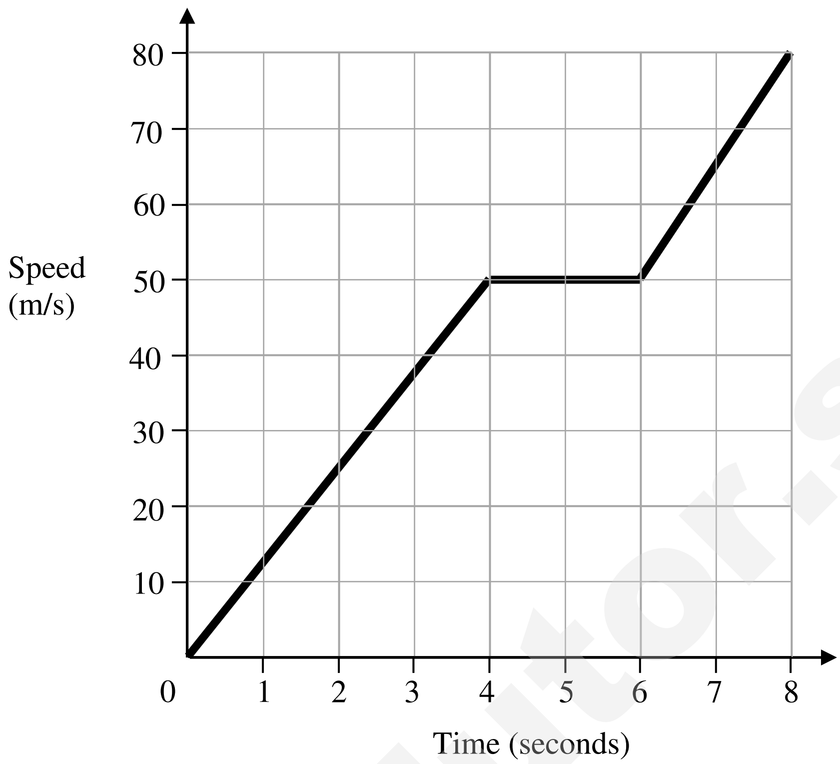
(iii) Write down an integer k, such that $\sqrt{\frac{2200}{k}}$ will give a whole number.

Answer.................................. [1]

(b) A glass marble has a mass of 30 grams. If the volume of the marble is 13 cm^3, correct to the nearest cubic centimetre. Find the greatest possible mass of 1 cubic centimetre of the marble.

Answer.......................... grams [2]

17 The diagram shows the speed-time graph of a plane before taking off from the runway.



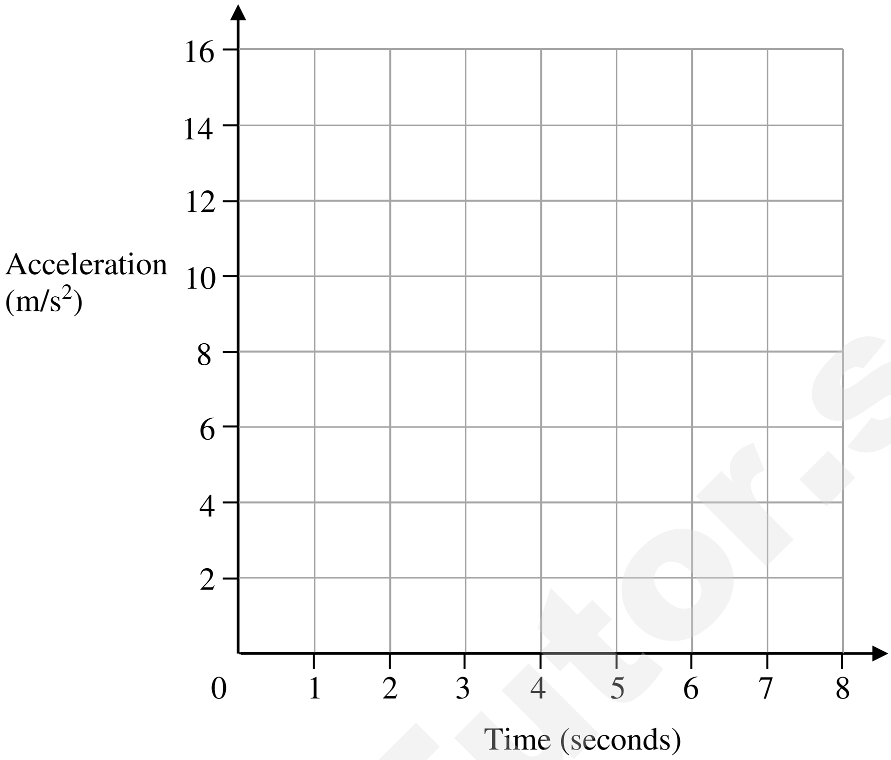
(i) Calculate the acceleration of the plane at 3 seconds.

Answer (i) ………………………… m/s^2 [1]

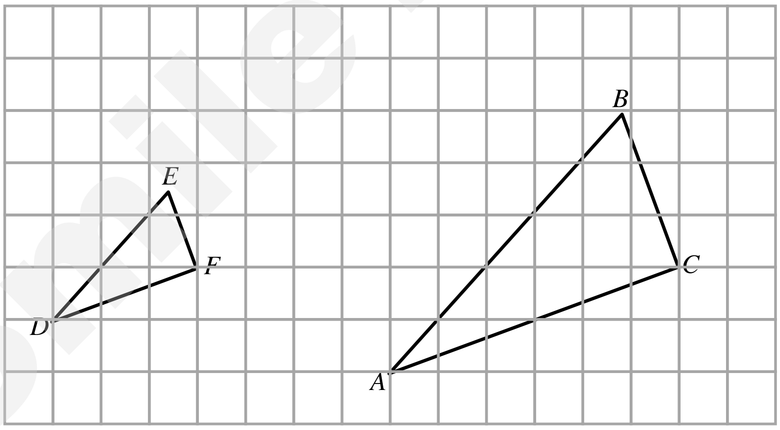
(ii) Calculate the total distance travelled by the plane before taking off from the runway.

Answer (ii) ………………………… m [2]

(iii) Use the grid below to sketch the acceleration-time graph of the plane during the first eight seconds. [2]



18 Triangle *ABC* is mapped onto triangle *DEF*.



(i) Write down the enlargement factor.

Answer *(a)(i)* ………………………… [1]

(ii) Given that the area of triangle *ABC* is 20 square units, calculate the area of triangle *DEF*.

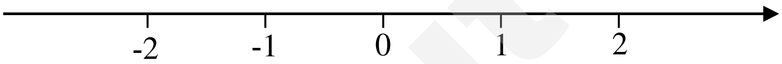
Answer *(a)(ii)* ………………………… square units [1]

19 **(a)** Solve the inequality

$$\frac{2-3x}{-3} \geq \frac{x-5}{4} \ .$$

Illustrate the above solution on the number line given below.

Answer



[3]

(b) State, with reasons, one condition for *a,* such that the following simultaneous equations have a solution.

$$ax - 2y = 13,$$
$$2x = y + 6.$$

Show your workings clearly.

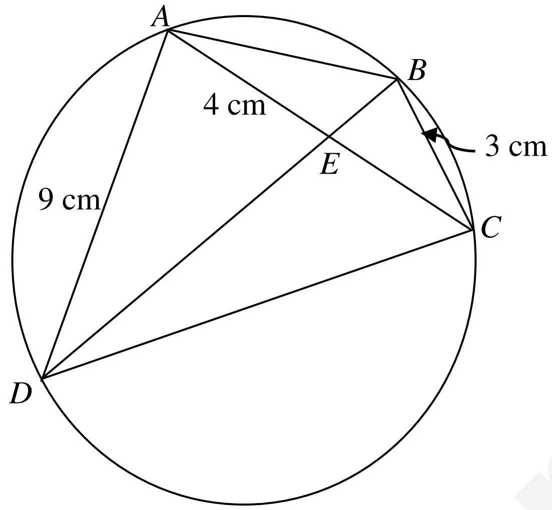
Answer

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………[2]

20 In the diagram below, A, B, C and D are points on the circumference of the circle. AEC and DEB are straight lines.



It is also given that $AE = 4$ cm, $BC = 3$ cm and $AD = 9$ cm.

(i) Show that triangles AED and BEC are similar.

Answer (i)

In triangles AED and BEC ………………………………………..…………..

……………………………………………………………………………………

……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………………… [2]

(ii) Find the length of BE.

Answer (b)(ii) ………………………… cm [2]

21 D is the point $(-2\ ,\ 1)$ and E is $(h\ ,\ 6)$ and $\overrightarrow{AB} = \begin{pmatrix} 7 \\ 1 \end{pmatrix}$.

(i) Express $\overrightarrow{DE}$ as a column vector, in terms of h.

Answer (i) ………………………… [1]

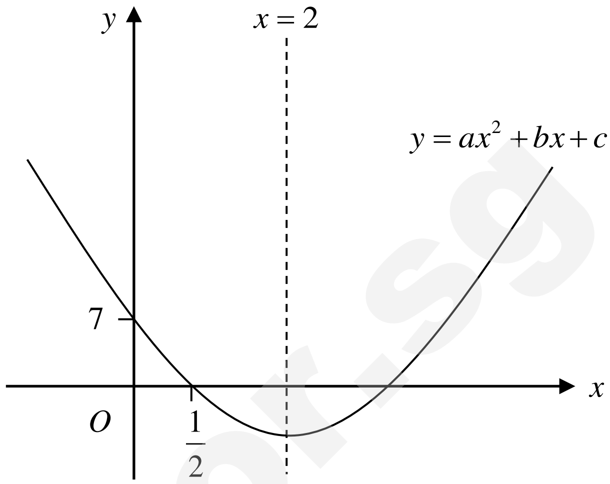
(ii) If $\overrightarrow{DE}$ is parallel to $\overrightarrow{AB}$, find the value of h.

Answer (ii) $h =$ ………………………… [2]

(iii) If instead, $\left|\overrightarrow{DE}\right| = \left|\overrightarrow{AB}\right|$, find the value(s) of h.

Answer (b)(iii) $h =$ …………… or …………… [3]

22 **(a)** A sketch of the graph $y = ax^2 + bx + c$, where a, b and c are integers, is given in the diagram below. The line of symmetry is $x = 2$, and the graph cuts the y-axis at 7, and the x-axis at $\frac{1}{2}$. Find the values of a, b and c.



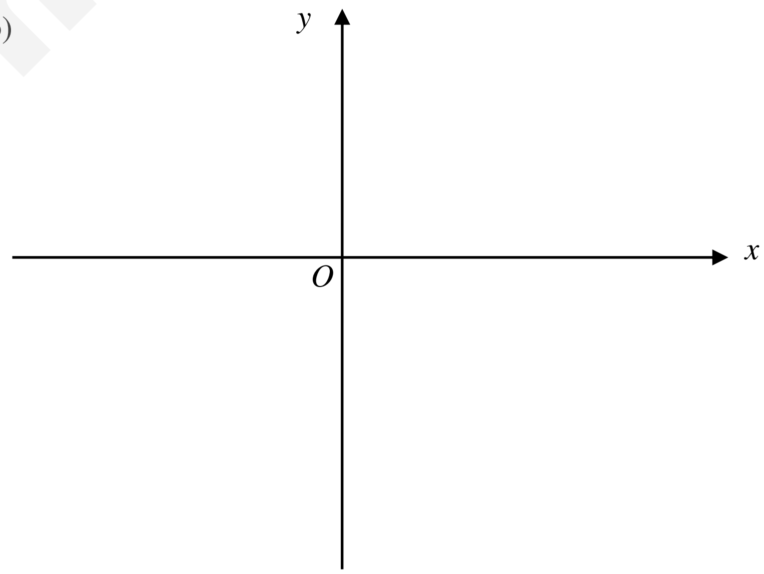
Answer $a =$ ……………………………

$b =$ ……………………………

$c =$ ……………………………[3]

(b) Sketch the graph of $y = -x^2 + 3x - 5$, indicating clearly the coordinates of the turning point and intercepts.

Answer (b)



[3]

23 *ABCD* is a trapezium. *AB* has already been drawn.

Answer (a) and (b).

(a) *C* is the point equidistant from *A* and *B* and angle *ABC* is $50°$.
Construct and label the point *C*. [2]

(b) Construct the trapezium *ABCD* with *DC* parallel to *AB* and the point *D* equidistant from the lines *BC* and *BA*. [2]

(c) Measure and write down the value of reflex angle *BAD*.

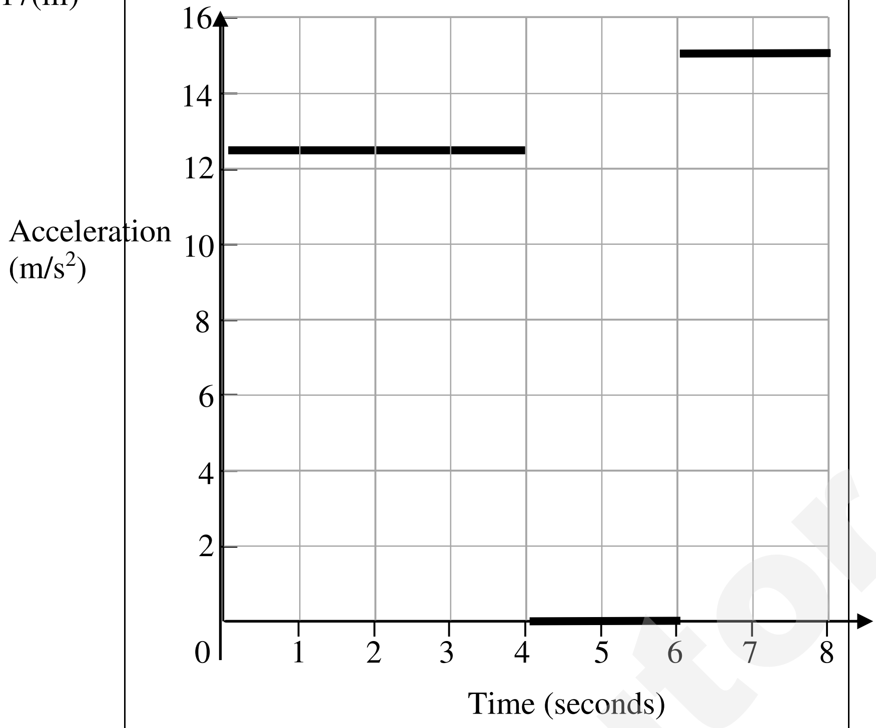
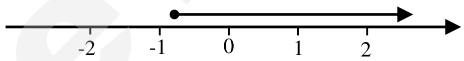
Answer (c) .... [1]

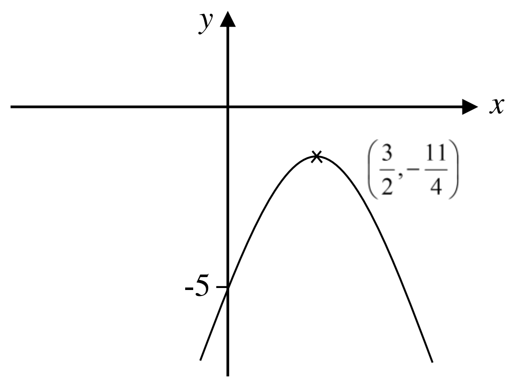
END OF PAPER

Marking Scheme for AHS 2016 EM Paper 1

1(a)	0.09644
1(b)	0.096 (2s.f)
2	$\frac{7}{4}=\frac{2}{3}k$ $k=2\frac{5}{8}\ (o.e)$
3(a)	69
3(b)	63
3(c)	Group A … higher mean or median
4 (a)	$\frac{17019}{1.61^2}=6565.718915\text{pop./km}^2$ Singapore is more densely populated.
4(b)	$total\ population = 5.53\times10^6$
5	$\text{distance travelled} = 80\times\frac{5}{4}$ $=100km$
6(i)	1.31 / $\frac{5\pi}{12}$ or o.e.
6(ii)	$6\times\frac{5\pi}{12}=7.85\text{cm}$
7(i)	15 units
7(ii)	$x=1$
7(iii)	$\frac{1}{2}\times3\times12=18$ sq units
8	According to Pythagoras' Theorem, triangle *ABC* is not right-angled. $16^2+6^2=292$ $17^2=289$ $AB^2+BC^2\neq AC^2$
9	$\begin{pmatrix}15\\17\end{pmatrix}$

	Peter is awarded <u>15</u> points and Mary is awarded <u>17</u> points.
10 (a)	$A \cap B'$
10(b)(i)	Any of the following answers. $x = T, R$
10(b)(ii)	$A \cup B = \{T, H, R, O, N, E, S, P\}$
11	$\frac{y}{x} = \frac{3}{5}$
12 (i)	$x = ky^2 \quad \& \quad y = \frac{l}{z}$ $xy = (ky^2)\left(\frac{l}{z}\right)$ $= k\left(\frac{l}{z}\right)^2\left(\frac{l}{z}\right)$ $= \frac{kl^3}{z^3}$, where kl^3 is a constant. $\therefore xy \propto \frac{1}{z^3}$ (shown)
12 (ii)	Percentage change of $z = -20.6\%$
13	$a = 6$ $b = 13$
14	$2(x - 2y - 3)(x - 2y + 3)$
15(a)(i)	36°
15(a)(ii)	10
15(a)(iii)	Angle PRS = 126°
15(b)	Decagon
16(a)(i)	$5880 = 2^3 \times 3 \times 5 \times 7^2$
16(a)(ii)	$HCF = 2^3 \times 5 = 40$
16(a)(iii)	Either $k = 2 \times 11 = 22$ (minimum) Or $k = 2200$ (maximum)
16(b)	greatest possible mass $= 2.4 gram$
17(i)	12.5 m/s^2
17(ii)	330 m

17(iii)	
18(i)	$\frac{1}{2}$
18(ii)	5 sq units
19(a)	$x \geq -\frac{7}{9}$ 
19(b)	Gradient of equation 1 $= \frac{a}{2}$ Gradient of equation 2: Gradient = 2 $\frac{a}{2} \neq 2$ $a \neq 4$ For solution, the two equations must not be parallel to each other.
20(ii)	$BE = 1\frac{1}{3}$ cm o.e.
21(i)	$\begin{pmatrix} h+2 \\ 5 \end{pmatrix}$
21(ii)	$h = 33$
21(iii)	$h = -7$ or $h = 3$
22(a)	$a = 4$, $b = -16$, $c = 7$

22(b)	
23(c)	245° $\pm$ 3°

Name ________________________________ (   )   Class 4 _______

ANGLICAN HIGH SCHOOL
Preliminary Examination
Secondary Four
MATHEMATICS 4048/02

S4

Friday **22 July 2016** **2 hours 30 minutes**

Additional Materials: 7 writing papers and 1 graph paper

READ THESE INSTRUCTIONS FIRST

Write your name and index number on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.
Write your answers on the writing papers provided.
Omission of essential working will result in loss of marks.
Calculators should be used where appropriate.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

At the end of the examination, attach the entire set of question papers on top of your answer scripts.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total of the marks for this paper is **100**.

For Examiner's Use

Question	1	2	3	4	5	6	7	8	9	10
Marks										

Parent's Name/Signature/Date

Table of Penalties		Qn. No.
Presentation	–1	
Units	–1	
Significant Figures	–1	

/ 100

This question paper consists of 9 printed pages.

Mathematical Formulae

Compound Interest

Total amount = $P\left(1+\frac{r}{100}\right)^n$

Mensuration

Curved surface area of a cone = πrl

Surface area of a sphere = $4\pi r^2$

Volume of a cone = $\frac{1}{3}\pi r^2 h$

Volume of a sphere = $\frac{4}{3}\pi r^3$

Area of triangle ABC = $\frac{1}{2}ab\sin C$

Arc length = $r\theta$, where θ is in radians

Sector area = $\frac{1}{2}r^2\theta$, where θ is in radians

Trigonometry

$$\frac{a}{\sin A}=\frac{b}{\sin B}=\frac{c}{\sin C}$$

$$a^2=b^2+c^2-2bc\cos A$$

Statistics

Mean = $\frac{\sum fx}{\sum f}$

Standard deviation = $\sqrt{\frac{\sum fx^2}{\sum f}-\left(\frac{\sum fx}{\sum f}\right)^2}$

Answer **all** the questions.

1 **(a)** Simplify $2x^3y^2 \div \frac{6x^2}{5y}$. [2]

(b) Express as a single fraction in its simplest form $\frac{3}{x-1} + \frac{6x}{1-x^2}$. [2]

(c) **(i)** Factorize $4ab - 10c + 6a^2b - 15ac$ completely. [2]

(ii) Given that $\frac{3x-7y}{4x+y} = \frac{2}{5}$, find the value of $\frac{x}{8y}$. [2]

---

2 **(a)** In the diagram, *ABCDE* is a regular pentagon and *ABQRST* is a regular hexagon. Calculate

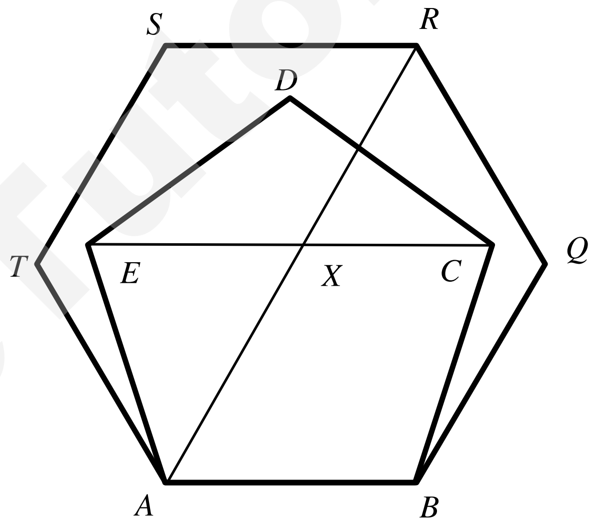
(i) $\angle BAE$, [1]

(ii) $\angle BAX$, [1]

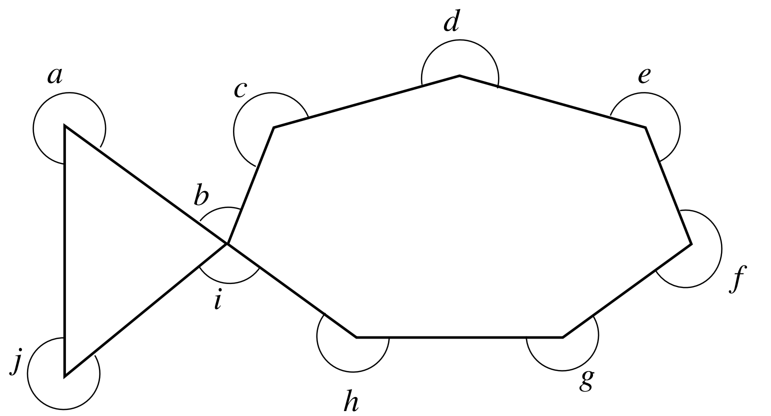
(iii) $\angle EAX$, [1]

(iv) $\angle EXR$, [1]

(v) $\angle XAC$. [2]



(b) Calculate the sum of the angles *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, *i* and *j* in the diagram below. [3]



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3 In this question, leave all your answers to 2 decimal places.
The table below shows the exchange rate in April 2016. To convert from the foreign currency to Singapore Dollars, we use the rate listed in the "Buy" column. To convert from Singapore Dollars to the foreign currency, we use the rate listed in the "Sell" column.

Currency	Amount	Buy (S$)	Sell (S$)
US Dollars	US$1	1.363	1.38
Australian Dollars	AU$1	1.050	1.10
Japanese Yen	¥1000	12.434	12.55
Hong Kong Dollars	HK$100	17.576	18.25
Malaysian Ringgit	RM100	35.080	36.00

(a) John wants to tour Hong Kong and wants to bring HK$2000. Calculate the amount of Singapore dollars he must pay to buy the foreign currency. [2]

(b) By using the rate listed in the "Buy" column, calculate the exchange rate between US$1 and the Malaysian Ringgit. [2]

(c) Mr Lim was originally going on a business trip to Japan and converted S$2000 to Japanese Yen. However, the trip was cancelled. He decided to convert the Japanese Yen he had back to Singapore dollars. Show that the amount he lost as a percentage of his original sum is less than 1%. [4]

(d) Sharon went to Australia and bought a luxury watch at AU$ 10 079. Calculate the amount of money (in Singapore dollars) she would need to exchange before the trip, if she paid in cash. [2]

---

4 **(a)** Consider the pattern.

$$11 - 2 = 3^2$$
$$1111 - 22 = 33^2$$
$$111111 - 222 = 333^2$$
$$\vdots$$
$$x - y = 333\,333\,333^2$$

(i) Write down the 4th line in the pattern. [2]
(ii) Find the number of 1s in x. [1]
(iii) Find the value of y. [1]

(b) The first four numbers of a sequence are 1, 4, 7, and 10.
(i) Write down the 10th term. [1]
(ii) Find, in terms of n, a formula for the general term, T_n, of the sequence. [1]
(iii) Show, with working, whether or not 45 is in this sequence. [3]

5 **(a)** Express $y = x^2 - 7x + 12$ in the form of $y = (x-a)^2 - b$. [2]

(i) Write down the equation of the line of symmetry and the minimum value of *y*. [2]

(ii) Find the solutions of $y - \frac{15}{4} = 0$. [3]

(b) Solve $\frac{15x}{x-9} - 3 = 0$. [3]

---

6 The diagram (not drawn to scale) shows a badge designed by a student for his CCA. It is made up of a regular octagon and a circle with centre *X*.
The line segments *AC*, *CE*, *EG*, *GI*, *IK*, *KM*, *MO*, *OA* are tangents to the circle at *B*, *D*, *F*, *H*, *J*, *L*, *N*, *P* respectively.

(a) Find, giving reasons for each answer,

(i) $\angle AXC$, [1]

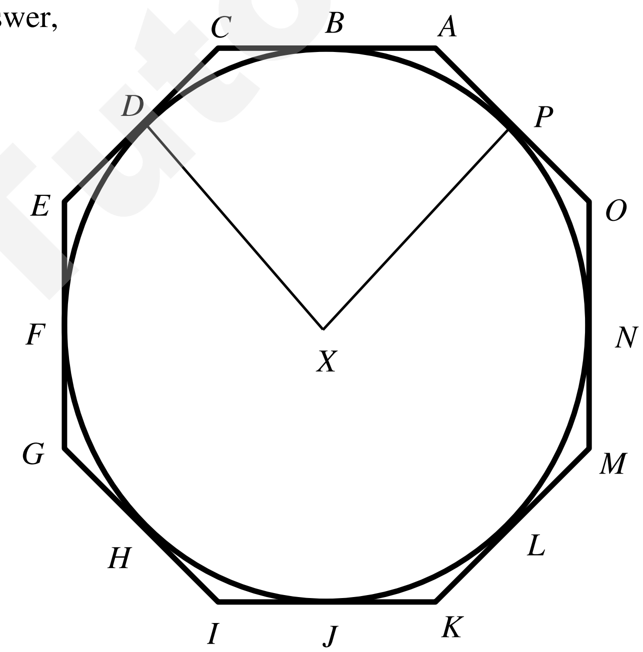
(ii) $\angle PXE$, [1]

(iii) $\angle PND$, [1]

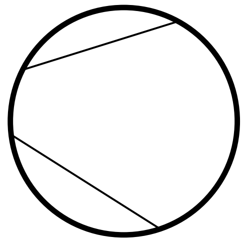
(iv) $\angle DNL$, [1]

(v) $\angle PNL$, [1]

(vi) $\angle PFL$. [1]



(b) Another student drew a circle on paper by tracing the circumference of a cup.
Explain how he can obtain the centre of the circle after he drew 2 more chords on the circle. [2]



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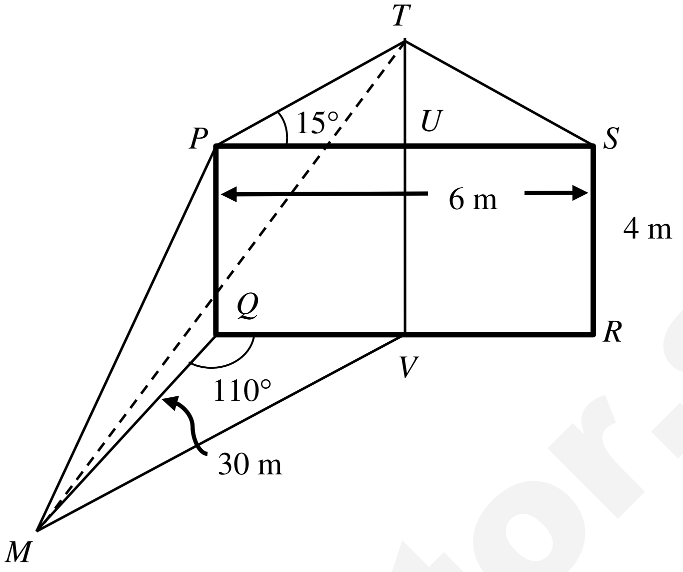
7 The diagram shows the front view of the N.R.G. greenhouse which is vertical to the ground. PT and ST make up the roof which make angles of 15° with the horizontal.



Given that $SR = 4$ m, $QR = 6$ m and M is a point due south of Q on the ground such that $MQ = 30$ m and angle $MQR = 110°$. U and V are the mid points of PS and QR respectively.

(a) Find

(i) the distance between T and V, [2]

(ii) the angle of elevation of T from M, [4]

(iii) the bearing of V from M. [2]

(b) A student walks from M to V. Find the distance that he has to walk so that he is closest to Q. [2]

8 **Answer the whole of this question on a sheet of graph paper.**

The variables x and y are connected by the equation

$$y = 24x^2 - 6x^3.$$

The table below shows some values of x and the corresponding values of y.

x	0	0.5	1	1.5	2	2.5	3	3.5	4
y	0	p	18	33.75	48	q	54	36.75	0

(a) Calculate the value of p and of q. [2]

(b) Using a scale of 2 cm to 0.5 units, draw a horizontal x-axis for $0 \le x \le 4$.
Using a scale of 2 cm to 10 units, draw a vertical y-axis for $0 \le y \le 60$.
On your axes, plot the points given in the table and join them with a smooth curve. [3]

(c) By drawing a tangent, find the gradient of the curve at $x = 2$. [2]

(d) By drawing a suitable straight line on your graph, solve $24x - 6x^2 - \dfrac{50}{x} = -55$. [3]

(e) Using the graph, solve $y \ge 40$. [2]

9 **(a)** The waiting time, in seconds, for 20 students queueing up to buy food in the canteen from 2 different stalls are recorded as follows.

Stall *A*

Time (s)	$30 < t \leq 35$	$35 < t \leq 40$	$40 < t \leq 45$	$45 < t \leq 50$
Number of students	6	11	1	2

Stall *B*

Mean	36 s
Standard Deviation	5 s

(i) For Stall *A*, calculate an estimate of

(a) the mean waiting time, [1]

(b) the standard deviation. [1]

(ii) Make two comparisons between the waiting times for the two stalls. [2]

(iii) Stall *C* has a standard deviation of 0s for its waiting time, suggest a reason for this. [1]

(b) A bag contains three identical red balls numbered 1 to 3 and two identical blue balls numbered 1 and 2.
Two balls are taken from the bag at random without replacement.

(i) Draw a possibility diagram to show all the possible outcomes. [2]

Using the possibility diagram or otherwise, find the probability that

(ii) the two balls bear the same number, [1]

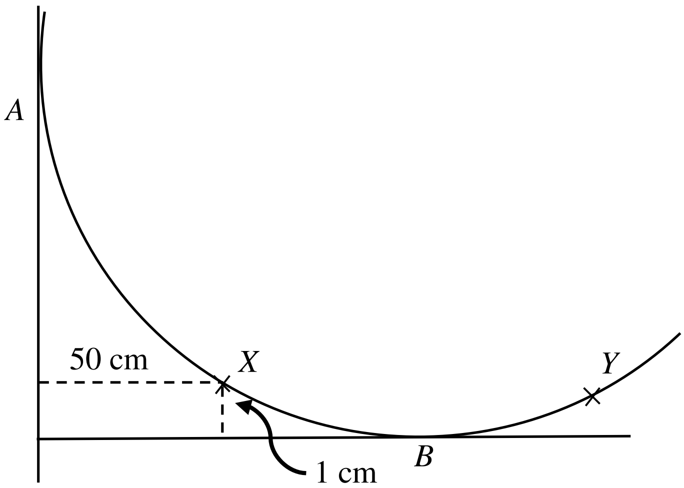
(iii) the two balls are of different colours. [1]

A third ball is next chosen from the bag without replacement after the first two.

(iv) What is the probability that all are blue? [1]

(v) What is the probability that only two red balls are chosen? [2]

10



The diagram shows part of a circular table that is pushed into a corner of a room. A boy measures a point, X, on the circumference of the table to be 1 cm from the south wall and 50 cm from the west wall. Points A and B are the points where the table meets the walls.

(a) By the use of the Pythagoras' Theorem, verify that the radius of the table is 61 cm. [3]

(b) Find the length of arc XB. [3]

(c) Calculate the length of the chord XB. [1]

(d) These tables are used by a restaurant as dining tables in a dining area of 100 m^2.

Useful information		
	Casual dining	Fine dining
Minimum area of table space per diner	1 700 cm^2	2 700 cm^2
Number of tables	12	9
Recommended amount of dining space (in square metres) per diner	1.4 m^2/ diner	1.8 m^2/ diner

Determine if the restaurant should be a casual dining or fine dining establishment. Justify your decision with calculations. [5]

End of Paper.

2016 AHS Prelim Math P2 Worked Solution

1(a)	$\frac{5xy^3}{3}$
(b)	$-\frac{3}{x+1}$
(c)(i)	$(3a+2)(2ab-5c)$
(ii)	$\frac{x}{8y}=\frac{37}{56}$
2 (a)(i)	108°
(ii)	60°
(iii)	48°
(iv)	120°
2a(v)	24°
(b)	2160°
3(a)	S$365.00
(b)	US$1 ≈ RM3.89
(c)	Percentage loss = 0.924305% < 1% (shown)
(d)	She needed to exchange S$11 086.90 before the trip.
4(i)	$11111111-2222=3333^2$
(ii)	18
(iii)	$y=222\ 222\ 222$
(b)(i)	10^{th} term = 28
(ii)	$3n-2$
4b(iii)	$3n-2=45$ $3n=47$ $n=\frac{47}{3}$ or $15\frac{2}{3}$ Since n has to be a positive integer, 45 is not in the sequence.
5(a)	$(x-\frac{7}{2})^2-\frac{1}{4}$
(i)	$x=\frac{7}{2}$ Minimum value of $y=-\frac{1}{4}$
(ii)	$x=5\frac{1}{2}$ or $1\frac{1}{2}$
(b)	

	$-\frac{9}{4}$ or $-2\frac{1}{4}$
6(a)(i)	45°
(ii)	112.5°
(iii)	45°
(iv)	90°
(v)	135°
(vi)	45°
(b)	Draw perpendicular bisectors for the 2 chords The perpendiculars will intersect at the centre, since the perpendicular bisectors of a chord will pass through the centre
7(a)(i)	4.80 m (3 sf)
(ii)	$\angle TMV° = 8.767°... \approx 8.8°$ (1 dp)
(iii)	Bearing is 005.2°
(b)	29.9 m
8(a)	$p = 5.25$, $q = 56.25$
(b)	
(c)	Gradient = 24
(d)	From the graph, $x \approx 0.7$
(e)	From the graph, $1.7 \le x \le 3.4$
9(a)(i)(a)	Mean = 37.25 s
(b)	s.d. = 4.32 s
(ii)	On average Stall *A* has a longer waiting time, due to a higher mean. The spread of the waiting time for Stall *A* is smaller as it has a smaller s.d.
(iii)	All the students who bought from Stall *C* had the same waiting time
9(b)(i)	(see table below)

	1ST DRAW					
2ND DRAW		R1	R2	R3	B1	B2
	R1		R2R1	R3R1	B1R1	B2R1
	R2	R1R2		R3R2	B1R2	B2R2
	R3	R1R3	R2R3		B1R3	B2R3
	B1	R1B1	R2B1	R3B1		B2B1
	B2	R1B2	R2B2	R3B2	B1B2	

(ii)	$\frac{1}{5}$
(iii)	$\frac{3}{5}$
(iv)	0
(v)	$\frac{3}{5}$
10(a)	Let the radius be R $R^2 = (R-50)^2 + (R-1)^2$ $R^2 - 102R + 2501 = 0$ Solve to get $R = 61$ only
(b)	11.1 cm
(c)	11.0 cm (3 sf)
10(d)	Number of diners the table can take for casual dining $= \pi \times 61 \times 61 \div 1700$ ≈ 6 Number of diners the table can take for fine dining $= \pi \times 61 \times 61 \div 2700$ ≈ 4 Number of diners the restaurant can host for casual dining $= 12 \times 6$ $= 72$ Number of diners the restaurant can host for fine dining $= 9 \times 4$ $= 36$ Recommended number of diners for casual dining $= 100 \div 1.4$ ≈ 71 Recommended number of diners for fine dining $100 \div 1.8$ ≈ 55 Since the number of diners the restaurant can host for casual dining is closer to the recommended number, it would appear that the restaurant is a casual dining establishment.

Candidate Name: ____________________ Class | Index No.

FUHUA SECONDARY SCHOOL

Secondary Four Express/ Five Normal (Academic)

Preliminary Examination 2016

4E & 5NA

Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary Fuhua Secondary
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MATHEMATICS **(4016/1)**
PAPER 1 **(4048/1)**

Additional Materials:
Construction Set & Electronic calculator

DATE **30 August 2016**
TIME **09 00 – 11 00**
DURATION **2 hours**

INSTRUCTIONS TO CANDIDATES

Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, correction tapes or correction fluid.

Answer **all** questions on the question paper itself.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result of loss of marks.
Calculator should be used where appropriate.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer correct to 3 significant figures. Give answers in degrees to 1 decimal place.
For π , use either your calculator value or 3.142, unless the question requires the answer in terms of π .

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 80.

PARENT'S SIGNATURE	FOR EXAMINER'S USE
	/ 80

This question paper consists of 18 printed pages including this page.

[Turn over

MATHEMATICAL FORMULAE

Compound Intetest

$$\text{Total amount} = P\left(1+\frac{r}{100}\right)^{n}$$

Mensuration

$$\text{Curved surface area of cone} = \pi rl$$
$$\text{Surface area of a sphere} = 4\pi r^2$$
$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$
$$\text{Volume of sphere} = \frac{4}{3}\pi r^3$$
$$\text{Area of triangle ABC} = \frac{1}{2}ab\sin C$$
$$\text{Arc length} = r\theta, \text{ where } \theta \text{ is in radians}$$
$$\text{Sector area} = \frac{1}{2}r^2\theta, \text{ where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard Deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

Answer **all** the questions.

1 **(a)** Calculate $\dfrac{-1.3^2 + 2\pi^3}{4-\sqrt{19}}$.

(b) Express 0.15% as a fraction in its simplest form.

Answer (*a*) .... [1]

(*b*) .... [1]

2 **(a)** Express $\dfrac{3}{2(5-x)} - \dfrac{4-x}{(x+1)(x-5)}$ as a single fraction in its simplest form.

(b) A man bought x kg rice at \$$y$. He sold all the rice at p cents per 100g.

Find an expression in terms of x, y and p for the profit he made in dollars.

Answer (*a*) .... [2]

(*b*) .... [1]

3 **(a)** Given that $8^{12} \div 4^{2w} = \left(\frac{1}{2}\right)^{3w-2}$, find the value of w.

(b) Simplify $\frac{2ab^2}{(2bc^0)^{-2}} \div \frac{8}{\sqrt{ab^2}}$, leaving your answer in positive index notation.

Answer (*a*) w = ..……………………………… [2]

(*b*) ……....…………………………… [2]

4 Solve the simultaneous equations.

$$\frac{x}{3} = \frac{1}{6} - \frac{y}{2}$$

$$7x - 3y + 1 = 0$$

Answer x = ……….…….. y = …………… [3]

5 Written as the product of its prime factors, $4536 = 2^3 \times 3^4 \times 7$.

(a) Write 4410 as the product of its prime factors.

(b) Find the highest common factor of 4536 and 4410. Give your answer as the product of prime factors.

(c) Find the smallest positive integer k such that $4410k$ is multiple of 4536.

Answer (*a*) 4410 = ………………………… [1]

(*b*) ……….………………………… [1]

(*c*) k = ...………………………… [1]

6 The temperature of a buffalo wing was $-15°\text{C}$ when taken out of a freezer. The buffalo wing was immediately heated up in an oven and after 15 minutes, its temperature was 120°C.

Given that the temperature of the buffalo wing increased at constant rate, calculate,

(a) the number of minutes it had been heated up when its temperature reached 40°C,

(b) its temperature when it had been warmed for 8 minutes.

Answer (*a*) ………………………... minutes [2]

(*b*) ……..…....………………….. °C [2]

7 A metal rod *A* has a length of 43 m, correct to the nearest m.

A metal rod *B* has a length of 61 m, correct to the nearest m. Find

(a) the least possible length of metal rod *A*,

(b) the greatest possible difference in their lengths.

Answer (*a*) ……………………………….m [1]

(*b*) ……………………………….m [1]

8 An area of 9 cm^2 on a map represents an actual area of 0.04 km^2. Calculate

(a) the area on the map, in square centimetres, which represents an actual area of 2000 m^2,

(b) the actual distance, in kilometres, represented by a length of 7.8 cm.

Answer (*a*) …………………………….cm^2 [2]

(*b*) …………………………….km [2]

9 A man bought a game for $86. He made a profit of 25% of the cost price after selling the game at a discount of 30% of the selling price. Find the actual selling price of the game.

Answer $…….……………….…………………... [2]

10 An athlete walks a distance of 20 km at an average speed of 8 km/h and takes a break for 15 minutes, and continue to run a further distance of 800 m in 3.4 minutes.

(a) Express 8 km/h in m/s.

(b) Find the average speed of the athlete for the whole journey in m/s.

.

Answer (*a*) …….…………………………...m/s [1]

(*b*) ……....……………………………..m/s [2]

11 One of the interior angles of a polygon is $120°$. The remaining interior angles are each equal to $165°$. Find the number of sides of the polygon.

Answer …………..………..…………………. [2]

12 Given that y varies inversely as the square root of x, and $y = 3$ for a particular value of x. Find the value of y when this value reduced to 36%.

Answer …………..………..…………………. [2]

13 The length of a rectangular microchip is 1.8 micrometre and the width is 720 nanometres.

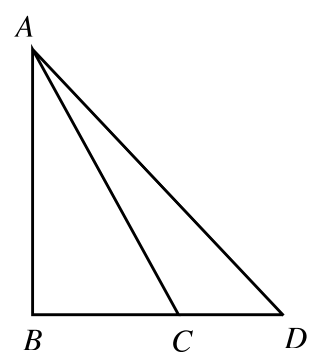
(a) Find the ratio of its length to its width.

(b) If the length is decreased by 50%, and the width is increased by 70%. Find the percentage change in the area of the microchip.

Answer (*a*) ………………… **:** ....…………….. [1]

(*b*) ……....………………………% [2]

14 In the diagram below, BCD is a straight line. It is given that $AB = 8$ cm, $CD = 3$ cm, $\angle ABC = 90^{\circ}$ and $\tan \angle BCA = \dfrac{4}{3}$.



(a) Find the length of BC.

(b) Write down cos $\angle ACD$.

(c) Find the area of triangle ACD.

Answer (*a*) ………………………...……cm [1]

(*b*) ……....……………………...... [1]

(*c*) ……...…………....……….cm^2 [1]

15 There are 40 students in a class. 12 students are in the NCC and 24 students are in the NPCC. 8 students are neither members of the NCC nor the NPCC. Let

$\mathcal{E}$ = {Students in the class}

N = {Students in the NCC}

P = {Students in the NPCC}

(a) Draw a Venn Diagram to illustrate the above information. Show on the Venn Diagram the number of elements in each distinct region.

(b) It is also given that

C = {Chinese students in the class}

M = {Malay students in the class}

I = {Indian students in the class}

(i) Describe in words the meaning of the set notation $M \cap N \neq \{\ \}$.

(ii) Describe what you can deduce from the set notation $I \subset N$.

(iii) Express in set notation {Chinese students who are neither in NCC nor NPCC}.

Answer (*a*) [2]

Answer (*bi*) ……………………………………………………………………………………

……………………………………………………………………………………[1]

(*bii*) ……………………………………………………………………………………

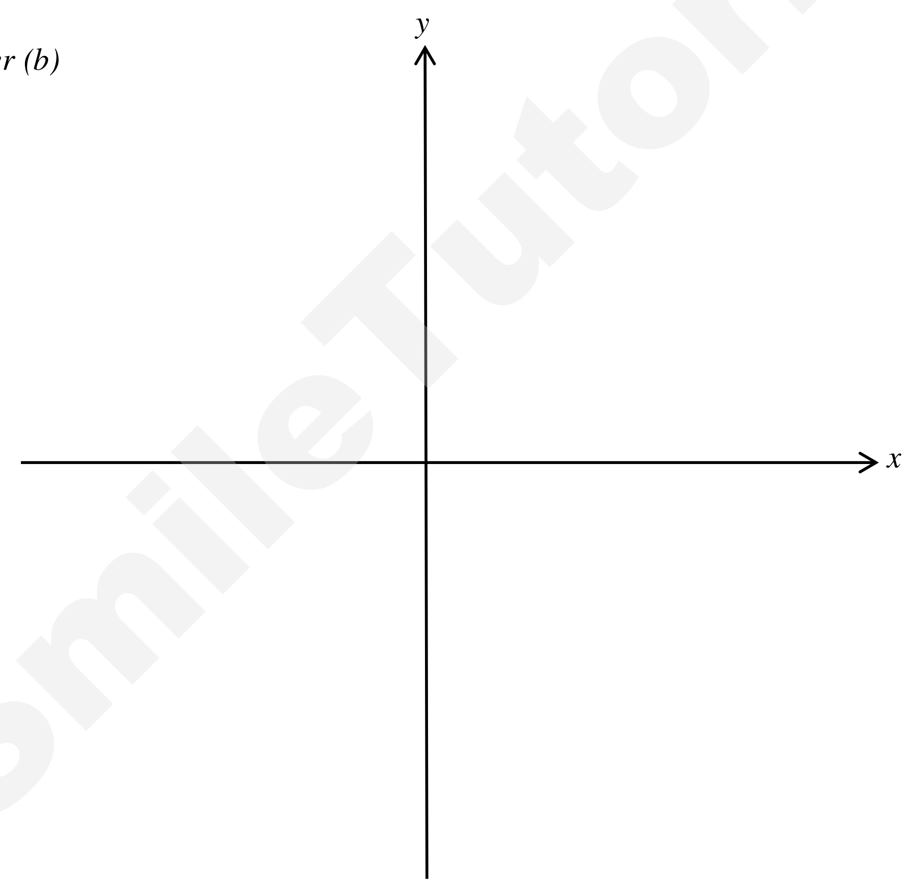
…………………………………………………………………………………… [1]

(*biii*)…………………………………… [1]

16 **(a)** Express $-x^2+2x-4$ in the form $-(x-a)^2+b$, where a and b are constants.

(b) Hence, sketch the graph of $y=-x^2+2x-4$. Label clearly in your sketch, the turning point and any intercepts with the axes.

Answer (b) [2]



Answer (*a*) ……………………………..……. [1]

17 Two similar claypots have volumes 240 cm^3 and 810 cm^3 respectively.

(a) Find the ratio of the depth of the smaller claypot to that of the larger claypot.

(b) If the base area of the larger claypot is 72 cm^2, find the base area of the smaller claypot.

Answer (*a*) ……………… **:** ……………… [1]

(*b*) ……………………………cm^2 [1]

18 Every morning James takes either the bus or the taxi to school. The probability that he will take the bus is $\frac{2}{3}$. If he takes the bus, the probability of him being late is $\frac{2}{15}$. If he takes the taxi, the probability of him being late is $\frac{3}{5}$. Find

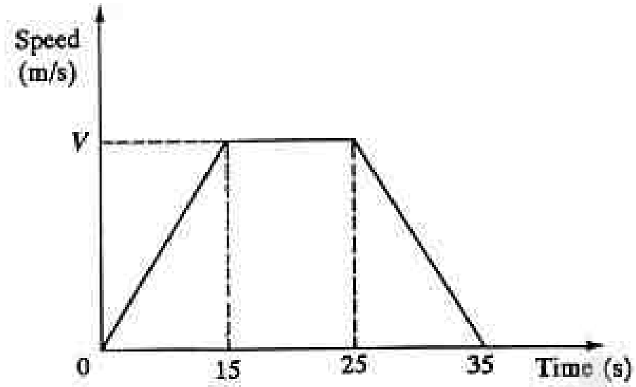
(a) the probability that James will be late on any given day,

(b) the probability that he will not be late for three consecutive days.

Answer (*a*) …………………………………… [2]

(*b*) …………………………………… [2]

19 The diagram shows a speed-time graph of a motorist. Given that the total distance travelled in the 35 seconds is 450 metres.



Calculate

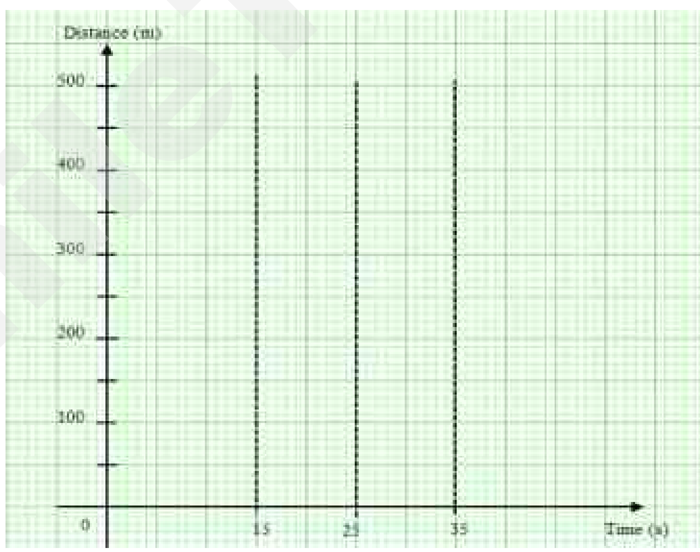
(a) the maximum speed V m/s,

(b) the speed at 28 seconds,

(c) the acceleration of the motorist during the first 15 seconds.

Sketch the distance-time graph of the motorist for the 35 seconds in the spaces provided below.

Answer [2]



Answer (*a*) ……………………………….m/s [2]

(*b*) ……………………………….m/s [2]

(*c*) ……………………………….m/s^2 [1]

20 Given $\mathbf{A} = \begin{pmatrix} -3 & 1 \\ x & -2 \end{pmatrix}$ and $\mathbf{B} = \begin{pmatrix} -2 & y \\ -5 & -3 \end{pmatrix}$,

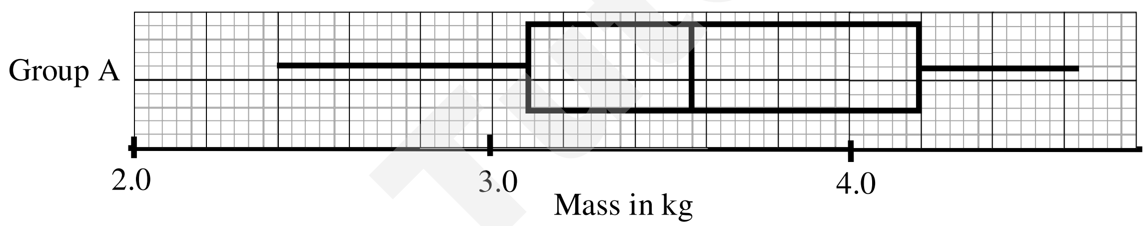
(a) Find **AB** in terms of x and y.

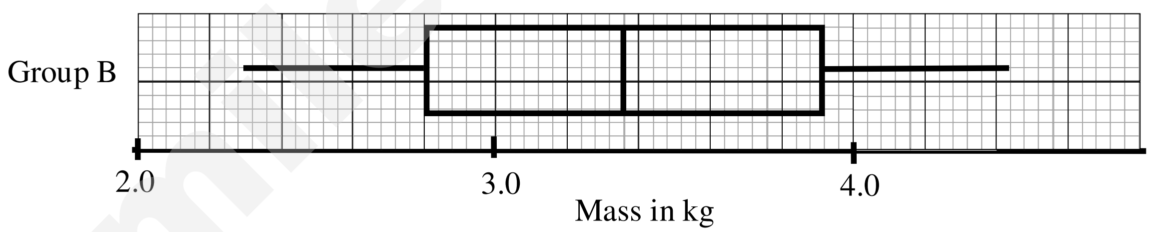
(b) If **AB** = **I**, where **I** is the identity matrix, find the value of x and y.

Answer (*a*) ………………………………....... [1]

(*b*) x =…………… y = ……………..... [2]

21





The box and whisker above represent the mass of the fish caught in a group fishing competition. Compare and comment on the results between Group A and Group B.

Answer ………………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

…………………………………………………………………………………… [2]

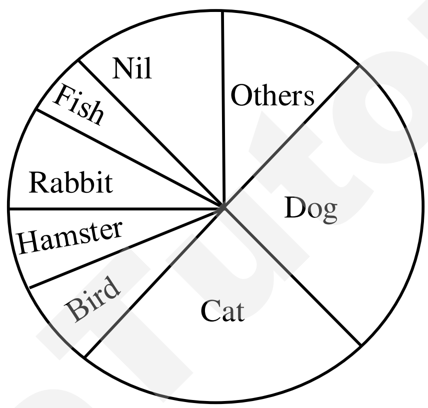
22 A simple survey was conducted with Secondary 1 students on the types of pets that they have at home using the survey form below.

Survey Form

Name: ____________________ Class: __________
Tick the type(s) of pets that you have in your house.
Pets: ☐ Dog ☐ Rabbit ☐ Cat ☐ Hamster
☐ Bird ☐ Fish ☐ Others ☐ Nil

The results from the survey are summarised in the Pie Chart below.

Results



(a) Explain why the Pie Chart is misleading.

(b) Suggest an improvement to better represent the data.

Answer (a) ……………………………………………………………………………………..

……………………………………………………………………………………………

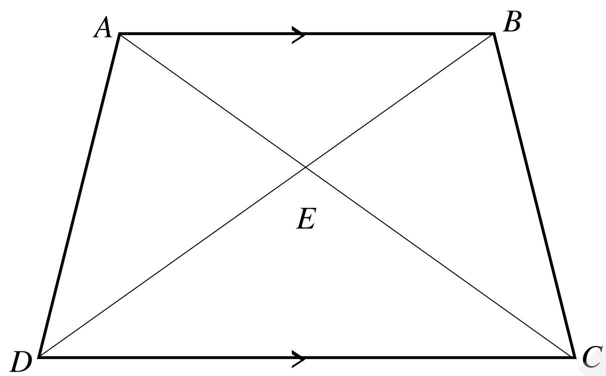
……………………………………………………………………………………………

…………………………………………………………………………………… [1]

(b)……………………………………………………………………………………...

…………………………………………………………………………………… [1]

23 The diagram shows a trapezium $ABCD$ where $AB = 8$ cm and $CD = 12$ cm. The diagonals AC and BD meet at E.



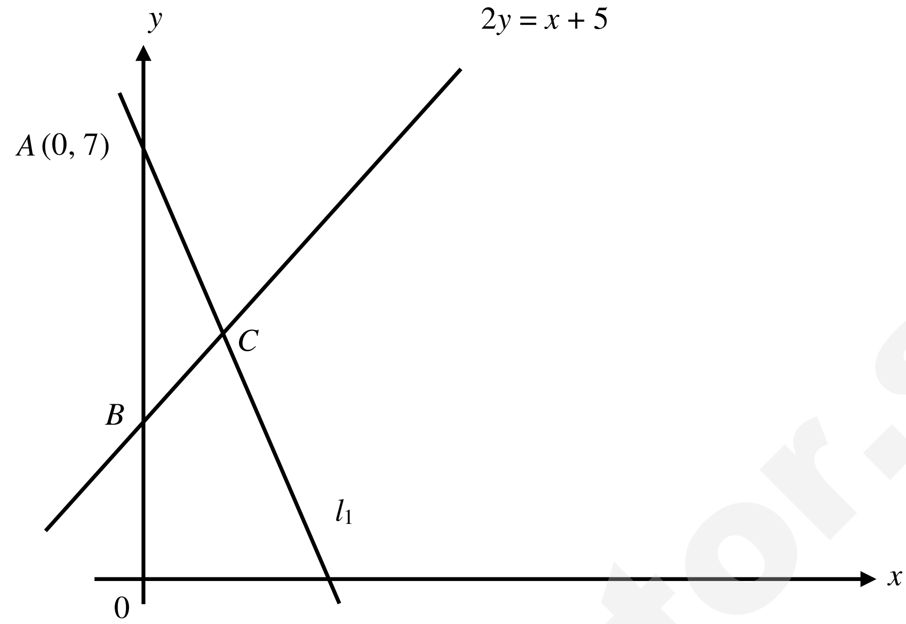
(a) Show that ΔABE and ΔCDE are similar.

(b) Given that the area of ΔCDE is 36 cm^2, find the area of trapezium, $ABCD$.

Answer (a) ……………………………………… [2]

(b) ………………………………………cm^2 [2]

24



The line l_1 meets the line $2y = x + 5$ at $x = 2$.
Find

(a) the equation of l_1,

(b) the area of triangle ABC.

Answer (*a*) ………………………………… [2]

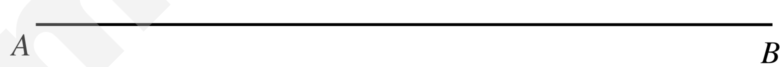
(*b*) ……………………………………units^2 [1]

25 A playground is in the shape of a triangle ABC. Construct the model of the playground ABC such that $AB = 9.6$ cm, $AC = 12$ cm and $BC = 7$ cm. [2]

(a) In the triangle ABC, construct using only compasses and ruler, the bisector of angle ABC. [1]

(b) In the triangle ABC, construct using only compasses and ruler the perpendicular bisector of the line AB. [1]

(c) These two lines will intersect at a point P.
Measure and write down the length of AP.

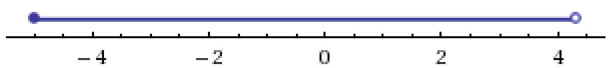


Answer (c) ……..……………………...……cm [1]

End of Paper

No	Solution	Marks
1a	$\dfrac{-13.37^2-\pi^3}{6.574-\sqrt{133.7}}=42.046\approx 42.0$	B1
1b	$3.75\%=\dfrac{3.75}{100}=\dfrac{3}{80}$	B1
2a	$-\dfrac{2a(2+a)}{4-a^2}-\dfrac{a}{a-2}$ $=\dfrac{2a(2+a)}{(a-2)(a+2)}-\dfrac{a}{a-2}$ $=\dfrac{2a}{a-2}-\dfrac{a}{a-2}$ $=\dfrac{a}{a-2}$ Accept $-\dfrac{a}{2-a}$	M1 A1
2b	$2ab+bx^2-b^2-2ax^2$ $=2ab-b^2-2ax^2+bx^2$ $=b(2a-b)-x^2(2a-b)$ $=(b-x^2)(2a-b)$	M1 A1
3a	$2^{2013}\div\dfrac{1}{2^{-2007}}=2^{2013+(-2007)}=2^6$ $k=6$	B1
3b	$\dfrac{12a^{-3}b}{(2bc^0)^{-2}}\div\dfrac{3}{\sqrt{a^6b^{-6}}}=\dfrac{2^2(3)a^{-3}b}{2^{-2}b^{-2}}\times\dfrac{a^3b^{-3}}{3}$ $=2^4a^0b^0=2^4$	B2 (Subtract 1 for each wrong term)
4	$\dfrac{x}{3}-\dfrac{y}{2}=\dfrac{1}{8}$ $2x-3y=\dfrac{3}{4}$ $8x-12y=3----(1)$ $5x-2y+5=0$ $2y=5+5x----(2)$ Subst (2) in (1)	M1

	$8x-6(5+5x)=3$ $8x-30-30x=3$ $22x=-33$ $x=-\frac{33}{22}=-\frac{3}{2}=-1\frac{1}{2}$ $y=-\frac{5}{4}=-1\frac{1}{4}$	A2
5a	$3528=2^3\times3^2\times7^2$	B1
5b	$18144=2^5\times3^4\times7$ HCF = $2^3\times3^2\times7$	B1
5c	$k=2^2\times3\times7=84$	B1
6a	*density* $=\frac{1.7\times10^{11}g}{21m\times21m\times21m}=\frac{1.7\times10^{8}kg}{21m\times21m\times21m}$ $=18356kg/m^3$ $=1.84\times10^4 kg/m^3$	M1 A1
6b	Total value of Gold $=1.7\times10^{11}g\times\$6.2\times10^2/g$ $=\$1.054\times10^{14}$ $=\$105.4\times10^{12}$ $\approx\$1.05\times10^2\,trillion$	M1 A1
7a	$24-(-9.5)=33.5$ $25-(-5)=30$ $23.5-(-11)=34.5$ Largest Difference is 34.5°C Accept 36°C	B1
7b	$25-\frac{x}{3000}\times30=0$ $25-\frac{x}{100}=0$ $x=2500m$	M1 A1
8	$-1-x<\frac{9-7x}{4}$ $-4-4x<9-7x$ $3x<13$ $x<4\frac{1}{3}$	M1

<table>
<tr><td></td><td>$\frac{9-7x}{4} \le 6-x$
$9-7x \le 24-4x$
$-15 \le 3x$
$-5 \le x$
$-5 \le x < 4\frac{1}{3}$
</td><td>

M1

A1</td></tr>
<tr><td>9a</td><td>$2x^2+3x-7 = 2\left(x+\frac{3}{4}\right)^2 - 8\frac{1}{8}$</td><td>B2</td></tr>
<tr><td>bi</td><td>Min value is $-8\frac{1}{8}$</td><td>B1</td></tr>
<tr><td>bii</td><td>x = -2.76556 or 1.26556 ≈ -2.8 or 1.3</td><td>B2</td></tr>
<tr><td>10a</td><td>1cm : 250 000cm
1cm : 2 500m
1cm : 2.5km
3.3cm : 8.25 km

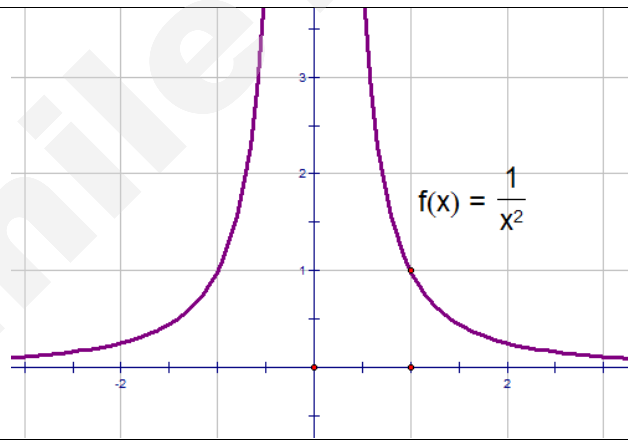
Actual Distance = 8.25km</td><td>B1</td></tr>
<tr><td>10b</td><td>0.4cm : 1km
$0.16cm^2 : 1km^2$
$0.112cm^2 : 0.7\ km^2$

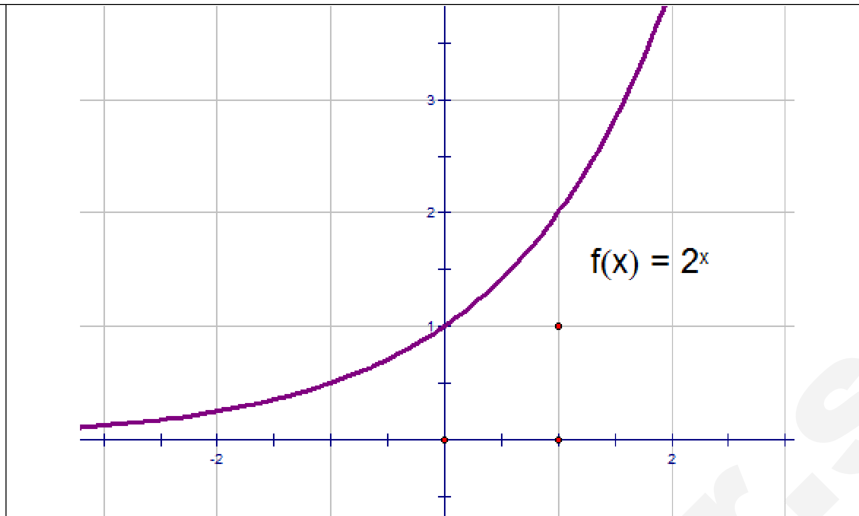
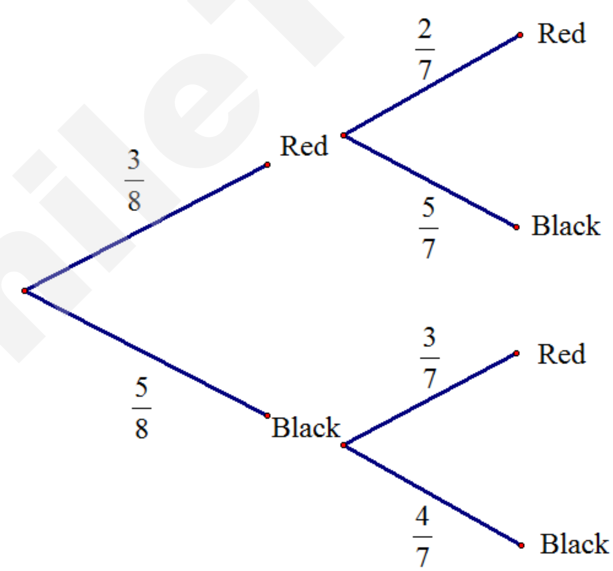
Ans: $0.112cm^2 \approx 0.11cm^2$</td><td>M1

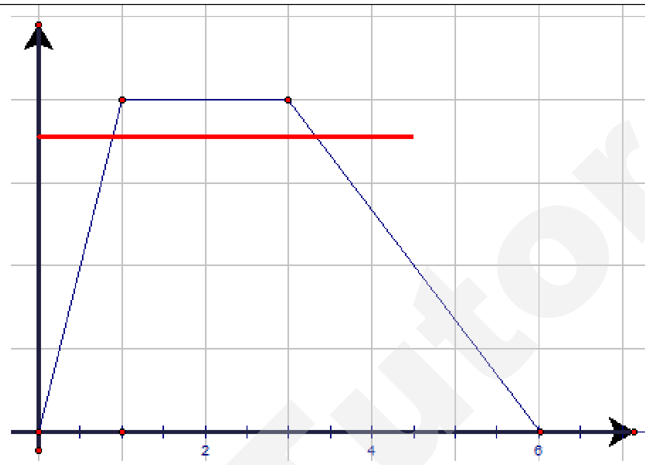
A1</td></tr>
<tr><td>11a</td><td><table><tr><td>Fig</td><td>Area of Shaded Squares, S</td><td>Area of White Squares, W</td><td>Total Area, A</td></tr><tr><td>5</td><td>11</td><td>50</td><td>61</td></tr></table></td><td>B2</td></tr>
<tr><td>11b</td><td><table><tr><td>n</td><td>$2n + 1$</td><td>$2n^2$</td><td>$2n^2 + 2n + 1$</td></tr></table></td><td>B2</td></tr>
<tr><td>12</td><td>Angle ABC = $7x$
Angle BAE = $3x$
Sum of angles of the pentagon
= $3x + 3x + 7x + 7x + 7x$
$27x$ = (5-2)180° = 540°
x = 20°

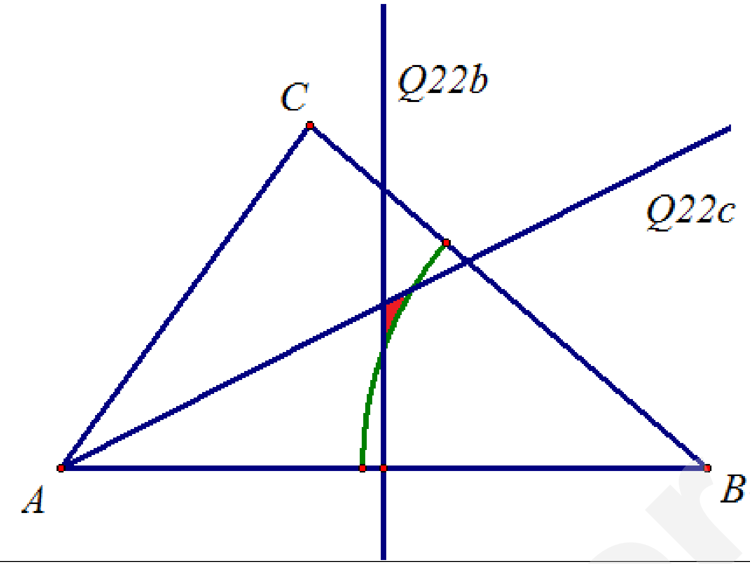
Interior Angle = $7x$ = 140°</td><td>M1

M1</td></tr>
</table>

	$(n\text{-}2)180° = 140°n$ $40°n = 360°$ $n = 9$	A1
13	$P = kT^4$ $6.32 = k(5.6\times10^3)^4$ $k = \dfrac{6.32}{(5.6\times10^3)^4}$ $3.25\times10^{-2} = \dfrac{6.32}{(5.6\times10^3)^4}T^4$ $T^4 = 5.0572962\times10^{12}$ $T = 1499.61 \approx 1.50\times10^3\,K$ Accept 1500K. (3s.f)	M1 for Eqn M1 for k A1
14a	$n(A\cap B) = 28$	B1
14b	$n(A\cup B)' = 0$	B1
14c	$C' = \varnothing$ All students take Additional Mathematics. There are no students who do not take Additional Mathematics.	B1
15a		B1

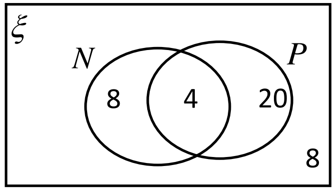
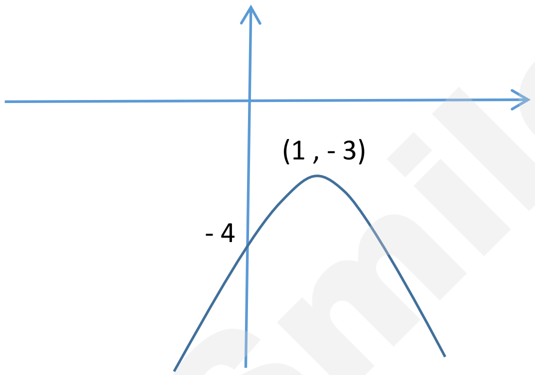
15b		B1 (No double penalty eg. For labelling)
16a	Mode = 36 marks	B1
16b	Median = 29.5 marks	B1
16c	Probability = $\frac{6}{20} \times \frac{1}{4} = \frac{3}{40}$	B2 (1 for boy, 1 for girl)
16d	Disagree. The number of boys (20) and girls (12) are not equal. As there are more boys than girls, the boys interquartile range will naturally be higher and are more spread out. It doesn't imply that they are less consistent.	B1
17a		B2 (Negative Marking)
17b	P(2 Blacks) = $\frac{5}{8} \times \frac{4}{7} = \frac{5}{14}$	B1
17c	P(At least 1 Red) = $1 - \frac{5}{14} = \frac{9}{14}$ P(Win) = $\left(\frac{9}{14}\right)^3 = \frac{729}{2744}$	M1 A1

18a	Acceleration $= \dfrac{80}{(10/60)} = 480 km/h^2$	B1
18b	Speed $= \dfrac{80}{3} = 26\dfrac{2}{3} km/h$	B1
18ci	Total Distance $= \dfrac{1}{2}\left(1+\dfrac{1}{3}\right)80 = 53\dfrac{1}{3} km = \dfrac{160}{3} km$ Speed $= \dfrac{160}{3} \div \dfrac{3}{4} = \dfrac{640}{9} = 71\dfrac{1}{9} km/h$	M1 A1
18cii		B1
19a	$BC = CB$ (Shared length) (S) $\angle ABC = \angle ACB (Given)$ $\angle CBD = \angle BCE (A)$ $AD = AE$ (Isos Triangles) $AB = AC$ (Isos Triangles) $BD = AD - AB = AE - AC = CE$ (S) Therefore BCD and CBE are congruent (SAS)	M1 A1
19b	Triangle ABC and Triangle ADE Triangle BCF and Triangle FDE	B1 B1
20a	$m = \dfrac{3-(-2)}{-2-(-1)}$ $= -5$	M1 A1
20b	$x = 4$	B1
20c	Area $= \dfrac{1}{2} \times 5 \times 5 = 12.5$ units^2	B1
21	Surface Area $= 6 \times (5 \times 5) - \pi(2.5)^2 + 2\pi(2.5)^2$ $= 169.63 \approx 169.6 cm^2$	M2 (Cube & Hemisphere) A1

22		B1 for pt C B1 for Perpendicular Bisector B1 for Angle Bisector B1 for Arc around B B1 for region & Coordinate X

Qn	Solution	Marks	Marker's Report
1(a)	-168	B1	Most students were able to get this question correct.
1(b)	$\frac{3}{2000}$	B1	Most students were able to get this question correct.
2(a)	$=\frac{3(x+1)+2(2(4-x)}{2(5-x)(x+1)}$ $=\frac{x+1}{2(5-x)(x+1)}$	M1 A1	Do not accept half factorisation Eg: $\frac{x+1}{(10-2x)(x+1)}$
2(b)	$\$(\frac{px}{10}-y)$	B1	Most students were not able to do this question.
3(a)	$36-4w=2-3w$ $w=34$	M1 A1	Most students were able to get this question correct.
3(b)	$=\frac{2ab^2}{2^{-2}b^{-2}}\times\frac{a^{\frac{1}{2}}b}{2^3}$ $=a^{\frac{3}{2}}b^5$	M1 A1	Most students were able to get this question correct.
4	$2x = 1 - 3y$ $x = 0$ $y = 1/3$	M1 A1 A1	Most students were able to get this question correct.
5(a)	$4410 = 2 \times 3^2 \times 5 \times 7^2$	B1	Most students were able to get this question correct.
5(b)	HCF = $2 \times 3^2 \times 7$	B1	Some students did not leave the answer in index prime notation.
5(c)	K = 36	B1	Some students were not able to do this question.
6(a)	Number of minutes = 15/135 x 55 $= 6\frac{1}{9}$	M1 A1	Do not accept 3sf or improper fraction. Quite a number of students took the temperature starting from 0^oC instead of -15^oC
6(b)	Temperature = 8/15 x 135 -15 = 57	M1 A1	Quite a number of students took the change in temperature as 120^oC instead of 135^oC
7(a)	42.5	B1	Some students do not understand the question

7(b)	Greatest difference = 61.5 – 42.5 = 19	A1	Most students were not able to do this question. Some students did not realise that $61.4\dot{9} = 61.5$. Many students got the answer by rounding up 18.9999 to 3 sf. BOD was given as the question was poorly answered.
8(a)	Area ratio = 9 cm^2 : 40000 m^2 = 9/20 cm^2 : 2000 m^2	M1 A1	Some students were not able to convert km^2 to m^2
8(b)	Length ratio = 3 cm : 0.2 km = 7.8 cm : 0.52	M1 A1	Well answered.
9	Actual selling price = $\frac{86\times1.25}{0.7}$ = $153.57	M1 A1	Some students were not able to differentiate the old selling price with the discounted selling price.
10(a)	$2\frac{2}{9}$	B1	Do not accept 3sf or improper fraction.
10(b)	Average speed = $\frac{(20+0.8)\times1000}{\frac{20}{8}\times3600+15\times60+3.4\times60}$ = $2\frac{74}{1263}$	M1 A1	Do not accept 3sf or improper fraction.
11	60 + 15(n-1) = 360 n = 21	M1 A1	Poorly answered.
12	$y_{new} = \frac{k}{0.6\sqrt{x}}$ = 5	M1 A1	Need to emphasize on "reduced **to** 36%" and "reduced **by** 36%" -1 if students substitute values into x/y to calculate
13(a)	5:2	B1	Do not accept 2.5:1
13(b)	Percentage change = $\frac{0.5x(1.7y)-xy}{xy}\times100\%$ = - 15%	M1 A1	Quite a number of students give 15% as answer as they thought percentage change do not have negative sign.

14(a)	BC = 6 cm	B1	Well answered.
14(b)	Cos ACD = -0.6	B1	Well answered.
14(c)	Area = 0.5 x 10 x 3 sin ACD = 12	B1	Well answered.
15(a)		B2	Poorly answered. Students were not able to find the number of students that join NPCC and NCC.
15(b)(i)	There are malay students from the class that join NCC.	B1	Some students were not able to interpret the set notation.
15(b)(ii)	All the indian students from the class joined NCC.	B1	Well answered.
15(b)(iii)	C n (N U P)'	B1	Poorly answered.
16(a)	$-(x-1)^2 - 3$	B1	Most students able to complete the square.
16(b)		B2	1m for shape 1m for turning point and y-intercept Poorly answered. Students were not able to identify the turning point and some were struggling to find the x-intercept.
17(a)	2:3	B1	Well answered.
17(b)	32	B1	Well answered.
18(a)	P(late) = $\frac{2}{3}\left(\frac{2}{15}\right)+\frac{1}{3}\left(\frac{3}{5}\right)$	M1	Well answered.

	$= \frac{13}{45}$	A1	
18(b)	P(not late for 3 consecutive days) = $\left(1-\frac{13}{45}\right)^3$ $= \frac{32768}{91125}$	M1 A1	Do not accept 3sf. Poorly answered. Many students wrote probability more than 1. Some just multiply the P(not late) by 3.
19(a)	V = $\frac{450}{0.5(10+35)}$ = 20	M1 A1	Well answered.
19(b)	$\frac{v}{20} = \frac{7}{10}$ $v = 14$	M1 A1	Well answered.
19(c)	Acceleration = $1\frac{1}{3}$ ms^{-2}	B1	Do not accept 3sf and improper fraction.
		B2	1M for shapes 1M for Distance 150m, 350m and 450m.

20(a)	$\begin{pmatrix} 1 & -3-3y \\ 10-2x & xy+6 \end{pmatrix}$	B1	Poorly answered. Many students make careless mistakes.
20(b)	x = 5 y = -1	A2	0 m for those who got their answer from wrong working
21	Generally, the mass of the fish caught by Group A is heavier than the mass of the fish caught by Group B because Group A median is higher than Group B. The mass of the fish caught by Group B is more wide spread compared to the mass of the fish caught by Group A because the interquartile range for Group B is higher than Group A.	B1 B1	Students need to be more specific in explaining.
22(a)	Some students might have more than 1 type of pets.	B1	Poorly answered.
22(b)	Venn Diagram	B1	Poorly answered.
23(a)	$\angle$AEB = $\angle$CED (vert. opp) $\angle$EBA = $\angle$EDC (alt $\angle$, AB parallel DC) $\angle$EAB = $\angle$ECD (alt $\angle$, AB parallel DC)	B2	Any two reasons. Well answered.
23(b)	Height of trapezium = $\frac{36}{0.5\times12}+\frac{8}{12}\times\frac{36}{0.5\times12}$ = 10 Area of trapezium = 0.5(8 + 12)(10) = 100	M1 A1	Some students used length ratio to find the area of triangle ABE.
24(a)	Gradient = -1.75 y = -1.75x + 7	M1 A1	Well answered.
24(b)	Area of triangle = 4.5	B1	Do not accept improper. Well answered.
25			Poorly answered. Students need to learn how to construct a triangle, perpendicular bisector and angle bisector.

Candidate Name: ____________________ Class ______ Index No. ______

FUHUA SECONDARY SCHOOL

Secondary Four Express & Five Normal Academic

Preliminary Examination 2016

4E/5N

MATHEMATICS 4016/02
PAPER 2 4048/02

Additional Materials:
Writing paper, Graph paper & Electronic calculator

DATE 25 August 2016
TIME 0750 – 1020
DURATION 2 h 30 min

INSTRUCTIONS TO CANDIDATES

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer all the questions.
Write your answers on the separate writing paper provided.
Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.
The use of an electronic calculator is expected, where appropriate.
You are reminded of the need for clear presentation in your answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 100.

PARENT'S SIGNATURE	FOR EXAMINER'S USE	
		/ 100

This question paper consists of 12 printed pages including this page.

[Turn Over

MATHEMATICAL FORMULAE

Compound Interest

$$\text{Total amount} = P(1+\frac{r}{100})^n$$

Mensuration

$$\text{Curved surface area of cone} = \pi rl$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of sphere} = \frac{4}{}$$

Area of triangle ABC

Arc length = $r\theta$, w

Sector area = $\frac{1}{}$ ans

Trigonometry

$$\frac{c}{\sin C}$$

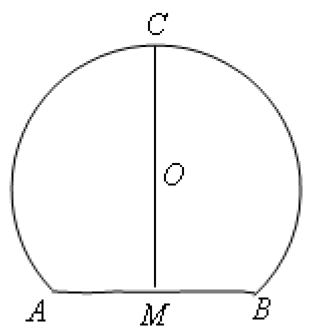
$$^2 - 2bc\cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard Deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

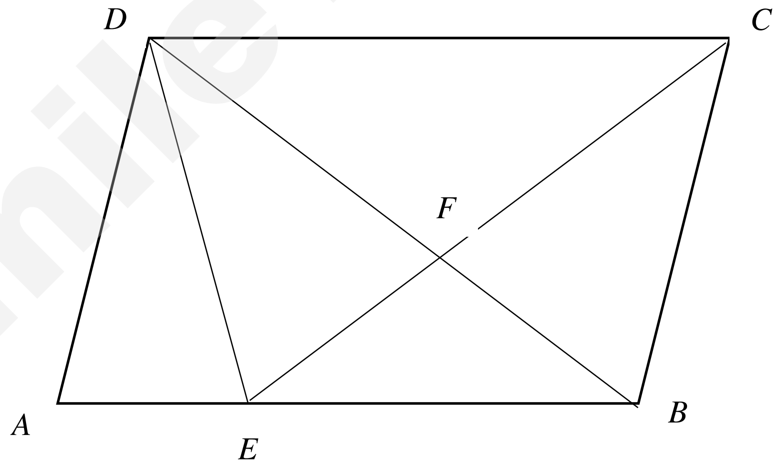
1 **(a)** The diagram below shows a segment *AMBC* of a circle centre *O* with diameter 86 cm. Given that CM = 68 cm, find the area of the segment. [4]



(b) In the diagram given below, *ABCD* is a parallelogram and *E* is a point on *AB* such that $DA = DE$. The lines *BD* and *EC* intersect at *F*. Prove that

(i) $\Delta DEC \equiv \Delta CBD$, [3]

(ii) $\Delta DEF \equiv \Delta CBF$. [2]



[Turn over

2 **(i)** Johnny borrowed \$50 000 from Joyful Bank to pay for the renovation of his new flat. The bank offered him two interest schemes.

Scheme A:

Year	Interest Rate (% per annum)
1	1.5
2	2
3 onwards	2.5

The interest would be computed on the original principal amount.

Scheme B:

The interest is computed on the amount owed at the beginning of the year at 2% per annum.

If Johnny clears the loan at the end of 5 years, which scheme should he take up? Justify your answer with working. [5]

(ii) The tables below show the exchange rates between Singapore dollars (SGD) and US dollars (USD) given by Unity Bank and Dedicated Bank.

Unity Bank

	Singapore Dollars (SGD)	
US Dollars (USD)	Selling	Buying
USD 1	1.342	1.327

Dedicated Bank

	Singapore Dollars (SGD)	
US Dollars (USD)	Selling	Buying
USD 1	1.361	1.340

Unity Bank charges no commission and Dedicated Bank charges a commission of $\frac{1}{2}\%$ for each transaction, subject to a minimum charge of S$12.

(a) Mary is planning a trip to US and wants to buy USD650. Calculate, in SGD, the least amount of money she needs so that she can buy the USD from either bank. [3]

(b) At the end of the trip, she went to Dedicated Bank and changed the remaining USD150 back to Singapore dollars. Calculate the amount of Singapore dollars she received. [2]

[Turn over

3 **(a)** The coordinates of points A and B are (6, 2) and $(-3, 8)$ respectively.

(i) Find $\left|\overrightarrow{AB}\right|$. [2]

(ii) Given that $\overrightarrow{BC} = \begin{pmatrix} 5 \\ -7 \end{pmatrix}$, express $\overrightarrow{OC}$ as a column vector. [1]

(iii) If $\overrightarrow{AD} = \begin{pmatrix} -7 \\ 1 \end{pmatrix}$, name the quadrilateral $ABDC$.

Justify your answer using vectors. [3]

(b) The following table shows the number of boxes of ice-cream bought by April and May.

	Chocolate	Strawberry	Vanilla
April	5	8	3
May	6	4	5

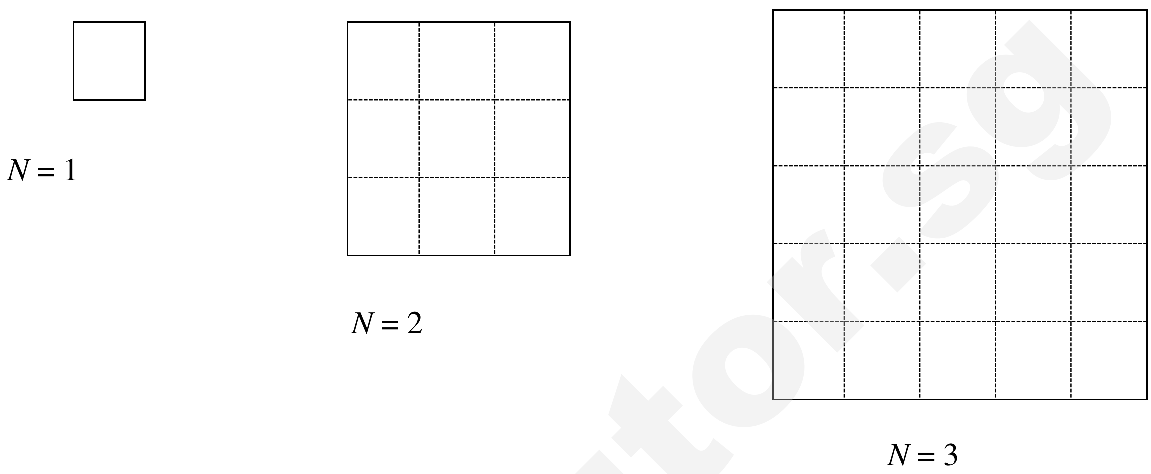
The price of each box of chocolate, strawberry and vanilla ice-cream is \$9.80, \$6.20 and \$8 respectively.

(i) Represent the data in the table by a 2×3 matrix **P**. [1]

(ii) Write down a matrix **Q** such that **PQ** will give the amount spent by April and May respectively. Evaluate **PQ**. Explain what the elements in **PQ** represent. [3]

(iii) Write down another matrix such that the product with **PQ** will give the total amount spent by both of them. Evaluate this product. [2]

4 Matchsticks are used to form shapes of squares. The table below shows the square number (N), the number of matchsticks on each side (n), the total number of matchsticks used to form the square (T) and the area of the square formed (A).



Square number (N)	1	2	3	…	9
No. of matchsticks per side (n)	1	3	5	…	p
Total number of matchsticks (T)	4	12	20	…	q
Area (A) units^2	1	9	25	…	r

(i) Write down the value of p, of q and of r. [2]

(ii) Express n, T and A in terms of N. [3]

(iii) Find the value of N if $A = 169$ units^2. [2]

(iv) Find the largest possible area of the square that can be formed with 168 matchsticks. [3]

[Turn over

5 **(a)** **(i)** Factorise $6x^2+22x-40$. [2]

(ii) Hence, find the value(s) of $2a-2b$ given

$3a^2+3b^2+11a-11b-6ab-20=0$ and $a<b$. [3]

(b) **(i)** Express $\dfrac{4x-2}{x+1}-\dfrac{6x+12}{2x^2-2}$ as a single fraction in its simplest form. [3]

(ii) Using the result in **(b) (i)**, solve $\dfrac{2x-1}{x+1}-\dfrac{3x+6}{2x^2-2}=3$, giving your answers correct to two decimal places. [4]

---

6 The diagram below shows a circle with diameter *BD* passing through the points *A*, *B*, *C* and *D*. *AT* and *BT* are tangents to the circle at *A* and *B* respectively. *BD* and *AC* intersect at *X*. Given that $\angle BAC = 55°$ and $\angle ABC = 75°$,

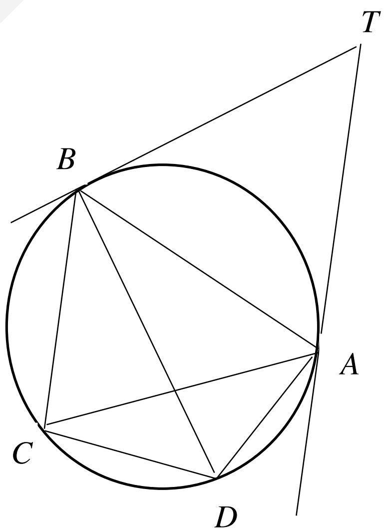
(a) calculate, stating your reasons clearly,

(i) $\angle CBX$, [2]

(ii) $\angle ADC$, [1]

(iii) $\angle ATB$. [3]

(b) Find the diameter of the circle given that *BT* = 8 cm. [2]



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7 **Answer the whole of this question on a sheet of graph paper.**

The value of car, currently estimated at \$140 000, depreciates at 15% each year.

The value of the car, \$$V$, in terms of n, is given by $V = 140000(0.85)^n$ where n is the number of years from now.

The table below shows some corresponding values of n and V where values of V are corrected to the nearest whole number.

n	0	1	2	3	4	5	6	7
V	140000	119000	101150	85977	p	62119	q	44881

(a) Find the value of p and of q. [1]

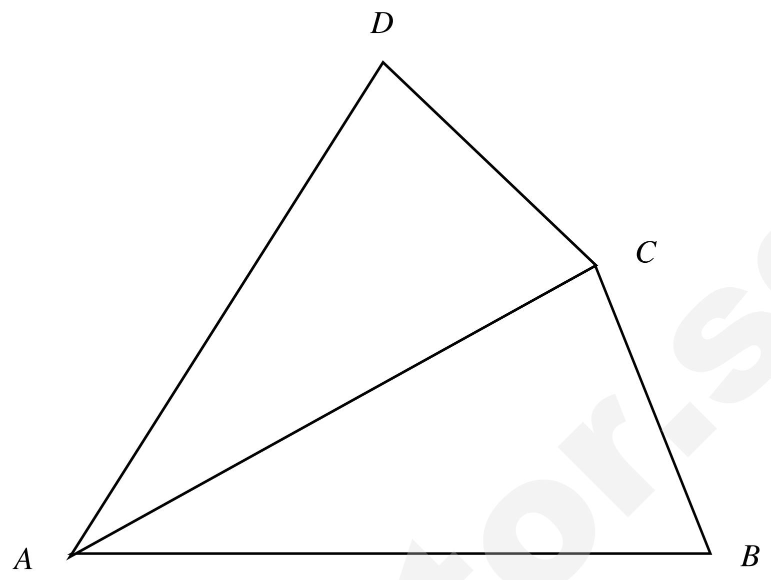
(b) Using a scale of 2 cm to 1 year, draw a horizontal axis for $0 \le n \le 7$ and a scale of 2 cm to \$10 000, draw a vertical axis for $40000 \le V \le 140000$. On your axis, plot the points and join them with a smooth curve. [3]

(c) The owner decides to sell his car if the cost incurred is not more than 40% of the original value. Use your graph to estimate the value of n when he can sell his car. [2]

(d) By drawing a tangent, find the gradient of the curve at $n = 2$. Explain the significance of this gradient. [3]

[Turn over

8 In the diagram below, A, B, C and D are four points on level ground with A due west of B.



Given that $AC = 50$ m, $CD = 30$ m, $AD = 70$ m, $\angle CAB = 50°$ and $\angle ABC = 60°$, calculate

(a) **(i)** the length of AB, [2]

(ii) $\angle CAD$, [2]

(iii) bearing of D from A. [1]

(b) A vertical building of height 30 m is at A. A man of height 1.75 m walks from D to C. Find the largest angle of depression from the top of the building to the top of the man's head. [3]

(c) A boy walks due east from A until he reaches a point P which is equidistant from B and from C. Calculate the distance of PB. [3]

[Turn over

9 The Mathematics test scores of 25 students are presented in the following stem-and-leaf diagram.

Stem	**Leaf**
4	*s* 5 5 6
5	0 1 2 4 6 6 8
6	0 1 3 4 6 7 8 9
7	0 1 1 1 2
8	2

Legend: 4 | 5 means 45 marks

(a) Find the value of s given that the range is 39. [1]

(b) Find the median mark. [1]

(c) A Distinction grade is awarded for students who score x marks and above.

Given that 20% of the students obtained a Distinction grade, find x. [2]

(d) Find the mean and standard deviation of the test scores. [3]

(e) A moderation is to be done and 4 marks are to be added across all scores.

Explain how the median and standard deviation of the marks would be affected by the moderation. [2]

(f) Two students are chosen at random. Find the probability that both students have obtained different scores in the test. [2]

[Turn over

10 Figure 1 shows a simplified model of a trophy consisting a sphere, a bifrustum and two cylinders. A bifrustum is made up of two frustums. Each frustum is made by slicing the top off a right circular cone as shown in Figure 2.

The cylindrical bases are made of oak and the bifrustum and sphere are made of teak.

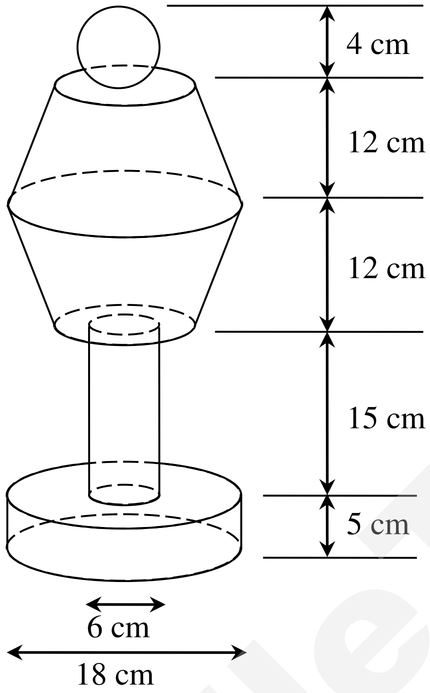


Fig 1

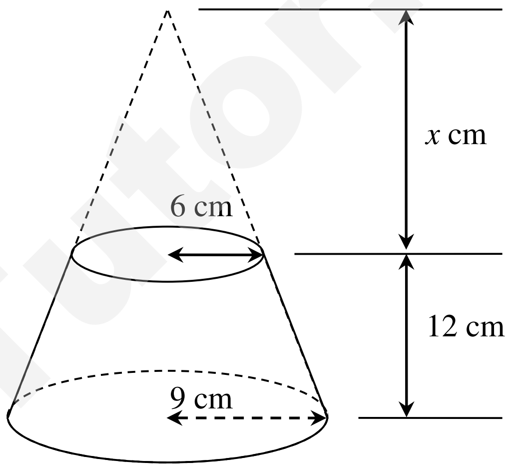


Fig 2

(i) Calculate the amount of teak needed to make a frustum. [3]

(ii) The trophy will be unstable if the mass of the bifrustum and the sphere is 10% greater than the mass of the cylindrical bases. Given that the densities of oak and teak are 2.7 g/cm^3 and 0.63 g/cm^3 respectively, will the trophy be unstable? Justify your answer with calculations. [5]

End of paper

Answers

1 (a) 4930 cm^2 (b) (i) SAS test (ii) ASA test

2 (i) Scheme B because the total amount payable is lesser than that of Scheme A

(ii) (a) SGD 896.65 (b) SGD 189

3 (a) (i) 10.8 units (ii) $\begin{pmatrix} 2 \\ 1 \end{pmatrix}$ (iii) Trapezium

(b) (i) $P = \begin{pmatrix} 5 & 8 & 3 \\ 6 & 4 & 5 \end{pmatrix}$ (ii) $Q = \begin{pmatrix} 9.80 \\ 6.20 \\ 8 \end{pmatrix}$, $PQ = \begin{pmatrix} 122.60 \\ 123.60 \end{pmatrix}$

(iii) $\begin{pmatrix} 1 & 1 \end{pmatrix}$, $\begin{pmatrix} 1 & 1 \end{pmatrix}\begin{pmatrix} 122.60 \\ 123.60 \end{pmatrix} = \begin{pmatrix} 246.20 \end{pmatrix}$

4 (i) $p = 17$, $q = 68$, $r = 289$

(ii) $n = 2N - 1$, $T = 4(2N - 1)$, $A = (2N - 1)^2$ (iii) $N = 7$

(iv) 1681 units^2

5 (a) (i) $2(3x - 4)(x + 5)$ (ii) -10

(b) (i) $\dfrac{4x^2 - 9x - 4}{x^2 - 1}$ (ii) 0.21 or - 4.71

6 (a) (i) 35° (ii) 105° (iii) 80° (b) 13.4 cm

7 (a) p = 73 081 (nearest whole number), q = 52 801 (nearest whole number)

(c) $0 < n < 3.2$ (d) -16250

8	(a)	(i)	54.3 m	(ii)	21.8°	(iii)	018.2°
	(b)	33.1°		(c)	44.2 m		

9 (a) 3 (b) 61 marks (c) 71

(d) Mean = 60.44 marks, standard deviation = 10.2 marks

(e) Median will increase by 4, no change in standard deviation

(f) $\frac{59}{60}$

10 (a) 2150 m^3 (b) It will not be unstable.

Marking Scheme [EM P2]

1 (a) Let the midpoint of AB be M.

$AO = BO = 43$ cm, $OM = 25$ cm

$$\cos\left(\frac{1}{2}\angle AOB\right) = \frac{25}{43}$$

$\angle AOB = 108.902°$ (to 3 dec pl) -- M1 [find angle]

Area of $\Delta AOB = \frac{1}{2}(43)^2 \times \sin 108.902°$

$= 874.6427$ cm^2 (7 sf) – M1 [find area of triangle]

Area of segment = $874.6427 + \frac{360° - 108.902°}{360°} \times \pi(43)^2$ -- M1 [find total]

$= 4926.25\ldots$CBD

$= 4930$ cm^2 (3 sf) -- A1 [final answer with units]

(b) (i) Given that $ABCD$ is a parallelogram, $DA = CB$.

Given $DA = DE$, therefore $CB = DE$. – M1

$\angle DAB = \angle BCD$ (opposite angles of parallelogram)

$\angle DAB = \angle EDC$ ($\Delta DAB \equiv \Delta EDC$)

$\therefore \angle BCD = \angle EDC$ -- M1

In ΔDEC and ΔCBD,

$CB = DE$ (S)

$\angle BCD = \angle EDC$ (A)

$DC = CD$ (common) (S)

$\therefore \Delta DEC \equiv \Delta CBD$ (SAS) -- M1

(ii) In ΔDEF and ΔCBF,

DE = CB (from bi) (S)

$\angle DFE = \angle CFB$ (vertically opposite angles) (A)

$\angle DEF = \angle CBF \quad \Rightarrow \angle EDF = \angle BCF$ (A)

$\therefore \Delta DEF \equiv \Delta CBF$ (ASA) -- M2

2 (i) Scheme A:

Interest at the end of year 1 = $\frac{1.5}{100} \times 50000 = \$750$

Interest at the end of year 2 = $\frac{2}{100} \times 50000 = \$1000$

Total amount payable = $\$50000 + 5000 \times 3 \times \frac{2.5}{100} + 750 + 1000$ -- M1

= \$ 55500 -- A1

Scheme B:

Total amount payable = $50000 \times \left(1 + \frac{2}{100}\right)^5$

= \$ 55 204.04 (2dp) -- B1

He should take up Scheme B because the total amount payable at the end of 5 years is lesser than that of Scheme A. – A2

(ii) (a) Unity Bank:

Amount needed = SGD 650×1.342

= SGD 872.30 -- B1

Dedicated Bank:

Amount needed without commission = SGD 650×1.361

= SGD 884.65

0.5% of SGD 884.65 = SGD 4.42 (< SGD 12) --

Total amount needed = SGD 884.65 + SGD 12 = SGD896.65 -- M1

Thus, the least amount needed = SGD 896.65 -- A1

(b) Amount received = SGD $150 \times 1.340 - 12$ -- M1

= SGD 189 -- A1

3 (a) (i) $\overrightarrow{OA} = \begin{pmatrix} 6 \\ 2 \end{pmatrix}$, $\overrightarrow{OB} = \begin{pmatrix} -3 \\ 8 \end{pmatrix}$, $\overrightarrow{AB} = \begin{pmatrix} -9 \\ 6 \end{pmatrix}$

$\left|\overrightarrow{AB}\right| = \sqrt{(-9)^2 + 6^2} = \sqrt{117}$ -- M1

= 10.8 units (to 3 sf) -- A1

(ii) $\overrightarrow{BC} = \begin{pmatrix} 5 \\ -7 \end{pmatrix}$

$\overrightarrow{BO} + \overrightarrow{OC} = \begin{pmatrix} 5 \\ -7 \end{pmatrix}$

$\overrightarrow{OC} = \begin{pmatrix} 5 \\ -7 \end{pmatrix} - \begin{pmatrix} 3 \\ -8 \end{pmatrix}$

$= \begin{pmatrix} 2 \\ 1 \end{pmatrix}$ -- B1

(iii) $\overrightarrow{OD} = \begin{pmatrix} -1 \\ 3 \end{pmatrix}$, $\overrightarrow{CD} = \begin{pmatrix} -3 \\ 2 \end{pmatrix}$

Since $\overrightarrow{AB} = 3\,\overrightarrow{CD}$, so AB // CD. – M1

$\overrightarrow{BD} = \begin{pmatrix} 2 \\ -5 \end{pmatrix}$, $\overrightarrow{AC} = \begin{pmatrix} -4 \\ -1 \end{pmatrix}$ -- M1

Since $\overrightarrow{BD} \neq k\overrightarrow{AC}$, where k is a constant, so BD is not parallel to AC.

Given that there is only one pair of parallel sides, $ABCD$ is a trapezium. – A1

(b) (i) $P = \begin{pmatrix} 5 & 8 & 3 \\ 6 & 4 & 5 \end{pmatrix}$ -- B1

(ii) $Q = \begin{pmatrix} 9.80 \\ 6.20 \\ 8 \end{pmatrix}$ -- B1 and $PQ = \begin{pmatrix} 122.60 \\ 123.60 \end{pmatrix}$ -- B1

(iii) Matrix is $\begin{pmatrix} 1 & 1 \end{pmatrix}$. – B1

Product = $\begin{pmatrix} 1 & 1 \end{pmatrix}\begin{pmatrix} 122.60 \\ 123.60 \end{pmatrix} = \begin{pmatrix} 246.20 \end{pmatrix}$ -- B1

The total amount spent on the three types of ice-cream by April and May respectively.

4 (i) $p = 17$, $q = 68$, $r = 289$ -- B2 for 3 correct, B1 for 2 correct

(ii) $n = 2N - 1$ -- B1

$T = 4(2N - 1)$ -- B1

$A = (2N - 1)^2$ -- B1

(iii) If $A = 169$, $(2N - 1)^2 = 169$

$2N - 1 = \pm 13$ -- M1

$N = 7$ or $N = -6$ (rejected) -- A1

(iv) $4(2N - 1) \leq 168$ -- M1

$2N - 1 \leq 42$

$2N \leq 43$

$N \leq 21.5$ -- A1

Largest possible value of $N = 21$

Hence, largest possible area = 1681 units^2 -- A1

5 (a) (i) $6x^2 + 22x - 40 = 2(3x - 4)(x + 5)$ -- B2

(ii) $3a^2 + 3b^2 + 11a - 11b - 6ab - 20 = 0$

$6(a^2 - 2ab + b^2) + 22(a - b) - 40 = 0$ -- M1

$6(a - b)^2 + 22(a - b) - 40 = 0$

$2[3(a - b) - 4][(a - b) + 5] = 0$

$a - b = \frac{4}{3}$ (rejected) or $a - b = -5$ -- A1

Hence, $2a - 2b = 2(a - b) = 2(-5) = -10$ -- A1

(b) (i) $$\frac{4x-2}{x+1}-\frac{6x+12}{2x^2-2}=\frac{4x-2}{x+1}-\frac{6(x+2)}{2(x+1)(x-1)}$$ -- M1 [factorisation]

$$=\frac{(4x-2)(x-1)-3(x+2)}{(x+1)(x-1)}$$

$$=\frac{4x^2-6x+2-3x-6}{x^2-1}$$ -- M1 [simplification]

$$=\frac{4x^2-9x-4}{x^2-1}$$ -- A1 [answer]

(ii) $$\frac{2x-1}{x+1}-\frac{3x+6}{2x^2-2}=3$$

$$2\left(\frac{2x-1}{x+1}-\frac{3x+6}{2x^2-2}\right)=6$$

$$\frac{4x^2-9x-4}{x^2-1}=6$$ -- M1

$$4x^2-9x-4=6x^2-6$$

$$2x^2+9x-2=0$$ -- M1

$$x=\frac{-9\pm\sqrt{9^2-4(2)(-2)}}{2(2)}$$ -- M1

$= 0.21$ or -4.71 (answers to 2 dp) -- A1

6 (a) (i) $\angle BAD = 90°$ (angle in semi-circle)

$\angle CAD = 90° - 55° = 35°$ -- M1

$\angle CBX = \angle CAD$ (angles in same segment)

$= 35°$ – A1

(ii) $\angle ADC = 180° - 75°$ (angles in opposite segment)

$= 105°$ -- A1

(iii) $\angle ABD = 75° - 35° = 40°$

$\angle DBT = 90°$ (tangent perpendicular to radius) -- M1

$\therefore \angle ABT = 90° - 40° = 50°$ -- M1

$\angle ATB = 180° - 2(50°)$ (angles sum of triangle)

$= 80°$ -- A1

(b) $\tan 40° = \frac{OB}{8}$

$OB = 8 \tan 40°$

Diameter = $2(8 \tan 40°)$ -- M1

= 13.4 cm (to 3 sf) -- A1

7 (a) p = 73 081 (nearest whole number), q = 52 801 (nearest whole number) – B1

(b) Graph – Plotted points A1

Smooth curve A1

Axes + Eqn + Scale A1

(c) $V \geq \frac{60}{100} \times 140000$

$V \geq 84\ 000$ -- M1

From graph, $0 \leq n \leq 3.2$ -- A1

(d) Gradient = $\frac{125000 - 60000}{0.5 - 4.5} = -16250$ -- M1 + A1

The value of the car is depreciating at a rate of \$16 250 at $n = 2$. – A1

[The rate of depreciation of the car at n = 2.]

8 (a) (i) $\angle ACB = 180° - 50° - 60°$ (angles sum of triangle)

$= 70°$

$\frac{AB}{\sin 70°} = \frac{50}{\sin 60°}$ -- M1

$AB = \frac{50}{\sin 60°} \times \sin 70° = 54.25317\ldots$

$= 54.3$ m (to 3 sf) -- A1

(ii) $30^2 = 50^2 + 70^2 - 2(50)(70)\cos \angle CAD$ -- M1

$\cos \angle CAD = \frac{-6500}{-7000}$

$\angle CAD = \cos^{-1}\left(\frac{13}{14}\right) = 21.7867\ldots$

$= 21.8°$ (to 1 dp) -- A1

(iii) Bearing of D from A = $090° - 050° - 021.7867°$

$= 018.2°$ (to 1 dp) -- A1

(b) Let the shortest distance from A to CD be x.

$\frac{1}{2}(30)x = \frac{1}{5}(50)(70)\sin 21.7867°$

$x = 43.3011$ (to 6sf) -- M1

Let the largest angle of depression be θ.

$\tan\theta = \frac{30 - 1.75}{43.3011}$ -- M1

$\theta = 33.1°$ (to 1 dp) -- A1

The largest angle of depression is 33.1°.

(c) Triangle *BCP* is an equilateral triangle.

$\angle APC = 180° - 60°$ (angles on a straight line)

$= 120°$

$\frac{AP}{\sin 10°} = \frac{50}{\sin 120°}$ -- M1

$AP = 10.02558$ m (to 7 sf) -- A1

$PB = 54.25317 - 10.02558$

$= 44.2$ m (to 3 sf) -- A1

9 (a) Lowest score = 82 – 39 = 43

So, $s = 3$ -- B1

(b) Median = 61 marks -- B1

(c) Number of students awarded Distinction = $\frac{20}{100} \times 25 = 5$ -- M1

So, $x = 71$ -- A1

(d) Mean = $\frac{1511}{25} = 60.44$ marks -- B1

Standard Deviation = $\sqrt{\frac{93919}{25} - 60.44^2}$ -- M1

= 10.2 marks (to 3 sf) -- A1

(e) The median will increase by 4 marks to become 65 marks. – A1

There will be no change in the standard deviation. – A1

(f) P (both with different scores)

= 1 – P (both with same scores)

= 1 – [P (45, 45) + P (56, 56) + P (71, 71)]

$= 1 - \frac{2}{25} \times \frac{1}{24} - \frac{2}{25} \times \frac{1}{24} - \frac{3}{25} \times \frac{2}{24}$ -- M1

$= \frac{59}{60}$ -- A1

10 (a) By similar triangles,

$$\frac{x}{x+12}=\frac{6}{9}$$

$$9x=6x+72$$

$$3x=72$$

$x=24$ -- M1

Volume of teak used = $\frac{1}{3}\pi(9)^2(36)-\frac{1}{3}\pi(6)^2(24)$ -- M1

= 2148.849 cm^3 (7 sf)

= 2150 cm^3 (to 3 sf) -- A1

(b) Total volume of teak needed = $2\times 2148.849+\frac{4}{3}\pi(2)^3$

= 4331.208 cm^3 (7 sf)

Mass of teak needed = $4331.208\times 0.63=2728.661g$ (7 sf) -- M1

Total volume of oak needed = $\pi(3)^2(15)+\pi(9)^2(5)$

= 1696.46 cm^3 (to 6 sf) -- M1

Mass of oak needed = $1696.46\times 2.7=4580.44g$ (to 6 sf) -- M1

$\frac{\text{Mass of teak}}{\text{Mass of oak}}=\frac{2728.661}{4580.44}=0.596$ (to 3 sf) (<1.1) -- M1

The trophy will not be unstable. – A1

End of marking scheme

Class | Index Number

Name : ________________________________

METHODIST GIRLS' SCHOOL

Founded in 1887

PRELIMINARY EXAMINATION 2016
Secondary 4

Thursday — **MATHEMATICS** — 4048/01

4 August 2016 — **Paper 1** — 2 h

INSTRUCTIONS TO CANDIDATES
Write your name, class and index number on the question paper.
Write in dark blue or black ink on both sides of the paper.
You may use a pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

Answer **all** questions.

If working is needed for any question, it must be shown with the answer.
Omission of essential working will result in loss of marks.
Calculators should be used where appropriate.

If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give your answer in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

INFORMATION FOR CANDIDATES
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 80.

Marks
/ 80

Mathematical Formulae

Compound Interest

$$\text{Total amount} = P\left(1+\frac{r}{100}\right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi rl$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3}\pi r^3$$

$$\text{Area of a triangle} = \frac{1}{2}ab\sin C$$

$$\text{Arc length} = r\theta\text{, where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2}r^2\theta\text{, where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

Answer **all** the questions.

1 **(a)** Calculate $7\frac{1}{3}-\sqrt[3]{\frac{5.25+13.5^2}{\sin 28^\circ}}$.

Write down the first six digits on your calculator display.

(b) Write your answer to part **(a)** correct to 2 significant figures.

Answer **(a)** .... [1]

(b) .... [1]

---

2 **(a)** Arrange the following numbers in ascending order:

$\frac{1}{20}$, $5\frac{1}{4}\%$, 5.22×10^{-3} , $0.\dot{0}\dot{5}$.

Answer **(a)** .... [1]

(b) State which of the following number(s) is / are irrational:

$0.\dot{3}$, $\frac{\pi}{5}$, $\sqrt{7}\times2\sqrt{7}$, $3\sqrt{3}$.

Answer **(b)** .... [1]

---

3 The length of each side of a cube is increased by 40%.
Find the percentage increase in the total surface area of the cube.

Answer .... % [2]

4 Given that $(2x - 5)(x + a) = 2x^2 + bx - 5$ for all values of x, find the values of a and b.

Answer a = ………… , b = …………. [2]

---

5 Two numbers p and q, written as the products of their prime factors, are $p = 2^2 \times 3^5 \times 5^6$ and $q = 2^2 \times 3^3$.

(a) Find the HCF of p and q.

(b) Find the smallest positive integer k such that $(p \times q \times k)$ is a perfect cube.

Answer **(a)** ……………………………. [1]

(b) k = ……………………. [1]

---

6 Local time in Singapore is 7 hours ahead of local time in London. Singapore Airlines SQ007 departed London on Monday at 19 16 London time. The flight arrived at Singapore on Tuesday at 15 51 Singapore time. Calculate how long the flight took, giving your answer in hours and minutes.

Answer ……… hours ………. minutes [2]

7 The diameter of a spherical micro-organism is 9.04 micrometres. Find the surface area in square millimetres, of the micro-organism, giving your answer in standard form.

Answer ……………………… mm^2 [2]

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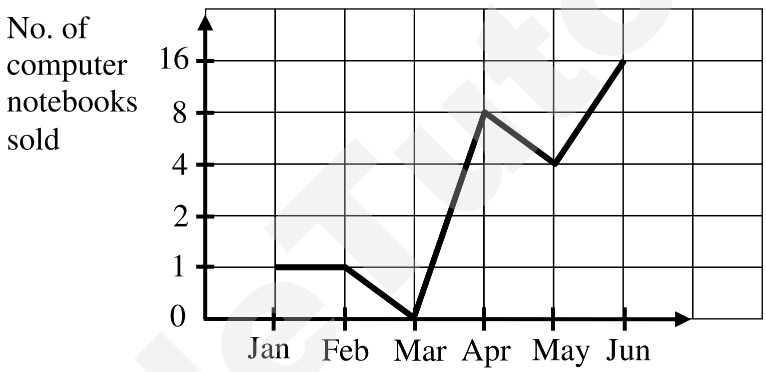
8 The graph below shows the sales of computer notebooks made by Angie over a period of 6 months in 2016.



Explain why the graph is misleading.

Answer ………………………………………………………………………………

………………………………………………………………………………………

………………………………………………………………………………………

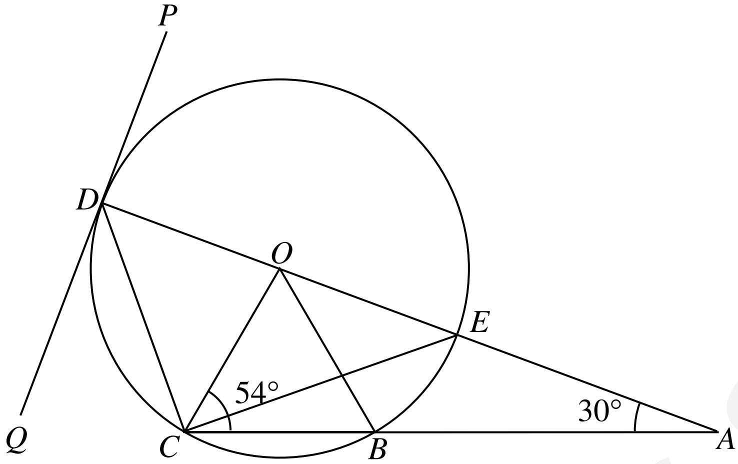
……………………………………………………………………………………… [2]

---

9 Two of the interior angles of a hexagon are $2x°$ and $(5x-200)°$. The remaining interior angles are $90°$ each. By forming an equation in x, find the value of x.

Answer $x =$ ………………… [2]

10 In the diagram, the points B, C, D and E lie on a circle with centre O. PQ is a tangent to the circle at D. ABC and $AEOD$ are straight lines. $\angle OCB = 54°$ and $\angle OAB = 30°$.



Find, giving reasons for each answer,

(a) $\angle ADC$,

(b) $\angle CDQ$,

(c) $\angle ACE$,

(d) $\angle CBE$.

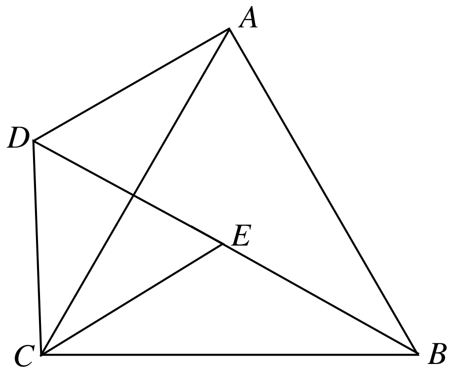
Answer **(a)**……………………… ° [2]

(b)……………………… ° [1]

(c)……………………… ° [2]

(d)……………………… ° [1]

11 *ABCD* is a quadrilateral. *ABC* and *CDE* are equilateral triangles. Using a pair of congruent triangles, show that $AD = BE$. State your reasons clearly.



Answer In triangles ……………………………………………………………………………

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……………………………………………………………………………………………

…………………………………………………………………………………………… [2]

---

12 Janet has $50000 to invest for 3 years. She invests her money in a unit trust with returns equivalent to 2% per annum interest, compounded every 3 months. Calculate the amount of interest she will get at the end of 3 years.

Answer $ ……..………………. [2]

13 **(a)** Given that $\left(\frac{1}{4}\right)^{p} \times 8 = 1$, find the value of p.

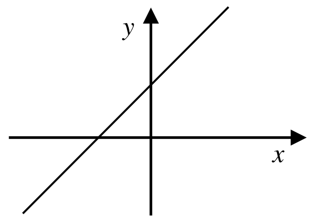
(b) Simplify $\left(\frac{2^{y+1}\sqrt{2}}{2^{y}}\right)^{-2}$.

Answer **(a)** p = ... [2]

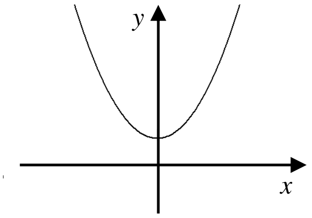
(b) .... [2]

14 The equations of the three graphs shown below are in the form $y = n + x^{n-1}$.
State the value of n for each of the following graph.

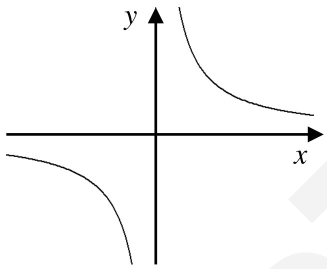
(a)



(b)



(c)



Answer **(a)** $n =$ …………..….. [1]

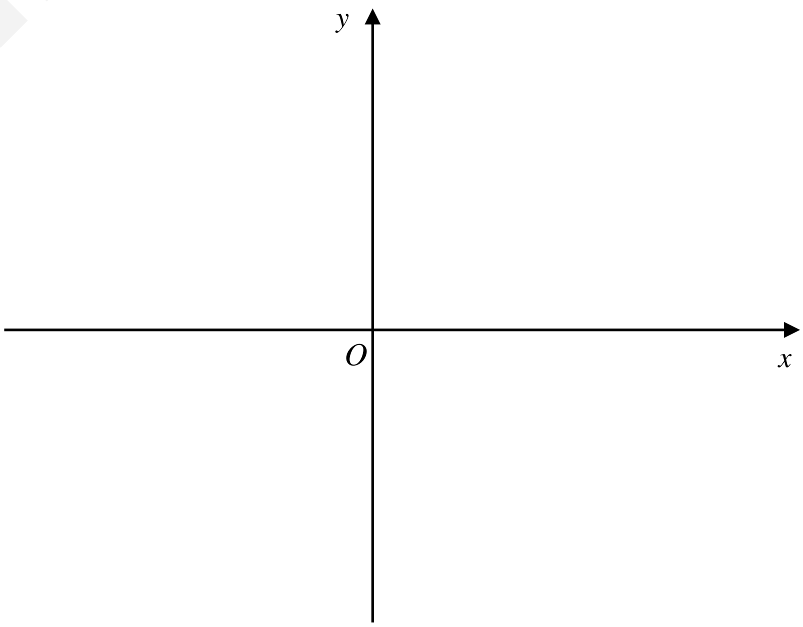
(b) $n =$ ……...…….. [1]

(c) $n =$ ……….…….. [1]

---

15 In the answer space, sketch the graph of $y = 5 - (x+1)^2$, indicate clearly the turning point and the intercepts on the x and y-axes (if any).

Answer [2]



16 **(a)** $\varepsilon = \{ x : x \text{ is an integer and } 1 \le x < 24 \}$
$A = \{ x : x \text{ is a perfect square} \}$
$B = \{ x : x \text{ is a factor of the number } 24 \}$
$C = \{ x : x + 1 \text{ is divisible by } 6 \}$

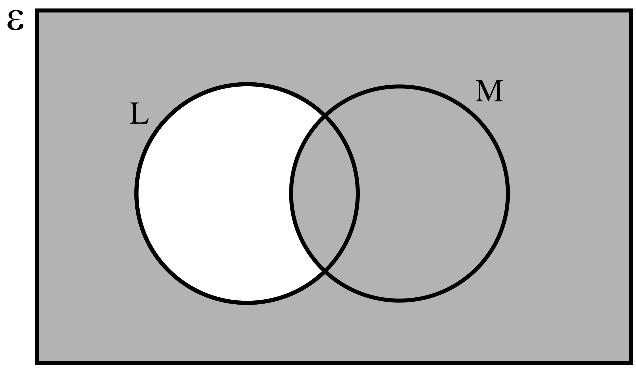
(i) List the elements in $A \cap C$.

(ii) Find $n (B' \cup C)$.

Answer **(a)(i)** ………………………….. [1]

(ii) ……....………………… [1]

(b) State the set notation of the shaded region in following Venn Diagram.



Answer **(b)**……....………………… [1]

17 Given that point $A(4, 2)$ and $\overrightarrow{AC} = \begin{pmatrix} -7 \\ 3 \end{pmatrix}$.

(a) Find $\left|\overrightarrow{CA}\right|$.

Answer **(a)** .... units [1]

(b) The point P lies on CA such that $\overrightarrow{PA} = k\,\overrightarrow{CA}$.

(i) Show that $\overrightarrow{OP} = \begin{pmatrix} 4-7k \\ 2+3k \end{pmatrix}$.

Answer **(b)(i)** [1]

(ii) Given that point P lies on the y-axis, find the coordinates of P.

Answer **(b)(ii)** P(......... , ...) [2]

18 Consider the number patterns in the table below. The first three terms of each column have been given.

Row, n	S	T	U
1	4	16	16
2	8	32	30
3	12	48	44
7	p	q	r
n			

(a) Find values of p, q and r.

(b) Write down the equation connecting S and T.

(c) Write down the equation connecting U and n.

(d) Betty said that 256 can be found in column U.
Write whether you agree or disagree with Betty. Give reason(s) for your answer.

Answer **(a)** p = ……… , q = ……… , r = ……… [1]

(b) ……………………………………………… [1]

(c) ……………………………………………… [1]

(d) I …………………with Betty. This is because ……………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………… [1]

19 The frequency table shows the number of countries that a group of students had visited.

Number of countries	0	1	2	3	4
Number of students	2	8	6	x	4

(a) Given that the mode is 1, state the largest possible value of x.

(b) Given that the median number of countries visited is 2, find the largest possible value of x.

(c) Given that the mean number of countries is more than 2, find the smallest possible value of x.

Answer **(a)** x = …..…………………… [1]

(b) x = ….......………………… [1]

(c) x = ……..………………… [2]

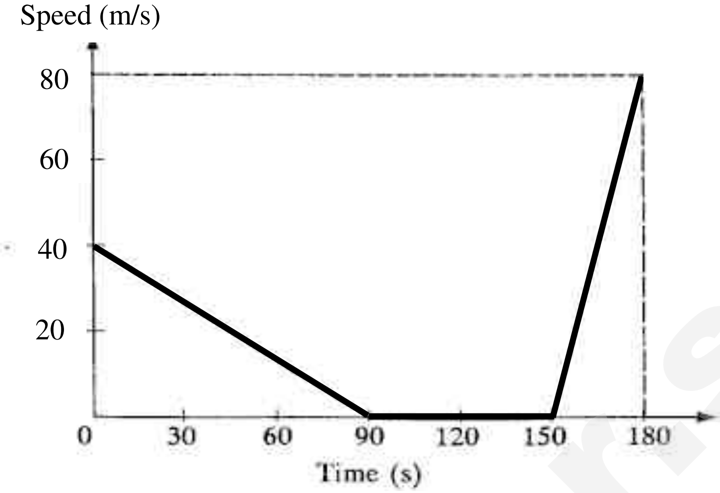
20 **(a)** The air resistance, R, is directly proportional to the square of the speed, V, of an object when it is falling. The air resistance is 24 newtons at a certain speed. Find the air resistance when the speed is increased by 50%.

(b) 48 men can build 2 huts in 60 hours. How many more men are needed if 3 huts are to be built in 72 hours?

Answer **(a)** .... newtons [2]

(b) .... men [2]

21 The diagram below shows the speed-time graph of the journey for the first 3 minutes of a train. The train slows down to a stop when entering station *J*. After a brief stop of 60 seconds, it starts to move off with acceleration for 30 seconds before it gets out of station *J*.



(a) Find the deceleration of the train as it enters station *J*.

(b) Calculate

(i) the total distance travelled by the train in the first 3 minutes,

(ii) the average speed of the train, in km/h, in the first 3 minutes.

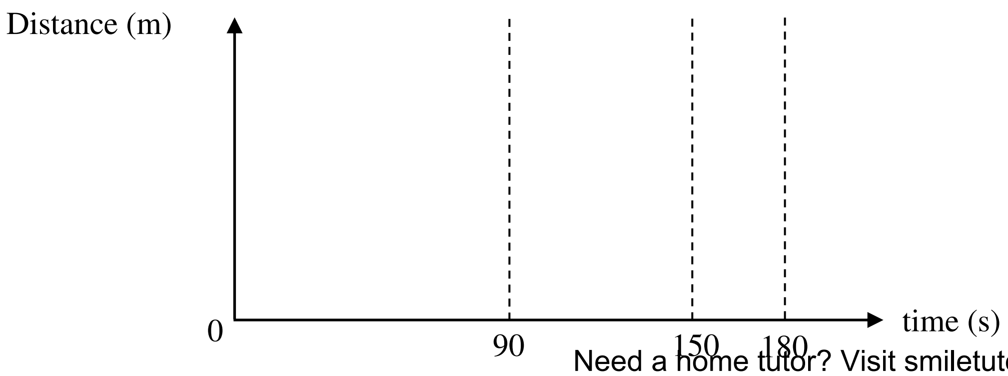
Answer **(a)** .... m/s^2 [1]

(b)(i) .... m [1]

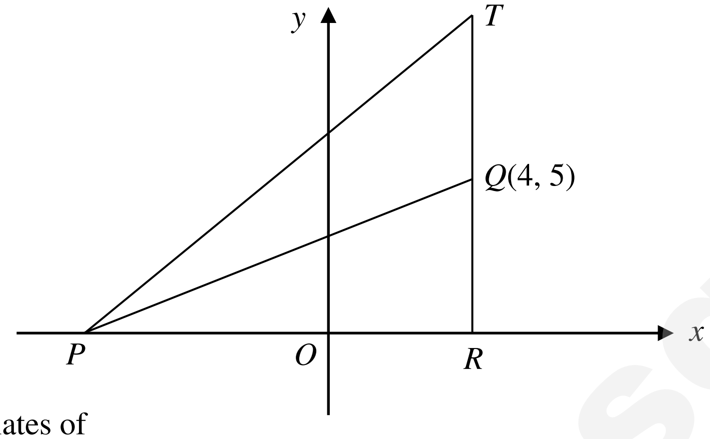
(ii) .... km/h [2]

(c) On the axes below, sketch the distance-time graph of the train for the first 3 minutes of its journey.

Answer **(c)** [2]



22 P and R are points on the x-axis. TQR is a straight line parallel to the y-axis.
Area of ΔPQR = 30 units^2.



(a) Find the coordinates of

(i) point R,

(ii) point P.

(b) Find the length of PQ.

(c) Find $\cos\angle PQT$, giving your answer as a fraction.

(d) Given that $PR = TR$, find the equation of PT.

Answer **(a)(i)** R (…..… , ………) [1]

(ii) P (…..… , ………) [2]

(b) ……..………..… units [1]

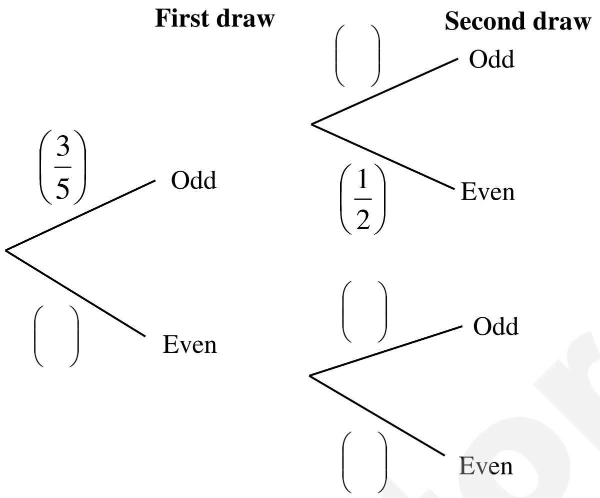
(c) ………..……..………… [1]

(d) ……………..………… [1]

23 Five discs numbered 1, 3, 4, 6 and 7 are placed in a bag. A disc is drawn out of the bag at random. Without replacing the first disc into the bag, a second disc is drawn.

(a) Complete the following probability tree diagram.

Answer **(a)** [2]



(b) Find

(i) the probability that one disc is odd and the other is even,

(ii) the probability that both numbers drawn are smaller than 4.

(c) By drawing a possibility diagram in the space below, find the probability that the sum of both numbers is a prime number.

Answer **(b)(i)** .... [1]

(ii) .... [1]

(c) .... [2]

24 The diagram below shows a horizontal field ABC.
A is due north of B and C is due west of B.
Use a scale of 1 cm to 40 m, show all the constructions clearly.

(a) A lamp post, L, is located on a bearing of 290° from A, and 300 m from A.

(i) By construction, mark and label clearly the position of the lamp post L. [1]

(ii) Measure and write down the bearing of the lamp post L from point C.

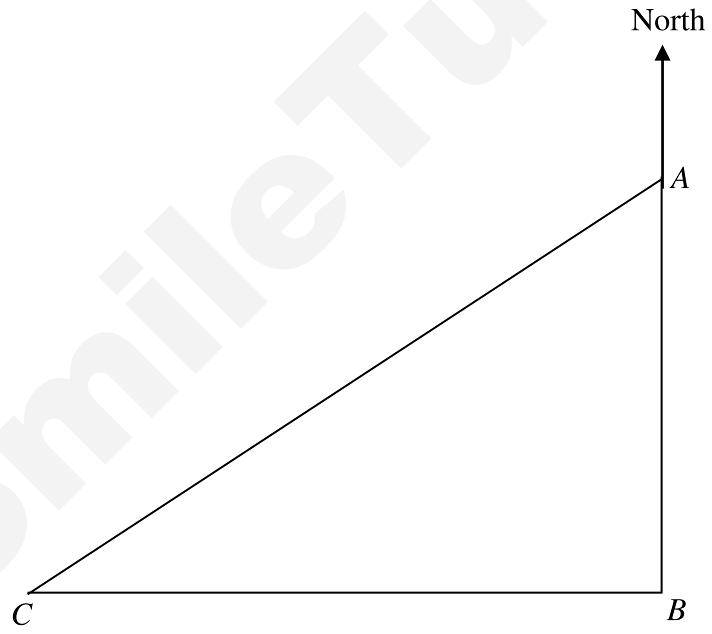
(b) A gate, G, is located along the path of BC, equidistant from B and C.
By construction, mark and label clearly the position of the gate G. [1]

(c) A circular flower bed is built such that it touches each side of the field at one point.

(i) By constructing two angle bisectors, draw the circular flower bed and label its centre O. [2]

(ii) Hence, measure and write down the actual radius of the flower bed.

Answer **(a)(i)**
(b)
(c)(i)



Answer **(a)(ii)** ……………..…….. ° [1]

(c)(ii) ……..………… m [1]

End of Paper 1

Class	Index Number

Name : ______________________________

METHODIST GIRLS' SCHOOL

Founded in 1887

PRELIMINARY EXAMINATION 2016
Secondary 4

Thursday	**MATHEMATICS**	4048/01
4 August 2016	**Paper 1 (Solutions)**	2 h

INSTRUCTIONS TO CANDIDATES
Write your name, class and index number on the question paper.
Write in dark blue or black ink on both sides of the paper.
You may use a pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

Answer **all** questions.

If working is needed for any question, it must be shown with the answer.
Omission of essential working will result in loss of marks.
Calculators should be used where appropriate.

If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give your answer in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

INFORMATION FOR CANDIDATES
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 80.

Marks
/ 80

Mathematical Formulae

Compound Interest

$$\text{Total amount} = P\left(1+\frac{r}{100}\right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi rl$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3}\pi r^3$$

$$\text{Area of a triangle} = \frac{1}{2}ab\sin C$$

$$\text{Arc length} = r\theta\text{, where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2}r^2\theta\text{, where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A}=\frac{b}{\sin B}=\frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f}-\left(\frac{\sum fx}{\sum f}\right)^2}$$

Answer **all** the questions.

1 **(a)** Calculate $7\frac{1}{3}-\sqrt[3]{\frac{5.25+13.5^2}{\sin 28^\circ}}$.

Write down the first six digits on your calculator display.

(b) Write your answer to part **(a)** correct to 2 significant figures.

B1

Answer **(a)** ....**−0.03095**........ [1]

B1

(b) ....**−0.031**........ [1]

---

2 **(a)** Arrange the following numbers in ascending order:

$\frac{1}{20}$, $5\frac{1}{4}\%$, 5.22×10^{-3} , $0.\dot{0}\dot{5}$.

0.05 **0.0525** **0.00522** **0.050505…**

B1

Answer **(a)** ....5.22×10^{-3} , $\frac{1}{20}$, $0.\dot{0}\dot{5}$, $5\frac{1}{4}\%$........ [1]

(b) State which of the following number(s) is / are irrational:

$0.\dot{3}$, $\frac{\pi}{5}$, $\sqrt{7}\times2\sqrt{7}$, $3\sqrt{3}$.

B1

Answer **(b)** ....$\frac{\pi}{5}$, $3\sqrt{3}$........ [1]

---

3 The length of each side of a cube is increased by 40%.
Find the percentage increase in the total surface area of the cube.

$$\%\text{ increase in surface area} = \frac{6(1.4l)^2-6l^2}{6l^2}\times100\% \quad \text{M1}$$
$$= \frac{11.76-6}{6}\times100\%$$
$$= 96\%$$

A1

Answer ....**96**........ % [2]

4 Given that $(2x - 5)(x + a) = 2x^2 + bx - 5$ for all values of x, find the values of a and b.

$$2x^2 + 2ax - 5x - 5a = 2x^2 + bx - 5$$

$-5a = -5$	$2a - 5 = b$
$a = 1$	$b = 2(1) - 5$
	$= -3$

B1 B1

Answer a = ...**1**.......... , b = ...**−3**....... [2]

---

5 Two numbers p and q, written as the products of their prime factors, are $p = 2^2 \times 3^5 \times 5^6$ and $q = 2^2 \times 3^3$.

(a) Find the HCF of p and q.

(b) Find the smallest positive integer k such that $(p \times q \times k)$ is a perfect cube.

(a) HCF $= 2^2 \times 3^3 = 108$

(b) $(p \times q \times k) = 2^4 \times 3^5 \times 5^6 \times k$

$k = 2^2 \times 3$

$= 12$

B1

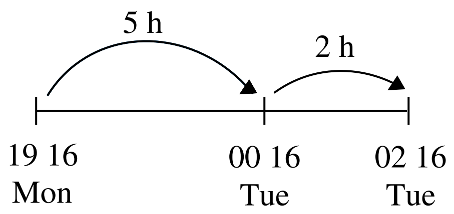
Answer **(a)** ....108.......................... [1]

B1

(b) k = ...12...................... [1]

---

6 Local time in Singapore is 7 hours ahead of local time in London. Singapore Airlines SQ007 departed London on Monday at 19 16 London time. The flight arrived at Singapore on Tuesday at 15 51 Singapore time. Calculate how long the flight took, giving your answer in hours and minutes.



Departure time from London (Singapore time)
= 02 16 Tuesday M1

Arrival time at Singapore (Singapore time)
= 15 51 Tuesday

h	min
15	51
− 02	16
13	35

Duration of Journey
= 13 h 35 min

A1

Answer .....**13**..... hours .....**35**..... minutes [2]

7 The diameter of a spherical micro-organism is 9.04 micrometres. Find the surface area in square millimetres, of the micro-organism, giving your answer in standard form.

$$\text{Radius} = \frac{1}{2} \times 9.04 \times 10^{-6} \text{ m}$$
$$= 4.52 \times 10^{-6} \times 10^{3} \text{ mm}$$
$$= 4.52 \times 10^{-3} \text{ mm} \qquad \textbf{M1}$$

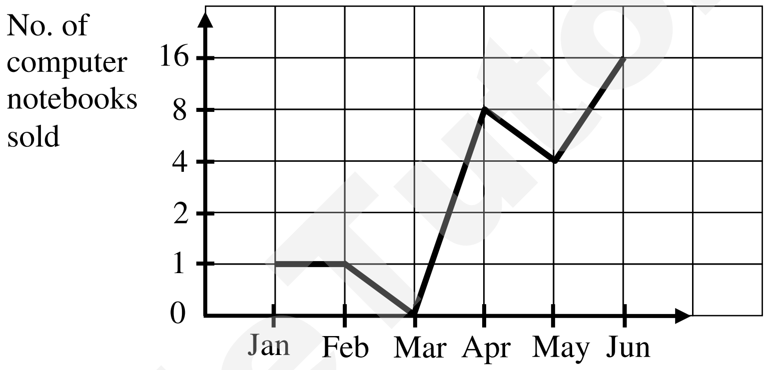
$$\text{Surface area} = 4\pi\,(4.52 \times 10^{-3})^{2}$$
$$= 2.57 \times 10^{-4} \text{ mm}^2$$

A1

Answer ……… 2.57×10^{-4} ……… mm^2 [2]

---

8 The graph below shows the sales of computer notebooks made by Angie over a period of 6 months in 2016.



Explain why the graph is misleading.

B1

Answer The scale of the vertical axis is **not consistent**.

This distorts the graph, making the **sales from May to June** (16 – 4 = 12 units)

seemed to be **less than** the **sales from March to April** (8 – 0 = 8 units).

…………………………………………………………………… [2]

---

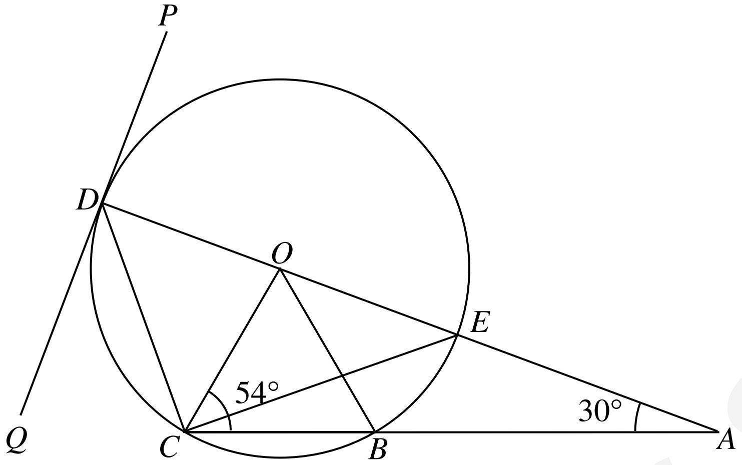
9 Two of the interior angles of a hexagon are $2x°$ and $(5x-200)°$. The remaining interior angles are $90°$ each. By forming an equation in x, find the value of x.

$$2x + (5x - 200) + 4(90) = (6 - 2) \times 180 \qquad \textbf{M1}$$
$$7x + 160 = 720$$
$$7x = 560$$
$$x = 80$$

A1

Answer $x =$ ……… 80 ……… [2]

10 In the diagram, the points B, C, D and E lie on a circle with centre O. PQ is a tangent to the circle at D. ABC and $AEOD$ are straight lines. $\angle OCB = 54°$ and $\angle OAB = 30°$.



Find, giving reasons for each answer,

(a) $\angle ADC$,

(b) $\angle CDQ$,

(c) $\angle ACE$,

(d) $\angle CBE$.

(a) $\angle COD = 54° + 30°$ (Ext $\angle$ of Δ)
$= 84°$ } **M1**

$\angle ADC = \dfrac{180° - 84°}{2}$ (Base $\angle$s of isos. Δ)
$= 48°$ } **A1**

(b) $\angle CDQ = 90° - 48°$ (tan $\perp$ rad)
$= 42°$ } **A1**

(c) $\angle DCE = 90°$ (Rt. $\angle$ in semi-circle) **M1**

$\angle ADC = 180° - 90° - 48° - 30°$ ($\angle$ sum of Δ)
$= 12°$ } **A1**

or $\angle COE = 48° \times 2$ ($\angle$ at centre = 2 $\angle$ at circumference)
$= 96°$

$\angle ACE = \dfrac{180° - 96°}{2}$ (Base $\angle$s of isos. Δ)
$= 42°$

$\angle ADC = 54° - 42°$
$= 12°$

(d) $\angle CBE = 180° - 48°$ ($\angle$s in opp segments are supp)
$= 132°$ } **A1**

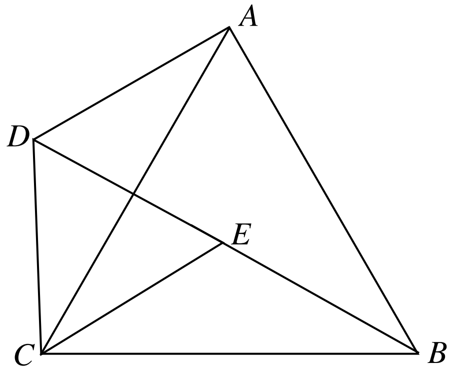
Answer **(a)**……**48**…… ° [2]

(b)……**42**…… ° [1]

(c)……**12**…… ° [2]

(d)……**132**…… ° [1]

11 *ABCD* is a quadrilateral. *ABC* and *CDE* are equilateral triangles. Using a pair of congruent triangles, show that $AD = BE$. State your reasons clearly.



Answer In triangles ACD and BCE,

CD and CE (sides of equil. ΔCDE)

AB and BC (sides of equil. ΔABC)

$\angle ACD = 60° - \angle ACE$ ($\angle$ of equil. $\Delta\ CDE$)

$\angle BCE = 60° - \angle ACE$ ($\angle$ of equil. $\Delta\ ABC$)

$\therefore\ \angle ACD = \angle BCE$

M1
(all criteria must be correct)

$\therefore\ \Delta ACD = \Delta BCE$ (SAS) **B1** **(criteria must tally with test)**

Hence, $AD = BE$

[2]

---

12 Janet has \$50000 to invest for 3 years. She invests her money in a unit trust with returns equivalent to 2% per annum interest, compounded every 3 months.
Calculate the amount of interest she will get at the end of 3 years.

$$\text{Amount} = 50000\left(1+\frac{0.02}{4}\right)^{12}$$ **M1**

$$= \$53083.8905$$

$$\text{Interest} = \$53083.8905 - \$50000$$

$$= \$3083.89 \text{ (to 2 dp)}$$

A1

Answer \$ \$3083.89 [2]

13 **(a)** Given that $\left(\frac{1}{4}\right)^p \times 8 = 1$, find the value of p.

$$\left(2^{-2}\right)^p \times 2^3 = 2^0$$

$$2^{-2p+3} = 2^0 \qquad \textbf{M1}$$

$$-2p+3=0$$

$$p = 1\frac{1}{2}$$

(b) Simplify $\left(\frac{2^{y+1}\sqrt{2}}{2^y}\right)^{-2}$.

$$\left(\frac{2^{y+1}\sqrt{2}}{2^y}\right)^{-2}$$

$$= \left(2^{y+1+\frac{1}{2}-y}\right)^{-2} \qquad \textbf{M1}$$

$$= \left(2^{\frac{3}{2}}\right)^{-2}$$

$$= 2^{-3}$$

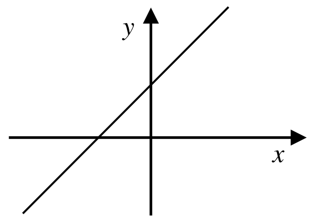
$$= \frac{1}{8}$$

Answer **(a)** p = ...$1\frac{1}{2}$........ [2] **A1**

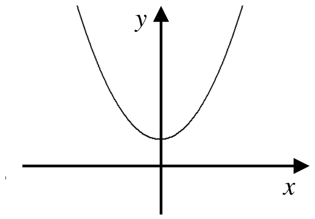
(b) ....$\frac{1}{8}$........ [2] **A1**

14 The equations of the three graphs shown below are in the form $y = n + x^{n-1}$.
State the value of n for each of the following graph.

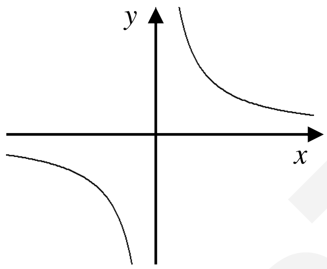
(a)



(b)



(c)



Answer **(a)** $n =$ ......2...... **B1** [1]

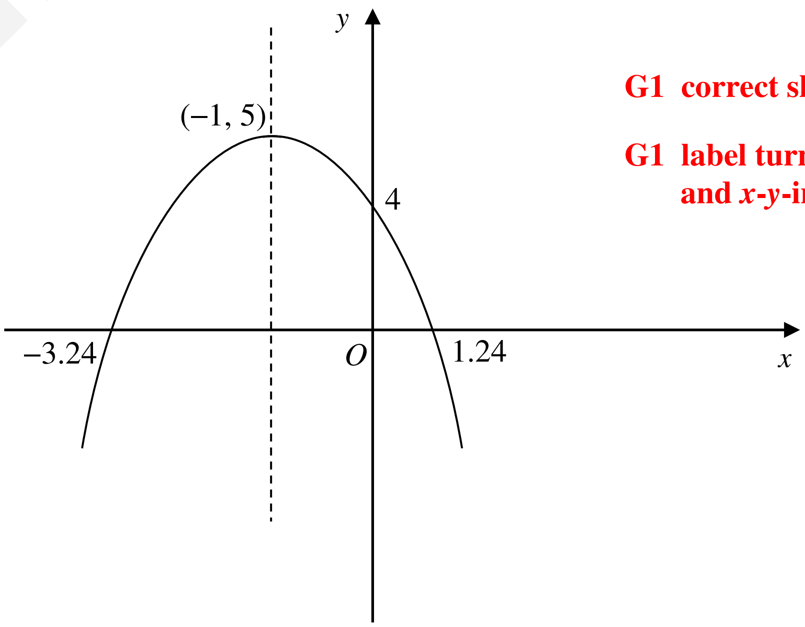
(b) $n =$ ......3...... **B1** [1]

(c) $n =$ ......0...... **B1** [1]

---

15 In the answer space, sketch the graph of $y = 5 - (x+1)^2$, indicate clearly the turning point and the intercepts on the x and y-axes (if any).

Answer [2]



G1 correct shape

G1 label turning point and x-y-intercepts

16 **(a)** $\varepsilon = \{ x : x \text{ is an integer and } 1 \leq x < 24 \}$ **= { 1, 2, 3, … 23 }**

$A = \{ x : x \text{ is a perfect square} \}$ **= { 1, 4, 9, 16 }**

$B = \{ x : x \text{ is a factor of the number } 24 \}$ **= { 1, 2, 3, 4, 6, 8, 12 }**

$C = \{ x : x + 1 \text{ is divisible by } 6 \}$ **= { 5, 11, 17, 23 }**

(i) List the elements in $A \cap C$.

(ii) Find $n (B' \cup C)$.

(a) (ii) $B' = \{ 5, 7, 9, 10, 11, 13, 14, 15, 16, \ldots 23 \}$

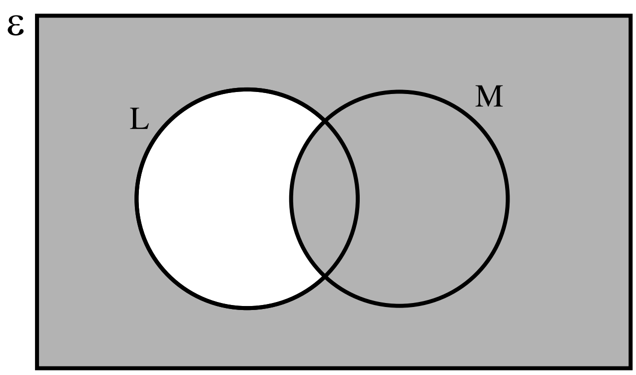
$$n (B' \cup C) = n (B')$$
$$= n (\varepsilon) - n (B)$$
$$= 23 - 7$$

or { }

Answer **(a)(i)** ……ϕ…………… [1] **B1**

(ii) ……16…………… [1] **B1**

(b) State the set notation of the shaded region in following Venn Diagram.



Answer **(b)**……$L' \cup M$…………… [1] **B1**

17 Given that point $A(4, 2)$ and $\overrightarrow{AC} = \begin{pmatrix} -7 \\ 3 \end{pmatrix}$.

(a) Find $\left|\overrightarrow{CA}\right|$.

$$\overrightarrow{CA} = \begin{pmatrix} 7 \\ -3 \end{pmatrix}$$

$$\left|\overrightarrow{CA}\right| = \sqrt{7^2 + (-3)^2}$$

$$= 7.62 \text{ (to 3 sf)}$$

B1

Answer **(a)** ......7.62...... units [1]

(b) The point P lies on CA such that $\overrightarrow{PA} = k\,\overrightarrow{CA}$.

(i) Show that $\overrightarrow{OP} = \begin{pmatrix} 4-7k \\ 2+3k \end{pmatrix}$.

Answer **(b)(i)** [1]

$$\overrightarrow{AP} = \overrightarrow{OP} - \overrightarrow{OA}$$

$$\overrightarrow{OP} = \overrightarrow{OA} + \overrightarrow{AP}$$

$$= \begin{pmatrix} 4 \\ 2 \end{pmatrix} + k\,\overrightarrow{AC}$$

$$= \begin{pmatrix} 4 \\ 2 \end{pmatrix} + k\begin{pmatrix} -7 \\ 3 \end{pmatrix}$$ **A1**

$$= \begin{pmatrix} 4-7k \\ 2+3k \end{pmatrix}$$ (shown)

(ii) Given that point P lies on the y-axis, find the coordinates of P.

$$4 - 7k = 0$$

$$k = \frac{4}{7}$$ **B1**

$$2 + 3\left(\frac{4}{7}\right) = 3\frac{5}{7}$$

A1

Answer **(b)(ii)** $P($ ......0...... , ...$3\frac{5}{7}$...... $)$ [2]

18 Consider the number patterns in the table below. The first three terms of each column have been given.

Row, n	S	T	U
1	4	16	16
2	8	32	30
3	12	48	44
7	p	q	r
n			

(a) Find values of p, q and r.

(b) Write down the equation connecting S and T.

(c) Write down the equation connecting U and n.

(d) Betty said that 256 can be found in column U.
Write whether you agree or disagree with Betty. Give reason(s) for your answer.

(d) $14n + 2 = 256$

$$14n = 254$$

$$n = \frac{254}{14}$$

$$= 18\frac{1}{7}$$

B1
(All 3 must be correct)

Answer **(a)** $p =$ 28 .... , $q =$ 112 .... , $r =$ 100 .... [1]

(b) $T = 4S$ **B1** .... [1]

(c) $U = 14n + 2$ **B1** .... [1]

(d) I **disagree** .... with Betty. This is because ....

If $N = 256$, $n = 18\frac{1}{7}$ which is not a natural number. ....

(is not a positive integer). **B1**

OR

When 2 is deducted from 256, the result 254 is not divisible by 14. ....

(is not a multiple of 14). .... [1]

19 The frequency table shows the number of countries that a group of students had visited.

Number of countries	0	1	2	3	4
Number of students	2	8	6	x	4

(a) Given that the mode is 1, state the largest possible value of x.

(b) Given that the median number of countries visited is 2, find the largest possible value of x.

(c) Given that the mean number of countries is more than 2, find the smallest possible value of x.

(b) $2 + 8 + (6 - 1) = x + 4$
$15 = x + 4$
$x = 11$

(c) Mean $= \dfrac{0(2)+1(8)+2(6)+3x+4(4)}{2+8+6+x+4} > 2$

$\dfrac{3x+36}{x+20} > 2$ **M1**

$3x + 36 > 2(x + 20)$

$3x + 36 > 2x + 40$

$x > 4$

smallest $x = 5$

Answer **(a)** $x =$ 7 [1] **B1**

(b) $x =$ 11 [1] **B1**

(c) $x =$ 5 [2] **B1**

20 **(a)** The air resistance, R, is directly proportional to the square of the speed, V, of an object when it is falling. The air resistance is 24 newtons at a certain speed. Find the air resistance when the speed is increased by 50%.

(b) 48 men can build 2 huts in 60 hours. How many more men are needed if 3 huts are to be built in 72 hours?

(a) $R = kV^2$, k constant

$24 = kV^2 \Rightarrow k = \dfrac{24}{V^2}$ **M1**

$R_{new} = k(1.5V)^2$

$= \dfrac{24}{V^2} \times 2.25V^2$

$= 54$ newtons

(b) No. of men required to build 3 huts in 72 h

$= \dfrac{3}{2} \times \dfrac{60}{72} \times 48$

$= 60$

$\therefore$ Extra no. of men needed $= 60 - 48$

$= 12$

$\boxed{\textbf{OR}}$

48 men ---- 2 huts ---- 60 h

48 men ---- 1 hut ---- 30 h

1 man ---- 1 hut ---- 1440 h **M1**

1 man ---- 3 huts ---- 4320 h

60 men ---- 3 huts ---- 72 h

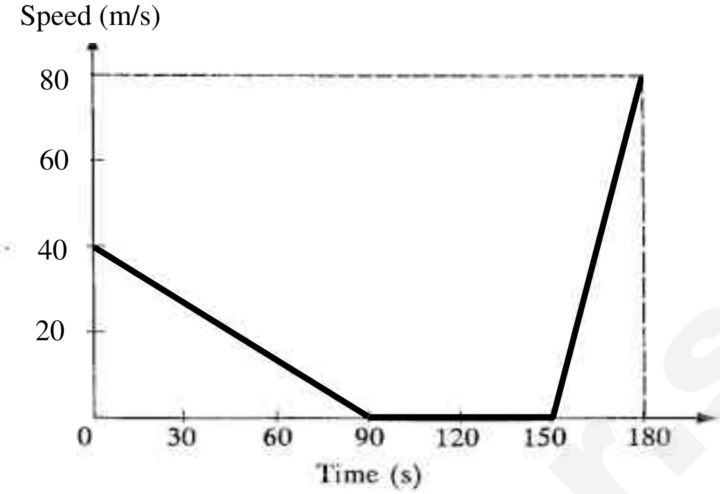
$\therefore$ Extra no. of men needed $= 60 - 48$

$= 12$

Answer **(a)** ....54 **A1**............ newtons [2]

(b) ....12 **A1**............ men [2]

21 The diagram below shows the speed-time graph of the journey for the first 3 minutes of a train. The train slows down to a stop when entering station *J*. After a brief stop of 60 seconds, it starts to move off with acceleration for 30 seconds before it gets out of station *J*.



(a) Find the deceleration of the train as it enters station *J*.

(b) Calculate

(i) the total distance travelled by the train in the first 3 minutes,

(ii) the average speed of the train, in km/h, in the first 3 minutes.

(a) Acceleration $= \dfrac{40-0}{0-90} = -\dfrac{4}{9}$ m/s^2 $\quad \therefore$ Deceleration $= \dfrac{4}{9}$ m/s^2

(b) (i) Total distance $= \dfrac{1}{2}(90)(40) + \dfrac{1}{2}(30)(80)$

$= 1800 + 1200$

$= 3000$ m

(ii) Average speed $= \dfrac{3000\,\text{m}}{3\,\text{min}}$ **M1**

$= \dfrac{3\,\text{km}}{\left(\dfrac{3}{60}\,\text{h}\right)}$

$= 60$ km/h

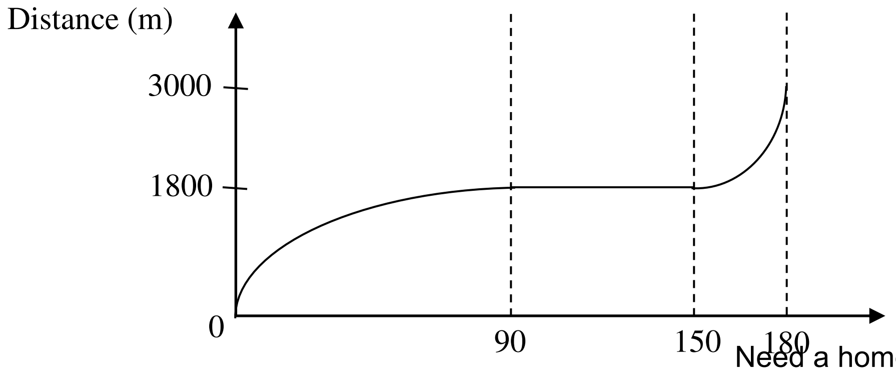
Answer **(a)** ......$\frac{4}{9}$...... **B1** m/s^2 [1]

(b)(i) ......3000...... **A1** m [1]

(ii) ......60...... **A1** km/h [2]

(c) On the axes below, sketch the distance-time graph of the train for the first 3 minutes of its journey.

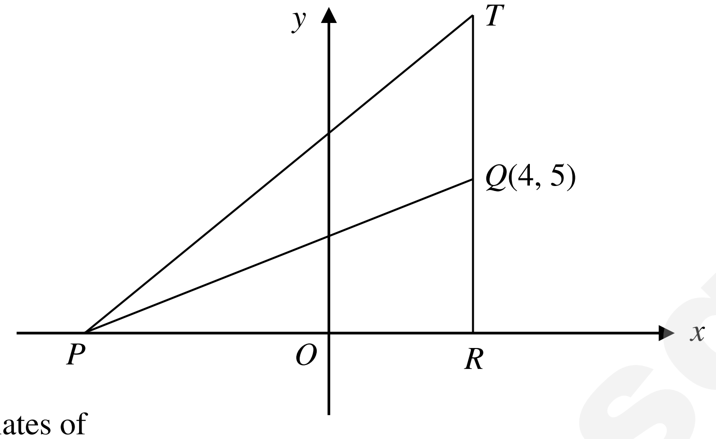
Answer **(c)** [2]



G1 correct shape

G1 label correct distance

22 P and R are points on the x-axis. TQR is a straight line parallel to the y-axis.
Area of ΔPQR = 30 units^2.



(a) Find the coordinates of

(i) point R,

(ii) point P.

(b) Find the length of PQ.

(c) Find $\cos\angle PQT$, giving your answer as a fraction.

(d) Given that $PR = TR$, find the equation of PT.

(a)(i) $R\ (4, 0)$

(ii) $\frac{1}{2} \times PR \times 5 = 30$ **M1**

$PR = \frac{2 \times 30}{5} = 12$ units

$\therefore P\ (-8, 0)$

(b) $P\ (-8, 0)$ $Q\ (4, 5)$

$$PQ = \sqrt{[4-(-8)]^2 + (5-0)^2}$$

$$= \sqrt{144 + 25}$$

$$= 13 \text{ units}$$

(c) $\cos\angle PQT = -\cos\angle PQR$

$$= -\frac{5}{13}$$

(d) $P\ (-8, 0)$ $T\ (4, 12)$

$$m = \frac{12-0}{4-(-8)} = 1$$

Equation of PT is

$y - 0 = 1\,[x - (-8)]$

$y = x + 8$

Answer **(a)(i)** R (……4…… , ……0……) [1] **B1**

(ii) P (……-8…… , ……0……) [2] **A1**

(b) ……13…… units [1] **B1**

(c) ……$-\frac{5}{13}$…… [1]

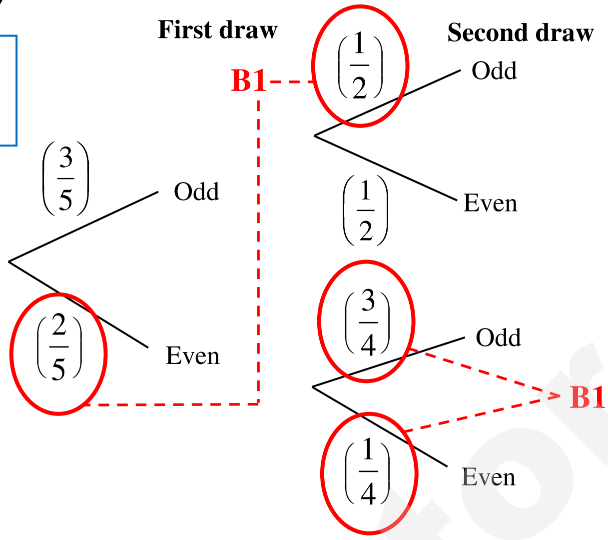
(d) ……$y = x + 8$…… [1] **A1**

23 Five discs numbered 1, 3, 4, 6 and 7 are placed in a bag. A disc is drawn out of the bag at random. Without replacing the first disc into the bag, a second disc is drawn.

(a) Complete the following probability tree diagram.

Answer **(a)** [2]

1, 3, 4, 6, 7
3 odd nos. , 2 even nos.



(b) Find

(i) the probability that one disc is odd and the other is even,

(ii) the probability that both numbers drawn are smaller than 4.

(c) By drawing a possibility diagram in the space below, find the probability that the sum of both numbers is a prime number.

(b) (i) P(odd, even) + P(even, odd) $= \frac{3}{5}\times\frac{1}{2} + \frac{2}{5}\times\frac{3}{4}$ or $= 2\times\frac{3}{5}\times\frac{1}{2}$

$= \frac{3}{5}$

(ii) P(both nos. < 4) $= \frac{2}{5}\times\frac{1}{4}$

$= \frac{1}{10}$

(c)

B1

+	1	3	4	6	7
1		4	5	7	8
3	4		7	9	10
4	5	7		10	11
6	7	9	10		13
7	8	10	11	13	

P(sum = prime no.) $= \frac{10}{20}$

$= \frac{1}{2}$

Answer **(b)(i)** ....$\frac{3}{5}$............ **B1** [1]

(ii) ....$\frac{1}{10}$............ **B1** [1]

(c) ....$\frac{1}{2}$............ **B1** [2]

24 The diagram below shows a horizontal field *ABC*.
A is due north of *B* and *C* is due west of *B*.
Use a scale of 1 cm to 40 m, show all the constructions clearly.

(a) A lamp post, *L*, is located on a bearing of 290° from *A*, and 300 m from *A*.

(i) By construction, mark and label clearly the position of the lamp post *L*. [1]

(ii) Measure and write down the bearing of the lamp post *L* from point *C*.

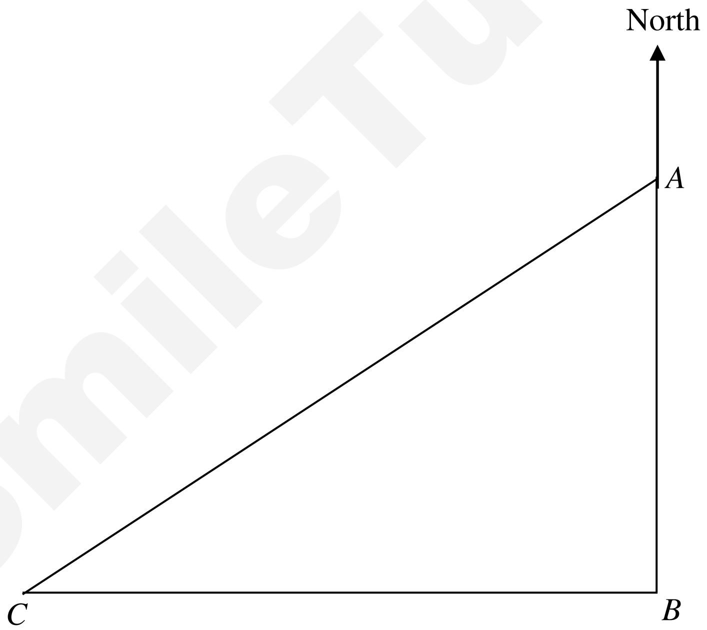
(b) A gate, *G*, is located along the path of *BC*, equidistant from *B* and *C*.
By construction, mark and label clearly the position of the gate *G*. [1]

(c) A circular flower bed is built such that it touches each side of the field at one point.

(i) By constructing two angle bisectors, draw the circular flower bed and label its centre *O*. [2]

(ii) Hence, measure and write down the actual radius of the flower bed.

Answer **(a)(i)**
(b)
(c)(i)



Answer **(a)(ii)** ……………..…….. ° [1]

(c)(ii) ……..………… m [1]

End of Paper 1

Class | Index Number

Name : ___________________________________

METHODIST GIRLS' SCHOOL

Founded in 1887

PRELIMINARY EXAMINATION 2016
Secondary 4

Tuesday
16 August 2016

MATHEMATICS
Paper 2

4048/02
2 h 30 mins

INSTRUCTIONS TO CANDIDATES

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
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Do not use paper clips, highlighters, glue or correction fluid.

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INFORMATION FOR CANDIDATES

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 100.

This question paper consists of 13 printed pages

Mathematical Formulae

Compound interest

$$\text{Total amount} = P\left(1+\frac{r}{100}\right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi rl$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3}\pi r^3$$

$$\text{Area of triangle } ABC = \frac{1}{2}ab\sin C$$

$$\text{Arc length} = r\theta, \text{ where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2}r^2\theta, \text{ where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

Answer **all** the questions.

1 **(a)** Given that $8 \quad x \quad 4$ and $3 \quad y \quad 2$, find

(i) the least value of xy, [1]

(ii) the greatest value of $x^2 \quad y^2$. [1]

(b) Express as a single fraction in its simplest form

(i) $\dfrac{x \quad y}{xy} + \dfrac{y \quad z}{yz}$, [2]

(ii) $\dfrac{2x^3}{x+y+z} \quad \dfrac{(x+y)^2 \quad z^2}{6x}$. [2]

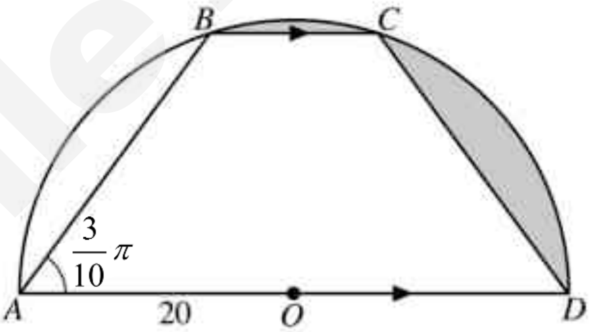
(c) It is given that $2pq = \sqrt{\dfrac{4q^2+p^2}{2}}$.

Express q in terms of p. [3]

---

2 In the diagram, *OABCD* is a semicircle with centre at *O*.

AD // *BC*, angle *CDA* = angle *BAD* = $\dfrac{3}{10}$ radians and *OA* = 20 mm.



(a) Show that angle $BOA = \dfrac{2}{5}$ rad. [1]

(b) Find the length of arc *AB*, leaving your answer in terms of . [1]

(c) Find angle BOC. [1]

(d) Calculate the area of the shaded region. [3]

(e) Find angle *BOA* in degrees. [1]

(f) The unshaded region forms a company logo. An enlarged copy of the logo is made. In the enlargement, *AD* = 60 mm. Find the area of the enlarged logo. [2]

---

3 The cash price of a car is \$74 000. Mr Smith is introduced to two types of payment schemes.

	Scheme *A*	**Scheme *B***
Down payment	40%	60%
Simple interest rate (per annum)	3.28%	R %
Loan period (years)	5	5

(a) Find the total amount that Mr Smith has to pay for the car, if he chose **Scheme *A***. [2]

(b) If Mr Smith chose **Scheme *B***, the monthly instalment he has to pay over 5 years is \$572.76. Calculate the value of R. [3]

(c) One day the exchange rate between US dollar (US\$) and Singapore dollars (S\$) was US\$1 = S\$1.27 .

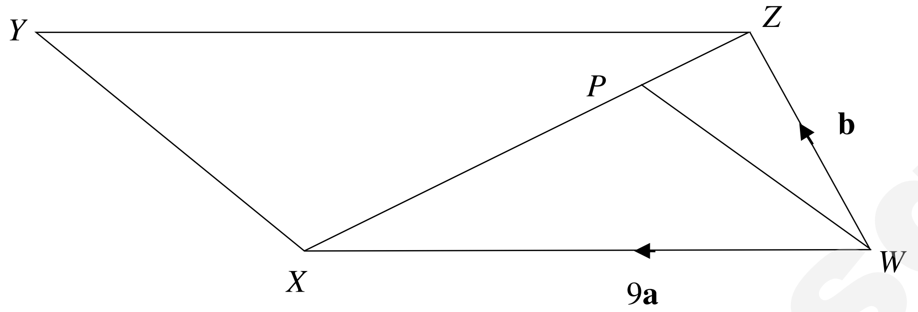
On the same day, the exchange rate between British pound (£) and US dollar was £1 = US\$1.33.

Calculate the cash price of the car in pounds, correct to the nearest pound. [2]

4 In the diagram, $WXYZ$ is a trapezium and WX is parallel to ZY.

The point P on XZ is such that $ZP : PX = 1 : 3$ and $WX : ZY = 3 : 4$.

It is given that $\overrightarrow{WX} = 9\mathbf{a}$ and $\overrightarrow{WZ} = \mathbf{b}$.



(a) Express, as simply as possible, in terms of **a** and **b**,

(i) $\overrightarrow{ZX}$, [1]

(ii) $\overrightarrow{WP}$, [1]

(iii) $\overrightarrow{YW}$. [1]

(b) Show that the line XY is parallel to the line WP. [2]

(c) Find, as a fraction in its simplest form,

(i) $\dfrac{\text{area of } WZP}{\text{area of } WXP}$, [1]

(ii) $\dfrac{\text{area of } WZP}{\text{area of } YXZ}$. [2]

---

5 **Answer the whole of this question on a sheet of graph paper.**

A group of friends founded a new social networking website. The table below shows the number of members at the beginning of each week over a period of 7 weeks.

Week (x)	0	1	2	3	4	5	6	7
Total number of members (y)	5	15	35	p	90	145	230	400

(a) Using a scale of 2 cm to 1 week, draw a horizontal x-axis for $0 \quad x \quad 7$.
Using a scale of 2 cm to 50 members, draw a vertical y-axis for $0 \quad y \quad 400$.
On your axes, plot the points given in the table and join them with a smooth curve. [3]

(b) Use your graph to estimate

(i) the value of p, [1]

(ii) the week that the total number of members reaches 300. [1]

(c) **(i)** By drawing a tangent, find the gradient of the curve at $x = 4$. [2]

(ii) What does this gradient represent? [2]

(d) The group of friends wish to estimate what the total number of members will be in one year's time. They propose to extend the graph line up to week, $x = 52$.
Explain why is it not possible to estimate the total number of members in this way. [1]

---

6 The distance between two houses, P and Q, is 200 km. Joe travelled by car from P to Q at an average speed of x km/h.

(a) Write down an expression, in terms of x, for the number of hours he took to travel from P to Q. [1]

(b) He returned from Q to P at an average speed of which was 5 km/h more than the first journey.
Write down an expression, in terms of x, for the number of hours he took to travel from Q to P. [1]

(c) The difference between the two times was 24 minutes.
Write down an equation in x to represent this information, and show that it reduces to

$$x^2+5x \quad 2500=0.$$ [3]

(d) Solve the equation $x^2+5x \quad 2500=0$, giving each answer correct to three decimal places. [3]

(e) Calculate the time that Joe took to travel from P to Q, giving your answer in hours, minutes and seconds, correct to the nearest second. [2]

---

7 **(a)** Jim exercises on Monday and Wednesday.

On Monday, he jogs for 10 minutes, cycles for 20 minutes and swims for 30 minutes.
On Wednesday, he jogs for 20 minutes, cycles for 10 minutes and swims for 15 minutes.

This information can be represented by the matrix $\mathbf{Q} = \begin{array}{cc} \begin{matrix} \text{J} & \text{C} & \text{S} \end{matrix} & \\ \begin{pmatrix} 10 & 20 & 30 \\ 20 & 10 & 15 \end{pmatrix} & \begin{matrix} \text{Mon} \\ \text{Wed} \end{matrix} \end{array}$.

(i) Evaluate the matrix $\mathbf{P} = 60\mathbf{Q}$. [1]

(ii) Jim's exercising speeds are the same for Monday and Wednesday.

His jogging speed is 4 m/s, cycling speed is 5.5 m/s and swimming speed is 1.3 m/s.

Represent his exercising speeds in a 3 1 column matrix **S**. [1]

(iii) Evaluate the matrix $\mathbf{R} = \mathbf{PS}$. [2]

(iv) State what the elements of **R** represent. [1]

(b) The cost of a shirt is $\$C$. If the shirt is sold at \$60, a shop makes a profit of $x\%$ on the cost price.

(i) Write down an equation in C and x to represent this information and show that it simplifies to

$$6000 - 100C = Cx.$$

[1]

If the shirt is sold at \$24, the shop makes a loss of $2x\,\%$ on the cost price.

(ii) Write down an equation in C and x to represent this information. [1]

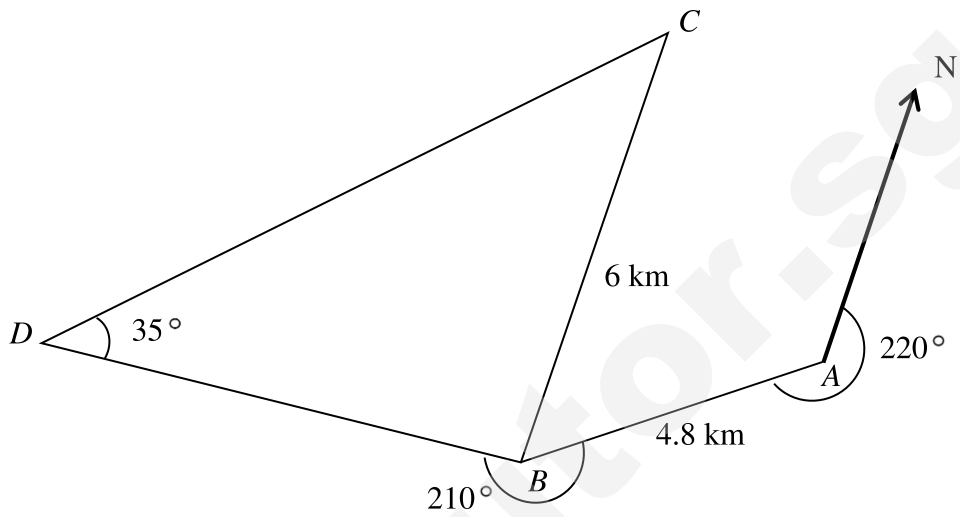
(iii) Solve these two equations to find the value of C and the value of x. [3]

(iv) Calculate the selling price of the shirt if the profit is 45% of the cost price. [2]

8 The diagram shows a triangular park BCD and the route that Ali has cycled.

Ali cycles from his home, A, on a bearing of $220°$ towards point B of the park. The distance from A to B is 4.8 km. From B, he cycles to C, which is 6 km away, and he continues to D.

C is due north of B. Reflex angle $ABD = 210°$ and angle $BDC = 35°$.



(a) Show that BCD is an isosceles triangle. [1]

(b) Calculate the

(i) distance of AC, [3]

(ii) area of the park BCD, [2]

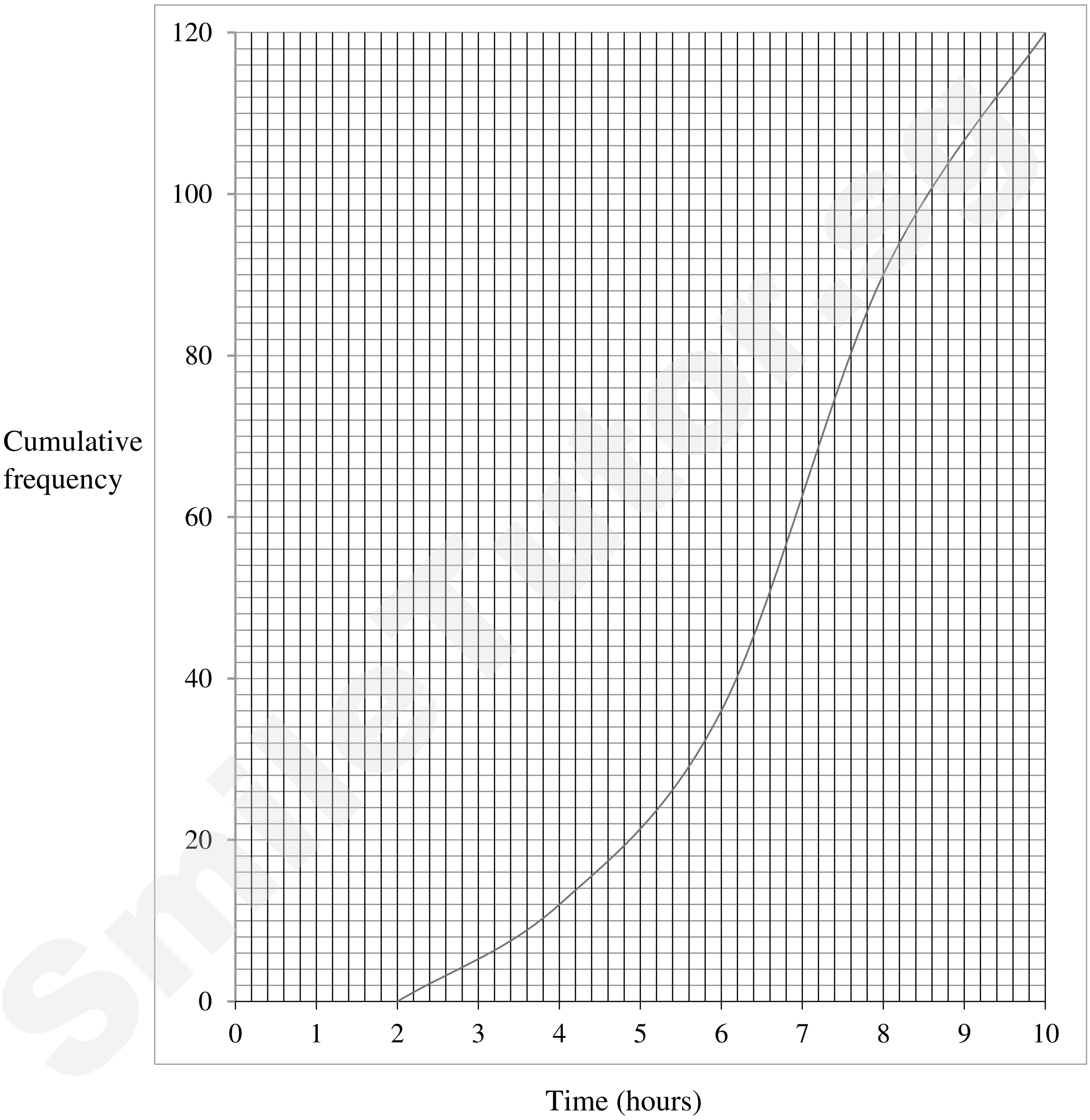
(iii) angle BAC, [2]

(iv) shortest distance from B to CD. [2]

(c) A building stands vertically at B. The angle of depression of C when viewed from the top of the building is $40°$. Find the height of the building. [2]

9 120 visitors took a survey on the number of hours they spent at the Gardens by the Bay in February 2016.

The cumulative frequency curve below shows the distribution of the time spent.



(a) Use the curve to estimate

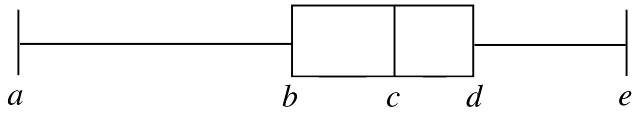
(i) the median time, [1]

(ii) the interquartile range of the times, [2]

(iii) the percentage of visitors who spent at least 4 hours at the Gardens by the Bay. [2]

(b) It was discovered that the number of hours has been recorded incorrectly. The correct number of hours was all 1 hour less than those recorded.

The box-and-whisker plot shows the correct distribution of hours.



Find the value of

(i) c , [1]

(ii) $e - a$. [1]

(c) The table below shows the results of the survey conducted on another 120 visitors on the number of hours they spent at the Gardens by the Bay in June 2016.

Number of hours spent (x h)	**Number of visitors**
$2 < x \quad 4$	33
$4 < x \quad 6$	46
$6 < x \quad 8$	30
$8 < x \quad 10$	11

Calculate an estimate of the

(i) mean time that the visitors spent in June, [1]

(ii) standard deviation. [2]

(d) The programme management team at the Gardens by the Bay commented that the visitors generally spent longer hours in February 2016 than in June 2016.

Justify if the comment is valid. [2]

10 A solid cone is cut into 2 parts, *X* and *Y*, by a plane parallel to the base.

The length of *AB* = the length of *BC*.

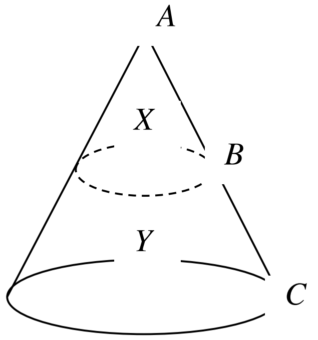


Diagram I

(a) Given that the volume of the solid cone is $\frac{64}{3}$ m^3, find the volume, in terms of , of the frustum, *Y*. [3]

(b) In **Diagram II**, a rocket can be modelled from a cylinder of height, *h*, 94.2 m with a cone, *X*, on top and a frustum, *Y*, at the bottom. The cone, *X*, has a diameter, d_2, of 4 m and the frustum, *Y*, has a base diameter, d_1, of 8 m. The parts *X* and *Y* are taken from **Diagram I** above.

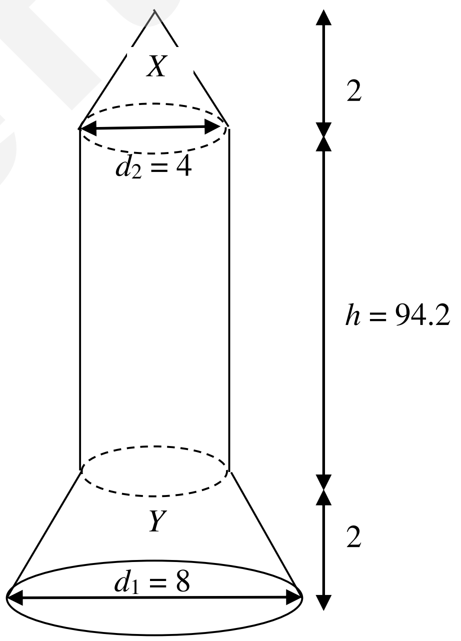


Diagram II

(i) Calculate the total surface area of the rocket. Give your answer correct to the nearest square meter. [3]

(ii) Calculate the volume, in cubic metres, of the rocket. [1]

(iii) The rocket is designed to launch to the moon.

Useful information

- Distance of moon from earth: 384 400 km
- Speed of rocket: 800 km /minute
- 1 m^3 = 264 gallon
- The rocket is filled with liquid fuel to a maximum of 95% of its volume.
- Rate of fuel consumption: 20 000 gallons /minute
- Capacity of each external fuel tank: $3.2 \quad 10^6$ gallons

How many external fuel tanks will the rocket require to sustain its journey to the moon?

Justify your answer with calculations. [4]

Class Index Number

Name : ___________________________________

METHODIST GIRLS' SCHOOL

Founded in 1887

PRELIMINARY EXAMINATION 2016
Secondary 4

Tuesday	**MATHEMATICS**	**4048/02**
16 August 2016	**Paper 2**	2 h 30 mins

INSTRUCTIONS TO CANDIDATES

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$$\text{Total amount} = P\left(1+\frac{r}{100}\right)^n$$

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$$\text{Curved surface area of a cone} = \pi rl$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3}\pi r^3$$

$$\text{Area of triangle } ABC = \frac{1}{2}ab\sin C$$

$$\text{Arc length} = r\theta, \text{ where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2}r^2\theta, \text{ where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

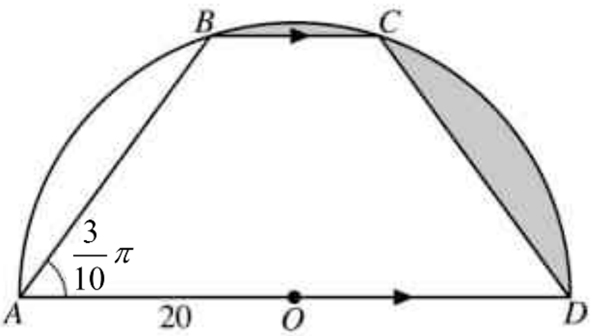
$$a^2 = b^2 + c^2 - 2bc\cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

Answer **all** the questions.

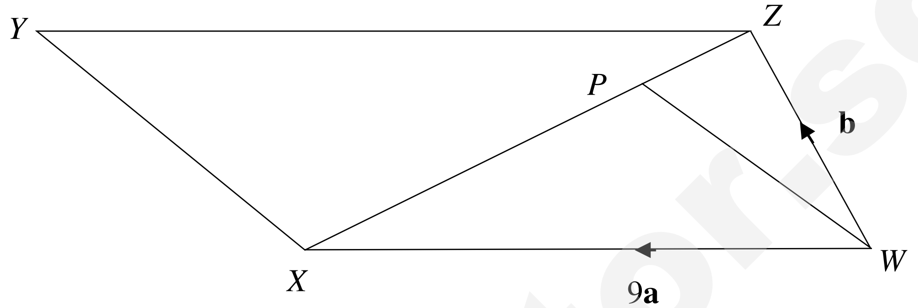
1	**(a)**	Given that $8 \quad x \quad 4$ and $3 \quad y \quad 2$, find		
		(i)	the least value of xy, **–16**	[1]
		(ii)	the greatest value of $x^2 \quad y^2$. **64**	[1]
	(b)	Express as a single fraction in its simplest form		
		(i)	$\dfrac{x-z}{xz}$	[2]
		(ii)	$\dfrac{x^2(x+y-z)}{3}$	[2]
	(c)	It is given that $2pq=\sqrt{\dfrac{4q^2+p^2}{2}}$. Express q in terms of p. $q=\pm\sqrt{\dfrac{p^2}{4(2p^2-1)}}$ or $q=\pm\dfrac{p}{2\sqrt{2p^2-1}}$ or $q=\pm\sqrt{\dfrac{p^2}{8p^2-4}}$		[3]
2	In the diagram, $OABCD$ is a semicircle with centre at O. AD // BC, angle CDA = angle BAD = $\dfrac{3}{10}$ radians and OA = 20 mm. 			
	(a)	Show that angle $BOA=\dfrac{2}{5}$ rad. ΔBOA is an isosceles triangle		[1]

	(b)	Find the length of arc AB, leaving your answer in terms of . 8π mm	[1]
	(c)	Find angle BOC. $\frac{\pi}{5}$ rad	[1]
	(d)	Calculate the area of the shaded region. 69.2 mm^2	[3]
	(e)	Find angle BOA in degrees. 72°	[1]
	(f)	The unshaded region forms a company logo. An enlarged copy of the logo is made. In the enlargement, AD = 60 mm. Find the area of the enlarged logo. $1260\,\text{mm}^2$	[2]
3	The cash price of a car is $74 000. Mr Smith is introduced to two types of payment schemes.		

	Scheme *A*	**Scheme *B***
Down payment	40%	60%
Simple interest rate (per annum)	3.28%	R %
Loan period (years)	5	5

	(a)	Find the total amount that Mr Smith has to pay for the car, if he chose **Scheme *A***. $81281.60	[2]
	(b)	If Mr Smith chose **Scheme *B***, the monthly instalment he has to pay over 5 years is $572.76. Calculate the value of R. $R = 3.22$	[3]
	(c)	One day the exchange rate between US dollar (US$) and Singapore dollars (S$) was US$1 = S$1.27 . On the same day, the exchange rate between British pound (£) and US dollar was £1 = US$1.33.	

		Calculate the cash price of the car in pounds, correct to the nearest pound. £43810		[2]

4	In the diagram, $WXYZ$ is a trapezium and WX is parallel to ZY. The point P on XZ is such that $ZP : PX = 1 : 3$ and $WX : ZY = 3 : 4$. It is given that $\overrightarrow{WX} = 9\mathbf{a}$ and $\overrightarrow{WZ} = \mathbf{b}$. 			
	(a)	Express, as simply as possible, in terms of **a** and **b**,		
		(i)	$\overrightarrow{ZX} = -\mathbf{b} + 9\mathbf{a}$	[1]
		(ii)	$\frac{3}{4}(\mathbf{b} + 3\mathbf{a})$	[1]
		(iii)	$-\mathbf{b} - 12\mathbf{a}$	[1]
	(b)	Show that the line XY is parallel to the line WP. Since $\overrightarrow{WP} = \frac{3}{4}\overrightarrow{XY}$ XY is parallel to WP.		[2]
	(c)	Find, as a fraction in its simplest form,		
		(i)	$\frac{\text{area of } WZP}{\text{area of } WXP}, = \frac{1}{3}$	[1]
		(ii)	$\frac{3}{6}$	[2]

5 **Answer the whole of this question on a sheet of graph paper.**

A group of friends founded a new social networking website. The table below shows the number of members at the beginning of each week over a period of 7 weeks.

Week (x)	0	1	2	3	4	5	6	7
Total number of members (y)	5	15	35	p	90	145	230	400

(a) Using a scale of 2 cm to 1 week, draw a horizontal x-axis for $0 \quad x \quad 7$.
Using a scale of 2 cm to 50 members, draw a vertical y-axis for $0 \quad y \quad 400$.
On your axes, plot the points given in the table and join them with a smooth curve. [3]

(b) Use your graph to estimate

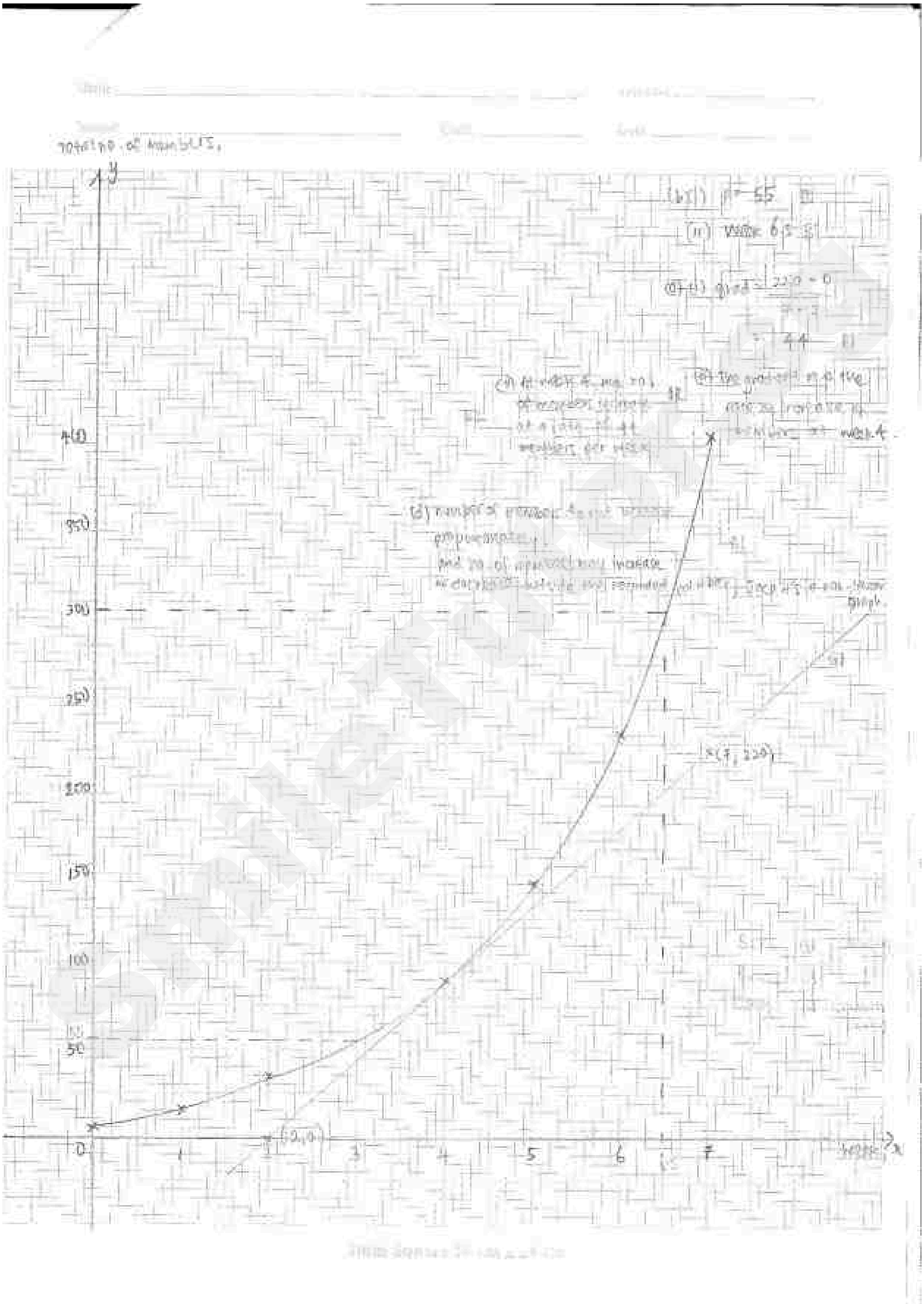
(i) the value of p, [1]

(ii) the week that the total number of members reaches 300. [1]

(c) **(i)** By drawing a tangent, find the gradient of the curve at $x = 4$. [2]

(ii) What does this gradient represent? [2]

(d) The group of friends wish to estimate what the total number of members will be in one year's time. They propose to extend the graph line up to week, $x = 52$.
Explain why is it not possible to estimate the total number of members in this way. [1]


y
400
350
300
250
200
150
100
50
0
1
2
3
4
5
6
7
x
(2, 0)
(7, 220)
(b)(i) $p = 55$
(ii) Week 6.5
= 44

6	The distance between two houses, P and Q, is 200 km. Joe travelled by car from P to Q at an average speed of x km/h.		
	(a)	Write down an expression, in terms of x, for the number of hours he took to travel from P to Q. $\text{time} = \frac{200}{x} h$	[1]
	(b)	He returned from Q to P at an average speed of which was 5 km/h more than the first journey. Write down an expression, in terms of x, for the number of hours he took to travel from Q to P. $\text{time} = \frac{200}{x+5} h$	[1]
	(d)	Solve the equation $x^2 + 5x \quad 2500 = 0$, giving each answer correct to three decimal places. 47.562 or -52.562	[3]
	(e)	Calculate the time that Joe took to travel from P to Q, giving your answer in hours, minutes and seconds, correct to the nearest second. $4\text{h}\,12\text{min}\,18\text{sec}$ (nearest sec)	[2]

7	**(a)**	Jim exercises on Monday and Wednesday. On Monday, he jogs for 10 minutes, cycles for 20 minutes and swims for 30 minutes. On Wednesday, he jogs for 20 minutes, cycles for 10 minutes and swims for 15 minutes. This information can be represented by the matrix $\mathbf{Q} = \begin{array}{c} \begin{array}{ccc} \text{J} & \text{C} & \text{S} \end{array} \\ \begin{pmatrix} 10 & 20 & 30 \\ 20 & 10 & 15 \end{pmatrix} \end{array} \begin{array}{l} \\ \text{Mon} \\ \text{Wed} \end{array}$.		
		(i)	Evaluate the matrix $\mathbf{P} = 60\mathbf{Q}$. $\begin{pmatrix} 600 & 1200 & 1800 \\ 1200 & 600 & 900 \end{pmatrix}$	[1]
		(ii)	Jim's exercising speeds are the same for Monday and Wednesday.	

His jogging speed is 4 m/s, cycling speed is 5.5 m/s and swimming speed is 1.3 m/s. [1]

Represent his exercising speeds in a 3 1 column matrix **S**.

$$\mathbf{S} = \begin{pmatrix} 4 \\ 5.5 \\ 1.3 \end{pmatrix}$$

(iii) Evaluate the matrix **R** = **PS**. [2]

$$\mathbf{R} = \begin{pmatrix} 11340 \\ 9270 \end{pmatrix}$$

(iv) State what the elements of **R** represent. [1]

The elements of **R** represent the distance, in metres, that Jim has exercised on Monday and Wednesday, respectively. A1

(b) The cost of a shirt is $$C$. If the shirt is sold at $60, a shop makes a profit of x% on the cost price.

(i) Write down an equation in C and x to represent this information and show that it simplifies to

$$6000 - 100C = Cx.$$

[1]

If the shirt is sold at $24, the shop makes a loss of $2x$ % on the cost price.

(ii) Write down an equation in C and x to represent this information. [1]

$100C - 2400 = 2Cx$

(iii) Solve these two equations to find the value of C and the value of x. [3]

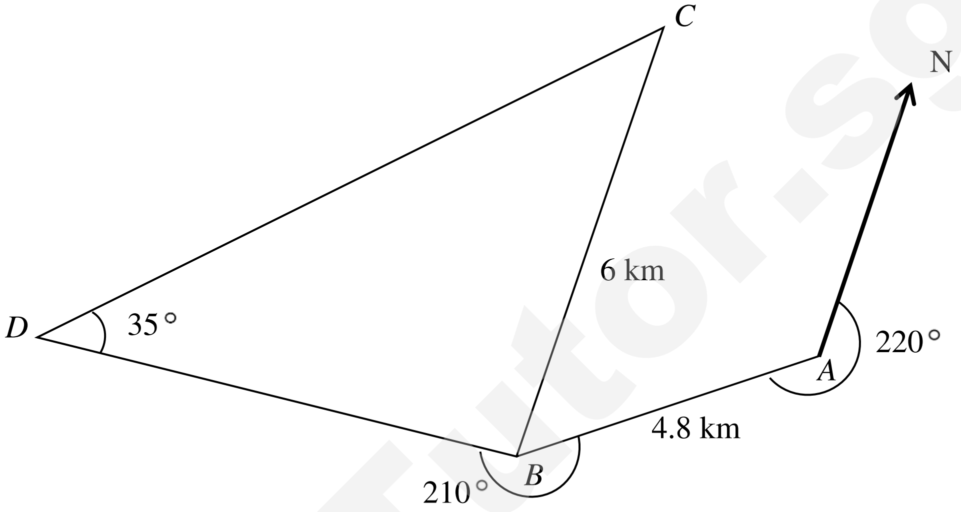
$C = 48$

$x = 25$

(iv) Calculate the selling price of the shirt if the profit is 45% of the cost price. [2]

A1+A1

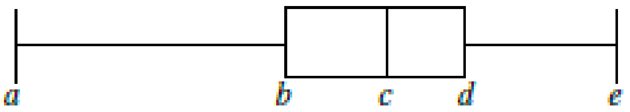
$69.60

8	The diagram shows a triangular park *BCD* and the route that Ali has cycled. Ali cycles from his home, *A*, on a bearing of 220° towards point *B* of the park. The distance from *A* to *B* is 4.8 km. From *B*, he cycles to *C*, which is 6 km away, and he continues to *D*. *C* is due north of *B*. Reflex angle $ABD = 210°$ and angle $BDC = 35°$. 			
	(b)	Calculate the		
		(i)	distance of *AC*, $3.86\,\text{km}^2$ (to 3 sf)	[3]
		(ii)	area of the park *BCD*, $16.9\,\text{km}^2$	[2]
		(iii)	angle *BAC*, $87.0°$ (to 1 dp)	[2]
		(iv)	shortest distance from *B* to *CD*. $3.44\,\text{km}$ (to 3 sf)	[2]
	(c)	A building stands vertically at *B*. The angle of depression of *C* when viewed from the top of the building is $40°$. Find the height of the building. $5.03\,\text{km}$ (to 3 sf)		[2]

90%

(b) It was discovered that the number of hours has been recorded incorrectly. The correct number of hours was all 1 hour less than those recorded.

The box-and-whisker plot shows the correct distribution of hours.



Find the value of

(i) c, [1]

$c = 5.9$ **hours**

(ii) $e - a$. [1]

$e - a = 8$ **hours**

(c) The table below shows the results of the survey conducted on another 120 visitors on the number of hours they spent at the Gardens by the Bay in June 2016.

Number of hours spent (x h)	**Number of visitors**
$2 < x \quad 4$	33
$4 < x \quad 6$	46
$6 < x \quad 8$	30
$8 < x \quad 10$	11

Calculate an estimate of the

(i) mean time that the visitors spent in June, [1]

5.32 hours (to 3 sf)

(ii) standard deviation. [2]

standard deviation = 1.86 hours (to 3 sf)

(d) The programme management team at the Gardens by the Bay commented that the visitors generally spent longer hours in February 2016 than in June 2016. [2]

Justify if the comment is valid.

Median in June is $4 < x \quad 6$.

		The comment is invalid as median is in February (5.9 hours) is within the median class in June ($4 < x \quad 6$).	

10 A solid cone is cut into 2 parts, X and Y, by a plane parallel to the base.

The length of AB = the length of BC.

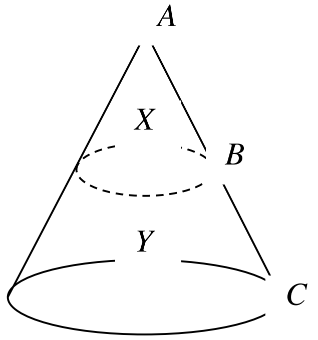


Diagram I

(a) Given that the volume of the solid cone is $\frac{64}{3}$ m^3, find the volume, in terms of , of the frustum, Y. [3]

$\frac{56}{3}\pi$ m^3

(b) In **Diagram II**, a rocket can be modelled from a cylinder of height, h, 94.2 m with a cone, X, on top and a frustum, Y, at the bottom. The cone, X, has a diameter, d_2, of 4 m and the frustum, Y, has a base diameter, d_1, of 8 m. The parts X and Y are taken from **Diagram I** above.

M1

A1

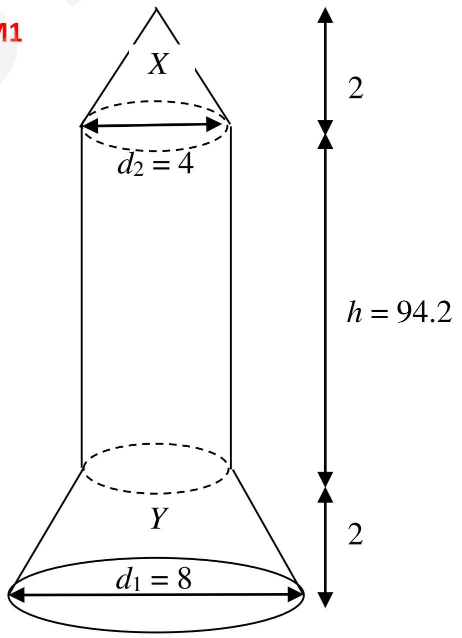


Diagram II

(i) Calculate the total surface area of the rocket. Give your answer correct to the nearest square meter. [3]

$1305\,\text{m}^2$ (to nearest square metre)

M2

A1

		(ii)	Calculate the volume, in cubic metres, of the rocket. $1250\,\text{m}^3$ (to 3 sf)	[1]
		(iii)	The rocket is designed to launch to the moon. **Useful information** • Distance of moon from earth: 384 400 km • Speed of rocket: 800 km /minute • 1 m^3 = 264 gallon • The rocket is filled with liquid fuel to a maximum of 95% of its volume. • Rate of fuel consumption: 20 000 gallons /minute • Capacity of each external fuel tank: $3.2 \quad 10^6$ gallons How many external fuel tanks will the rocket require to sustain its journey to the moon? Justify your answer with calculations. Therefore, number of external tanks required is 3.	[4]

O-Level Centre / Index Number	Class	Name
/		

新加坡海星中学

MARIS STELLA HIGH SCHOOL
PRELIMINARY EXAMINATION TWO
SECONDARY FOUR

MATHEMATICS **4048/1**
Paper 1 **15 August 2016**
2 hours

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** the questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
The use of an approved scientifc calculator is expected, where appropriate.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give your answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 80.

For Examiner's Use		
Subtotal		
Presentation		
Accuracy		80
Units		
Deduction		

This document consists of 18 printed pages.

Mathematical Formulae

Compound Interest

$$\text{Total amount} = p\left(1+\frac{r}{100}\right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi r l$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3}\pi r^3$$

$$\text{Area of triangle } ABC = \frac{1}{2}ab\sin C$$

$$\text{Arc length} = r\theta\text{, where } \theta \text{ is in radians}$$

$$\text{Sector area } = \frac{1}{2}r^2\theta\text{, where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

1 The Basal Metabolic Rate (BMR) is the number of calories one would burn with NO activity. It is given by the following formula:

$$\text{BMR for males} = 66 + 13.7 \times m + 5.0 \times h - 6.8 \times a,$$

where m is mass in kg, h is height in cm and a is age in years.
Given that $m = 65.5$, $h = 170$ and $a = 29$,

(a) Calculate the BMR and write down the first five digits on your calculator display.

Answer ……………………..Calories [1]

(b) Write your answer to part (a) correct to 3 significant figures.

Answer ……………………..Calories [1]

---

2 **(a)** Write down the next two terms in the sequence

$$21,\ 18\frac{2}{3},\ 16\frac{1}{3},\ 14,\ 11\frac{2}{3},\ ...$$

Answer ……………..………………. [1]

(b) Write down an expression, in terms of n, for the nth term of the sequence

$$8,\ 3,\ -2,\ -7,\ -12,\ ...$$

Answer ………………..……………. [1]

---

3 **(a)** Given that $243 \div 9^{-x} = 3^8$, find the value of x.

Answer …………………..…………. [1]

(b) A StarHub Smart TV Digital Video Storage Device has a capacity of 1 terabyte. If a drama television series episode takes up 2.94 gigabytes of storage space, how many episodes can be recorded on the storage device? Give your answer in standard form.

Answer ……………..………………. [1]

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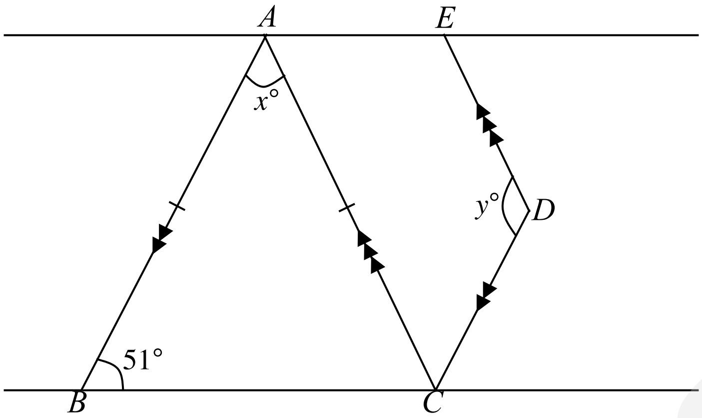
4 In the diagram, $AB = AC$, $\angle ABC = 51°$, AB is parallel to DC and AC is parallel to ED.



(a) Find x.

Answer $x =$ …………….…………… [1]

(b) Find y.

Answer $y =$ …………….…………… [1]

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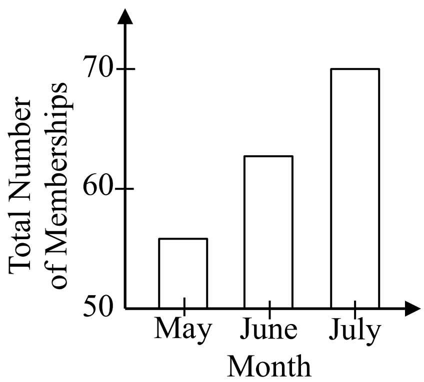
5 A True Fitness Branch Manager reported that there has been a marked improvement in the monthly sales of gym membership from May to July by presenting the following graph.



Explain why the graph is misleading and how the graph can be rectified.

Answer ………………………...…………………………………………………...

……………………………………………………………………………………....

………………………………………………………………………………………

……………………………………………………………………………….. [2]

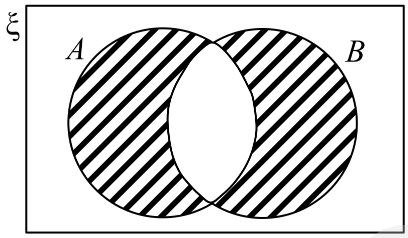
---

6 Simplify $(p^2-4)^2-(p^2+4)^2$.

Answer ……………………………………… [2]

---

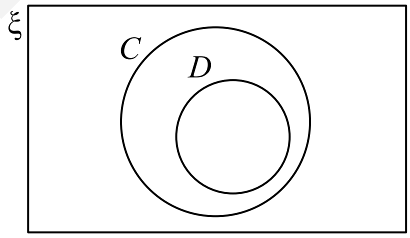
7 **(a)** Identify the set shaded in the Venn diagram below.



Answer ……………………………………… [1]

(b) Shade $(C \cap D')'$ in the Venn diagram below.

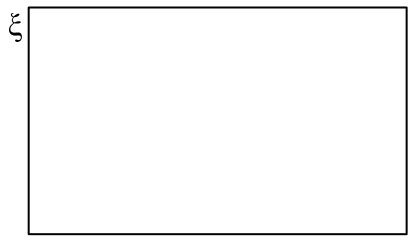
Answer



[1]

(c) If $P \subset Q$ and $Q \cap R = \{\ \}$, illustrate this information on the Venn diagram below and shade $P \cup Q$.

Answer



[1]

---

8 By Coulomb's law, the electric force, F N, between two balloons is inversely proportional to the square of the distance, d m, between them.

(a) If $F = 0.626$, when $d = 2$, find an equation for F in terms of d.

Answer $F =$ …………………………… [2]

(b) Calculate the distance between the balloons when the electric force is 1N.

Answer ……………………………….m [1]

---

9 The Soup Spoon Restaurant sells soup in geometrically similar bowls of different sizes. The regular sized bowl has a height of 8cm and capacity 250ml. The large sized bowl has a height of 12cm and a base diameter of 21cm.

(a) Calculate the base diameter of the regular sized bowl.

Answer ………………………………cm [1]

(b) Calculate the capacity of the large sized bowl.

Answer ………………………………..ml [2]

---

10 **(a)** Factorise completely $2.25x^2 - 0.64y^2$.

Answer …………………………………… [1]

(b) Factorise completely $9x^2 - 4xy - 18xyz + 8y^2z$.

Answer …………………………………… [2]

---

11 The angles, in degrees of a quadrilateral $ABCD$ are represented by these expressions: Angle $A = 3y + 40$, angle $B = 5y - 10$, angle $C = 6y - 20$, and angle $D = 2y + 30$.

(a) Calculate the value of y.

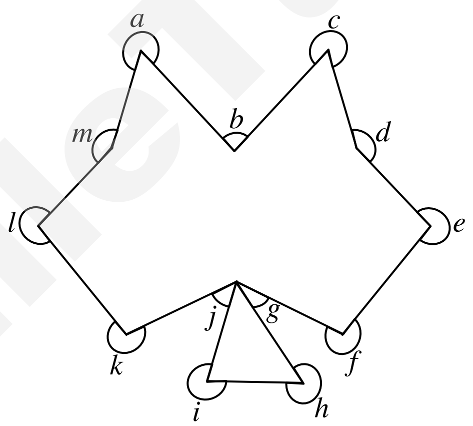
Answer $y =$ ……………………………… [2]

(b) What is the name of the quadrilateral?

Answer …………………………………… [1]

---

12 Calculate the sum of the angles a, b, c, d, e, f, g, h, i, j, k, l and m in this diagram.



Answer …………………………………… [3]

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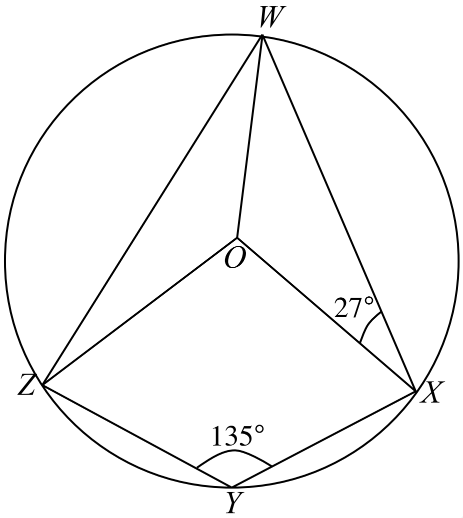
13 W, X, Y, Z are points on the circumference of a circle with centre O. Given that $\angle XYZ = 135°$ and $\angle OXW = 27°$,



(a) Find $Z\hat{W}X$. Give a reason for your answer.

Answer $Z\hat{W}X$ = ……………….. because …………………………………………..

……………………………………………..…………………………………… [1]

(b) Find $Z\hat{W}O$.

Answer ………………………………..…… [2]

---

14 Two fair dice are tossed. Calculate the probability that

(a) both numbers obtained are even,

Answer ………………………………..…… [1]

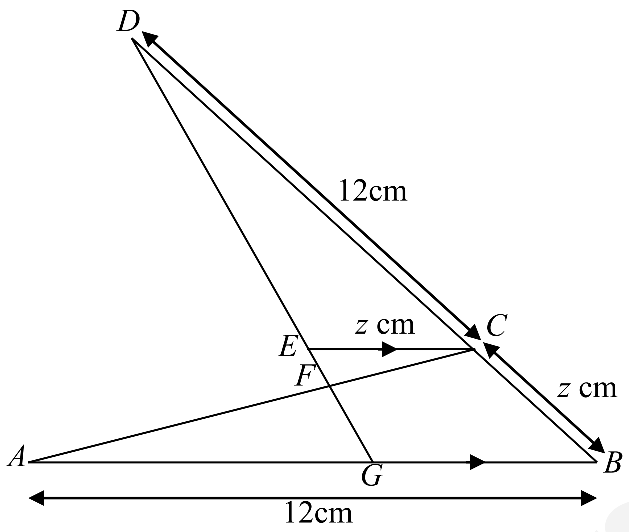
(b) the product of the two numbers obtained is a prime number,

Answer ………………………………..…… [1]

(c) the sum of the two numbers obtained is a prime number.

Answer ………………………………..…… [1]

15 In the diagram, $AB = CD = 12$ cm, $BC = CE = z$ cm and AB is parallel to EC.



Name the triangle that is congruent to triangle ABC. Justify your answer.

Answer …………………….. because …………………………………………….

………………………………………………………………………………………

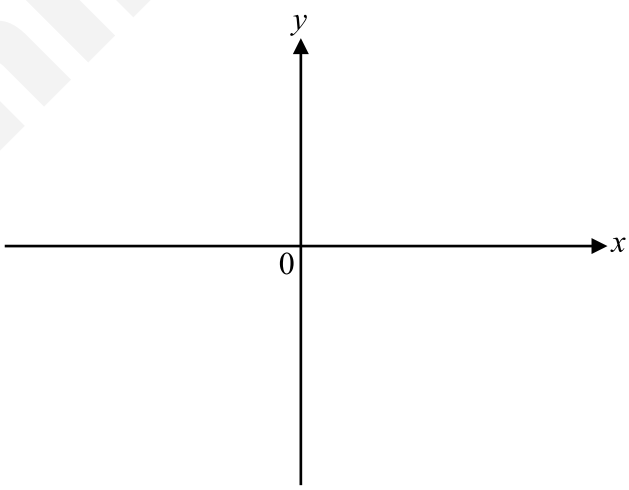
………………………………………………………………………………………

…………………………………………………………………………….. [3]

---

16 **(a)** Sketch the graph of $y = -(2x+1)(x-3)$.

Answer



[2]

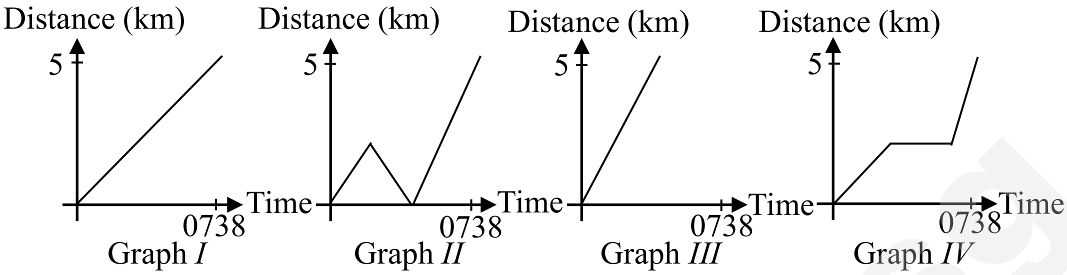
(b) Write down the equation of the line of symmetry of the graph $y = -(2x+1)(x-3)$.

Answer ……………………………….…… [1]

---

17 In order to maintain a healthy lifestyle, 5 students in a certain neighbourhood cycle to the same school.

(a) Below are four graphs and accounts by 4 students. Match each of the graphs to the student's name that best fit each of the accounts.



Aloysius: I was on my way to school when a cat suddenly cut into my path! Luckily, I managed to brake on time. After I got over the shock, I realized I was going to be late. So, I sped up!

Benedict: My teacher warned me not to be late again, so this time round, I cycled faster and I was among the first few to reach school.

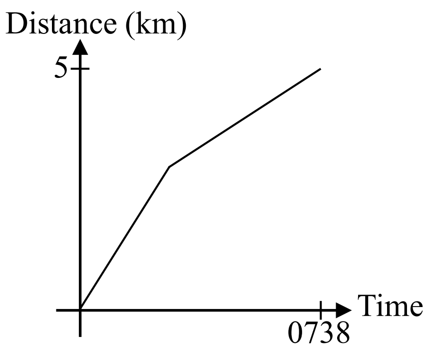
Charles: I just left home and discovered that I did not bring my wallet! So I went home again but I still managed to reach school on time.

Dominic: I cycled to school as usual and reached school before morning assembly.

Answer Graph *I* ……………………. Graph *II* …………………….

Graph *III* ……………………. Graph *IV* …………………….. [2]

(b) Write down what Edward might say based on the sketch of his travel graph below.



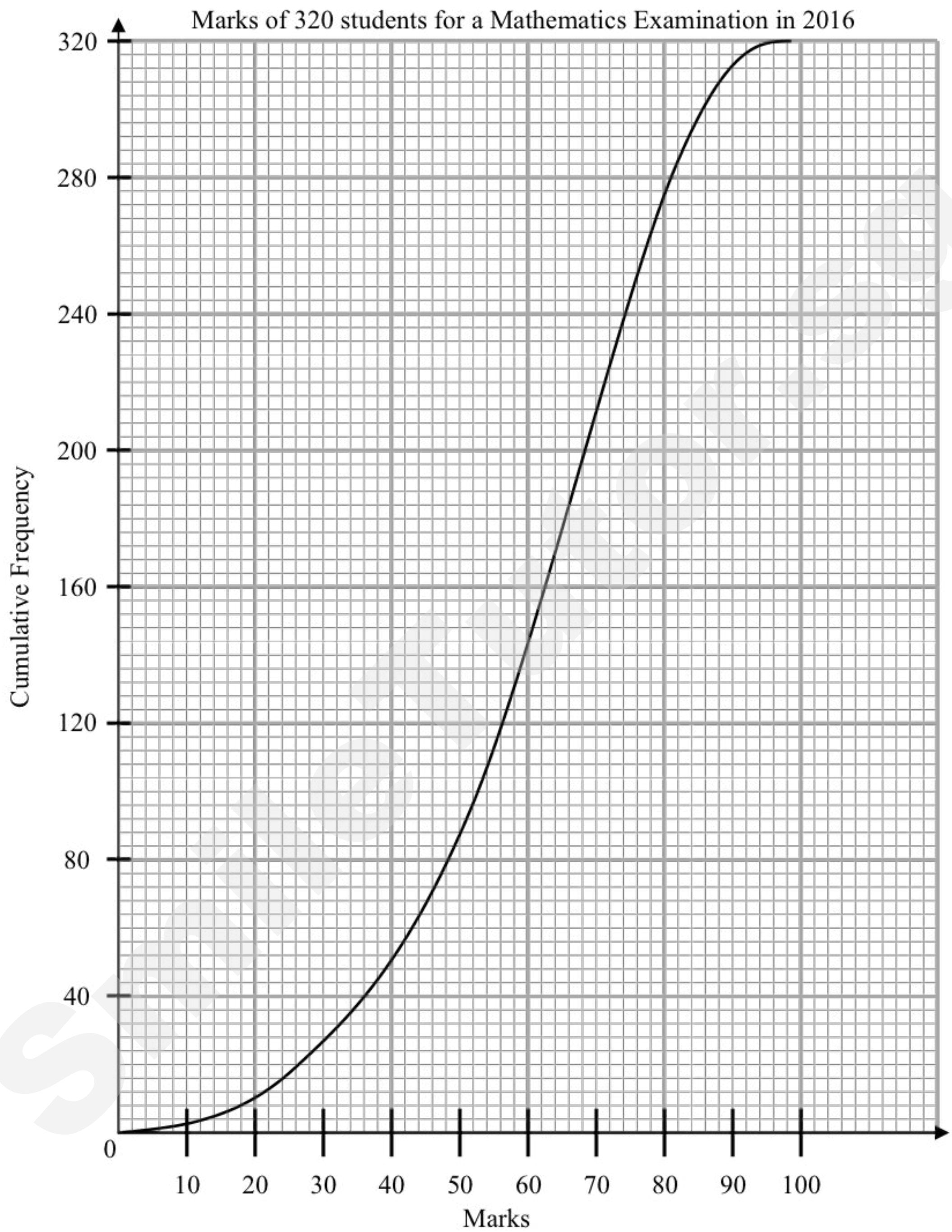
Answer ……………………………………………………………………………

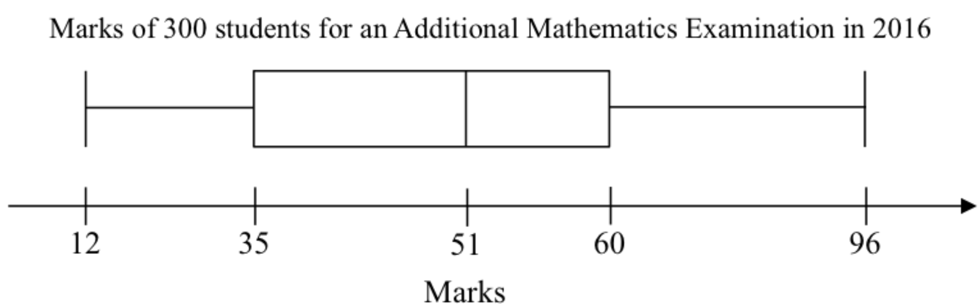
……………………………………………………………………………………

……………………………………………………………………………………

…………………………………………………………………………….. [1]

18 The cumulative frequency curve and box plot show the distributions of marks scored by 320 students in a Mathematics examination and 300 students inr an Additional Mathematics examination respectively.





(a) Find the interquartile range for the Mathematics examination.

Answer …………………………….……. [1]

(b) Here are two statements comparing the marks for the two examinations.

For each one, write whether you agree or disagree.
Give a reason for each answer, stating clearly which statistic you use to make your decision.

(i) On average, students performed better for the Additional Mathematics examination than the Mathematics examination.

Answer .... because …………………………………..

……………………………………………………………………..

…………………………………………………………………… [1]

(ii) A smaller proportion of the students scored less than 35 marks at the Mathematics examination than at the Additional Mathematics examination. [1]

Answer .... because …………………………………..

……………………………………………………………………..

…………………………………………………………………… [1]

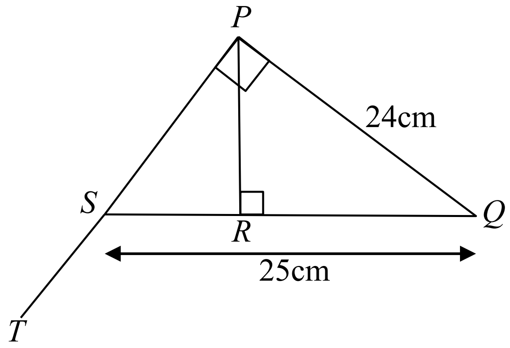
19 **(a)** Express $-x^2 + 7x - 5$ in the form $-(x-a)^2 + b$.

Answer …………………………….……. [2]

(b) Hence solve the equation $-x^2 + 7x - 5 = 0$, giving your answers correct to two decimal places.

Answer …………..…. and ………..…….. [2]

20 In the diagram, $\angle QPS = \angle QRP = 90°$, $PQ = 24$ cm, $QS = 25$ cm, PST and QRS are straight lines.



Calculate

(a) PS

Answer ……………………….....…….cm [1]

(b) PR

Answer …………………………….....cm [2]

(c) $\cos\angle QST$

Answer …………………………….……. [1]

21 Challenger offers discounts to customers who pay $30 for a 2-year ValueClub membership.

Item	Members' discount
11" Apple MacBook Air	5% off
Seagate Backup Plus Slim Portable Drive 2TB	15% off
Valore Bluetooth Speaker	25% off

Dory wants to buy a MacBook Air which costs $1188. The salesperson suggests that she joins as a member.

(a) How much less does she pay in total if she joins as a member and buys the MacBook Air?

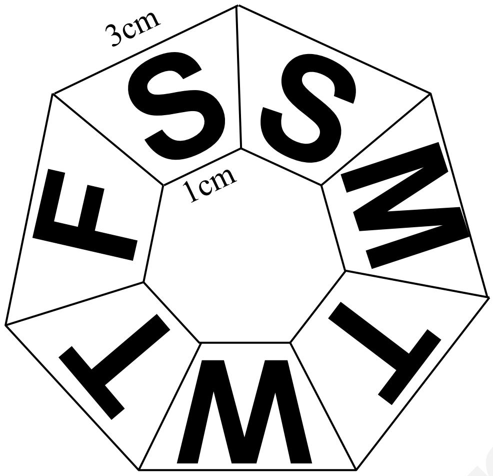
Answer $ .... [2]

After she joined as a member and bought the MacBook, the salesperson offers Dory a further 10% discount on the members' price for a portable drive and Bluetooth speaker in view of the Great Singapore Sale.

(b) Write down and simplify a formula for the total amount, T, that she needs to pay for a portable drive and Bluetooth speaker. Use d and s to represent the original price of a portable drive and a Bluetooth speaker respectively.

Answer $T =$ .... [2]

22 A pill box is in the shape of a regular heptagon with sides of length 3cm and has a hole in the centre in the shape of a regular heptagon with sides of length 1cm.



The height of the pill box is 2cm. Calculate the volume of the pill box.

Answer ……………………………. cm^3 [4]

23 **(a)** Solve the equation $\frac{4(7a-3)}{5}+\frac{5(2a+7)}{3}=\frac{5(5a-2)}{2}$.

Answer a = ……………………………… [3]

(b) Given that 2 is a solution of the quadratic equation $6(x-5)^2+k=38$, where k is a constant, find the

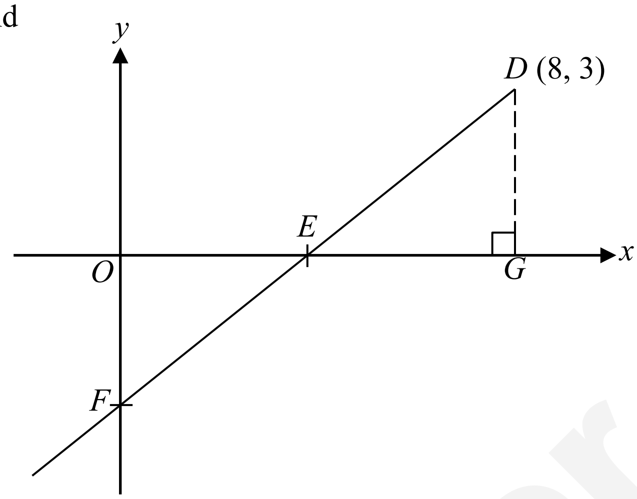
(i) value of k,

Answer k = ……………………………… [1]

(ii) other solution.

Answer x = ……………………………… [1]

24 In the diagram, D is the point (8, 3) and the line passing through the points D and F intersects the x-axis at the point E. Point G is on the x-axis such that the line DG is perpendicular to the x-axis. Given that the area of the triangle DEG is 6 units^2, find



(a) the coordinates of E,

Answer E(……….………,……….…….) [2]

(b) the equation of line FD,

Answer ……………………………….……. [2]

(c) the coordinates of F.

Answer F(……….………,……….…….) [1]

25 In 2008, the International Court of Justice (ICJ) awarded the sovereignty of the island, Pedra Branca (P) to Singapore. There are two maritime features near the island: Middle Rocks (M) and South Ledge (S). Middle Rocks is due west of Pedra Branca. The bearing of S from P is $200°$ with a distance of 1.0 Nautical Miles (nm) between them.

(a) (i) Construct a scaled drawing of the Triangle MPS using the scale 1 cm to represent 0.1 nm. Line MP has been drawn for you. [2]

(ii) Construct the perpendicular bisector of line MP. [1]

(iii) Construct the angle bisector of $\angle SMP$. [1]

(b) A ship in distress sends a SOS signal for help at a location within the Triangle MPS. The ship is known to be located in the triangle at a point that is nearer to MS than MP and equidistant from M and P.
Mark a possible point with a cross and label the point as W. [1]

O-Level Centre / Index Number	Class	Name
/		Solution

新加坡海星中学

MARIS STELLA HIGH SCHOOL
PRELIMINARY EXAMINATION TWO
SECONDARY FOUR

MATHEMATICS **4048/1**
Paper 1
15 August 2016
2 hours

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer all the questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
The use of an approved scientifc calculator is expected, where appropriate.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give your answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 80.

For Examiner's Use		
Subtotal		80
Presentation		
Accuracy		
Units		
Deduction		

This document consists of 18 printed pages.

Mathematical Formulae

Compound Interest

$$\text{Total amount} = p\left(1+\frac{r}{100}\right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi rl$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3}\pi r^3$$

$$\text{Area of triangle } ABC = \frac{1}{2}ab\sin C$$

$$\text{Arc length} = r\theta\text{, where } \theta \text{ is in radians}$$

$$\text{Sector area } = \frac{1}{2}r^2\theta\text{, where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin c}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

Statistics

$$\text{Mean } = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

1 The Basal Metabolic Rate (BMR) is the number of calories one would burn with NO activity. It is given by the following formula:

$$\text{BMR for males} = 66 + 13.7 \times m + 5.0 \times h - 6.8 \times a\,,$$

where m is mass in kg, h is height in cm and a is age in years.
Given that $m = 65.5$, $h = 170$ and $a = 29$,

(a) Calculate the BMR and write down the first five digits on your calculator display.

Answer ....1616·1..........Calories [1]

(b) Write your answer to part (a) correct to 3 significant figures.

Answer ....1620...........Calories [1]

---

2 **(a)** Write down the next two terms in the sequence

$$21,\ 18\frac{2}{3},\ 16\frac{1}{3},\ 14,\ 11\frac{2}{3},\ \ldots$$

Answer ..$9\frac{1}{3}$, 7.......................... [1]

(b) Write down an expression, in terms of n, for the nth term of the sequence

$$8,\ 3,\ -2,\ -7,\ -12,\ \ldots$$

Answer ..13−5n.......................... [1]

---

3 **(a)** Given that $243 \div 9^{-x} = 3^8$, find the value of x.

$3^5 \div 3^{-2x} = 3^8$

$3^{5+2x} = 3^8$

$\therefore 5+2x = 8$

$x = \frac{3}{2} = 1\frac{1}{2}$

Answer ..$1\frac{1}{2}$.......................... [1]

(b) A StarHub Smart TV Digital Video Storage Device has a capacity of 1 terabytes. If a drama television series episode takes up 2.94 gigabytes of storage space, how many episodes can be recorded on the storage device? Give your answer in standard form.

Number of episodes $= 1\times10^{12} \div 2.94\times10^{9}$

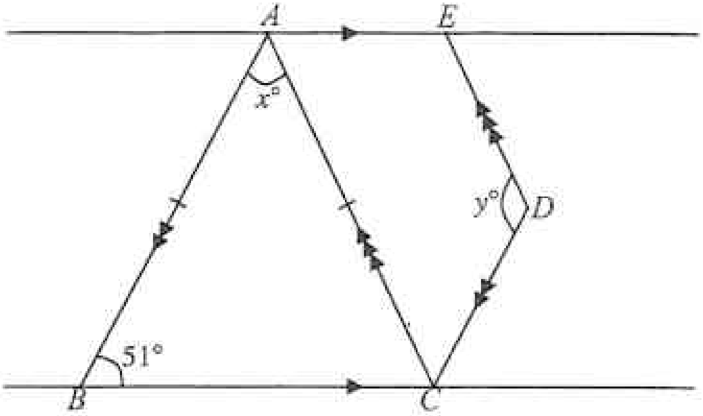
$= 340.14$ (5 sig fig.)

$= 3.40\times10^{2}$ (3 sig fig.)

Answer ..3.40×10^{2}.......................... [1]

---

4 In the diagram, $AB = AC$, $\angle ABC = 51°$, AB is parallel to DC and AC is parallel to ED.



(a) Find x.

$x° = 180° - 2\times51°$ (sum of $\angle$s in $\triangle$)
$= 78°$
$\therefore x = 78$

Answer $x =$ 78 .... [1]

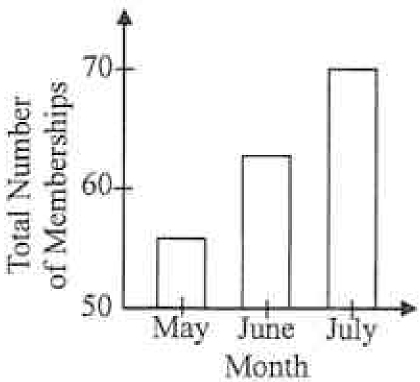
(b) Find y.

$\angle DCA = x° = 78°$ (alt $\angle$s, AB // CD)
$y° = 180° - 78°$ (int $\angle$s, AC // ED)
$= 102°$
$y = 102$

Answer $y =$ 102 .... [1]

---

5 A True Fitness Branch Manager reported that there has been a marked improvement in the monthly sales of gym membership from May to July by presenting the following graph.



Explain why the graph is misleading and how the graph can be rectified.

Answer The graph is misleading as the vertical axis does not start at zero. From this graph, it may show marked improvement in the sales, but if the graph were to start from zero, the improvement will not be significant. The graph can be rectified if the vertical axis starts from zero. [2]

6 Simplify $(p^2-4)^2-(p^2+4)^2$.

$= (p^2-4-p^2-4)(p^2-4+p^2+4)$

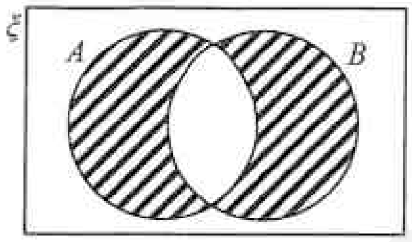
$= (-8)(2p^2)$

$= -16p^2$

Answer $-16p^2$ .... [2]

---

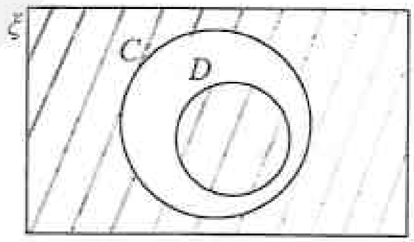
7 **(a)** Identify the set shaded in the Venn diagram below.



Answer $(A\cap B)'\cap(A\cup B)$ .... [1]

(b) Shade $(C\cap D')'$ in the Venn diagram below.

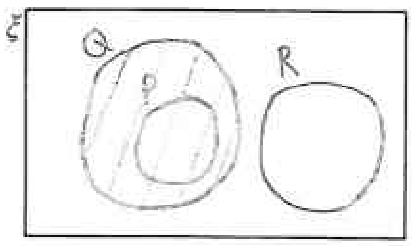
Answer



[1]

(c) If $P\subset Q$ and $Q\cap R=\{\ \}$, illustrate this information on the Venn diagram below and shade $P\cup Q$.

Answer



[1]

---

8 By Coulomb's law, the electric force, F N, between two balloons is inversely proportional to the square of the distance, d m, between them.

(a) If $F = 0.626$, when $d = 2$, find an equation for F in terms of d.

$F = \frac{k}{d^2}$, where k is a constant

$0.626 = \frac{k}{2^2}$

$k = 2.504$

$F = \frac{2.504}{d^2}$

Answer $F =$ $\frac{2.504}{d^2}$ .... [2]

(b) Calculate the distance between the balloons when the electric force is 1N.

When $F = 1$,

$1 = \frac{2.504}{d^2}$

$d^2 = 2.504$

$d = 1.58$ m (3 sig fig)

Answer 1.58 ....m [1]

---

9 A Soup Spoon regular size bowl has a height of 8cm and capacity 250ml. A geometrically similar Soup Spoon large size bowl has a height of 12cm and a base diameter of 21cm.

(a) Calculate the base diameter of the regular size bowl.

let r be regular and l be large

$\frac{d_r}{d_l} = \frac{h_r}{h_l}$

$\frac{d_r}{21} = \frac{8}{12}$

$d_r = 14$ cm

Answer 14 ....cm [1]

(b) Calculate the capacity of the large size bowl.

$\frac{V_r}{V_l} = \left(\frac{h_r}{h_l}\right)^3$

$\frac{250}{V_l} = \left(\frac{2}{3}\right)^3$

$V_l = \frac{250 \times 27}{8}$

$= 843.75$ ml

Answer 843.75 ....ml [2]

---

10 (a) Factorise completely $2.25x^2 - 0.64y^2$.

$= \frac{9}{4}x^2 - \frac{16}{25}y^2$

$= \left(\frac{3}{2}x - \frac{4}{5}y\right)\left(\frac{3}{2}x + \frac{4}{5}y\right)$

$= (1.5x - 0.8y)(1.5x + 0.8y)$

Answer $(1.5x - 0.8y)(1.5x + 0.8y)$ [1]

(b) Factorise completely $9x^2 - 4xy - 18xyz + 8y^2z$.

$9x^2 - 4xy - 18xyz + 8y^2z$

$= x(9x - 4y) - 2yz(9x - 4y)$

$= (x - 2yz)(9x - 4y)$

Answer $(x - 2yz)(9x - 4y)$ .... [2]

---

11 The angles, in degrees of a quadrilateral $ABCD$ are represented by these expressions: Angle $A = 3y + 40$, angle $B = 5y - 10$, angle $C = 6y - 20$, and angle $D = 2y + 30$.

(a) Calculate the value of y.

$(3y+40)^\circ + (5y-10)^\circ + (6y-20)^\circ + (2y+30^\circ) = 360^\circ$ (sum of $\angle$s in quad.)

$16y^\circ + 40^\circ = 360^\circ$

$16y^\circ = 320^\circ$

$y^\circ = 20^\circ$

$\therefore y = 20$

Answer $y =$ 20 .... [2]

(b) What is the name of the quadrilateral?

$\angle A = 100^\circ$

$\angle B = 90^\circ$

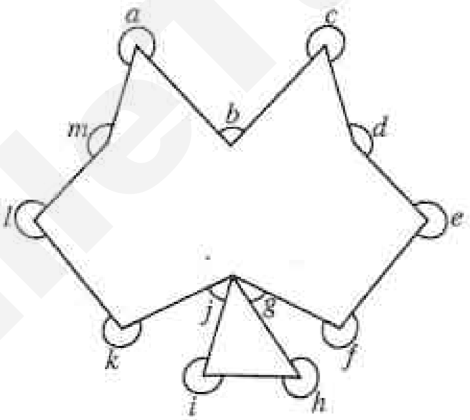
$\angle C = 100^\circ$

$\angle D = 70^\circ$

Answer Kite .... [1]

---

12 Calculate the sum of the angles a, b, c, d, e, f, g, h, i, j, k, l and m in this diagram.



Sum of $\angle$s at 12 points $= 360^\circ \times 12$
$= 4320^\circ$

Sum of interior $\angle$ of Decagon $= (10-2) \times 180^\circ$
$= 1440^\circ$

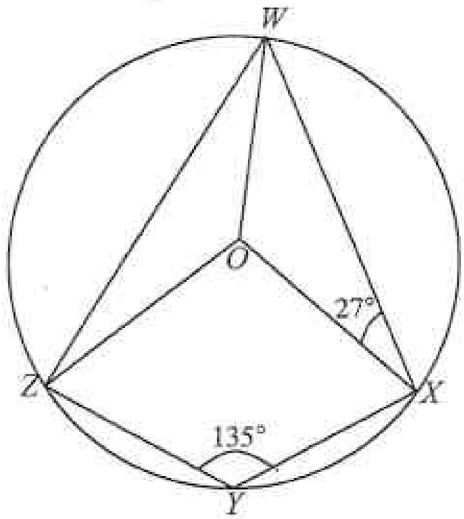
Sum of interior $\angle$ of triangle $= 180^\circ$

$\hat{a}+\hat{b}+\hat{c}+\hat{d}+\hat{e}+\hat{f}+\hat{g}+\hat{h}+\hat{i}+\hat{j}+\hat{k}+\hat{l}+\hat{m} = 4320^\circ - 1440^\circ - 180^\circ$
$= 2700^\circ$

Answer 2700° .... [3]

---

13 W, X, Y, Z are points on the circumference of a circle with centre O. Given that $\angle XYZ = 135°$ and $\angle OXW = 27°$,



(a) Find $Z\hat{W}X$. Give a reason for your answer.

Answer $Z\hat{W}X =$ $180° - 135° = 45°$ because angles in opposite segments are supplementary. [1]

(b) Find $Z\hat{W}O$.

$\angle OWX = 27°$ (base $\angle$ of isos $\triangle$)

$Z\hat{W}O = 45° - 27°$

$= 18°$

Answer $18°$ [2]

---

14 Two fair dice are tossed. Calculate the probability that

(a) both numbers obtained are even,

Req'd prob $= \frac{1}{2} \times \frac{1}{2} = \frac{1}{4}$

Answer $\frac{1}{4}$ [1]

(b) the product of the two numbers obtained is a prime number,

Req'd prob $= \frac{6}{36} = \frac{1}{6}$

Answer $\frac{1}{6}$ [1]

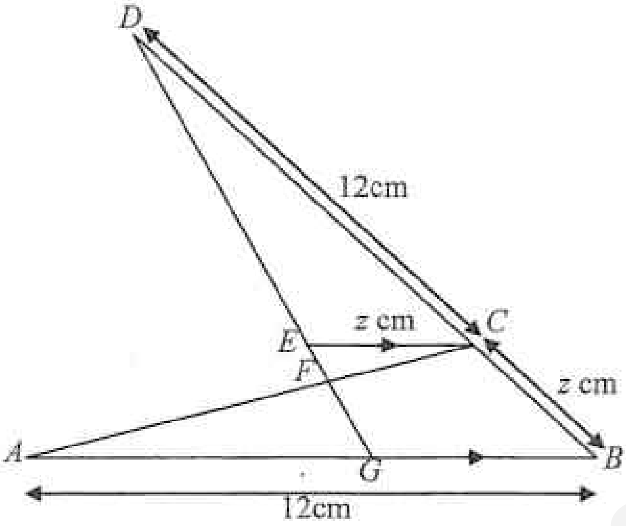
(c) the sum of the two numbers obtained is a prime number.

Req'd prob $= \frac{15}{36} = \frac{5}{12}$

Answer $\frac{5}{12}$ [1]

---

15 In the diagram, $AB = CD = 12$ cm, $BC = CE = z$ cm and AB is parallel to EC.



Name the triangle that is congruent to triangle ABC. Justify your answer.

B1

Answer Triangle DCE because AB = DC = 12 cm (S)

$\angle ABC = \angle DCE$ (corr $\angle$s, CE // BG) (A)

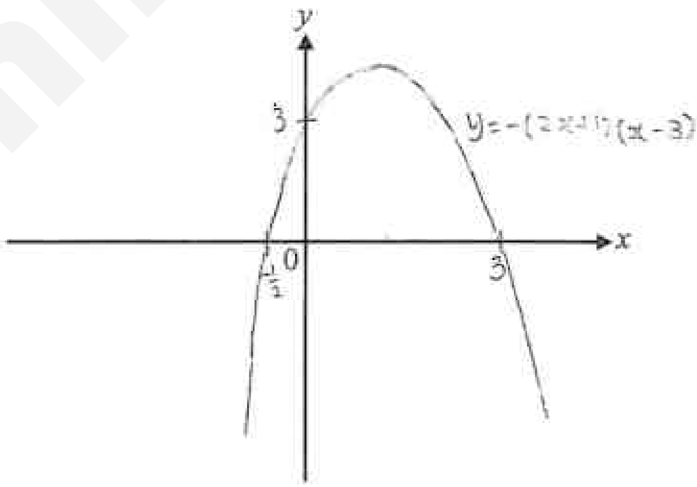
BC = CE = z cm (S)

$\therefore \triangle ABC \equiv \triangle DCE$ (SAS) [3]

16 **(a)** Sketch the graph of $y = -(2x+1)(x-3)$.

Answer

When $x = 0$,
$y = -(1)(-3)$
$= 3$
y-intercept: $(0, 3)$
when $y = 0$
$-(2x+1)(x-3) = 0$
$x = -\frac{1}{2}$ or 3
x-intercept:
$(-\frac{1}{2}, 0)$ and $(3, 0)$



x-intercept cut $-\frac{1}{2}$ and 3
y-intercept cut 3

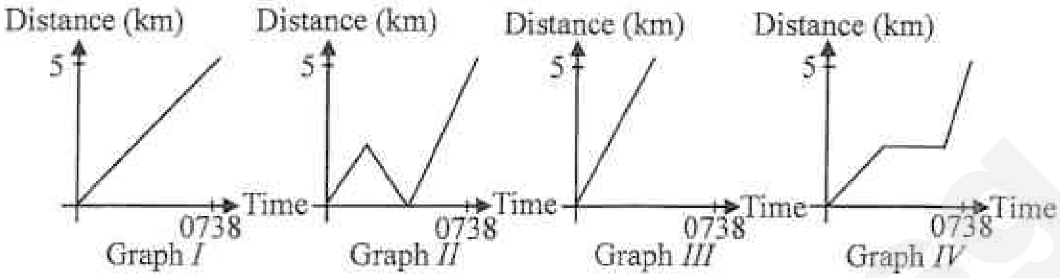
(b) Write down the equation of the line of symmetry of the graph $y = -(2x+1)(x-3)$.

eqn of line symmetry: $x = \frac{3-(-\frac{1}{2})}{2} - \frac{1}{2}$
$= \frac{5}{4} = 1\frac{1}{4}$

Answer $x = 1\frac{1}{4}$ [1]

17 In order to maintain a healthy lifestyle, 5 students in a certain neighbourhood cycle to the same school.

(a) Below are four graphs and accounts by 4 students. Match each of the graphs to the student's name that best fit each of the stories.



Aloysius: I was on my way to school when a cat suddenly cut into my path! Luckily, I managed to brake on time. After I got over the shock, I realized I was going to be late. So, I sped up!

Benedict: My teacher warned me not to be late again, so this time round, I cycled faster and I was among the first few to reach school.

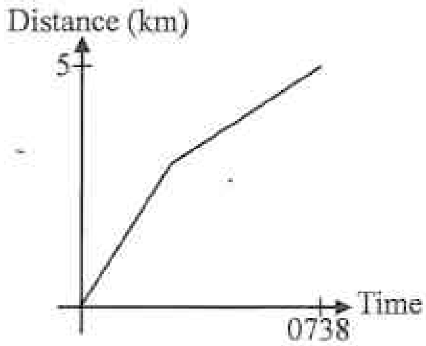
Charles: I just left home and discovered that I did not bring my wallet! So I went home again but I still managed to reach school on time.

Dominic: I cycled to school as usual and reached school before morning assembly.

Answer Graph *I* Dominic Graph *II* Charles

Graph *III* Benedict Graph *IV* Aloysius [2]

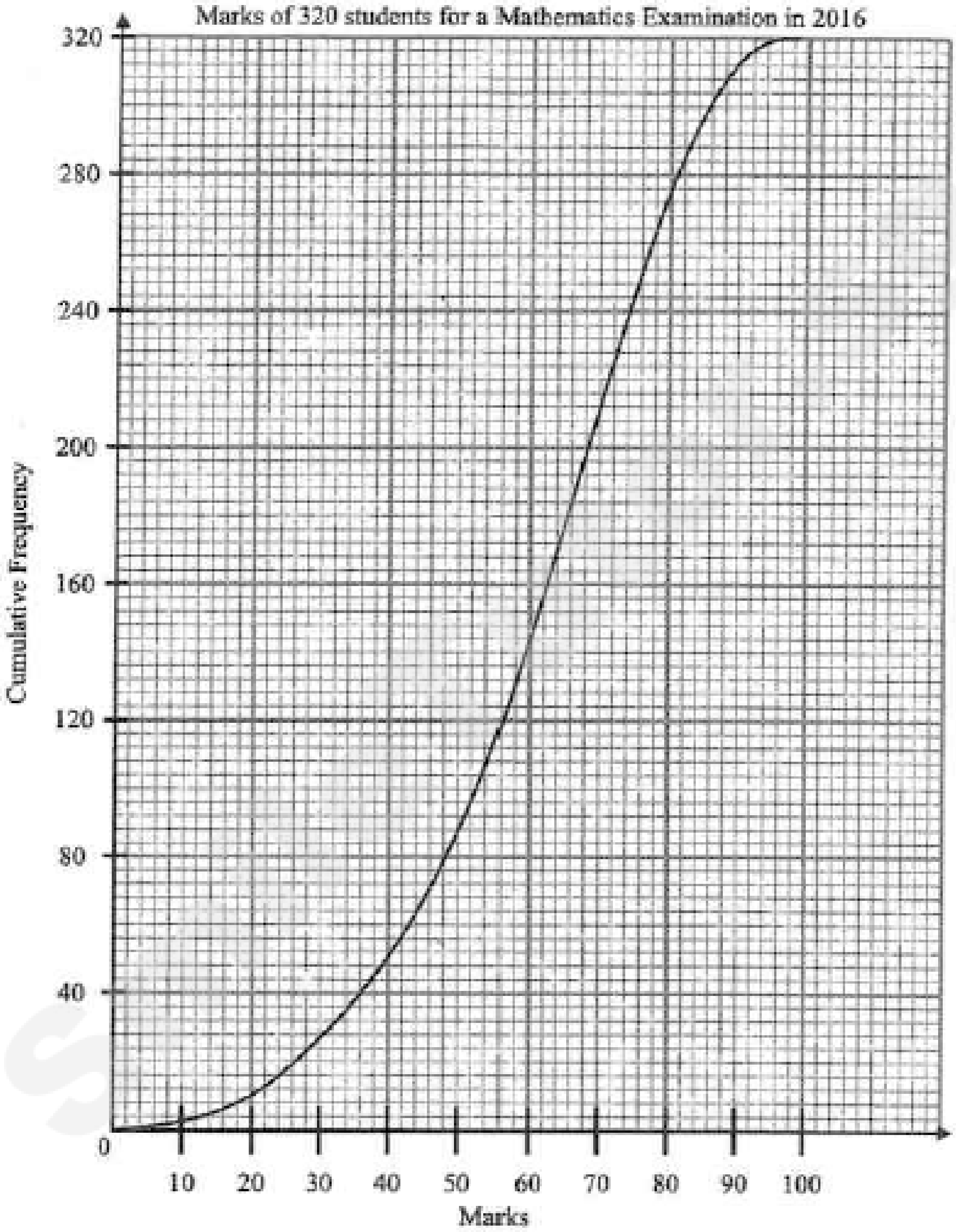
(b) Write down what Edward might say when given a sketch of his travel graph below.

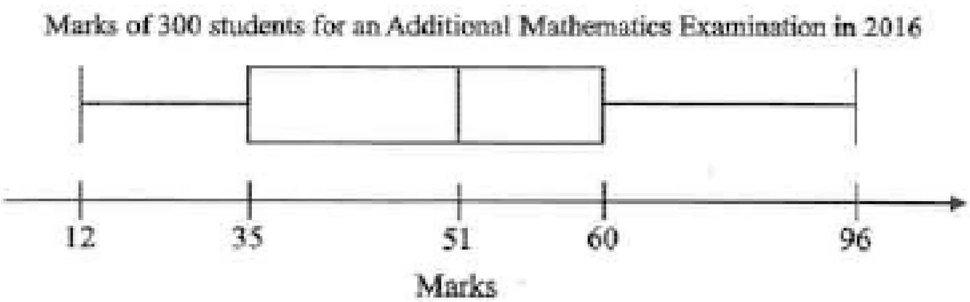


Answer I was cycling to school when my tyre was punctured. I walked to school thereafter pulling along my bicycle as quickly as I could so that I will not be late school.

[1]

18 The cumulative frequency curve and box plot show the distributions of the marks of 320 students for a Mathematics examination and 300 students for an Additional Mathematics examination respectively.





(a) Find the interquartile range for the Mathematics examination.

interquartile range
$= 74 - 48$
$= 26$ marks

Answer 26 marks .... [1]

(b) Here are two statements comparing the marks for the two examinations.

For each one, write whether you agree or disagree.
Give a reason for each answer, stating clearly which statistic you use to make your decision.

(i) On average, students performed better for the Additional Mathematics examination than the Mathematics examination.

Answer Disagree because the median for Additional Mathematics examination is lower than the median for the Mathematics examination [1]

(ii) A smaller proportion of the students scored less than 35 marks at the Mathematics examination than at the Additional Mathematics examination.

Answer Agree because the lower quartile for Mathematics examination is higher than the lower quartile for the Additional Mathematics examination. [1]

---

19 **(a)** Express $-x^2+7x-5$ in the form $-(x-a)^2+b$.

$= -(x^2-7x)-5$
$= -(x^2-7x+[\frac{7}{2}]^2)-5+(\frac{7}{2})^2$
$= -(x-\frac{7}{2})^2+\frac{29}{4}$

Answer $-(x-\frac{7}{2})^2+\frac{29}{4}$ .... [2]

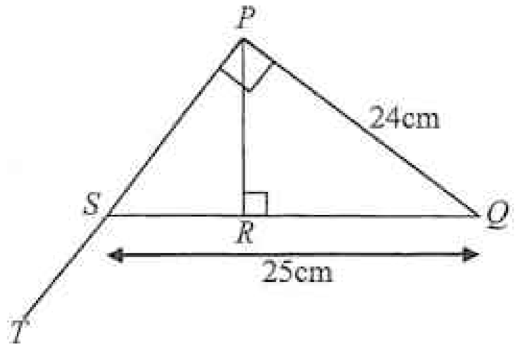
(b) Hence solve the equation $-x^2+7x-5=0$, giving your answers correct to two decimal places.

$-x^2+7x-5=0$
$-(x-\frac{7}{2})^2+\frac{29}{4}=0$
$-(x-\frac{7}{2})^2=-\frac{29}{4}$
$(x-\frac{7}{2})^2=\frac{29}{4}$
$x-\frac{7}{2}=\pm\sqrt{\frac{29}{4}}$
$x=0.81$ and 6.19 (2 dec. pl.)

Answer 0.81 and 6.19 [2]

---

20 In the diagram, $\angle QPS = \angle QRP = 90°$, $PQ = 24$ cm, $QS = 25$ cm, PST and QRS are straight lines.



Calculate

(a) PS

By Pythagoras' Theorem,

$PS^2 = 25^2 - 24^2$

$PS = 7$ cm

Answer 7 ....cm [1]

(b) PR

Area of $\triangle PQS = \frac{1}{2} \times PQ \times PS$

$\frac{1}{2} \times 25 \times PR = \frac{1}{2} \times 24 \times 7$

$PR = \frac{168}{25}$

$= 6.72$ cm

Answer 6.72 ....cm [2]

(c) $\cos\angle QST$

$\cos\angle QST = -\cos\angle QSP$

$= -\frac{7}{25}$

Answer $-\frac{7}{25}$ .... [1]

21 Challenger offers discounts to customers who pay $30 for a 2-year ValueClub membership.

Item	Members' discount
11" Apple MacBook Air	5% off
Seagate Backup Plus Slim Portable Drive 2TB	15% off
Valore Bluetooth Speaker	25% off

Dory wants to buy a MacBook Air which costs $1188. The salesperson suggests that he joins as a member.

(a) How much less does she he pay in total if he joins as a member and buys the MacBook Air?

Total Amount Payable $= \$30 + \frac{\$1188 \times 95}{100}$

$= \$1158.60$

Amount less she paid as a member

$= \$1188 - \$1158.60$

$= \$29.40$

Answer $ 29.40 .... [2]

After he joined as a member and bought the MacBook, the salesperson offers Dory a further 10% discount on the members' price for a portable drive and Bluetooth speaker in view of the Great Singapore Sale.

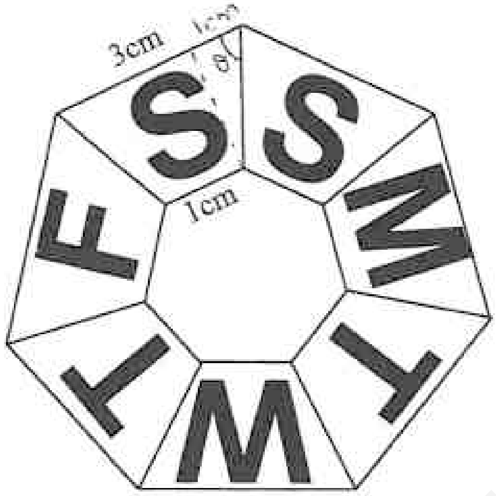
(b) Write down and simplify a formula for the total amount, T, that she needs pay for a portable drive and Bluetooth speaker. Use d and s to represent the original price of a portable drive and a Bluetooth speaker respectively.

$T = 0.9(0.85d + 0.75s)$

$= 0.765d + 0.675s$

Answer $T =$ 0.765d + 0.675s .... [2]

22 A pill box is in the shape of a regular heptagon with sides of length 3cm and has a hole in the centre in the shape of a regular heptagon with sides of length 1cm.



The height of the pill box is 2cm. Calculate the volume of the pill box.

Size of an interior ∠ of heptagon

$= \frac{(7-2)\times 180^\circ}{7}$

$= \frac{900^\circ}{7}$

$\theta = \frac{900^\circ}{7} \div 2$

$= \frac{450^\circ}{7}$

let h be height of trapezium

$\tan\theta = \frac{h}{1}$

$h = \tan\frac{450^\circ}{7}$ cm

Area of trapezium $= \frac{1}{2}(1+3)\tan\frac{450^\circ}{7}$

$= 2\tan\frac{450^\circ}{7}$ cm^2

Area of cross-section $= 7 \times 2\tan\frac{450^\circ}{7}$

$= 14\tan\frac{450^\circ}{7}$ cm^2

Volume of pill box $= 2 \times 14\tan\frac{450^\circ}{7}$

$= 58.1$ cm^3 (3 sig fig.)

Answer ....58.1.......................... cm^3 [5]

23 **(a)** Solve the equation $\frac{4(7a-3)}{5}+\frac{5(2a+7)}{3}=\frac{5(5a-2)}{2}$.

$24(7a-3)+50(2a+7)=75(5a-2)$

$168a-72+100a+350=375a-150$

$107a=428$

$a=4$

Answer $a=4$ .... [3]

(b) Given that 2 is a solution of the quadratic equation $6(x-5)^2+k=38$, where k is a constant, find the

(i) value of k,

when $x=2$,

$6(2-5)^2+k=38$

$k=38-54$

$=-16$

Answer -16 .... [1]

(ii) other solution.

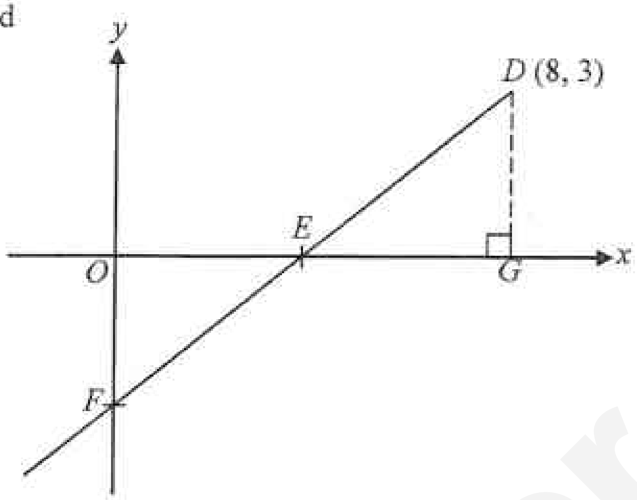
$x=5+(5-2)$

$=5+3$

$=8$

Answer $x=8$ .... [1]

24 In the diagram, D is the point $(8, 3)$ and the line passing through the points D and F intersects the x-axis at the point E. Point G is on the x-axis such that the line DG is perpendicular to the x-axis. Given that the area of the triangle DEG is 6 units^2, find



(a) the coordinates of E,

Area of $\triangle DEG = \frac{1}{2} \times EG \times DG$

$6 = \frac{1}{2} \times EG \times 3$

$EG = 4$ units

$\therefore E(8-4, 0)$

$= E(4, 0)$

Answer $E($ 4 , 0 $)$ [2]

(b) the equation of line FD,

gradient of $FD = \frac{3-0}{8-4}$

$= \frac{3}{4}$

eqn of line FD: $y = \frac{3}{4}x + c$

when $x = 4, y = 0$

$0 = \frac{3}{4}(4) + c$

$c = -3$

$\therefore y = \frac{3}{4}x - 3$

Answer $y = \frac{3}{4}x - 3$ [2]

(c) the coordinates of F.

y-intercept $= F(0, -3)$

Answer $F($ 0 , −3 $)$ [1]

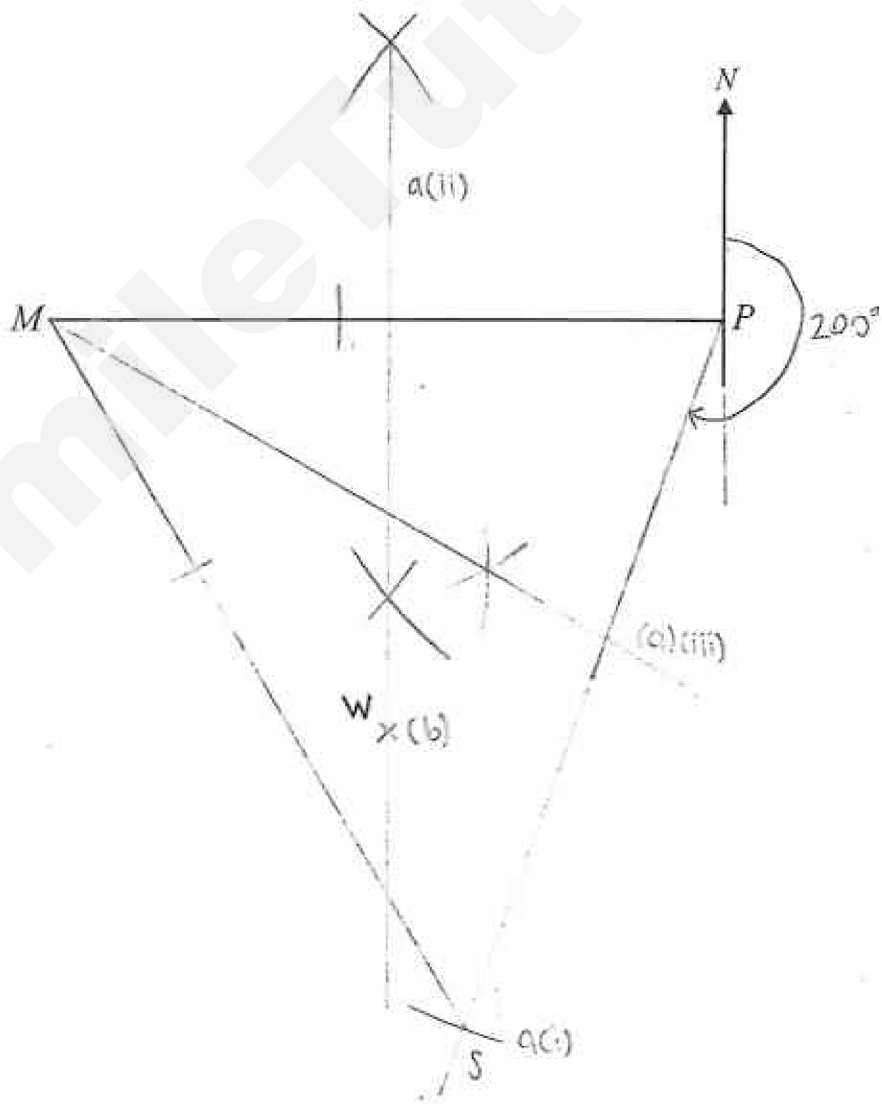
25 In 2008, the International Court of Justice (ICJ) awarded the sovereignty of the island, Pedra Branca (P) to Singapore. There are two maritime features near the island: Middle Rocks (M) and South Ledge (S). Middle Rocks is due west of Pedra Branca. The bearing of S from P is $200°$ with a distance of 1.0 Nautical Miles (nm) between them.

(a) (i) Construct a scaled drawing of the Triangle MPS using the scale 1 cm to represent 0.1 nm. Line MP has been drawn for you. [2]

(ii) Construct the perpendicular bisector of line MP. [1]

(iii) Construct the angle bisector of $\angle SMP$. [1]

(b) A ship in distress sends a SOS signal for help at a location within the Triangle MPS. The ship is known to be located in the triangle at a point that is nearer to MS than MP and equidistant from M and P.
Mark a possible point with a cross and label the point as W. [1]



O Level Centre/ Index Number /	Class	Name

新加坡海星中学

MARIS STELLA HIGH SCHOOL
PRELIMINARY EXAMINATION TWO
SECONDARY FOUR

MATHEMATICS **4048/2**

Paper 2 **16 August 2016**

2 hours 30 minutes

Additional Materials: Writing Paper (7 sheets)
Graph Paper (1 sheet)

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** the questions.
Write your answers on the separate Answer Paper provided.
Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.
The use of an approved scientific calculator is expected, where appropriate.
You are reminded of the need for clear presentation in your answers.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The total number of marks for this paper is 100.

For Examiner's Use
100

This document consists of **12** printed pages.

Mathematical Formulae

Compound Interest

$$\text{Total amount} = P\left(1+\frac{r}{100}\right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi r l$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3}\pi r^3$$

$$\text{Area of triangle } ABC = \frac{1}{2}ab\sin C$$

$$\text{Arc length} = r\theta \text{, where } \theta \text{ is in radians}$$

$$\text{Sector area } = \frac{1}{2}r^2\theta \text{, where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

Statistics

$$\text{Mean} = \frac{\Sigma fx}{\Sigma f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

1 **(a)** Simplify $\dfrac{3a-6}{2a^2-7a+6}$. [2]

(b) Solve the inequality $\dfrac{3x-1}{5} \geq \dfrac{6x+1}{7}$. [2]

(c) It is given that $q=\sqrt{\dfrac{4p^2-5q}{p^2+2}}$. Express p in terms of q. [3]

(d) **(i)** Express 4536 as the product of its prime factors. [1]

(ii) Given that $\dfrac{4536}{k^2}=p$, where k and p are integers and k is as large as possible, find the values of k and p. [1]

(iii) The lowest common multiple of two numbers is 4536.
The highest common factor of these two numbers is 189.
Both numbers are greater than 189.

Find the two numbers. [2]

2 **(a)** $\mathbf{P} = \begin{pmatrix} 2 & -8 \\ 0 & 4 \end{pmatrix}$ and $\mathbf{Q} = \begin{pmatrix} \frac{1}{2} & x \\ 0 & \frac{1}{4} \end{pmatrix}$

Find the value of x given that **PQ** is an identity matrix. [2]

(b) The price of a ticket in each category at the River Safari is given below:

Child: \$20
Adult: \$30
Senior Citizen: \$14

(i) Represent the above information as a 3×1 column matrix A. [1]

The number of tickets sold on one particular weekend is given as follows:

	Child	Adult	Senior Citizen
Saturday	500	800	480
Sunday	700	1000	580

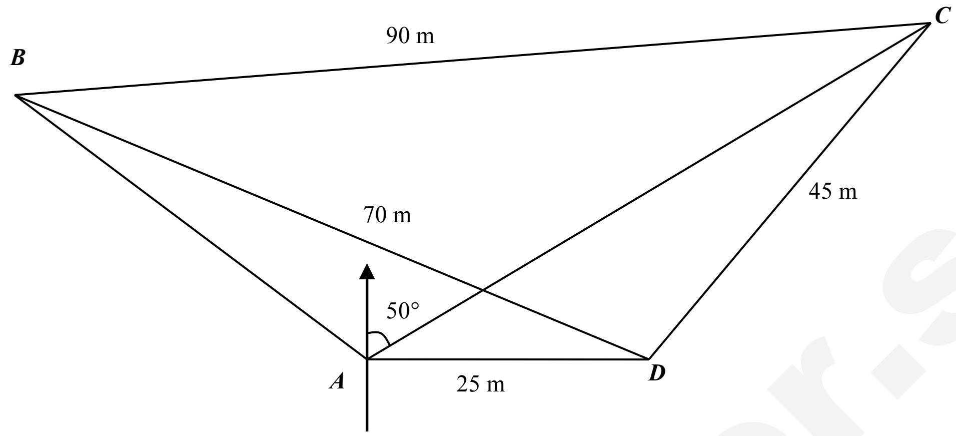
This information can be represented by the matrix

$$B = \begin{pmatrix} 500 & 800 & 480 \\ 700 & 1000 & 580 \end{pmatrix}$$

(ii) Given that $C = BA$, find C and describe what is represented by the elements of C. [2]

(iii) On that particular weekend, the River Safari decided to donate 40% of Saturday's ticket sales and 50% of Sunday's ticket sales to charity. Write a matrix D such that the product of DC will give the total amount donated. Hence find the total amount donated. [2]

3 A, B, C and D are four points on level ground. A is due west of D and the bearing of C from A is 050°. AD = 25 m, DC = 45 m, DB = 70 m and BC = 90 m.



(a) Calculate

(i) $\angle DCA$, [2]

(ii) $\angle CDB$, [2]

(iii) the bearing of C from D, [2]

(iv) the area of ΔBDC. [1]

(b) A tower of height h metres stands at D and the angle of elevation of the top of the tower from B is 37°. Calculate

(i) the value of h, [2]

(ii) the shortest distance of D from BC. [2]

(c) A man walks along a straight path from B to C until he reaches a point E where the angle of elevation of the top of the tower from E is at its greatest. Calculate the distance of BE. [2]

4 Two taps A and B run water at different speed. Tap A runs water at x litres per minute. Tap B runs water at a rate of 5 litres per minute faster than tap A. A rectangular tank with a capacity of 9000 litres is to be filled with water. It takes 5 hours longer to fill the tank with water using tap A as compared to using tap B.

(a) Write down an expression, in terms of x, the time taken to fill the tank by using

(i) Tap A, [1]

(ii) Tap B. [1]

(b) Form an equation in x and show that it reduces to $x^2 + 5x - 150 = 0$. [3]

(c) Solve the equation $x^2 + 5x - 150 = 0$. [2]

(d) Hence find the time taken, in hours, to fill the rectangular tank if both taps A and B are turned on at the same time. [2]

5 Map A is drawn to a scale of 1 : 250 000.

(a) Find the length, in centimetres, represented by a 12.4 km road on Map A. [1]

(b) Calculate the area of a town on Map A if its actual area is 60 km^2. [2]

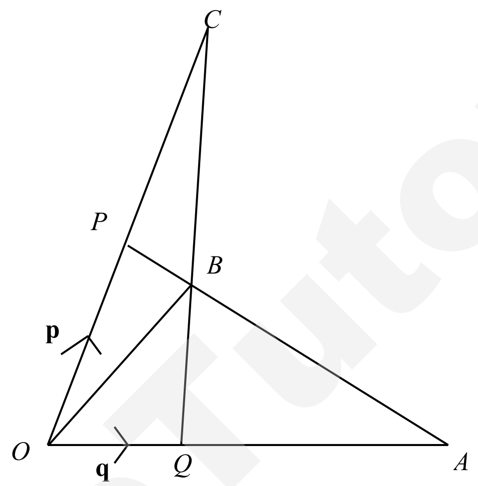
(c) The very same town occupies an area of $6\frac{2}{3}$ cm^2 on Map B, find the scale of Map B, giving your answer in the format of 1 : n . [2]

6 **(a)** $\overrightarrow{AB} = \begin{pmatrix} -3 \\ 2 \end{pmatrix}$, $\overrightarrow{OB} = \begin{pmatrix} 2 \\ 4 \end{pmatrix}$ and $\overrightarrow{BC} = \begin{pmatrix} -5 \\ -7 \end{pmatrix}$.

(i) Find the column vector $\overrightarrow{AC}$. [1]

(ii) Find the value of $\left|\overrightarrow{BC} - 2\overrightarrow{AB}\right|$. [2]

(b)



OPC and OQA are straight lines and PA intersects QC at B.
Given that $\overrightarrow{OA} = 3\overrightarrow{OQ}$, $\overrightarrow{OP} = \overrightarrow{PC}$, $PB : BA = 1 : 4$, $\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OQ} = \mathbf{q}$, express the following vectors as simply as possible in terms of **p** and/or **q**.

(i) $\overrightarrow{AP}$, [1]

(ii) $\overrightarrow{PB}$, [1]

(iii) $\overrightarrow{OB}$, [1]

(iv) $\overrightarrow{QB}$. [1]

(c) Find the value of $\dfrac{\text{Area of } \Delta OBC}{\text{Area of } \Delta QBA}$. [2]

7 **Answer the whole of this question on a sheet of graph paper.**

The following table gives the corresponding values of x and y which are connected by the equation $y = \frac{2x^3}{5} - 4x + 2$.

x	-4	-3	-2	-1	0	1	2	3	4
y	-7.6	3.2	6.8	5.6	2	-1.6	-2.8	a	11.6

(a) Find the value of a, giving your answer correct to 1 decimal place. [1]

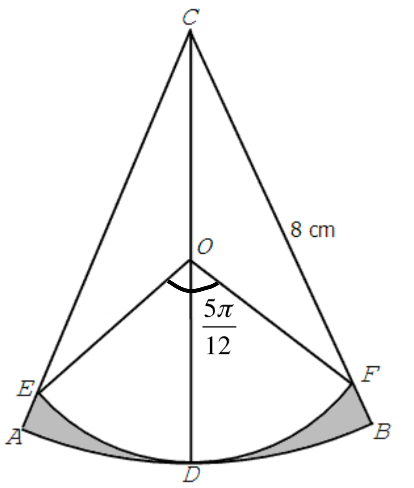
(b) Using a scale of 2 cm to represent 1 unit on the x-axis and 1 cm to represent 1 unit on the y-axis, draw the graph of y against x for values of x in the range $-4 \le x \le 4$. [3]

(c) Use your graph to find the solutions of $\frac{2x^3}{5} - 4x + 2 = 0$. [2]

(d) By drawing a tangent, find the gradient of the curve when $x = -3$. [2]

(e) By drawing a suitable straight line on your graph, solve $2x^3 - 25x + 20 = 0$. [3]

8 **(a)**



In the figure above, the sector CAB has centre C and radius 8 cm.
CD bisects $\angle ACB$ and O is the midpoint of CD.
An arc with centre O, is drawn to meet CA and CB at E and F respectively. Given that $\angle EOF = \frac{5\pi}{12}$,

(i) find in terms of [redacted],

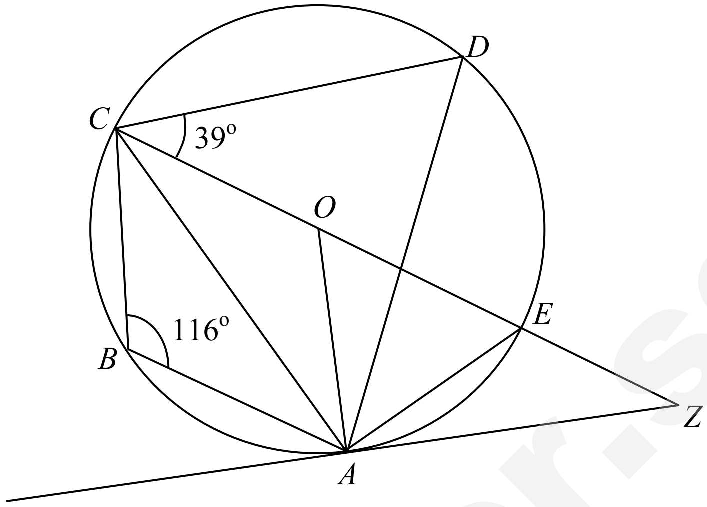
(a) the angle ACB, [1]

(b) the length of arc ADB, [1]

(c) the area of the sector CAB. [1]

(ii) find the area of the shaded region $ADBFE$, correct to 2 significant figures. [3]

(b)



The line CE is a diameter of the circle $ABCDE$, centre O. The tangent at A meets CE produced at Z.

Angle $CBA = 116°$ and angle $DCZ = 39°$.

Find, **giving reasons for each answer,**

(i) $\angle CDA$, [1]

(ii) $\angle COA$, [1]

(iii) $\angle DAE$, [1]

(iv) $\angle EAZ$, [2]

(v) $\angle CAZ$. [2]

9 **(a)** A group of students was asked to complete a class test. The time taken to complete the test is shown in the following table:

Time in minutes (x)	$30 < x \leq 35$	$35 < x \leq 40$	$40 < x \leq 45$	$45 < x \leq 50$	$50 < x \leq 55$
No. of students	12	40	81	42	25

(i) State the median class. [1]

(ii) Calculate

(a) the estimated mean time taken for a student to complete the test, [1]

(b) the estimated standard deviation of the time taken to complete the test. [2]

(iii) If one more question is added to the test, each student took 5 more minutes to complete the test. Comment on how this will affect the mean and standard deviation of the data found in part **(ii)**. [2]

(b) 15 red balls, 5 blue balls and 2 white balls were placed in a bag. Two balls were drawn at random.

(i) Draw a tree diagram to show the possible outcomes and their probabilities. [2]

(ii) Expressing each of your answers as a fraction in its lowest term, calculate the probability that when two balls are drawn,

(a) both of them will be red, [1]

(b) only one of the ball drawn is blue, [2]

(c) both are of different colours. [2]

10 (a) Mr Ng bought a new car that cost \$100 000. Each year the value of the car decreases by 10% of its value at the start of the year. At the end of 5 years, Mr Ng decides to sell the car.

Calculate the overall percentage reduction in the value of the car compared with the original purchase price. [3]

(b) Mr Wong wishes to purchase a new 4-Room Flat at the upcoming Bidadari estate near the school. The flat can be bought on a hire purchase scheme with a down payment of 10% of the purchase price and the remaining amount to be paid by monthly instalments throughout the loan period.

Useful information:
Simple Interest rate for housing loan : 1.8% per annum
Maximum loan period allowed : 25 years

The selling price of a new 4-Room Flat starts from \$440,000 for a 2nd floor unit and increases at a constant rate to \$520,000 for a highest 18th floor unit.

With his savings, Mr Wong is able to pay the 10% down payment for the flat. With his current income, Mr Wong can only afford to spend at most \$2100 per month to service future instalments.

Using the information provided in the question, determine what is the highest floor unit that Mr Wong can afford to purchase. [6]

O Level Centre/ Index Number /	Class	Name

新加坡海星中学

MARIS STELLA HIGH SCHOOL
PRELIMINARY EXAMINATION TWO
SECONDARY FOUR

MATHEMATICS **4048/2**

Paper 2 **16 August 2016**

2 hours 30 minutes

Additional Materials: Writing Paper (7 sheets)
Graph Paper (1 sheet)

READ THESE INSTRUCTIONS FIRST

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At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

The total number of marks for this paper is 100.

For Examiner's Use
100

This document consists of 12 printed pages.

<u>Solution to Prelim 2 EM Paper 2</u>

1 **(a)**

$$\frac{3a-6}{2a^2-7a+6}$$
$$=\frac{3(a-2)}{(2a-3)(a-2)} \quad [M1]$$
$$=\frac{3}{2a-3} \quad [A1]$$

(b)

$$\frac{3x-1}{5}\geq\frac{6x+1}{7}$$
$$21x-7\geq 30x+5 \quad [M1]$$
$$-12\geq 9x$$
$$x\leq -1\frac{1}{3} \quad [A1]$$

(c)

$$q=\sqrt{\frac{4p^2-5q}{p^2+2}}$$
$$q^2=\frac{4p^2-5q}{p^2+2} \quad [M1]$$
$$q^2(p^2+2)=4p^2-5q$$
$$p^2(q^2-4)=-2q^2-5q$$
$$p^2=\frac{-2q^2-5q}{q^2-4} \quad \text{or} \quad \frac{2q^2+5q}{4-q^2} \quad [M1]$$
$$p=\pm\sqrt{\frac{-2q^2-5q}{q^2-4}} \quad \text{or} \quad \pm\sqrt{\frac{2q^2+5q}{4-q^2}} \quad [\text{A1, minus 0.5 if no } \pm]$$

(d) **(i)** $4536=2^3\times3^4\times7$ [B1]

(ii) $k=18, p=14$ [B1]

(iii) $189=3^3\times7$ [M1]

The 2 numbers are 567 and 1512 [A1]

2 **(a)**

$$\begin{pmatrix} 2 & -8 \\ 0 & 4 \end{pmatrix}\begin{pmatrix} \frac{1}{2} & x \\ 0 & \frac{1}{4} \end{pmatrix}=\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix} \qquad [M1]$$

$$\begin{pmatrix} 1 & 2x-2 \\ 0 & 1 \end{pmatrix}=\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

$$2x-2=0$$

$$x=1 \qquad [A1]$$

(b)(i)

$$A=\begin{pmatrix} 20 \\ 30 \\ 14 \end{pmatrix} \qquad [B1]$$

(ii)

$$C=\begin{pmatrix} 500 & 800 & 480 \\ 700 & 1000 & 580 \end{pmatrix}\begin{pmatrix} 20 \\ 30 \\ 14 \end{pmatrix}$$

$$=\begin{pmatrix} 40720 \\ 52120 \end{pmatrix} \qquad [B1]$$

The elements in C represents the total ticket sales on Saturday and Sunday respectively. [B1]

(iii)

$$D=\begin{pmatrix} 0.4 & 0.5 \end{pmatrix} \qquad [B1]$$

$$DC=\begin{pmatrix} 0.4 & 0.5 \end{pmatrix}\begin{pmatrix} 40720 \\ 52120 \end{pmatrix}$$

$$=(42348)$$

The amount donated is $42348. [A1, P if no statement]

3(a)

(i) $\angle CAD = 40°$

$$\frac{45}{\sin 40°} = \frac{25}{\sin \angle DCA} \quad [M1]$$

$$\sin \angle DCA = 0.35710$$

$$\angle DCA = 20.922°$$

$$= 20.9° \quad (1 \text{ d.p}) \quad [A1]$$

(ii) $90^2 = 70^2 + 45^2 - 2(70(45)\cos \angle CDB$ [M1]

$$\cos \angle CDB = \frac{-1175}{6300}$$

$$\angle CDB = 100.749°$$

$$= 100.7° \quad (1 \text{ d.p}) \quad [A1]$$

(iii) Bearing of C from $D = 180° - 130° - \angle DCA$ [M1]

$$= 29.078°$$

$$= 029.1° \quad [\text{A1,no mark if no 0}]$$

(iv) Area of $\Delta BDC = \frac{1}{2}(70)(45)\sin 100.749°$

$$= 1547.36$$

$$= 1550 m^2 \quad [3 \text{ s.f.}] \quad [\text{B1, R if not to 3 s.f.}]$$

(b)

(i) $\tan 37° = \frac{h}{70}$ [M1]

$$h = 70 \tan 37°$$

$$= 52.749$$

$$= 52.7 \quad (3 \text{ s.f}) \quad [A1]$$

(ii) Let the shortest distance be x m.

$$\frac{1}{2}(90)(x) = 1547.36 \quad [M1]$$

$$x = 34.386$$

$$= 34.4 \quad (3 \text{ s.f.})$$

The shortest distance is 34.4 m. [A1]

(c) Area of $\Delta BDC = \frac{1}{2}(70)(90)\sin\angle DBC$

$$= 1547.36$$

$$\sin\angle DBC = 0.49123$$

$$\angle DBC = 29.421° \quad \text{[M1]}$$

$$\tan\angle DBC = \frac{x}{BE}$$

$$BE = \frac{34.386}{\tan 29.421°}$$

$$= 60.973$$

$$= 61.0 \text{ m } (3.\text{s.f}) \quad \text{[A1,R is never give to 3 s.f]}$$

4 (a)

(i) Time taken by Tap A = $\dfrac{9000}{x}$ mins [B1, unit error applicable]

(ii) Time taken by Tap B = $\dfrac{9000}{x+5}$ mins [B1, unit error applicable]

(b)

$\dfrac{9000}{x} - \dfrac{9000}{x+5} = 5 \times 60$ [M1]

$9000(x+5) - 9000x = 300x(x+5)$ [M1]

$45000 = 300x^2 + 1500x$

$x^2 + 5x - 150 = 0$ (shown) [A1]

(c) Solve the equation $x^2 + 5x - 150 = 0$. [2]

$x^2 + 5x - 150 = 0$

$(x-10)(x+15) = 0$ [M1]

$x = 10$ or -15 [A1]

(d)

$x = 10$

Combined rate = 25 litres per min [M1]

Time taken to fill the tank = $(9000 \div 25) \div 60$

$= 6$ hours [A1]

5

(a) 1 cm : 250 000 cm

= 1 cm : 2.5 km

Length of road on Map A = $\dfrac{12.4}{2.5}$

$= 4.96$ cm ---- [A1]

(b) 1 cm^2 : 6.25 km^2 ---- [M1]

Area of town on Map A = $\dfrac{60}{6.25}$

$= 9.6$ cm^2 ---- [A1]

(c) $6\frac{2}{3}$ cm^2 : 60 km^2

= 1 cm^2 : 9 km^2

= 1 cm : 3 km ---- [M1]

= 1 cm : 300 000 cm

= 1 : 300 000 ---- [A1]

6 **(a)**

$(i)\ \overrightarrow{AC} = \overrightarrow{AB} + \overrightarrow{BC}$

$= \begin{pmatrix} -3 \\ 2 \end{pmatrix} + \begin{pmatrix} -5 \\ -7 \end{pmatrix}$

$= \begin{pmatrix} -8 \\ -5 \end{pmatrix}$ [B1]

$(ii)\ \left|\overrightarrow{BC} - 2\overrightarrow{AB}\right| = \left|\begin{pmatrix} -5 \\ -7 \end{pmatrix} - 2\begin{pmatrix} -3 \\ 2 \end{pmatrix}\right|$

$= \left|\begin{pmatrix} 1 \\ -11 \end{pmatrix}\right|$ [M1]

$= \sqrt{1^2 + (-11)^2}$

$= 11.0\ units$ (3 s.f.) [A1, P if no unit]

(b)

$(i)\ \overrightarrow{AP} = \overrightarrow{AO} + \overrightarrow{OP}$

$= -3\overrightarrow{OQ} + \overrightarrow{OP}$

$= \underline{p} - 3\underline{q}$ [B1]

$(ii)\ \overrightarrow{PB} = -\frac{1}{5}\overrightarrow{PA}$

$= \frac{1}{5}\left(3\underline{q} - \underline{p}\right)$ [B1]

$(iii)\ \overrightarrow{OB} = \overrightarrow{OP} + \overrightarrow{PB}$

$= \underline{p} + \frac{1}{5}\left(3\underline{q} - \underline{p}\right)$

$= \frac{1}{5}\left(3\underline{q} + 4\underline{p}\right)$ [B1]

(iv) $\overrightarrow{QB} = \overrightarrow{QO} + \overrightarrow{OB}$

$$= -\underline{q} + \frac{1}{5}\left(3\underline{q} + 4\underline{p}\right)$$

$$= \frac{2}{5}\left(2\underline{p} - \underline{q}\right) \quad \text{[B1]}$$

(c)

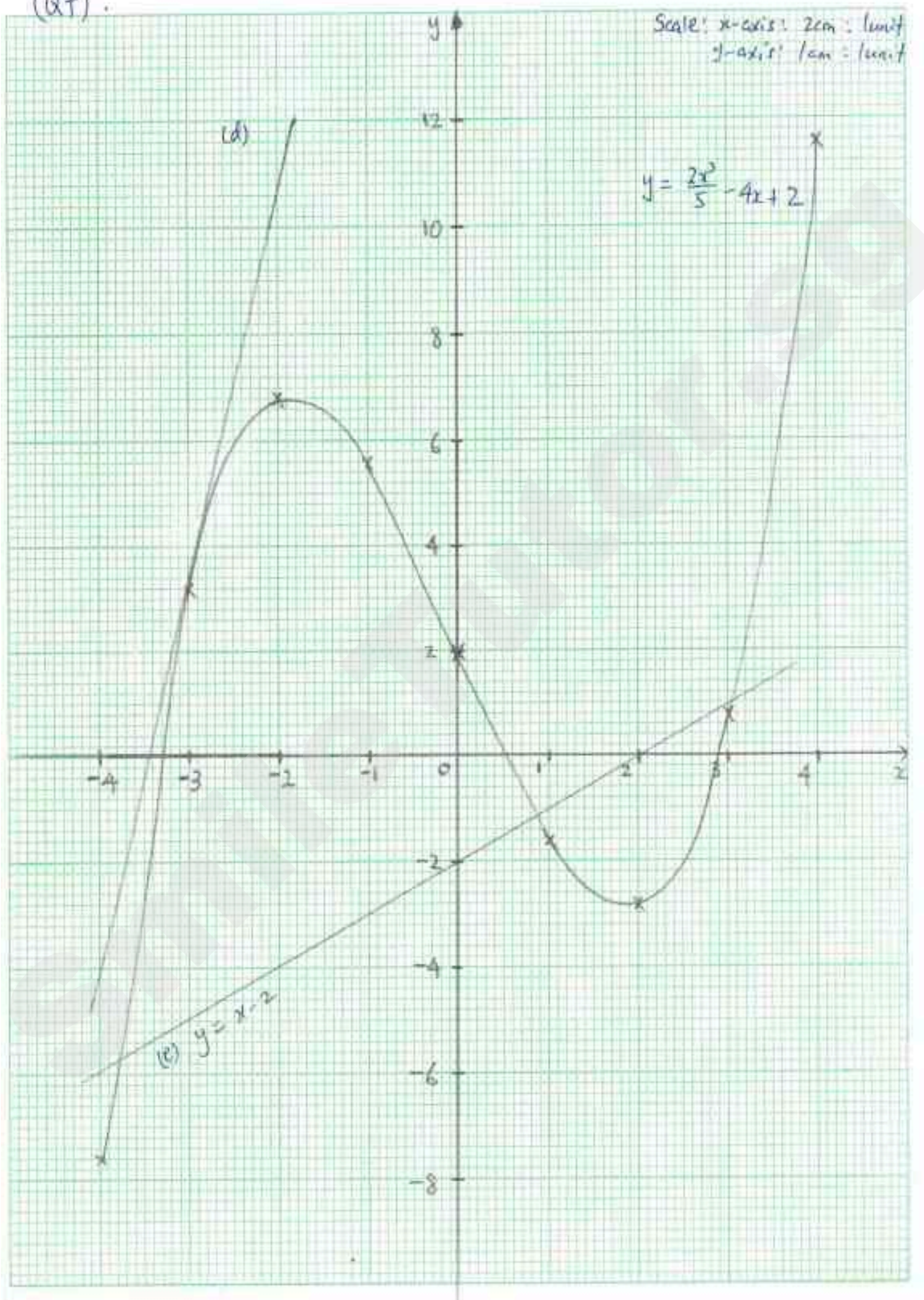
$$\frac{\text{Area of } \Delta OBC}{\text{Area of } \Delta QBA} = \frac{2 \times \text{Area of } \Delta OPB}{\text{Area of } \Delta OBA} \times \frac{\text{Area of } \Delta OBA}{\text{Area of } \Delta QBA} \quad \text{[M1]}$$

$$= 2 \times \frac{1}{4} \times \frac{3}{2}$$

$$= \frac{3}{4} \quad \text{[A1]}$$

Subject Class Date

(Q7).



<u>The following parts of Q7 is to be answered on the back of graph paper</u>

Q7(a) $a = 0.8$ [B1]

(c) From the graph, the solution is $-3.3,\ 0.5,\ 2.9$. (Accept ± 0.1) [B2]

(d) Gradient of the curve at $x = -3$ is $= \dfrac{12-(-4)}{-1.8-(-4)}$

$= 7.27$ (3s.f) (Accept 6.12 to 7.48) [A1]

(e) $2x^3 - 25x + 20 = 0$

$\dfrac{2x^3}{5} - 5x + 4 = 0$

$\dfrac{2x^3}{5} - 4x + 2 = x - 2$ [M1]

Draw the line $y = x - 2$

From the graph, the solution is $x = -3.8,\ 0.85,\ 3.05$ Accept [± 0.1] [A1]

8 (a)(i)

$(a)\quad \angle ACB = \frac{1}{2}\left(\frac{5\pi}{12}\right)$ ($\angle$ at center $= 2\angle$ at circumference)

$= \frac{5\pi}{24}$ [B1]

(b) Arc $ADB = 8 \times \angle ACB$

$= \frac{5\pi}{3}$ cm [B1]

(c) Area of sector $CAB = \frac{1}{2} \times (8)^2 \left(\frac{5\pi}{24}\right)$

$= \frac{20\pi}{3}$ cm^2 [B1]

(ii) Area of shaded region

= Area of sector CAB – Area of sector OEF $- 2 \times$ Area of ΔOCF [M1]

$= \frac{20\pi}{3} - \frac{1}{2}(4)^2\left(\frac{5\pi}{12}\right) - 2 \times \frac{1}{2}(4)^2 \sin(\pi - \frac{5\pi}{24})$ [M1]

$= 0.73179$

$= 0.73$ cm^2 (2 s.f.) [A1]

$(b)(i)$ $\angle CDA + \angle CBA = 180°$ ($\angle$s in opp. segment)

$\angle CDA = 180° - 116°$

$= 64°$ [B1]

$(b)(ii)$ $\angle COA = 2 \times \angle CDA$ ($\angle$ at centre $= 2 \times \angle$ at circumference)

$= 128°$ [B1]

$(b)(iii)$ $\angle DAE = \angle DCE$ ($\angle$s in same segment)

$= 39°$ [B1]

$(b)(iv)$ $\angle AOE = 180° - \angle COA$ (adj $\angle$s on a st. line)

$= 52°$

$\angle OAE = \frac{180° - \angle AOE}{2}$ (Base $\angle$s isos ΔOAE)

$= 64°$ [M1]

$\angle OAZ = 90°$ (tangent $\perp$ radius)

$\angle EAZ = 90° - \angle OAE$

$= 26°$ [A1]

$(b)(v)$ $\angle CAE = 90°$ ($\angle$ in semi circle) [M1]

$\angle CAZ = \angle CAE + \angle EAZ$

$= 90° + 26°$

$= 116°$ [A1]

9(a) **(i)** Median class is $40 < x \le 45$ [B1]

(ii)

(a) Mean $= \dfrac{\sum fx}{\sum f}$

$= \dfrac{8640}{200}$

$= 43.2$ mins [B1]

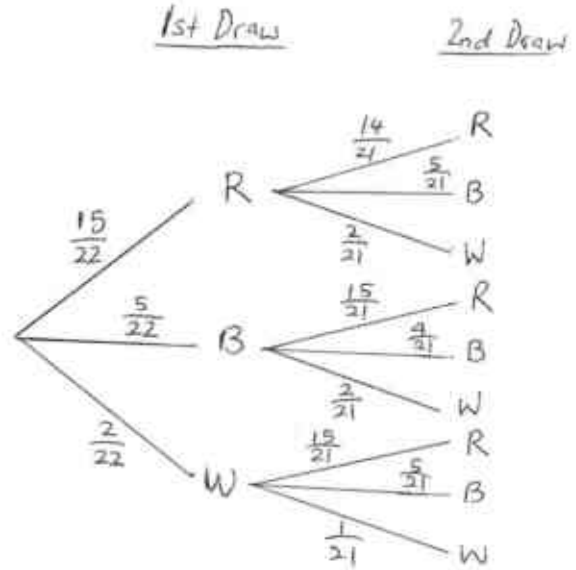
(b) Mean $= \sqrt{\dfrac{\sum fx^2}{\sum f} - \left(\dfrac{\sum fx}{\sum f}\right)^2}$

$= \sqrt{\dfrac{378900}{200} - (43.2)^2}$

$= 5.32$ mins (3 s.f) [A1]

(iii) The mean time taken will increase to 48.2 mins.
The standard deviation will remain the same at 5.32 mins.
[1 mark for each correct statement]

9(b)(i)



[B2]

R represent Red
B represent Blue
W represent white

$(ii)(a)$ P(both are red) $= \frac{15}{22} \times \frac{14}{21}$

$= \frac{5}{11}$ [B1]

(ii)(b) P(only one blue ball) $= 2 \times \frac{5}{22} \times \frac{17}{21}$ [M1]

$= \frac{85}{231}$ [A1]

$(iii)(c)$ P(both are of different colour) $= 1 -$ P(both red) $-$ P(both blue) $-$ P(both white) [M1]

$= 1 - \frac{15}{22} \times \frac{14}{21} - \frac{5}{22} \times \frac{4}{21} - \frac{2}{22} \times \frac{1}{21}$

$= \frac{115}{231}$ [A1]

10(a) Value of the car at the end of 5 years $= (0.9)^5 \times 100000$

$= \$59049$ [M1]

Overall percentage reduction $= \dfrac{100000 - 59049}{100000} \times 100\%$ [M1]

$= 40.951\%$ [A1]

(b) Let x be the floor number of the flat to be purchased.

Price of a flat $= 440000 + 5000(x - 2)$

$= 430000 + 5000x$ [M1]

Loan amount $= 0.9(430000+5000x)$

$= 4500x + 387000$ [M1]

Interest charge $= \dfrac{(4500x + 387000) \times 1.8 \times 25}{100}$

$= 2025x + 174150$ [M1]

Monthly instalment $= \dfrac{6525x + 561150}{25 \times 12}$ [M1]

$= 21.75x + 1870.50$

$21.75x + 1870.50 \leq 2100$ [M1]

$x \leq 10.55$

$\therefore$ the highest floor Mr Wong can purchase is a 10th floor unit. [A1]

(Can accept other logical method presented by students)

Answer **all** the questions.

1 Write the following numbers in order of size, starting with the **smallest**.

$$-\frac{4}{7},\ -\frac{4}{5},\ -0.8^2,\ -0.\dot{8}$$

Answer ………, ………, ………, ……… [1]
smallest largest

---

2 During a children's day celebration, a charity organization distributed 825 files, 495 pens and 660 pencils equally among the children in a children's home. Each child received the same number of files, pens and pencils.

(a) Find the largest possible number of children.

Answer (a) ………………………… [2]

(b) Hence, find the number of files, pens and pencils each child received.

Answer (b) ……………files, ……………pens, ……………pencils [1]

---

3 It is given that $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$.

(a) Find f when $u = 1.2$ and $v = 0.4$.

Answer (a) $f =$ ……………………… [1]

(b) Express u in terms of f and v.

Answer (b) ………………………… [2]

---

4 A restaurant charges \$27.80 per person for buffet lunch. On a particular day, 114 people dined in the restaurant.
By approximating both the charge and the number of diners to 2 significant figures, **estimate** the total amount received by the restaurant on that particular day.

Show your working and give your answer to a reasonable degree of accuracy.

Answer \$…..……………………… [2]

---

5 A piece of metal is heated to 375 ^{o}C and then left to cool for 15 minutes.
The temperature of the metal decreases at a rate of 18 ^{o}C/min for the first 5 minutes and then decreases at a rate of 7 ^{o}C/min for the next 10 minutes.

Find the time taken for the metal to cool to a temperature of 250 ^{o}C.

Answer……………..………….min [2]

---

6 **(a)** Solve the inequality $1-x \le 4+x < 13-2x$.

Answer (*a*) ……..…………..…………… [2]

(b) Write down all the integers which satisfy $1-x \le 4+x < 13-2x$.

Answer (*b*) ……..…………..…………… [1]

---

7 The current, I amperes, passing through a circuit is inversely proportional to its resistance, R ohms. When the resistance of the circuit is 3 ohms, the current passing through it is 2 amperes.

(a) Find an equation connecting I and R.

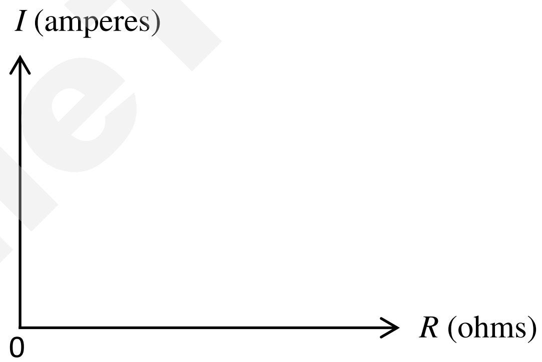
Answer (*a*) ……………………………… [2]

(b) Calculate the resistance of the circuit when 1.5 amperes of current passes through it.

Answer (*b*)……………………………ohms [1]

(c) Sketch the graph of I against R.

Answer (c)



[1]

8 Two containers are geometrically similar.
The surface area of the larger container is 63 cm^2 and the surface area of the smaller container is 28 cm^2.
The height of the smaller container is 5 cm.

Calculate the height of the larger container.

Answer………………………… cm [2]

9 Between 2014 and 2015, the number of pupils who applied for a particular school as their first choice increased by 25%.
In 2015, the number of applicants for that school was 425.

Calculate the number of applicants in 2014.

Answer .... [2]

---

10 The probability that it will rain on any particular day is 0.3.

Calculate the probability that on two consecutive days, it will rain on only one of the days.

Answer .... [2]

---

11 The table below shows the number of internet-connected devices in some households.

Number of devices	1	2	3	4	5	6
Number of households	2	4	x	7	5	3

(a) If the modal number of devices is 4, state the maximum possible value of x.

Answer (*a*) .... [1]

(b) If the mean number of devices is 3.6, calculate the value of x.

Answer (*b*) .... [2]

(c) If the median number of devices is 4, write down all the possible values of x.

Answer (*c*) .... [1]

---

12 Peter drove from Town X to Town Z, passing by Town Y along the way.
He took 40 minutes to drive from Town X to Town Y at an average speed of 72 km/h.
He rested in Town Y for 10 minutes before continuing his journey to Town Z.
The distance between Town Y and Town Z is 52 km.
His average speed for the whole journey was 60 km/h.

Calculate

(a) the distance between Town X and Town Y,

Answer (*a*) ………………..………… km [1]

(b) the average speed for the journey between Town Y and Town Z.

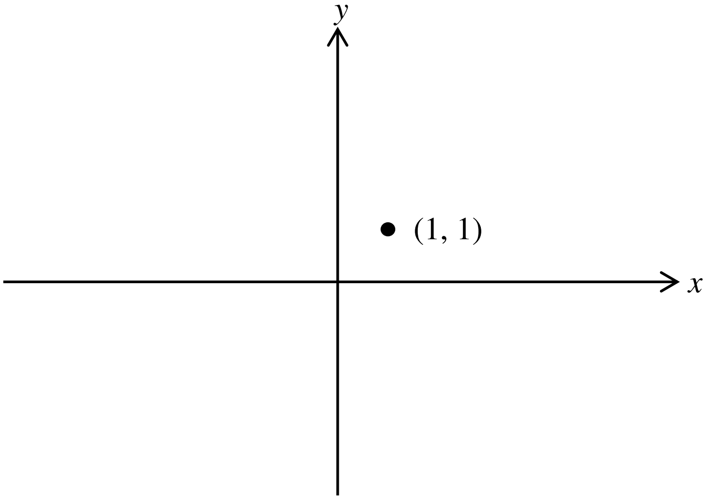
Answer (*b*) ………………..……..… km/h [3]

---

13 The point (1, 1) is marked on the diagram.

Sketch the graph of $y = 8 - x^3$ in the answer space below.

Answer



[1]

---

14 David wants to invest \$500 for 3 years.
Company *A* offers 8% simple interest per year.
Company *B* offers 6% interest per year compounded quarterly.

In which company should David invest his money? Justify your answer.

Answer ……………………………………………………………………………………....

……………………………………………………………………………….............. [3]

---

15 $\xi = \{x: x \text{ is an integer}, 1 \le x \le 100\}$

$A = \{x: x \text{ is divisible by } 11\}$

$B = \{x: x \text{ is divisible by } 22\}$

$C = \{x: x \text{ is divisible by } 33\}$

(a) List the elements of $A \cap (B \cup C)'$.

Answer (*a*) ……….……………………… [1]

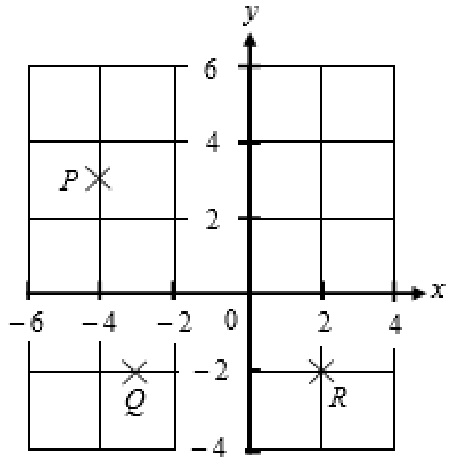
(b) Draw, in the answer space, a clearly labelled Venn diagram to illustrate the three sets *A*, *B* and *C*.

Answer (*b*) ξ

[2]

---

16 On the axes shown, P is $(-4\,,3)$, Q is $(-3\,,-2)$ and R is $(2\,,-2)$.



Find

(a) the gradient of PQ,

Answer (*a*) ………………..…………… [1]

(b) tan $P\hat{R}Q$ **,**

Answer (*b*) ………………..…………… [1]

(c) the equation of the line PR,

Answer (*c*) ………………..…………… [2]

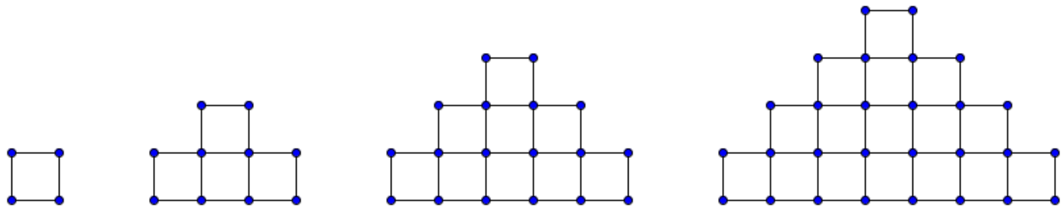
(d) the area of triangle PQR,

Answer (*d*) ………………..……… units^2 [1]

(e) the coordinates of two possible points S, such that the four points P, Q, R and S are the four vertices of a parallelogram.

Answer (*e*) (……..… , ……….) or (………. , ……….) [2]

17



The figures T_1, T_2, T_3 ….. are made up of squares.
N is the number of rows of squares in each shape.
S is the number of squares in each shape.
D is the number of dots in each shape.
The values of N, S and D in T_1, T_2, T_3 and T_4 are recorded in the table below.

Figure	T_1	T_2	T_3	T_4
N	1	2	3	4
S	1	4	p	16
D	4	10	q	28
$D-N^2$	3	6	r	s

(a) Find the values of p, q, r and s.

Answer (*a*) p = ………. , q = ………. , r = ………. , s = ………. [2]

(b) Express S in terms of N.

Answer (*b*) …………………………………. [1]

(c) Express D in terms of N.

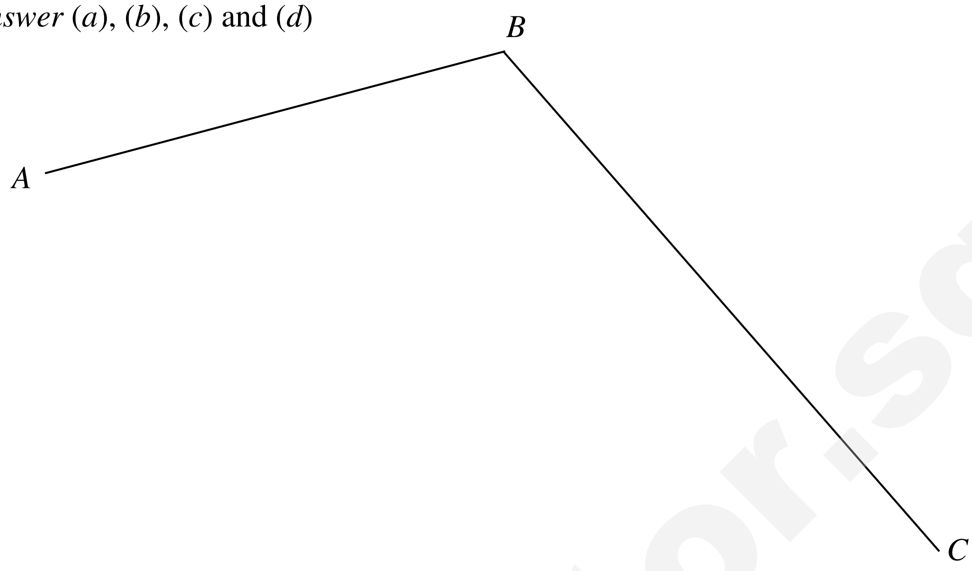
Answer (*c*) …………………………………. [1]

(d) Explain why the number of dots cannot be 42.

Answer ……………………………………………………………………. [1]

18 Three points A, B and C are shown below.

Answer (a), (b), (c) and (d)



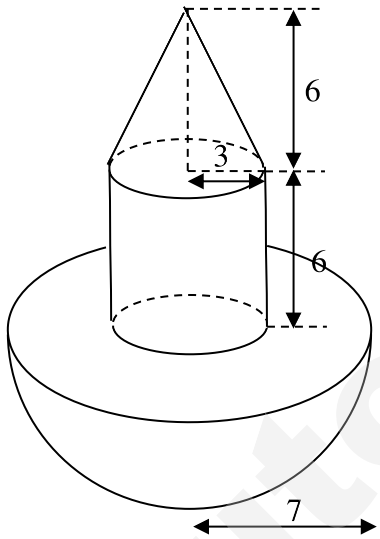
(a) Construct the perpendicular bisector of BC. [1]

(b) Construct the bisector of angle ABC. [1]

(c) Mark clearly the point, P, which is equidistant from the lines AB and BC, and equidistant from B and C. [1]

(d) The point D is such that $ABCD$ is a parallelogram. Find and label the position of D. [1]

19 A gold solid is formed by joining the plane faces of a cone, a cylinder and a hemisphere.
The cone and cylinder have a base radius of 3 cm and height 6 cm.
The hemisphere has a radius of 7 cm.



Calculate

(a) the length of the slant height of the cone,

Answer (*a*) …………………………… cm [2]

(b) the surface area of the gold solid,

Answer (*b*) …………………………… cm^2 [3]

(c) the volume of the gold solid.

Answer (*c*) …………………………… cm^3 [2]

The density of gold is 19.32 g/cm^3.

A gold bar has length 25 cm, width 7 cm and height 3.5 cm.
Five gold bars were melted down and all the gold was used to make a large number of these gold solids.

(d) Calculate the mass of gold that remains after the gold solids are made, giving your answer correct to two significant figures.

Answer (*d*) ………………..……..…….. g [4]

---

20 O is the origin. A is the point $(3, p)$. B is the point $(-4, 5)$. $\overrightarrow{BC} = \begin{pmatrix} 6 \\ 5 \end{pmatrix}$.

(a) If $\overrightarrow{BC}$ is parallel to $\overrightarrow{OA}$, find the value of p.

Answer (*a*) $p =$ ..…………..…………… [2]

(b) Find the ratio $OA : BC$.

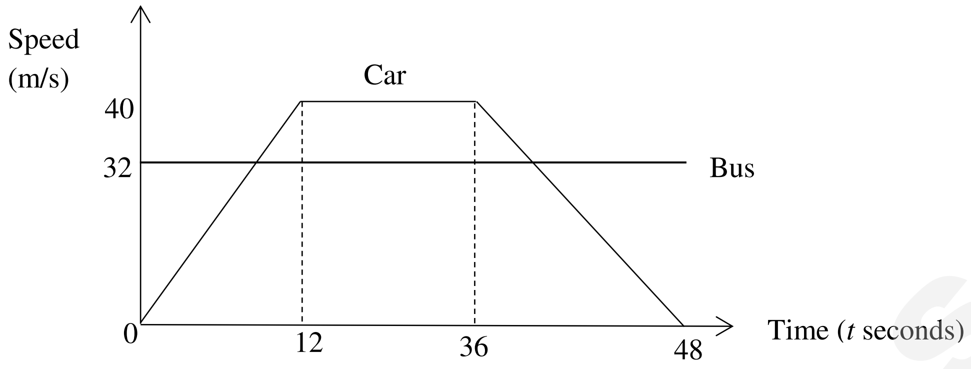
Answer (*b*) ……..…………..…………… [1]

(c) Find the position vector of M such that $OAMB$ is a parallelogram.

Answer (*c*) ……..…………..…………… [2]

---

21 The diagram, not drawn to scale, shows the speed-time graph of a car and a bus during a period of 48 seconds. The car and the bus start from the same point, at the same time and travel in the same direction.



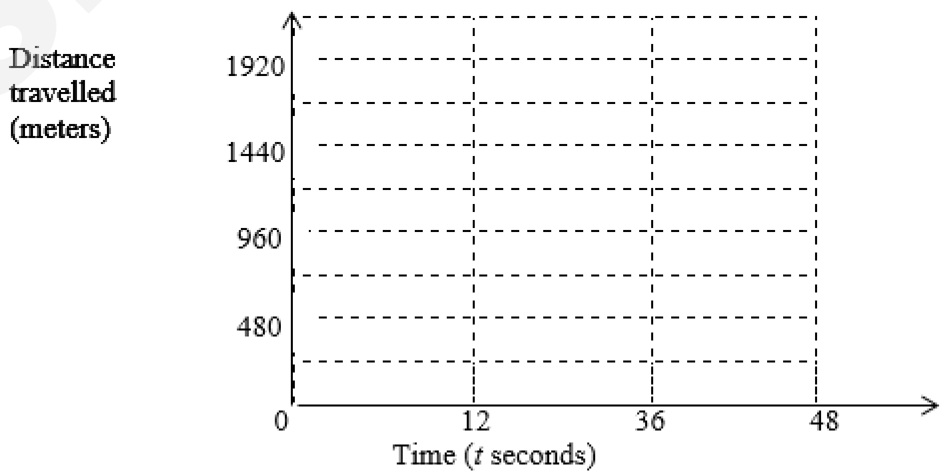
(a) Calculate the value(s) of t when the car and bus have the same speed.

Answer (*a*) …………………..…………… [3]

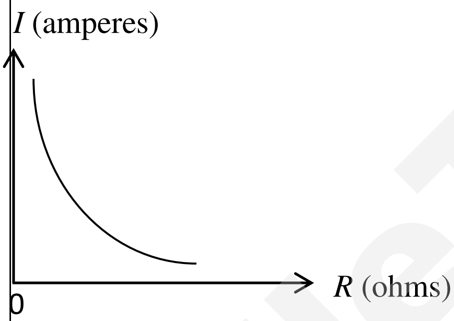
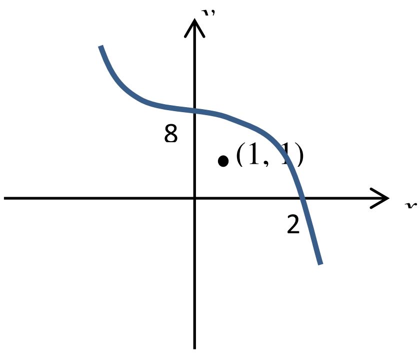
(b) Find the value of t when the car overtakes the bus.

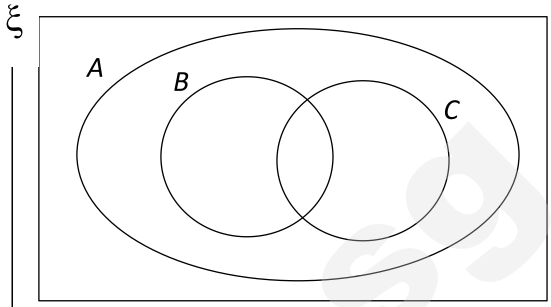
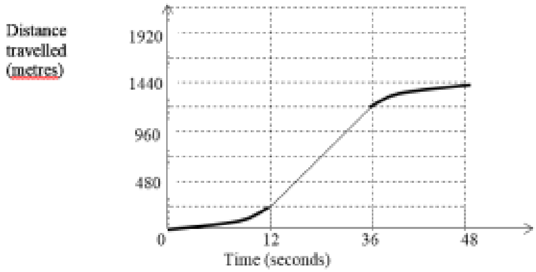
Answer (*b*) …………………..…… seconds [3]

(c) Use the grid below to sketch the distance-time graph of the car for the same journey.



[3]

1	$-0.\dot{8}, -\frac{4}{5}, -0.8^2, -\frac{4}{7}$
2a)	165
2b)	5 files, 3 pens, 4 pencils
3a)	$f = 0.3$
3b)	$u = \frac{f\ v}{v - f}$
4	\$3100
5	10 min
6a)	$-1\frac{1}{2} \leq x < 3$
6b)	$-1,\ 0,\ 1,\ 2$
7a)	$I = \frac{6}{R}$
7b)	$R = 4$ ohms
7c)	
8	$h_l = 7.5\,cm$
9	340
10	0.42
11a)	6
11b)	9
11c)	0, 1,2,3……8
12a)	48 km
12b)	62.4 km/h
13	
14	Company A

15a)	$A \cap (B \cup C)' = \{11,55,77\}$
15b)	
16a)	-5
16b)	$\frac{5}{6}$
16c)	$y = -\frac{5}{6}x - \frac{1}{3}$
16d)	$12.5\ square\ units$
16e)	$S(1,3)\ or\ S(3,-7)\ or\ S(-9,3)$
17a)	p = 9, q = 18, r = 9, s = 12
17b)	$S = N^2$
17c)	$D = 3N + N^2$
17d)	$N = \frac{-3 \pm \sqrt{9+168}}{2}$ which is no a whole number
19a)	$6.71\ cm$
19b)	$610\ cm^2$
19c)	$945\ cm^3$
19d)	$4400\ g$
20a)	$p = 2.5$
20b)	$OA : BC = 1 : 2$
20c)	$\begin{pmatrix} -1 \\ 7.5 \end{pmatrix}$
21a)	38.4
21b)	30
21c)	

Answer **all** the questions.

1 **(a)** Express as a single fraction in its simplest form $1-\frac{2x}{2x-7}+\frac{7}{(2x-7)^2}$. [3]

(b) Simplify $5a^{-3}b^5 \div \frac{10}{9}a^3b^{-2}$. [2]

(c) Factorise fully

(i) $11p^2-44pq+4q-p$, [2]

(ii) $30m^2+14mn-4n^2$. [2]

(d) Solve the equation $\frac{1}{x}-\frac{x-5}{2x-3}=1$. [3]

---

2 Twenty five boys took a quiz.
The marks are shown in the stem-and-leaf diagram.

1	4 7
2	3 5 7 7 9
3	0 1 2 3 3 5 7 7 8 9 9 9
4	3 4 6 6 7
5	0

Key
1 | 4 means 14 marks

(a) Find

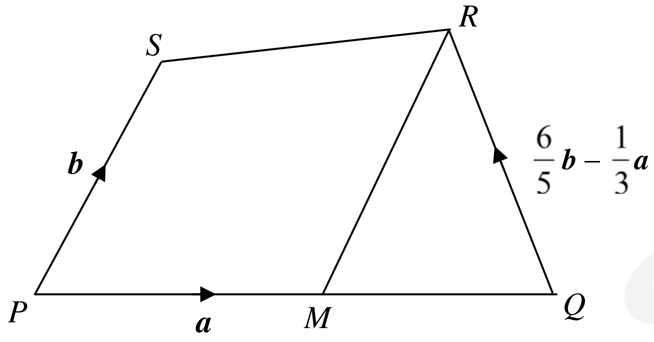
(i) the median mark, [1]

(ii) the interquartile range. [3]

Twenty five girls took the same quiz.
The median mark and interquartile range of the girls' marks are 35 and 6 respectively.

(b) Compare and comment on the performance of the boys and girls in this quiz. [2]

3 $PQRS$ is a quadrilateral. M is the mid-point of PQ.
$\overrightarrow{PQ} = \boldsymbol{a}$, $\overrightarrow{PS} = \boldsymbol{b}$ and $\overrightarrow{QR} = \frac{6}{5}\boldsymbol{b} - \frac{1}{3}\boldsymbol{a}$.

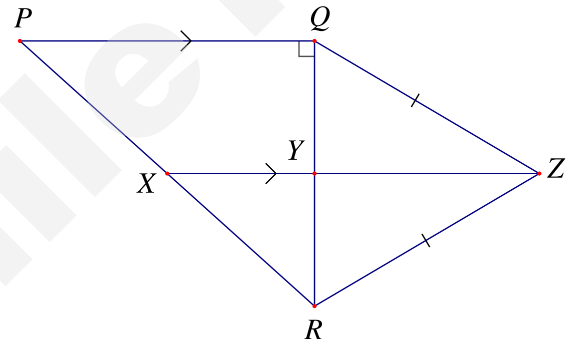


(a) Find $\overrightarrow{SR}$ in terms of $\boldsymbol{a}$ and $\boldsymbol{b}$. [1]

(b) Use vectors to show that PS and MR are **not** parallel. [2]

---

4 In the diagram, PXR, QYR, and XYZ are straight lines.
PQ is parallel to XZ, $QZ = RZ$, $\frac{YZ}{XZ} = \frac{3}{5}$ and $P\hat{Q}R = 90^\circ$.



(a) Show that triangles QYZ and RYZ are congruent. [3]

(b) Show that triangles PQR and XYR are similar. [2]

(c) Find

(i) $\dfrac{\text{area of } \Delta XYR}{\text{area of } \Delta RYZ}$, [1]

(ii) $\dfrac{\text{area of } \Delta XYR}{\text{area of } \Delta PQR}$. [1]

---

5 Jeannie bought some health drink for \$6400. She paid \$$x$ for each litre of the drink.

(a) Find, in terms of x, an expression for the number of litres she bought. [1]

(b) She gave away 8 litres of the drink to her friends. She sold the remainder of the drink for \$50 per litre more than she paid for it. Write down an expression, in terms of x, for the sum of money she received. [1]

(c) She made a profit of \$2960.

(i) Write down an equation in x to represent this information, and show that it reduces to $x^2 + 420x - 40\,000 = 0$. [2]

(ii) Solve the equation $x^2 + 420x - 40\,000 = 0$. [3]

(d) Find the number of litres of drink Jeannie sold. [1]

---

6 Two satay stalls sell 3 types of satay.
The number of sticks of each type of satay sold per day is given by the matrix **S**.

$$\mathbf{S} = \begin{array}{c} \\ \end{array}\begin{array}{ccc} \text{Chicken} & \text{Mutton} & \text{Beef} \end{array}$$
$$\mathbf{S} = \begin{pmatrix} 400 & 300 & 200 \\ 200 & 500 & 300 \end{pmatrix} \begin{array}{l} \text{Stall A} \\ \text{Stall B} \end{array}$$

(a) The price of each stick of chicken, mutton and beef satay is \$0.35, \$0.45 and \$0.40 respectively.

Represent these prices in a 3×1 column matrix **P**. [1]

(b) Evaluate the matrix $\mathbf{T} = \mathbf{SP}$. [1]

(c) State what the elements of **T** represent. [1]

(d) In June 2016, Stall A operated 20 days and Stall B operated 25 days.

Use matrix multiplication to find the total amount of money collected by the two stalls in June 2016. [2]

(e) In July, the number of sticks of each type of satay sold per day is increased by 10%. The information is given by the matrix **Q**.

$$\begin{array}{ccc} \text{Chicken} & \text{Mutton} & \text{Beef} \end{array}$$
$$\mathbf{Q} = \begin{pmatrix} 440 & 330 & 220 \\ 220 & 550 & 330 \end{pmatrix} \begin{array}{l} \text{Stall A} \\ \text{Stall B} \end{array}$$

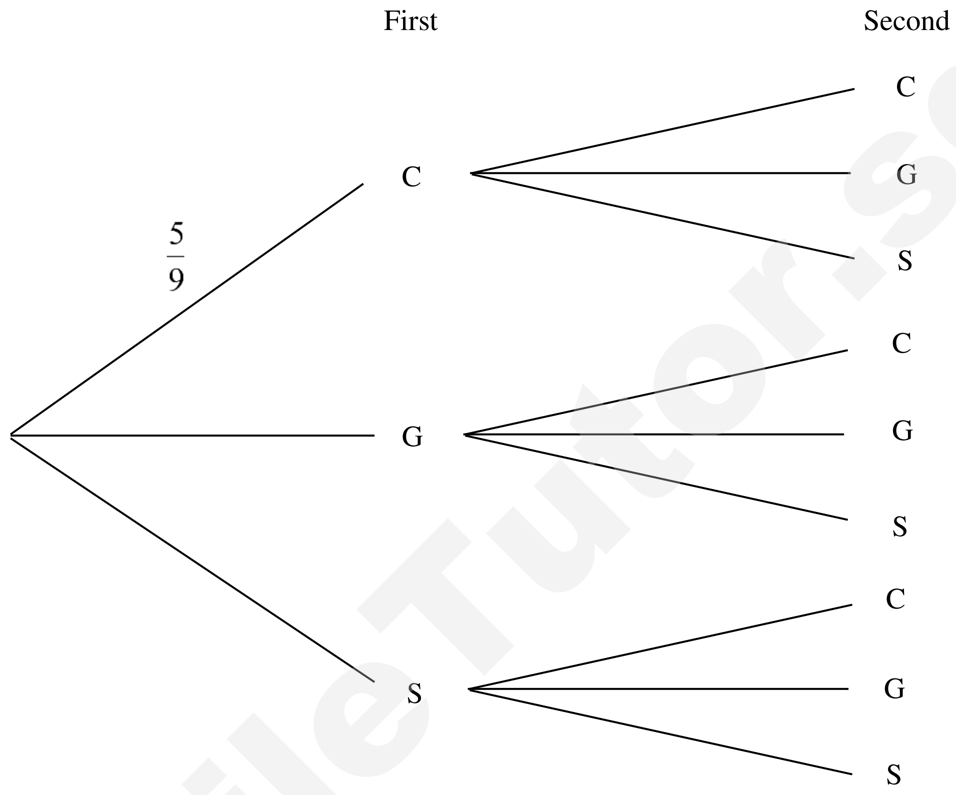
Write down the matrix **R** such that **Q** = **SR**. [1]

---

7 A box contains 5 Chocolate doughnuts, 3 Glazed doughnuts and 1 Strawberry doughnut.

(a) Two doughnuts were taken out of the box at random, without replacement.

Copy and complete the tree diagram to show this information. [3]

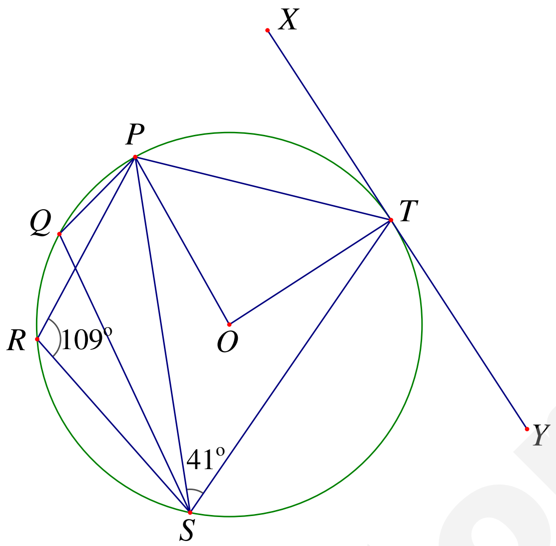


(b) Find, as a fraction in its simplest form, the probability that

(i) the two doughnuts are the same flavour, [3]

(ii) at least one of the doughnuts is Chocolate. [2]

8 In the diagram, the points P, Q, R, S and T lie on a circle, centre O. XTY is a tangent to the circle. Angle $PRS = 109^{\circ}$ and angle $PST = 41^{\circ}$.



(a) Find, giving reasons for each answer,

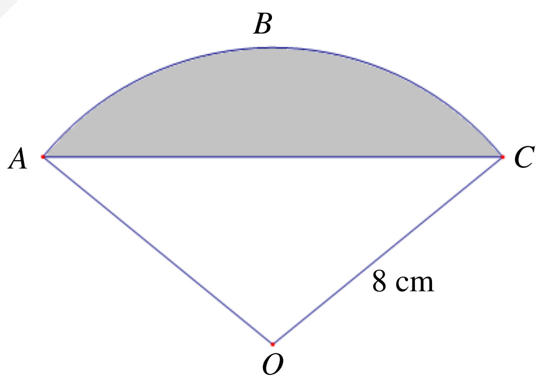
(i) $P\hat{Q}S$, [1]

(ii) $P\hat{T}S$, [1]

(iii) $Y\hat{T}S$, [2]

(iv) $O\hat{T}P$. [2]

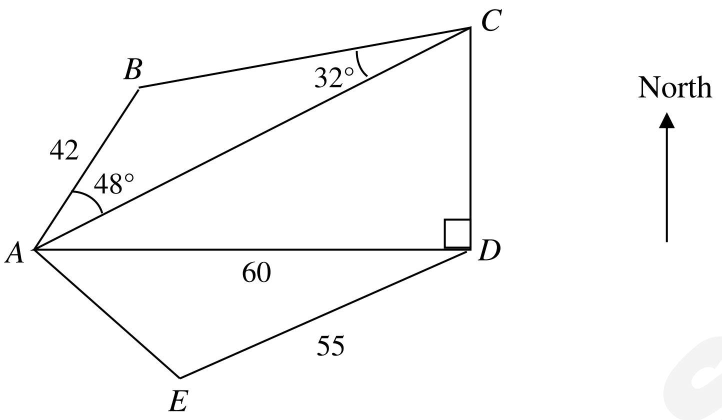
(b) $OABC$ is a sector of a circle, centre O and radius 8 cm. The perimeter of the sector is 30 cm.



(i) Show that angle $AOC = 1.75$ radians. [1]

(ii) Calculate the area of the shaded region. [3]

9



The diagram shows a field, *ABCDE*, which is crossed by two paths, *AC* and *AD*. *AD* is perpendicular to *CD*. $AB = 42$ m, $AD = 60$ m, $DE = 55$ m, angle $BAC = 48°$ and angle $ACB = 32°$.

(a) Show that $AC = 78.05$ m, correct to four significant figures. [2]

(b) Calculate *CD*. [2]

(c) A bird is at *P*, which is 8 m vertically above *E*.
Calculate the angle of depression of *D* from *P*. [2]

(d) Given that the area of triangle *ADE* is 1300 m^2, calculate angle *ADE*. [2]

(e) *D* is due east of *A*.
Calculate the bearing of *E* from *A*. [3]

10 Answer the whole of this question on a sheet of graph paper.

The variables x and y are connected by the equation $y = \frac{5x^2}{4} + \frac{60}{x} - 40$.

Some corresponding values of x and y are given in the following table.

x	1	1.5	2	3	3.5	4	4.5	5	6
y	p	2.81	-5	-8.75	-7.54	-5	-1.35	3.25	15

(a) Find the value of p. [1]

(b) Using a scale of 2 cm to represent 1 unit, draw a horizontal x-axis for $1 \le x \le 6$.
Using a scale of 2 cm to represent 5 units, draw a vertical y-axis for $-15 \le y \le 25$.
On your axes, plot the points given in the table and join them with a smooth curve. [2]

(c) Using your graph, find the range of values of x for which
$\frac{5x^2}{4} + \frac{60}{x} - 40 < 0$. [3]

(d) By drawing a tangent, find the gradient of the curve at the point where $x = 4$. [2]

(e) Draw the tangent to the curve at the point where the gradient is -10.
Write down the equation of this tangent. [2]

(f) The line l intersects the curve $y = \frac{5x^2}{4} + \frac{60}{x} - 40$ at $x = 2$ and $x = 6$.

(i) Find the equation of l. [2]

It is given that $x = 2$ and $x = 6$ are solutions of the equation
$5x^3 + Ax^2 + Bx + 240 = 0$.

(ii) By using your answer from **(f)(i)**, find the value of A and of B. [3]

11 **Diagram I** shows a pencil before it is sharpened. It is made up of a piece of cylindrical carbon encased in wood. The length of the pencil is 19 cm.
Diagram II shows the cross-sectional area of the pencil. *ABCDEF* is a regular hexagon with side 0.45 cm. The diameter of the carbon is 0.2 cm.

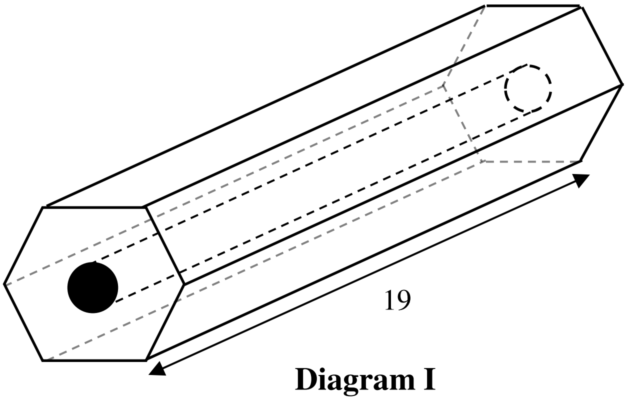


Diagram I

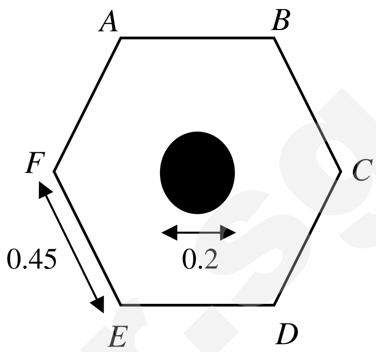


Diagram II

(a) Find

(i) the interior angle of the regular hexagon *ABCDEF*, [2]

(ii) *CF*. [1]

(b) Show that $AE = 0.7794$ cm. [2]

(c) Calculate the area of the regular hexagon *ABCDEF*. [2]

(d) Calculate the volume of the carbon as a percentage of the volume of the pencil. [2]

Diagram III shows ten of these pencils which just fit into a rectangular box which is open on one side.
Diagram IV shows ten of these pencils which just fit into a box whose cross-sectional area is an equilateral triangle which is open on one side.

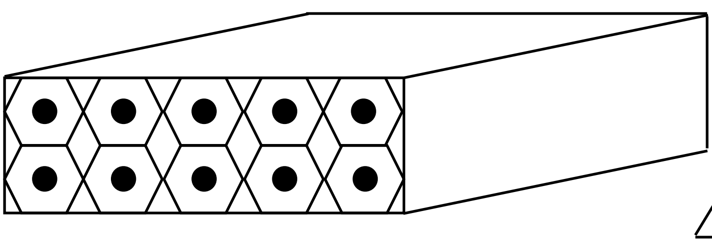


Diagram III

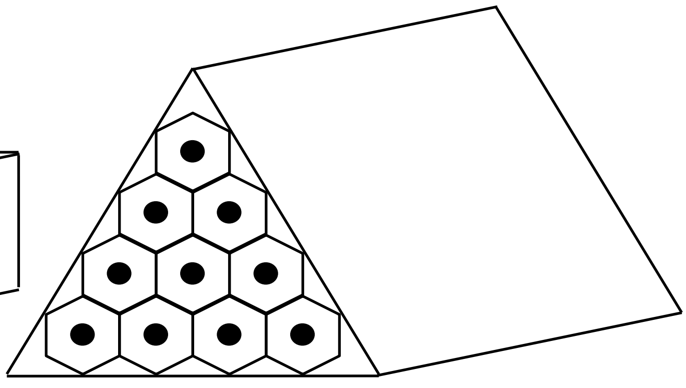


Diagram IV

(e) The boxes are made of cardboard which cost \$10 per m^2.
Determine which box will be cheaper to produce for 1000 boxes.
Justify your decision with calculations. [5]

1a)	$\frac{56-14x}{(2x-7)^2}$
1b)	$\frac{9b^7}{2a^6}$
1c)	(i) $(11p-1)(p-4q)$
	(ii) $2(3m+2n)(5m-n)$
1d)	$x=\frac{1}{3}\quad or \quad 3$
2a)	35 marks
2b)	13 marks
3a)	$\frac{2}{3}\boldsymbol{a}+\frac{1}{5}\boldsymbol{b}$
4c)	(i) $\frac{\text{area of } \Delta XYR}{\text{area of } \Delta RYZ}=\frac{2}{3}$
	(ii) $\frac{\text{area of } \Delta XYR}{\text{area of } \Delta PQR}=\left(\frac{1}{2}\right)^2=\frac{1}{4}$
5a)	$\frac{6400}{x}$
5b)	$\left(\frac{320\,000}{x}-8x+6000\right)$
5c)	(ii) $x=-500$ or $x=80$
5d)	72
6a)	$\begin{pmatrix}0.35\\0.45\\0.40\end{pmatrix}$
6b)	$\begin{pmatrix}355\\415\end{pmatrix}$
6c)	The total amount of money collected by each stall (per day from the selling the satay)
6d)	\$17 475
6e)	$\begin{pmatrix}1.1&0&0\\0&1.1&0\\0&0&1.1\end{pmatrix}$
7b)	(i) $\frac{5}{6}$
	(ii) $\frac{13}{36}$
8a)	(i) 109^{o}
	(ii) 71^{o}
	(iii) 68^{o}
	(iv) 49^{o}

8b)	(ii) 24.5 cm^2
9b)	49.9 cm
9c)	8.3°
9d)	52.0°
9e)	148.9°
10a)	21.25
10c)	$1.65 < x < 4.65$
10d)	m = 6.25
10e)	y = -10x+15
10f)	(i) y=5x-15
	(ii) A=-20 & B=-100
11a)	(i) 120°
	(ii) 0.9 cm
11c)	0.526 cm^2
11d)	5.97%
11e)	Design IV will be cheaper to produce for 1000 boxes

	Class	Register Number
Name ______________________		

4048/01 **16/S4PR2/EM/1**

MATHEMATICS PAPER 1

Friday **29 July 2016** **2 hours**

VICTORIA SCHOOL

PRELIMINARY EXAMINATION TWO
SECONDARY FOUR

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

Answer **all** the questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
You are expected to use a scientific calculator to evaluate explicit numerical expressions.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For , use either your calculator value or 3.142, unless the question requires the answer in terms of .

The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 80.

This paper consists of 15 printed pages, including the cover page.

Mathematical Formulae

Compound interest

Total amount =

Mensuration

Curved surface area of a cone =

Surface area of a sphere =

Volume of a cone =

Volume of a sphere =

Area of triangle *ABC* =

Arc length = , where is in radians

Sector area = , where is in radians

Trigonometry

Statistics

Mean =

Standard deviation =

1 Calculate giving your answer correct to

(a) 5 decimal places,

Answer (a).................................. [1]

(b) 5 significant figures.

Answer (b).................................. [1]

---

2 A sequence of numbers is given as follows;

1st line: $1^2 + 1 - 1 = 1$

2nd line : $2^2 + 2 - 1 = 5$

3rd line: $3^2 + 3 - 1 = 11$

4th line: $4^2 + 4 - 1 = 19$

(a) Write down an expression, in terms of n, for the nth term in the sequence.

Answer (a).................................. [1]

(b) Calculate the value of the 67th term of the sequence.

Answer (b).................................. [1]

---

3 (a) Given that find the value of x.

Answer (a) ____________________ [1]

(b) Light travels 1 metre in 3.3 nanoseconds.
Find the total distance, in metres, that light will travel in 6.6 microseconds.

*Answer (b)*________________________m [1]

4

PQ is parallel to *RS*.

(a) Find

Answer (*a*) .... [1]

(b) Find

Answer (*b*) .... [1]

---

5 A group of students were asked to determine which of the following allows more water to flow through in a given time:

A	Two hoses with diameters of 5 cm each.	OR	*B*	A hose with a diameter of 8 cm.

Paul chooses *A*. His reasoning is that the two hoses have a bigger combined diameter of $5 + 5 = 10 > 8$. Is Paul right? Explain.

Answer……………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………[2]

---

6 Simplify

Answer …………………………… [2]

---

7 Some students were interviewed to find out the languages they spoke at home.

(a) Describe, as simply as possible, in words, the set

Answer (*a*) ..…………….…………………………………………………………………………

…..........…………………………………………………………..……………………....[1]

(b) On the Venn Diagram, shade the region which represents

[1]

It is given that , and

(c) If , find the number of students who did not speak either English or their Mother Tongue.

Answer (*c*)………...………………… [1]

---

8 **(a)** Factorise

Answer (*a*)………...………………… [1]

(b) Factorise completely

Answer (*b*)………...………………… [2]

---

9 Boris and Bram jog on a circular track with radius 15 m. Boris jogs with a constant speed of and Bram jogs with a constant speed of If both boys start jogging in the opposite direction from point *A* at 08 10, when will they meet again at *A*?

Answer ………..……..……… [3]

---

10 Two similar marbles made from the same material have radii in the ratio of 2 : 5.

(a) If it costs \$2 to paint the small marble, calculate the cost to paint the large marble using the same paint.

Answer (*a*) \$ ……..……………… [1]

(b) If the mass of the larger marble is 250 g, what is the mass of the smaller marble?

Answer (*b*)………..……………g [2]

---

11 A painter takes 4 days to paint a house. His apprentice takes 2 more days to paint the same house.

(a) Find the number of similar houses that the apprentice can paint in 30 days.

Answer (*a*)………..………houses [1]

(b) If the painter and the apprentice paint the house together, how many days will it take the both of them to complete painting 1 house?

Answer (*b*)………..…………days [2]

---

12 **(a)** Sketch the graph of

.

Answer (*a*)..

[2]

(b) Write down the equation of the line of symmetry of the graph of

Answer (*b*).. [1]

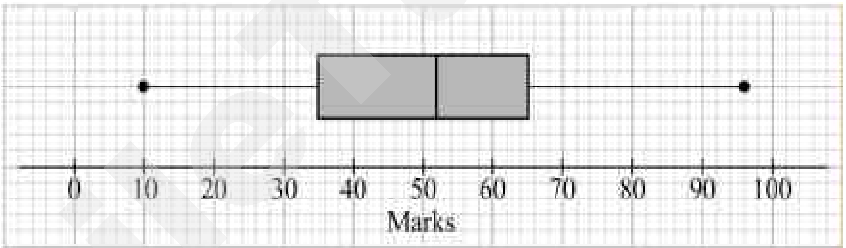
---

13 The cumulative frequency curve below shows the marks obtained, out of 100, by 60 students in an Elementary Mathematics paper.

(a) Find interquartile range of the distribution.

Answer (*a*)……….…………marks [1]

(b) The same 60 students also sat for the Additional Mathematics paper. The box-and-whisker diagram below illustrates the marks obtained. The maximum mark was again 100.



A parent commented that the Elementary Mathematics paper was easier than the Additional Mathematics paper.

Do you agree? Give a reason for your answer.

Answer (*b*) ………….………………because…………………………………………

……………......….………………………………………………………..……………

…………………………………………………………………………………... [2]

14 The period of oscillation, T seconds of a string varies directly as the square root of the length of the string, l cm. When the length of the string is 36 cm, the period of the oscillation is 0.3 seconds.

(a) Find the length of the string when the period of oscillation is 0.4 seconds.

Answer (*a*)………..……………cm [2]

(b) Calculate the percentage change in l if T is decreased by 30%.

Answer (*b*)………..………………% [2]

---

15 **(a)** The lowest point of a quadratic curve is It intersects the y-axis at Write down the equation of the curve in the form , where a, b, c are integers.

Answer (*a*) y .... [2]

(b) Hence solve the equation , giving your answers correct to two decimal places.

Answer (*b*) x .... [2]

---

16 **(a)** Is it possible to draw a regular polygon whose exterior angle is ?
Give a reason for your answer.

Answer (*a*)…...……………………………………………………………………………

..……………………………………………………………………………..…… [2]

(b)

In the diagram above, *ABC*… is part of a polygon. is The size of the remaining interior angles are each equal to Find the number of sides of this polygon.

Answer (*b*).. [2]

---

17 Vernon travels to school either by bus or by car. The probability of being late for school is if he travels by bus and if he travels by car.

(a) Find the probability that he will be late on just two out of three days if he travels by bus on three consecutive days.

Answer (*a*)………..……………… [2]

(b) If the probability that he travels by bus is , find the probability that he will be late for school on any given day.

Answer (*b*)………..……………… [2]

---

18 The graph shows the charges made by a telecommunication company for making local phone calls lasting up to 70 minutes. The total cost is made up of a fixed charge, $3.00, together with a charge of $*x* per minute for making local phone calls.

[1]

(a) State the cost of making 44 minutes of local phone call.

Answer (*a*) $ ……..………………. [1]

(b) **(i)** A second telecommunication company that does not have a fixed charge, charges 8¢ per minute for the first 50 minutes and 15¢ per minute after that.

Draw a graph, on the same axes, to represent the charge made by this second company.

(ii) Find the range of times, T, for which it would be cheaper to subscribe to the second company.

Answer (*b*)(*ii*) .... [1]

---

19 In the diagram, *ABCD* is a parallelogram with, and *EF* intersects *HD* and *HC* at *G* and *K* respectively.
If the area of , find the area of

(a) ,

Answer (*a*)………..……………. [2]

(b)

Answer (*b*)………..……………[2]

20 The diagram shows a circle with centre *O* and radius 7 cm inscribed in a regular octagon of sides 5.8 cm each.

(a) Calculate the area of the octagon.

Answer (*a*)………..…………… [2]

(b) Find the total area of the shaded region between the circle and the octagon.

Answer (*b*)………..…………… [2]

21 **(a)** Solve the equation

Answer (*a*) .... [2]

(b) 216 cubes, each having edges of 2.6 cm, measured to the nearest 0.1 cm, fit exactly into a larger cubic box. Find the

(i) greatest possible length of the cubic box, *Answer* (b)(i) .... [2]

(ii) least possible volume of the cubic box.

Answer (b)(ii) .... [1]

---

22 The equation of a straight line is

(a) Find the gradient of the line.

Answer (a) .... [1]

(b) Find the equation of the line, parallel to , which passes through the point

Answer (b) .... [2]

(c) Find the distance between the points at which these two lines cut the x-axis.

Answer (c).................................... units [2]

---

23 **(a)** In the diagram, O is the centre of the circle $ADBC$. AB and CD are two perpendicular diameters. L and R are points on AB. N and P are points on CD. M and Q are points on the circumference of the circle. $LMNO$ and $OPQR$ are two rectangles.

Explain briefly why LN and PR are equal in length.

Answer (a) ……………………………………………………………………………..

…..........………………………………………………………………..……………………

......…………………………………………………………………………………… [2]

(b) In the diagram, the points A, B, C, D and E lie on a circle, centre O.

BOE is a diameter,
AE is parallel to *CD*.

(i) Find

Answer (*b*)(*i*) .... [2]

(ii) Hence show that triangle *ACE* is an equilateral triangle.

Answer (*b*)(*ii*) …………………………………………………………………………
…...........
…………………………………………………………..……………

…..........……………………………………………………………...……………

.......…………………………………………………………………………...… [1]

---

24 The point *H* represents the position of a harbour located along a coastline. Another point *J* represents the position of a jetty situated along the same coastline. The point *L* represents the position of a lighthouse.
It is given that

(a) Using a scale of 1: 20000, construct the [2]

Answer (*a*) *and* (*c*)

(b) Measure and write down the distance *LH*.

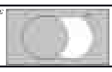
Answer (*b*) .... m [1]

(c) A yacht sails directly from *H* to *L*. By drawing a suitable line, measure and write down its closest distance to the jetty.

Answer (*c*) .... m [2]

End of Paper

2016 Victoria School Prelim 2 Mathematics Paper 1 Answer Key

1a	0.00504
1b	0.0050408
2a	
2b	4555
3a	
3b	2000 m
4a	
4b	
5	No, Paul is wrong. The hose in *B* with a larger cross sectional area allows more water to flow through than in *A*.
6	
7a	is the set of students who spoke only in their Mother Tongue at home
7b	
7c	61 students
8a	
8b	
9	
10a	$12.50
10b	16g
11a	5 days

11b	days
12a	
12b	
13a	39 marks
13b	Disagree. Median marks in Elementary Mathematics paper is lower.
14a	64
14b	Increase by 69%
15a	
15b	
16a	No. is not divisible by 7
16b	9 sides
17a	
17b	
18a	$5.20
18bi i	
19i	50
19ii	20
20a	162.4
20b	8.4
21a	
21bi	15.9
21bi i	
22a	
22b	
22c	
23b	
24a	Constructions
24b	2055 m
24c	790 m

	Class	Register Number
Name MARK SCHEME		

4048/01 **16/S4PR2/EM/1**

MATHEMATICS **PAPER 1**

Friday **29 July 2016** **2 hours**

VICTORIA SCHOOL

PRELIMINARY EXAMINATION TWO
SECONDARY FOUR

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

Answer **all** the questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
You are expected to use a scientific calculator to evaluate explicit numerical expressions.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 80.

This paper consists of 17 printed pages, including the cover page.

[Turn over

Mathematical Formulae

Compound interest

$$\text{Total amount} = P\left(1+\frac{r}{100}\right)^{n}$$

Mensuration

$$\text{Curved surface area of a cone} = \pi rl$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3}\pi r^3$$

$$\text{Area of triangle } ABC = \frac{1}{2}ab\sin C$$

$$\text{Arc length} = r\theta, \text{ where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2}r^2\theta, \text{ where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

1 Calculate $\frac{\sqrt{0.00234 \times 9.45}}{29.5}$, giving your answer correct to

(a) 5 decimal places,

$\boxed{0.00504 \quad \text{---- [B1]}}$

(b) 5 significant figures.

$\boxed{0.0050408 \quad \text{---- [B1]}}$

---

2 A sequence of numbers is given as follows;

1st line:	$1^2 + 1 - 1 = 1$
2nd line:	$2^2 + 2 - 1 = 5$
3rd line:	$3^2 + 3 - 1 = 11$
4th line:	$4^2 + 4 - 1 = 19$

(a) Write down an expression, in terms of n, for the nth term in the sequence.

$\boxed{n^2 + n - 1 \quad \text{------ [B1]}}$

(b) Calculate the value of the 67th term of the sequence.

$\boxed{4555 \quad \text{------- [B1]}}$

---

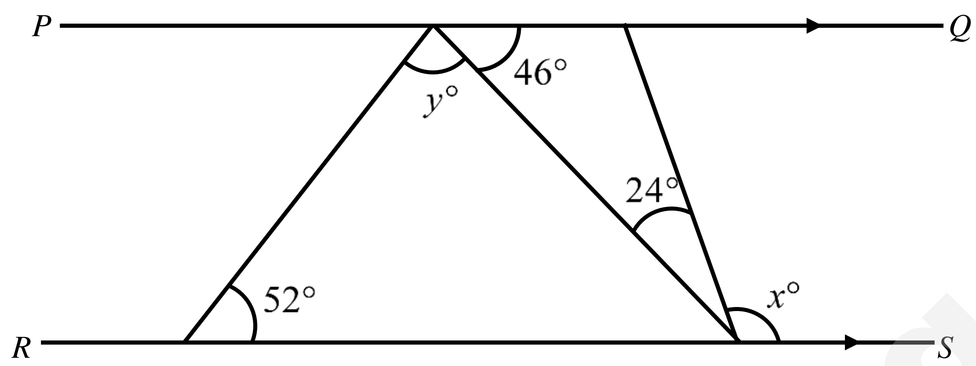
3 **(a)** Given that $3^4 \times 3^{\frac{2}{x}} = 3^{-\frac{1}{2}}$, find the value of x.

$$3^4 \times 3^{\frac{2}{x}} = 3^{-\frac{1}{2}}$$
$$\Rightarrow 4 + \frac{2}{x} = -\frac{1}{2}$$
$$8x + 4 = -x$$
$$9x = -4$$
$$x = -\frac{4}{9} \quad \text{------- [A1]}$$

(b) Light travels 1 metre in 3.3 nanoseconds.
Find the total distance, in metres, that light will travel in 6.6 microseconds.

$$3.3 \text{ nanoseconds} = 3.3 \times 10^{-9} \text{ seconds}$$
$$6.6 \text{ microseconds} = 6.6 \times 10^{-6} \text{ seconds}$$
$$\therefore \text{Distance travelled} = \frac{6.6 \times 10^{-6}}{3.3 \times 10^{-9}}$$
$$= 2000 \text{ m} \quad \text{--------- [A1]}$$

4



PQ is parallel to *RS*.

(a) Find *x*.

$x = 180° - 46° - 24°$
$= 110$ ------- [A1]

(b) Find *y*.

$y = 180° - 46° - 52°$
$= 82$ ------- [A1]

---

5 A group of students were asked to determine which of the following allows more water to flow through in a given time:

A	Two hoses with diameters of 5 cm each.	OR	*B*	A hose with a diameter of 8 cm.

Paul chooses *A*. His reasoning is that the two hoses have a bigger combined diameter of 5 + 5 = 10 > 8. Is Paul right? Explain.

No, Paul is wrong. ----- [B1]

Total cross-sectional area of $A = 2\pi(2.5)^2 = 12.5\pi \text{ cm}^2$.

Total cross-sectional area of $B = 2\pi(4)^2 = 16\pi \text{ cm}^2$.

$\therefore$ The hose in *B* with a larger cross sectional area allows more water to flow through than in *A*. ---- [A1]

---

6 Simplify $36b^2 - 25(1-b)^2$.

$36b^2 - 25(1-b)^2 = (6b)^2 - [5(1-b)]^2$

$= [6b - 5(1-b)][6b + 5(1-b)]$ -------- [B1 - Identity]

$= (6b - 5 + 5b)(6b + 5 - 5b)$

$= (11b - 5)(b + 5)$ ------- [A1]

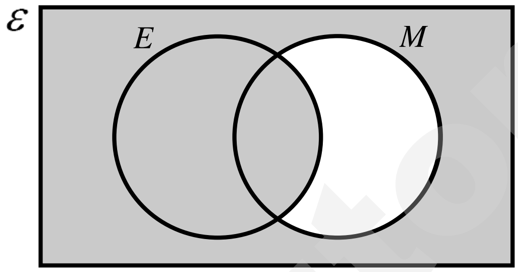
7 Some students were interviewed to find out the languages they spoke at home.

$\varepsilon = \{$The set of students who were interviewed$\}$
$E = \{$The set of students who spoke English$\}$
$M = \{$The set of students who spoke their Mother Tongue$\}$

(a) Describe, as simply as possible, in words, the set $M \cap E'$.

$M \cap E'$ is the set of students who spoke only in their Mother Tongue at home. [B1]

(b) On the Venn Diagram, shade the region which represents $E \cup (M \cup E)'$.



[B1 – Correct Shading]

It is given that $n(\varepsilon) = 256$, $n(E) = 195$ and $n(M) = 123$.

(c) If $M \subset E$, find the number of students who did not speak either English or their Mother Tongue.

Number of students who did not speak either English or their Mother Tongue
$= 256 - 195$
$= 61$ --------- [B1]

---

8 **(a)** Factorise completely $x^2 - 2xy + y^2$.

$x^2 - 2xy + y^2$
$= (x - y)^2$ ------ [B1]

(b) Factorise completely $x^3 - 3x^2 - 4x + 12$.

$x^3 - 3x^2 - 4x + 12$
$= x^2(x-3) - 4(x-3)$ -------- [B1]
$= (x^2 - 4)(x-3)$
$= (x-2)(x+2)(x-3)$ ------- [A1]

9 Boris and Bram jog on a circular track with radius 15 m. Boris jogs with a constant speed of 0.15π ms^{-1} and Bram jogs with a constant speed of 0.25π ms^{-1}. If both boys start jogging in the opposite direction from point A at 08 10, when will they meet again at A?

$$\left.\begin{aligned}\text{Time taken for Boris to finish 1 lap} &= \frac{2\pi(15)}{0.15\pi}\\ &= 200 \text{ s}\\ \text{Time taken for Bram to finish 1 lap} &= \frac{2\pi(15)}{0.25\pi}\\ &= 120\text{s}\end{aligned}\right\} \text{------- [M1]}$$

$\therefore 200 = 2^3 \times 5^2, 120 = 2^3 \times 3 \times 5$

LCM of 200 and 120 $= 2^3 \times 3 \times 5^2$ -------- [M1]

$= 600$ s

$= 10$ mins

Time they will meet again = 10 min after 08 10

= 08 20 ----------[A1]

---

10 Two similar marbles made from the same material have radii in the ratio of 2 : 5.

(a) If it costs \$2 to paint the small marble, calculate the cost to paint the large marble using the same paint.

Since the marbles are similar,

$$\frac{\text{Surface area of large marble}}{\text{Surface area of small marble}} = \left(\frac{5}{2}\right)^2$$

$$\therefore \text{Cost to paint larger marble} = \left(\frac{5}{2}\right)^2 \times \$2$$

$= \$12.50$ ------- [A1]

(b) If the mass of the larger marble is 250 g, what is the mass of the smaller marble?

Since the marbles are similar,

$$\frac{\text{Mass of small marble}}{250} = \left(\frac{2}{5}\right)^3 \quad \text{------- [B1]}$$

$$\therefore \text{Mass of small marble} = \left(\frac{2}{5}\right)^3 \times 250$$

$= 16$ g ------- [A1]

11 A painter takes 4 days to paint a house. His apprentice takes 2 more days to paint the same house.

(a) Find the number of similar houses that the apprentice can paint in 30 days.

No. of days the apprentice takes $= 4 + 2$
$= 6$

$\therefore$ No. of houses he can paint in 30 days $= \dfrac{30}{6}$
$= 5$ ----- [A1]

(b) If the painter and the apprentice paint the house together, how many days will it take the both of them to complete painting 1 house?

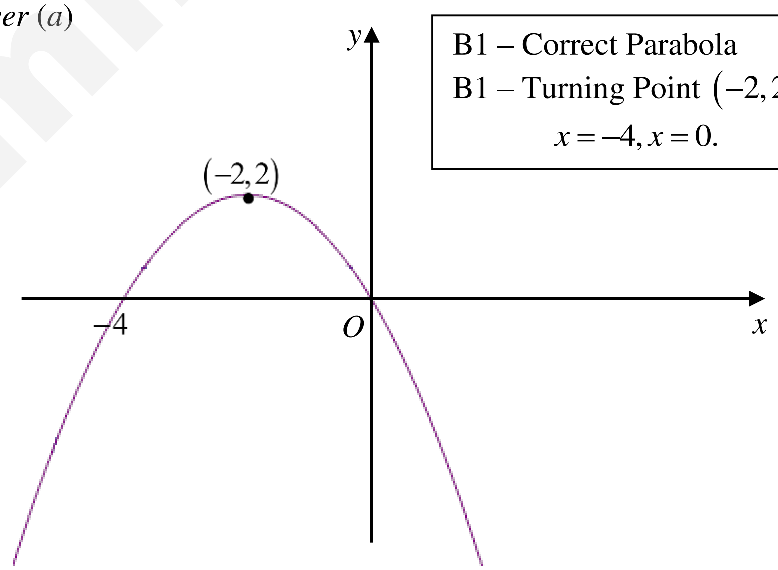
Rate for painter $= \dfrac{1}{4}$, Rate for apprentice $= \dfrac{1}{6}$

$\therefore$ No. of days taken if they paint together $= \dfrac{1}{\frac{1}{4}+\frac{1}{6}}$ ----- [M1]
$= \dfrac{12}{5}$
$= 2\dfrac{2}{5}$ ----- [A1]

---

12 **(a)** Sketch the graph of $y = 2 - \dfrac{1}{2}(x+2)^2$.

Answer (a)



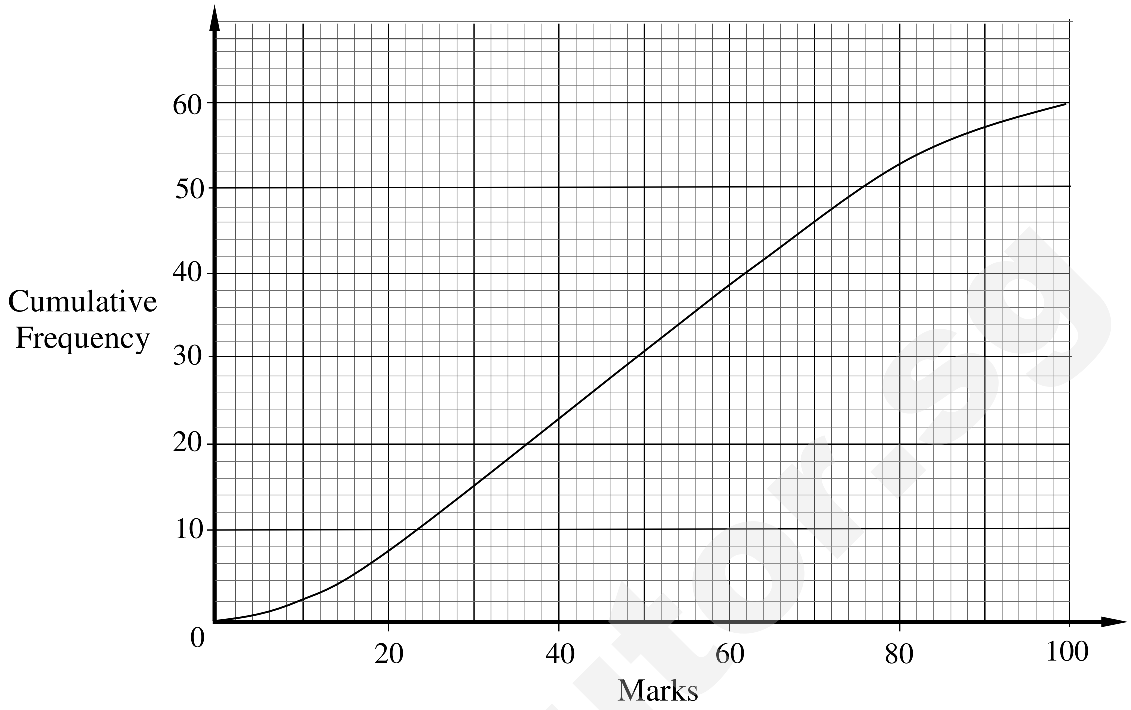
B1 – Correct Parabola
B1 – Turning Point $(-2, 2)$ &
$x = -4, x = 0.$

(b) Write down the equation of the line of symmetry of the graph of $y = 2 - \dfrac{1}{2}(x+2)^2$.

Equation of the line of symmetry $x = -2$ ------ [B1]

---

13 The cumulative frequency curve below shows the marks obtained, out of 100, by 60 students in an Elementary Mathematics paper.

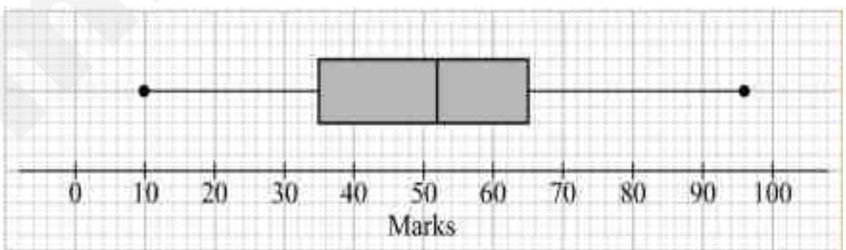


(a) Find interquartile range of the distribution.

Interquartile range $= 69 - 30$ [or $68 - 30 = 38$ marks]

$= 39$ marks -------- [A1]

(b) The same 60 students also sat for the Additional Mathematics paper. The box-and-whisker diagram below illustrates the marks obtained. The maximum mark was again 100.



A parent commented that the Elementary Mathematics paper was easier than the

Additional Mathematics paper.

Do you agree? Give a reason for your answer.

Disagree. Median marks in Elementary Mathematics paper is lower. ------- [B1, B1]

14 The period of oscillation, T seconds of a string varies directly as the square root of the length of the string, l cm. When the length of the string is 36 cm, the period of the oscillation is 0.3 seconds.

(a) Find the length of the string when the period of oscillation is 0.4 seconds.

$T = k\sqrt{l},\ k$ is a constant
When $T = 0.3, l = 36$
$\Rightarrow k = \dfrac{0.3}{\sqrt{36}} = 0.05$ ------ [B1 for finding $k = 0.05$]
$\therefore T = 0.05\sqrt{l}$
When $T = 0.4$,
$0.4 = 0.05\sqrt{l}$
$\sqrt{l} = 8 \therefore l = 64 \text{ cm}^2$ ------ [A1]

(b) Calculate the percentage change in l if T is decreased by 30%.

Old : $T_{old} = 0.05\sqrt{l} \Rightarrow l = (20T_{old})^2$
When T is decreased by 30%,
New: $0.7T_{old} = 0.05\sqrt{l} \Rightarrow l = (14T_{old})^2$
$\therefore$ % change in $l = \dfrac{(14T_{old})^2 - (20T_{old})^2}{(20T_{old})^2} \times 100\%$ ------ [M1]
$= -51\%$ ------ [A1]

---

15 **(a)** The lowest point of a quadratic curve is $(-1,-6)$. It intersects the y-axis at -5. Write down the equation of the curve in the form $y = a(x+b)^2 + c$, where a, b, c are integers.

Since $(-1,-6)$ is the lowest point $\Rightarrow b = 1, c = -6$
$y = a(x+1)^2 - 6$ ------ [B1]
At $x = 0$, $y = -5, \Rightarrow a = 1$
$y = (x+1)^2 - 6$ ------ [A1]

(b) Hence solve the equation $a(x+b)^2 + c = 0$, giving your answers correct to two decimal places.

$(x+1)^2 - 6 = 0$ ------ [M1]

$(x+1)^2 = 6$

$x+1 = \pm\sqrt{6}$

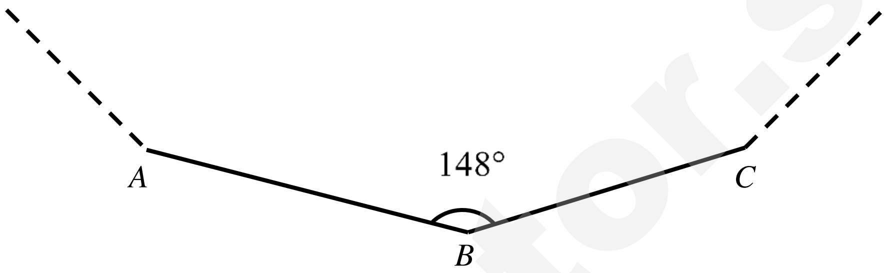
$\Rightarrow x = -1-\sqrt{6}$ or $x = -1+\sqrt{6}$

$\therefore x = -3.45$ or $x = 1.45$ ------ [A1]

16 **(a)** Is it possible to draw a regular polygon whose exterior angle is $7°$? Give a reason for your answer.

No. $360°$ is not divisible by 7 ------ [B1, B1]

(b)



In the diagram above, $ABC\ldots$ is part of a polygon. $\angle ABC$ is $148°$. The size of the remaining interior angles are each equal to $139°$. Find the number of sides of this polygon.

Exterior $\angle ABC = 180° - 148° = 32°$

Let n be the number of sides of the polygon.

Since the sum of exterior angles of polygon $= 360°$

$\therefore 32° + (n-1)(180° - 139°) = 360°$ ------ [B1]

$32 + 41n - 41 = 360$

$41n = 369$

$n = 9$ ------ [A1]

Exterior $\angle ABC = 180° - 148° = 32°$

Number of sides of polygon

$= \dfrac{360° - 32°}{41°} + 1$ ------ [B1]

$= 9$ ------ [A1]

17 Vernon travels to school either by bus or by car. The probability of being late for school is $\frac{1}{5}$ if he travels by bus and $\frac{1}{20}$ if he travels by car.

(a) Find the probability that he will be late on just two out of three days if he travels by bus on three consecutive days.

Probability $= \frac{1}{5} \times \frac{1}{5} \times \frac{4}{5} \times 3$------ [M1]

$= \frac{12}{125}$ ------ [A1]

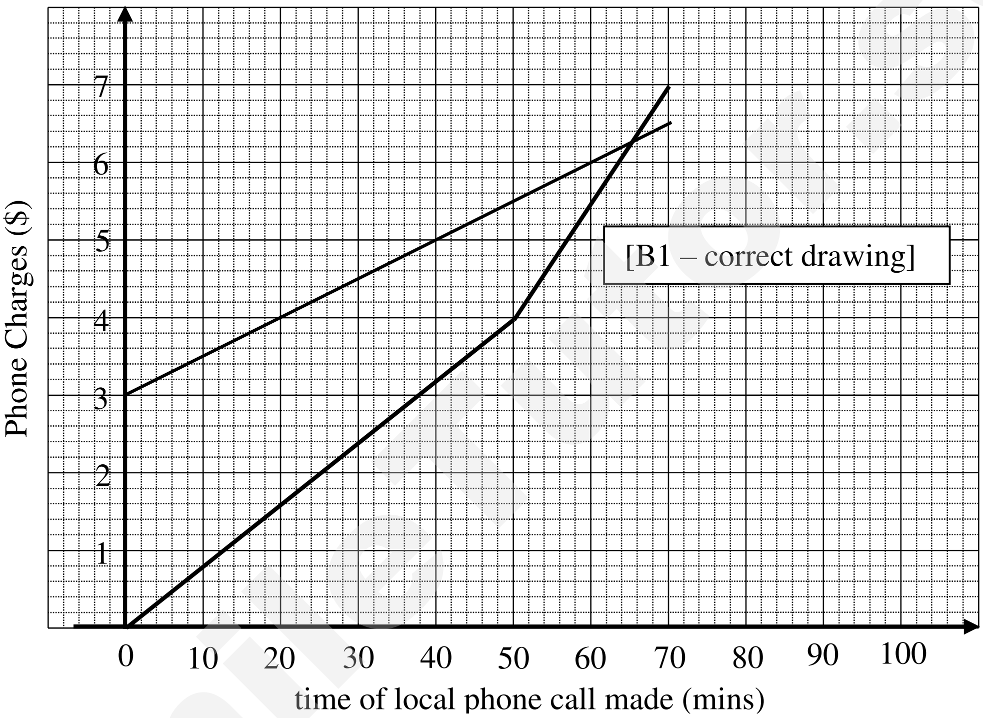
(b) If the probability that he travels by bus is $\frac{2}{3}$, find the probability that he will be late for school on any given day.

$$\text{Probability} = \frac{1}{3}\times\frac{1}{20}+\frac{2}{3}\times\frac{1}{5} \text{ ----- [B1]}$$

$$= \frac{3}{20} \text{ ------ [A1]}$$

---

18 The graph shows the charges made by a telecommunication company for making local phone calls lasting up to 70 minutes. The total cost is made up of a fixed charge, \$3.00, together with a charge of \$$x$ per minute for making local phone calls.



(a) State the cost of making 44 minutes of local phone call.

The cost is \$5.20 ------ [B1]

(b) **(i)** A second telecommunication company that does not have a fixed charge, charges 8¢ per minute for the first 50 minutes and 15¢ per minute after that.

Draw a graph, on the same axes, to represent the charge made by this second company.

(ii) Find the range of times for which it would be cheaper to subscribe to the second company.

The range of time is $0 \le T < 65$. ----- [B1]

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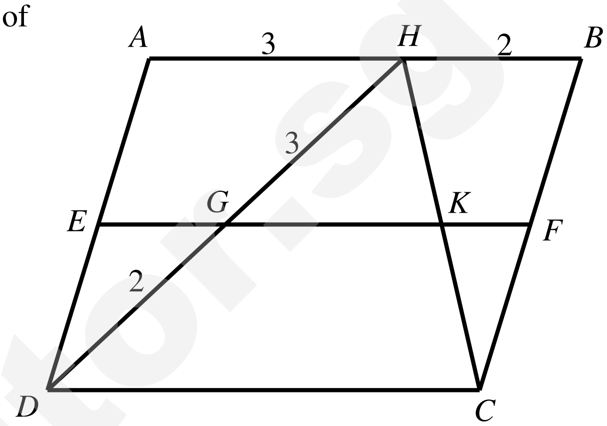
19 In the diagram, $ABCD$ is a parallelogram with $EF // AB$, $AH = GH = 3$ cm and $HB = DG = 2$ cm. EF intersects HD and HC at G and K respectively.
If the area of $\Delta GHK = 18\text{ cm}^2$, find the area of



(i) triangle DHC,

ΔGHK is similar to ΔDHC.

$\therefore \dfrac{\text{Area } \Delta DCH}{\text{Area } \Delta GHK} = \left(\dfrac{5}{3}\right)^2$

$\dfrac{\text{Area } \Delta DCH}{18} = \left(\dfrac{5}{3}\right)^2$ ----- [B1]

$\text{Area } \Delta DCH = 18 \times \dfrac{25}{9}$

$= 50 \text{ cm}^2$ ----- [A1]

(ii) triangle BCH.

Let h be the perpendicular height of ΔDCH.
ΔBCH shares the same height as ΔDCH.

$\text{Area } \Delta DCH = \dfrac{1}{2} \times DC \times h$

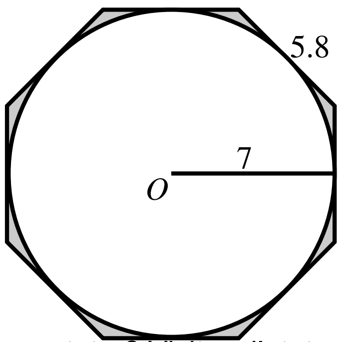
$50 = \dfrac{1}{2} \times 5 \times h$ ----- [M1]

$h = 20$

$\therefore \text{Area } \Delta BCH = \dfrac{1}{2} \times 2 \times 20$

$= 20 \text{ cm}^2$ ----- [A1]

20 The diagram shows a circle with centre O and radius 7 cm inscribed in a regular octagon of sides 5.8 cm each.



(a) Calculate the area of the octagon.

$\text{Area of octagon} = \dfrac{1}{2} \times 5.8 \times 7 \times 8$ ------ [M1]

$= 162.4 \text{ cm}^2$ ------ [A1]

(b) Find the total area of the shaded region between the circle and the octagon.

Area of shaded region $= 162.4 - \pi \times 7^2$ ------ [M1]

$= 8.46 \text{ cm}^2$ (3SF) ------ [A1]

21 **(a)** Solve the equation $\dfrac{x-3}{2} - 5 = \dfrac{7}{2}x$.

$$\frac{x-3}{2} - 5 = \frac{7}{2}x$$

$x - 3 - 10 = 7x$ ------- [M1]

$$6x = -13$$

$$x = -\frac{13}{6}$$

$= -2\dfrac{1}{6}$ ------- [A1]

(c) 216 cubes, each having edges of 2.6 cm, measured to the nearest 0.1 cm, fit exactly into a larger cubic box. Find the

(i) greatest possible length of the cubic box.

Greatest possible length of cubic box

$= 2.65 \times 6$ ------- [M1]

$= 15.9$ cm ------- [A1]

(ii) least possible volume of the cubic box.

Least possible volume of cubic box

$= 216 \times 2.55^3$

$= 3581.577 \text{ cm}^3$ ------- [A1]

22 The equation of a straight line is $\frac{x}{3}-\frac{y}{4}=1$.

(a) Find the gradient of the line.

$$\frac{x}{3}-\frac{y}{4}=1$$
$$y=\frac{4}{3}x-4$$
$\therefore$ Gradient is $1\frac{1}{3}$ ------- [A1]

(b) Find the equation of the line, parallel to $\frac{x}{3}-\frac{y}{4}=1$, which passes through the point $\left(1\frac{1}{2},\frac{1}{2}\right)$.

$y-\frac{1}{2}=\frac{4}{3}\left(x-\frac{3}{2}\right)$ ----- [M1]

$$y=\frac{4}{3}x-2+\frac{1}{2}$$

$\Rightarrow y=\frac{4}{3}x-1\frac{1}{2}$ ----- [A1 o.e]

(c) Find the distance between the points at which these two lines cut the x-axis.

At $y=0$,

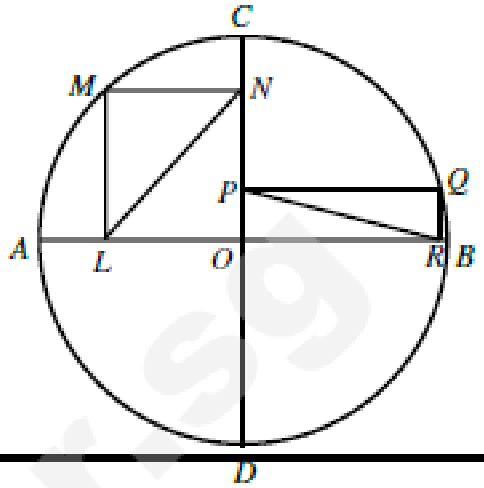
For $y=\frac{4}{3}x-4$: $x=3$

For $y=\frac{4}{3}x-\frac{3}{2}$: $x=\frac{9}{8}$

$\therefore$ Distance between the two points $=3-\frac{9}{8}$ ----- [M1]

$=1\frac{7}{8}$ units ------- [A1]

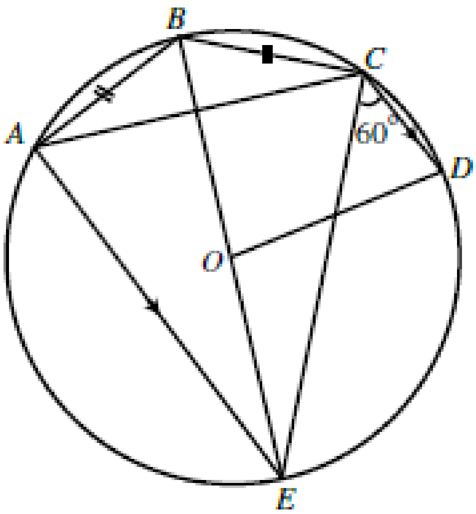
23 **(a)** In the diagram, O is the centre of the circle $ABCD$. AB and CD are two perpendicular diameters. L and R are points on AB. N and P are points on CD. M and Q are points on the circumference of the circle. $LMNO$ and $OPQR$ are two rectangles.



Explain briefly why LN and PR are equal in length.

> OM and OQ are radii to the circle. ----- [B1]
> Since OM is the diagonal of rectangle $LMNO$ and OQ is the diagonal of rectangle $OPQR$
> => $OM = LN = OQ = PR$. ------ [A1]

(b) In the diagram, the points A, B, C, D and E lie on a circle, centre O.
BOE is a diameter, $AB = BC$, $\angle ECD = 60°$.
AE is parallel to CD.



(i) Find $\angle AEB$.

> $\angle ABC = 120°$ (opp $\angle$s of cyclic quad)
> $\angle BAC = \angle BCA = \frac{1}{2}(180° - 120°)$ ------ [M1]
> $= 30°$ (base $\angle$s of isos Δ)
> $\angle AEB = \angle ACB = 30°$ ($\angle$s in same segment) ----- [A1]

(ii) Hence show that triangle ACE is an equilateral triangle.

> $\angle AEC = 60°$(alt. $\angle$, $AE // CD$)
> $\angle BCE = 90°$(Right $\angle$ in semicircle)
> $\angle BCA = 30°$(base $\angle$s of isos Δ)
> $\angle ACE = 90° - 30° = 60°$
> $\therefore \Delta ACE$ is an equilateral triangle.

24 The point H represents the position of a harbour located along a coastline. Another point J represents the position of a jetty situated along the same coastline. The point L represents the position of a lighthouse.
It is given that $HJ = 1800$ m, $\angle LHJ = 26°$ and $\angle HJL = 93°$.

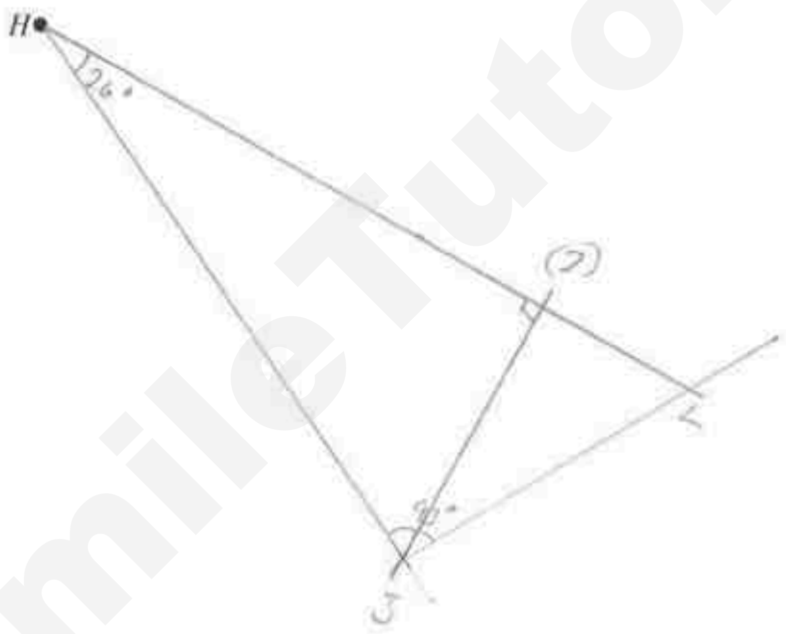
(a) Using a scale of 1: 20000, construct the ΔHJL. [2]

Answer (*a*) *and* (*c*)

Answer (*a*) *and* (*c*)

B1 – Correct construction

B1 – Correct labels.



(b) Measure and write down the distance LH.

Answer (*b*) 2055 m [1]

(c) A yacht sails directly from H to L. By drawing a suitable line, measure and write down its closest distance to the jetty.

Answer (*c*) 790 m [2]

End of Paper

Class Register Number

Name ______________________

4048/02 **16/S4PR2/EM/2**

MATHEMATICS **PAPER 2**

Tuesday **2 August 2016** **2 hours 30 minutes**

VICTORIA SCHOOL

PRELIMINARY EXAMINATION TWO
SECONDARY FOUR

Additional Materials: Answer Paper
Graph Paper

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
You are expected to use a scientific calculator to evaluate explicit numerical expressions.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 100.

This paper consists of 10 printed pages, including the cover page.

[Turn over

Mathematical Formulae

Compound interest

$$\text{Total amount} = P\left(1+\frac{r}{100}\right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi rl$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3}\pi r^3$$

$$\text{Area of triangle } ABC = \frac{1}{2}ab\sin C$$

$$\text{Arc length} = r\theta, \text{ where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2}r^2\theta, \text{ where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

Answer **all** the questions.

1 **(a)** Victor and Gloria are in an organic farm in Murai Farmway with their families.
Victor buys five pieces of tofu and four packets of mushroom for $23.55.
Gloria buys four pieces of tofu and three packets of mushroom.
She pays with two $10 notes and receives change of $1.80.

(i) Write down a pair of simultaneous equations to represent this information.
Use t to represent the cost, in dollars, of a piece of tofu
and m to represent the cost, in dollars, of a packet of mushrooms. [2]

(ii) Solve your simultaneous equations to find t and m. [2]

(iii) Calculate the total cost of buying two pieces of tofu and five packets of mushroom. [1]

(b) Solve the equation $3+13x-4x^2=0$, giving the answers correct to three decimal places. [4]

---

2 **(a)** **(i)** Express 8064 as the product of its prime factors. [1]

(ii) Find the value of k such that $\frac{8064}{k}$ is the largest possible perfect cube. [1]

Given that $p=2^3\times3^4\times7$. Write down the

(iii) lowest common multiple of 8064 and p, giving your answer as the product of its prime factors, [1]

(iv) greatest integer that will divide both 8064 and p exactly. [1]

(b) When n is a whole number, $2n+1$ is an odd number.

(i) Write down an expression for the next two consecutive odd numbers after $2n+1$. [1]

(ii) Find and simplify an expression for the difference between the squares of the two consecutive odd numbers found in **(b)(i)**. [2]

(iii) Hence, explain why the difference between the squares of two consecutive odd numbers is always a multiple of 8. [1]

3 The table below shows the ticket prices at the Singapore Garden Festival held at Gardens by the Bay.

Ticket	Price
Adult	\$20
Child	\$12
Senior Citizen	\$15

(a) Represent the ticket price for adult, child and senior citizen by a column matrix **Q**. [1]

(b) Mr Ang bought 4 adults, 2 children and 1 senior citizen tickets to the festival. Write down a matrix **P** such that the matrix multiplication $\mathbf{R} = \mathbf{PQ}$ gives the total amount Mr Ang paid for the tickets. Hence, find **R**. [2]

(c) The table below shows the number of tickets sold at the festival.

Number of tickets sold			
Day	Adult	Child	Senior Citizen
Monday	81	c	36
Tuesday	85	42	s

(i) The ticket sales collected on Monday and Tuesday was \$2724 and \$2744 respectively.
Represent these ticket sales in a 2×1 matrix **T**. [1]

(ii) Form a matrix multiplication such that the product will be **T**. [1]

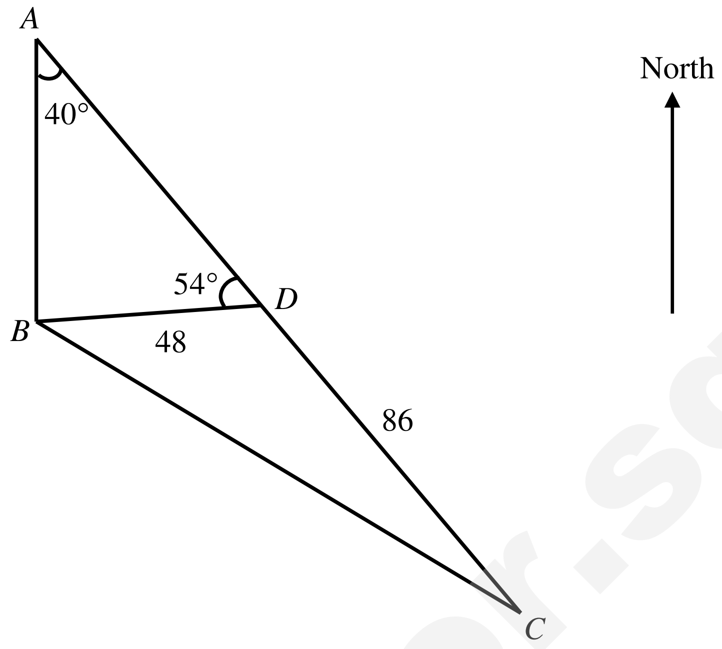
(iii) Find the value of c and of s. [2]

Gardens by the Bay donated part of their ticket sales to a charity organization. **U** represents the total amount of money donated to the organization on Monday and Tuesday.

(iv) Evaluate the matrix $\mathbf{U} = \begin{pmatrix} 0.15 & 0.1 \end{pmatrix} \mathbf{T}$. [1]

(v) Explain what the elements of the matrix $\begin{pmatrix} 0.15 & 0.1 \end{pmatrix}$ represent. [1]

4



ABD and *BCD* are two horizontal triangular plots of land.
$BD = 48$ m and $CD = 86$ m.
Angle $BAD = 40°$ and angle $BDA = 54°$.
A is due north of *B* and *ADC* is a straight line.

(a) Calculate

(i) *AD*, [2]

(ii) the total area of the plots of land *ABCD*, [2]

(iii) *BC*. [2]

(b) Given that *Z* is a point on *CD* such that $ZD = 48$ m, calculate the bearing of *B* from *Z*. [2]

(c) The base of a vertical mast is at *B*.
The greatest angle of elevation of the top of the mast from a point on *AC* is 17.4°.

Calculate the angle of depression of *C* when viewed from the top of the mast. [3]

5 **(a)** Simplify $\frac{16a^3b^4}{7c^4} \div \frac{4ab^2}{21c^3} \times \frac{27a^{n+1}}{8a^{n-2}}$. [2]

(b) Simplify $\frac{2u+18v}{(u+4v)^2-25v^2}$. [2]

(c) **(i)** Solve the inequality $\frac{6x}{7} - \frac{3}{8} \le x + 2\frac{1}{4}$. [1]

(ii) Hence, state the smallest integer value of x such that $\frac{6x}{7} - \frac{3}{8} \le x + 2\frac{1}{4}$. [1]

(d) **(i)** Express as a single fraction in its simplest form $\frac{h}{4-h} - \frac{1}{h+3}$. [2]

(ii) Solve the equation $\frac{h}{4-h} - \frac{1}{h+3} = \frac{4}{5}$. [3]

---

6 **Answer the whole of this question on a sheet of graph paper.**

The variables x and y are connected by the equation

$$y = x + \frac{12}{x} - 5.$$

Some corresponding values of x and y are given in the table below.

x	1	1.5	2	3	4	5	6	7	8
y	8	p	3	2	2	2.4	3	3.7	4.5

(a) Calculate the value of p. [1]

(b) Using a scale of 2 cm to represent 1 unit, draw a horizontal x-axis for $0 \le x \le 8$.
Using a scale of 2 cm to represent 1 unit, draw a vertical y-axis for $0 \le y \le 8$.

On your axes, plot the points given in the table and join them with a smooth curve. [3]

(c) Use your graph to find the solutions of $x + \frac{12}{x} = 8\frac{1}{5}$. [1]

(d) By drawing a tangent, find the gradient of the curve at $(6,\ 3)$. [2]

(e) By drawing a suitable straight line on your graph, solve $2x^2 - 11x + 12 = 0$. [2]

7 **(a)** A is a point $(-4, 1)$, $\overrightarrow{AB} = \begin{pmatrix} 5 \\ 4 \end{pmatrix}$ and $\overrightarrow{AC} = \begin{pmatrix} -3 \\ 8 \end{pmatrix}$.

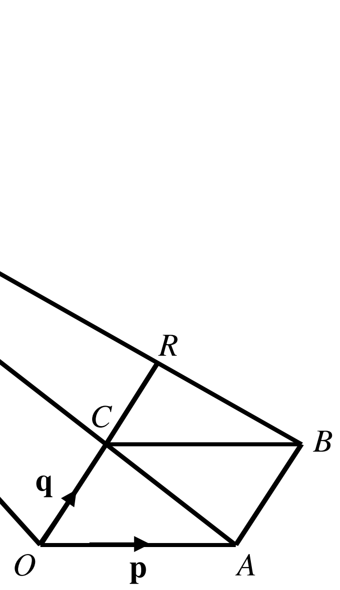
(i) Write down the column vector $\overrightarrow{BC}$. [1]

(ii) Find $\left|\overrightarrow{BC}\right|$. [2]

(iii) P is a point such that $\overrightarrow{BP} = 2\overrightarrow{PC}$.
Find the column vector $\overrightarrow{AP}$. [2]

(iv) Given $\overrightarrow{OQ} = \begin{pmatrix} \frac{2}{3} \\ 11\frac{2}{3} \end{pmatrix}$.
What type of quadrilateral is $APQB$?
Justify your answer using vectors. [3]

(b)



$OABC$ is a parallelogram.
$\overrightarrow{OA} = \mathbf{p}$, $\overrightarrow{OC} = \mathbf{q}$ and $\overrightarrow{CT} = 4\overrightarrow{AC}$.
ACT, BRT and OCR are straight lines.

(i) Express each of the following, as simply as possible, in terms of **p** and/or **q**,

(a) $\overrightarrow{OB}$, [1]

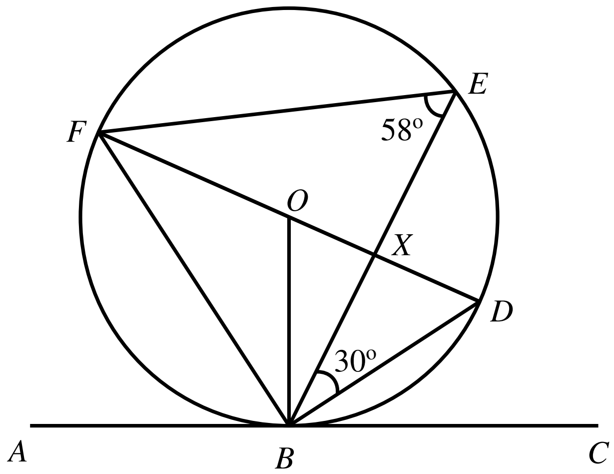
(b) $\overrightarrow{OT}$, [1]

(c) $\overrightarrow{BT}$. [1]

(ii) Given that $\overrightarrow{BR} = \frac{4}{5}\mathbf{q} - \mathbf{p}$, find k if $\overrightarrow{OC} = k\overrightarrow{CR}$. [1]

(iii) Find the value of $\dfrac{\text{area of } \Delta BCR}{\text{area of } \Delta OCT}$. [1]

8 **(a)**



The line DF is a diameter of the circle $BDEF$ with centre O.
ABC is a tangent to the circle at B.
X is the point of intersection of DF and BE.
Angle $DBE = 30°$ and angle $BEF = 58°$.

(i) Find

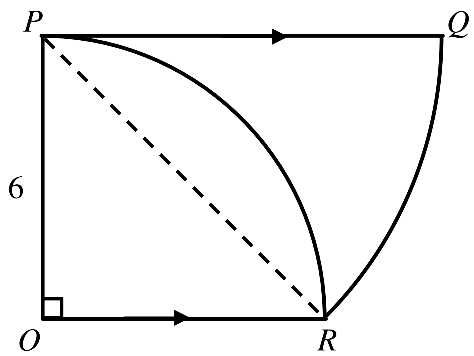
(a) angle FBO, [2]

(b) angle ABF, [1]

(c) angle DXE. [1]

(ii) Given that the radius of the circle is 14 cm, find the area of triangle BDF. [2]

(b)



In the diagram, POR is a quadrant of a circle with radius 6 cm.
OR and PQ are parallel.
QR is an arc of a circle with centre P.

Calculate the area and the perimeter of the shaded region. [4]

9 **(a)** The ages of 50 employees in Company V is shown in the table below.

Age in years	$24 < x \le 28$	$28 < x \le 32$	$32 < x \le 36$	$36 < x \le 40$	$40 < x \le 44$
Number of employees	7	10	13	8	p

(i) State the value of p. [1]

(ii) Hence, calculate the

(a) mean age of the employees, [1]

(b) standard deviation. [1]

(iii) The age distribution of 50 employees in Company W is summarized below.

Mean	29.6 years
Standard deviation	7.13 years

Make two comparisons between the ages of employees in both companies. [2]

(b) A box contains 5 red flags and 8 yellow flags.
Two flags are taken from the bag at random without replacement.

(i) Draw a tree diagram to show the probabilities of the possible outcomes. [2]

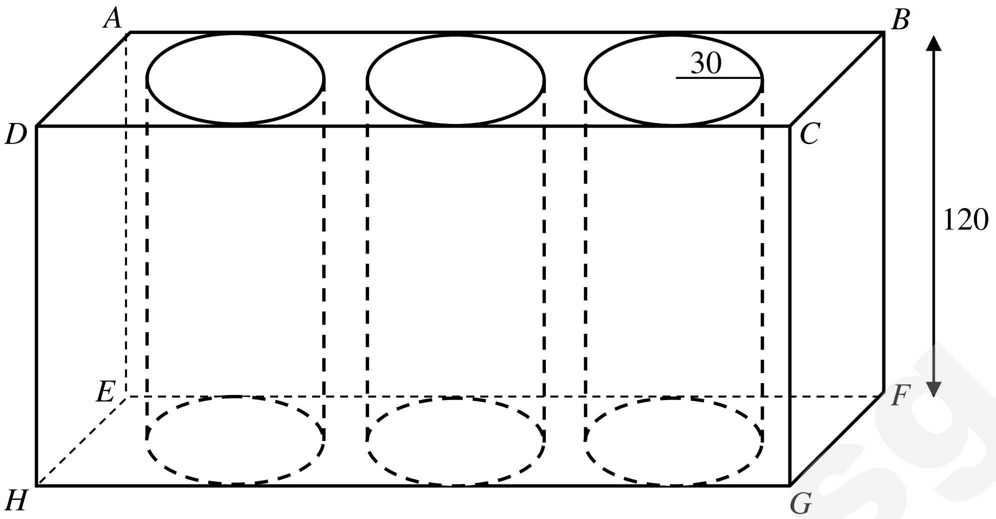
(ii) Find, as a fraction in its simplest form, the probability that

(a) the first flag is red and the second flag is yellow, [1]

(b) both flags are the same colour, [1]

(c) at least one flag is yellow. [1]

10



Class 4*V* has chosen the 'Go Green' theme for their Social Innovation Project.
The diagram above shows the recycling bins structure that they have built.

The whole structure consists of 3 open identical cylindrical plastic containers fit into a wooden cuboid crate. All the containers and the crate are of negligible thickness.

3 circles had to be cut from the top of the crate to fit the containers.
Each plastic container is placed in the crate such that they are 20 cm away from the sides of the crate, *ADHE* and *BCGF*, as well as 20 cm apart from each other.
Each plastic container touches the base and sides, *ABFE* and *DCGH*, of the crate too.
The radius and height of the plastic container are 30 cm and 120 cm respectively.

(a) Write down the dimensions of the crate. [1]

(b) Calculate the

(i) exact total surface area of the crate that was cut out, [1]

(ii) exact total internal surface area of each cylindrical container, [2]

(iii) total **exposed** external surface area of the crate. [2]

(c) The class would like to paint all the exposed external surfaces of the crate yellow. One tin of paint can cover an area of 3.75 m^2. How many tins do they need to purchase? Justify your answer. [2]

(d) If each cylindrical container is filled to the brim, what is the maximum volume of recyclables that can be collected by the class in a single collection? [2]

End of Paper

2016 Victoria School Prelim 2 Mathematics Paper 2 Answer Key

1a(i)	$5t+4m=23.55$ $4t+3m=18.20$
1a(ii)	$t=2.15$ and $m=3.20$
1a(iii)	\$ 20.30
1b	$x=-0.216$ (3 d.p.) or $x=3.466$ (3 d.p.)
2a(i)	$8064=2^7\times3^2\times7$
2a(ii)	$k=126$
2a(iii)	$2^7\times3^4\times7$
2a(iv)	504
2b(i)	$(2n+3)$ and $(2n+5)$
2b(ii)	$8(n+2)$
2b(iii)	Since 8 is a factor of $8(n+2)$, the difference between two consecutive odd numbers will always be a multiple of 8.
3(a)	$\mathbf{Q}=\begin{pmatrix}20\\12\\15\end{pmatrix}$
3(b)	$\mathbf{P}=\begin{pmatrix}4&2&1\end{pmatrix}$ $\mathbf{R}=\begin{pmatrix}4&2&1\end{pmatrix}\begin{pmatrix}20\\12\\15\end{pmatrix}$ $=\begin{pmatrix}119\end{pmatrix}$
3(c)(i)	$\mathbf{T}=\begin{pmatrix}2724\\2744\end{pmatrix}$
3(c)(ii)	$\begin{pmatrix}81&c&36\\85&42&s\end{pmatrix}\begin{pmatrix}20\\12\\15\end{pmatrix}=\begin{pmatrix}2724\\2744\end{pmatrix}$
3(c)(iii)	$c=47$ and $s=36$
3(c)(iv)	$\begin{pmatrix}683\end{pmatrix}$
3(c)(v)	Elements of $\begin{pmatrix}0.15&0.1\end{pmatrix}$ represent the **percentage** of the **total ticket sales** that Gardens by the Bay had **donated** to the charity organization on **Monday and Tuesday respectively**
4(a)(i)	74.5 m (3 s.f.)
4(a)(ii)	3120 m^2 (3 s.f.)
4(a)(iii)	121 m (3 s.f.)
4(b)	293°
4(c)	5.8° (1 d.p.)

5(a)	$\dfrac{81a^5b^2}{2c}$
5(b)	$\dfrac{2}{u-v}$
5(c)(i)	$x \geq -18\dfrac{3}{8}$
5(c)(ii)	-18
5(d)(i)	$\dfrac{h^2+4h-4}{(4-h)(h+3)}$
5(d)(ii)	$h=-3\dfrac{7}{9}$ or $h=2$
6(a)	$p=4.5$
6(c)	$x=1.9$ or $x=6.3$
6(d)	0.660 (3 s.f.)
6(e)	$x=1.5$ or $x=4$
7(a)(i)	$\begin{pmatrix} -8 \\ 4 \end{pmatrix}$
7(a)(ii)	8.94 units (3 s.f.)
7(a)(iii)	$\begin{pmatrix} \dfrac{-1}{3} \\ 6\dfrac{2}{3} \end{pmatrix}$
7(a)(iv)	$\overrightarrow{AP}=\overrightarrow{BQ}$ and $\overrightarrow{AB}=\overrightarrow{PQ}$ $\lvert\overrightarrow{AP}\rvert=\lvert\overrightarrow{BQ}\rvert$ and $\lvert\overrightarrow{AB}\rvert=\lvert\overrightarrow{PQ}\rvert$ Thus, $APQB$ is a parallelogram.
7(b)(i)(a)	$\underset{\sim}{p}+\underset{\sim}{q}$
7(b)(i)(b)	$5\underset{\sim}{q}-4\underset{\sim}{p}$
7(b)(i)(c)	$4\underset{\sim}{q}-5\underset{\sim}{p}$
7(b)(ii)	$k=1\dfrac{1}{4}$
7(b)(iii)	$\dfrac{1}{5}$
8(a)(i)(a)	32°
8(a)(i)(b)	58°
8(a)(i)(c)	88°
8(a)(ii)	176 cm^2 (3 s.f.)
8(b)	Area of shaded region $=18$ cm^2 Perimeter of shaded region = 24.6 cm (3 s.f.)

9(a)(i)	$p = 12$
9(a)(ii)(a)	34.64 years
9(a)(ii)(b)	5.45 years (3 s.f.)
9(a)(iii)	The employees in company *W* are younger than those in company *V* since the mean age of employees in company *W* is lower than that of company *V*. The spread of ages of employees in company *W* is wider since the standard deviation of ages of employees in company *W* is larger than that of company *V*.
9(b)(ii)(a)	$\frac{10}{39}$
9(b)(ii)(b)	$\frac{19}{39}$
9(b)(ii)(c)	$\frac{34}{39}$
10(a)	260 cm by 60 cm by 120 cm
10(b)(i)	2700π cm^2
10(b)(ii)	8100π cm^2
10(b)(iii)	83900 cm^2 (3 s.f.)
10(c)	3
10(d)	1 020 000 cm^3 (3 s.f.)

	Class	Register Number
Name MARK SCHEME		

4048/02 **16/S4PR2/EM/2**

MATHEMATICS PAPER 2

Tuesday **2 August 2016** **2 hours 30 minutes**

VICTORIA SCHOOL

PRELIMINARY EXAMINATION TWO
SECONDARY FOUR

Additional Materials: Answer Paper
Graph Paper

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
You are expected to use a scientific calculator to evaluate explicit numerical expressions.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 100.

This paper consists of 28 printed pages, including the cover page.

[Turn over

Mathematical Formulae

Compound interest

$$\text{Total amount} = P\left(1+\frac{r}{100}\right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi rl$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3}\pi r^3$$

$$\text{Area of triangle } ABC = \frac{1}{2}ab\sin C$$

$$\text{Arc length} = r\theta\text{, where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2}r^2\theta\text{, where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

Answer **all** the questions.

1 **(a)** Victor and Gloria are in an organic farm in Murai Farmway with their families.
Victor buys five pieces of tofu and four packets of mushroom for \$23.55.
Gloria buys four pieces of tofu and three packets of mushroom.
She pays with two \$10 notes and receives change of \$1.80.

(i) Write down a pair of simultaneous equations to represent this information.
Use t to represent the cost, in dollars, of a piece of tofu
and m to represent the cost, in dollars, of a packet of mushrooms. [2]

(ii) Solve your simultaneous equations to find t and m. [2]

(iii) Calculate the total cost of buying two pieces of tofu and five packets of mushroom. [1]

(b) Solve the equation $3+13x-4x^2=0$, giving the answers correct to three decimal places. [4]

Solutions:

(a) **(i)**

$$\boxed{\begin{aligned} 5t+4m&=23.55 \\ 4t+3m&=18.20 \end{aligned}}$$

(ii)

$5t+4m=23.55 \quad \cdots \ (1)$

$4t+3m=18.20 \quad \cdots \ (2)$

$(1)\times 3: \quad 15t+12m=70.65 \quad \cdots \ (3)$

$(2)\times 4: \quad 16t+12m=72.80 \quad \cdots \ (4)$

$(4)-(3): \quad t=2.15$

Sub. $t=2.15$ into (2):

$4(2.15)+3m=18.20$

$3m=9.6$

$m=3.20$

M1

$t=2.15$ and $m=3.20$ ← **A1**

(a) (iii)

$$\text{Cost} = 2(2.15) + 5(3.20)$$
$$= \$\ 20.30 \quad \leftarrow \quad \textbf{A1}$$

(b)

$$3 + 13x - 4x^2 = 0$$

$$x = \frac{-13 \pm \sqrt{(13)^2 - 4(-4)(3)}}{2(-4)} \quad \text{or} \quad x = \frac{-(-13) \pm \sqrt{(-13)^2 - 4(4)(-3)}}{2(4)} \quad \leftarrow \textbf{M1} \quad \leftarrow \textbf{M1}$$

$$= \frac{-13 \pm \sqrt{217}}{-8} \qquad\qquad = \frac{13 \pm \sqrt{217}}{8}$$

$x = -0.216$ (3 d.p.) or $x = 3.466$ (3 d.p.) $\leftarrow$ **A2**

2 **(a)** **(i)** Express 8064 as the product of its prime factors. [1]

(ii) Find the value of k such that $\frac{8064}{k}$ is the largest possible perfect cube. [1]

Given that $p = 2^3 \times 3^4 \times 7$. Write down the

(iii) lowest common multiple of 8064 and p, giving your answer as the product of its prime factors, [1]

(iv) greatest integer that will divide both 8064 and p exactly. [1]

(b) When n is a whole number, $2n+1$ is an odd number.

(i) Write down an expression for the next two consecutive odd numbers after $2n+1$. [1]

(ii) Find and simplify an expression for the difference between the squares of the two consecutive odd numbers found in **(b)(i)**. [2]

(iii) Hence, explain why the difference between the squares of two consecutive odd numbers is always a multiple of 8. [1]

Solutions:

(a) **(i)**

$8064 = 2^7 \times 3^2 \times 7$ ← **B1**

(ii)

For $\frac{8064}{k}$ to be the largest perfect cube, k needs to be the smallest possible value.

Largest $\frac{8064}{k}$ will be 2^6.

$k = 2 \times 3^2 \times 7$

$k = 126$ ← **B1**

(iii)

$8064 = 2^7 \times 3^2 \times 7$

$p = 2^3 \times 3^4 \times 7$

Lowest common multiple $= 2^7 \times 3^4 \times 7$ ← **B1**

(iv)

$$8064 = 2^7 \times 3^2 \times 7$$
$$p = 2^3 \times 3^4 \times 7$$

$$\text{Greatest integer} = 2^3 \times 3^2 \times 7$$
$$= 504 \quad \longleftarrow \quad \textbf{B1}$$

(b) **(i)** The next two numbers are $(2n+3)$ and $(2n+5)$. $\longleftarrow$ **B1**

(ii)

$$\begin{aligned}(2n+5)^2-(2n+3)^2 &= 4n^2+20n+25-(4n^2+12n+9)\\ &= 4n^2+20n+25-4n^2-12n-9 \quad \longleftarrow \quad \textbf{M1}\\ &= 8n+16\\ &= 8(n+2) \quad \longleftarrow \quad \textbf{B1}\end{aligned}$$

(iii) Since 8 is a factor of $8(n+2)$, the difference between two consecutive odd numbers will always be a multiple of 8. $\longleftarrow$ **B1**

3 The table below shows the ticket prices at the Singapore Garden Festival held at Gardens by the Bay.

Ticket	Price
Adult	\$20
Child	\$12
Senior Citizen	\$15

(a) Represent the ticket price for adult, child and senior citizen by a column matrix **Q**. [1]

(b) Mr Ang bought 4 adults, 2 children and 1 senior citizen tickets to the festival. Write down a matrix **P** such that the matrix multiplication $\mathbf{R} = \mathbf{PQ}$ gives the total amount Mr Ang paid for the tickets. Hence, find **R**. [2]

(c) The table below shows the number of tickets sold at the festival.

Number of tickets sold			
Day	Adult	Child	Senior Citizen
Monday	81	c	36
Tuesday	85	42	s

(i) The ticket sales collected on Monday and Tuesday was \$2724 and \$2744 respectively.
Represent these ticket sales in a 2×1 matrix **T**. [1]

(ii) Form a matrix multiplication such that the product will be **T**. [1]

(iii) Find the value of c and of s. [2]

Gardens by the Bay donated part of their ticket sales to a charity organization. **U** represents the total amount of money donated to the organization on Monday and Tuesday.

(iv) Evaluate the matrix $\mathbf{U} = \begin{pmatrix} 0.15 & 0.1 \end{pmatrix} \mathbf{T}$. [1]

(v) Explain what the elements of the matrix $\begin{pmatrix} 0.15 & 0.1 \end{pmatrix}$ represent. [1]

Solutions:

(a)

$$\mathbf{Q} = \begin{pmatrix} 20 \\ 12 \\ 15 \end{pmatrix} \longleftarrow \textbf{B1}$$

(b)

$$\mathbf{P} = \begin{pmatrix} 4 & 2 & 1 \end{pmatrix} \longleftarrow \textbf{B1}$$

$$\mathbf{R} = \begin{pmatrix} 4 & 2 & 1 \end{pmatrix} \begin{pmatrix} 20 \\ 12 \\ 15 \end{pmatrix}$$

$$= \begin{pmatrix} 119 \end{pmatrix} \longleftarrow \textbf{A1}$$

(c) **(i)**

$$\mathbf{T} = \begin{pmatrix} 2724 \\ 2744 \end{pmatrix} \longleftarrow \textbf{B1}$$

(ii)

$$\begin{pmatrix} 81 & c & 36 \\ 85 & 42 & s \end{pmatrix} \begin{pmatrix} 20 \\ 12 \\ 15 \end{pmatrix} = \begin{pmatrix} 2724 \\ 2744 \end{pmatrix} \longleftarrow \textbf{B1}$$

(iii)

$$1620 + 12c + 540 = 2724$$
$$12c = 564$$
$$c = 47 \longleftarrow \textbf{A1}$$

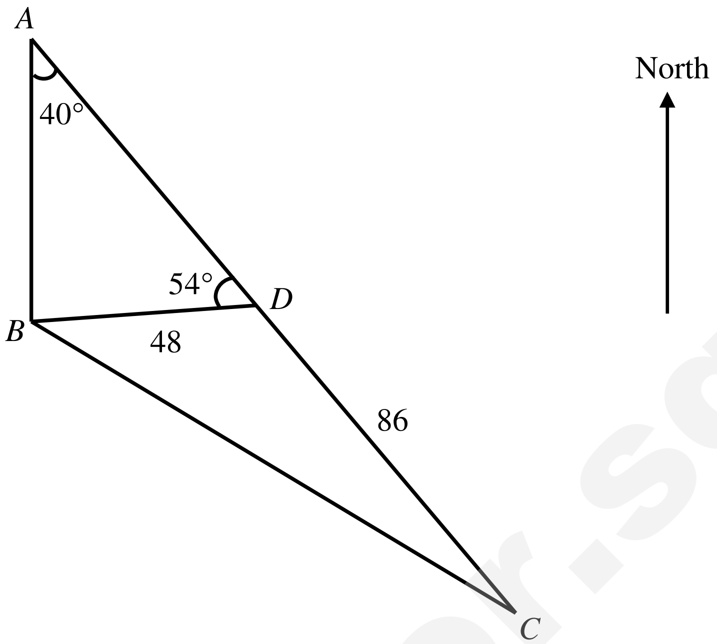
$$1700 + 504 + 15s = 2744$$
$$15s = 540$$
$$s = 36 \longleftarrow \textbf{A1}$$

(iv)

$$\mathbf{U} = \begin{pmatrix} 0.15 & 0.1 \end{pmatrix} \mathbf{T}$$
$$= \begin{pmatrix} 0.15 & 0.1 \end{pmatrix} \begin{pmatrix} 2724 \\ 2744 \end{pmatrix}$$
$$= \begin{pmatrix} 683 \end{pmatrix} \longleftarrow \textbf{A1}$$

(v) Elements of $\begin{pmatrix} 0.15 & 0.1 \end{pmatrix}$ represent the **percentage** of the **total ticket sales** that Gardens by the Bay had **donated** to the charity organization on **Monday and Tuesday respectively.** **[B1]**

4



ABD and *BCD* are two horizontal triangular plots of land.
$BD = 48$ m and $CD = 86$ m.
Angle $BAD = 40°$ and angle $BDA = 54°$.
A is due north of *B* and *ADC* is a straight line.

(a) Calculate

(i) *AD*, [2]

(ii) the total area of the plots of land *ABCD*, [2]

(iii) *BC*. [2]

(b) Given that *Z* is a point on *CD* such that $ZD = 48$ m, calculate the bearing of *B* from *Z*. [2]

(c) The base of a vertical mast is at *B*.
The greatest angle of elevation of the top of the mast from a point on *AC* is $17.4°$.

Calculate the angle of depression of *C* when viewed from the top of the mast. [3]

Solutions:

(a) (i)

$\angle ABD = 180° - 54° - 40°$ ($\angle$ sum of Δ)
$= 86°$

$\dfrac{AD}{\sin 86°} = \dfrac{48}{\sin 40°}$ ← **M1**

$AD = \dfrac{48 \sin 86°}{\sin 40°}$

$AD \approx 74.4928$

$AD = 74.5$ m (3 s.f.) ← **A1**

(ii)

$\angle ABD = 180° - 54°$ (adj. $\angle$s on a str. line)

$= 126°$

Total area $= \frac{1}{2}(74.49)(48)\sin 54° + \frac{1}{2}(48)(86)\sin 126°$ ← **M1**

≈ 3116.139

$= 3120 \text{ m}^2$ (3 s.f.) ← **A1**

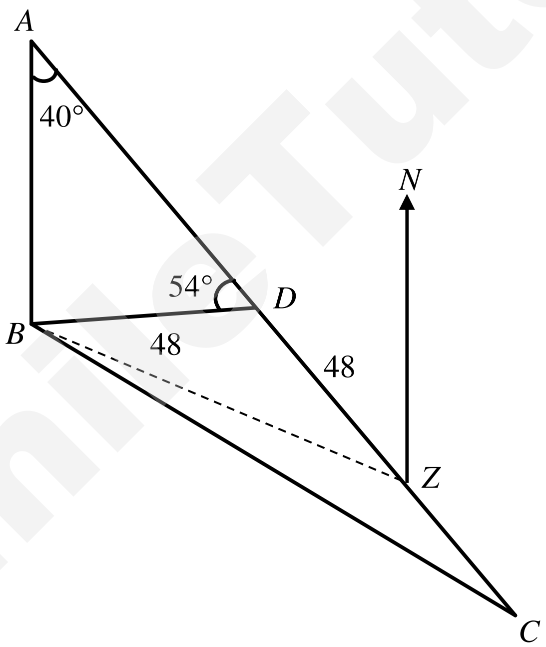
(iii)

$BC^2 = 48^2 + 86^2 - 2(48)(86)\cos 126°$ ← **M1**

$BC \approx 120.6348$

$BC = 121$ m (3 s.f.) ← **A1**

(b)



$\angle AZN = 40°$ (alt. $\angle$s, $BA // ZN$)

$\angle DBZ = \angle DZB$ (base $\angle$s of isos. Δ)

$\angle DBZ = \dfrac{180° - 126°}{2}$ ($\angle$ sum of Δ) ← **M1**

$= 27°$

Bearing of B from $Z = 360° - 40° - 27°$ ($\angle$s at a pt.)

$= 293°$ ← **A1**

(c)

Let the point on AC be Y and the top of the mast be T.

$\frac{1}{2} \times BY \times AC = 3116$

$\frac{1}{2} \times BY \times (74.49 + 86) = 3116$ ← **M1**

$BY = \frac{2 \times 3116}{160.49}$

$BY \approx 38.83$ m

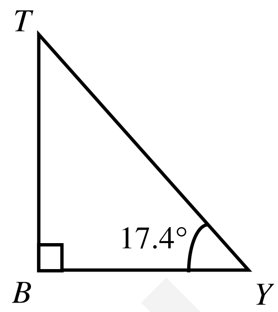
$\tan 17.4° = \frac{BT}{38.83}$ ← **M1**

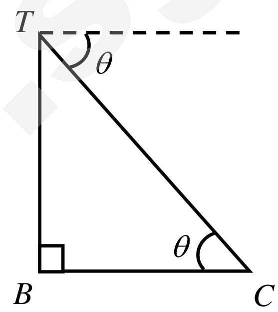
$BT \approx 12.168584$ m

Let the angle of depression be θ.

$\tan\theta = \frac{12.17}{120.6}$

$\theta = 5.8°$ (1 d.p.) ← **A1**





5 **(a)** Simplify $\dfrac{16a^3b^4}{7c^4} \div \dfrac{4ab^2}{21c^3} \times \dfrac{27a^{n+1}}{8a^{n-2}}$. [2]

(b) Simplify $\dfrac{2u+18v}{(u+4v)^2-25v^2}$. [2]

(c) **(i)** Solve the inequality $\dfrac{6x}{7} - \dfrac{3}{8} \le x + 2\dfrac{1}{4}$. [1]

(ii) Hence, state the smallest integer value of x such that $\dfrac{6x}{7} - \dfrac{3}{8} \le x + 2\dfrac{1}{4}$. [1]

(d) **(i)** Express as a single fraction in its simplest form $\dfrac{h}{4-h} - \dfrac{1}{h+3}$. [2]

(ii) Solve the equation $\dfrac{h}{4-h} - \dfrac{1}{h+3} = \dfrac{4}{5}$. [3]

Solutions:

(a)

$$\frac{16a^3b^4}{7c^4} \div \frac{4ab^2}{21c^3} \times \frac{27a^{n+1}}{8a^{n-2}} = \frac{16a^3b^4}{7c^4} \times \frac{21c^3}{4ab^2} \times \frac{27a^3}{8}$$

$$= \frac{81a^5b^2}{2c} \longleftarrow \textbf{A2}$$

(b)

$$\frac{2u+18v}{(u+4v)^2-25v^2} = \frac{2u+18v}{(u+4v)^2-(5v)^2}$$

$$= \frac{2u+18v}{(u+4v+5v)(u+4v-5v)}$$

$$= \frac{2(u+9v)}{(u+9v)(u-v)} \longleftarrow \textbf{M1 (factorising the denominator)}$$

$$= \frac{2}{u-v} \longleftarrow \textbf{A1}$$

(c) (i)

$$\frac{6x}{7} - \frac{3}{8} \le x + 2\frac{1}{4}$$

$$-\frac{x}{7} \le \frac{21}{8}$$

$$x \ge -\frac{147}{8}$$

$$x \ge -18\frac{3}{8} \longleftarrow \textbf{A1}$$

(ii) The smallest integer value of x is -18. ⟵ **B1**

(d) (i)

$$\frac{h}{4-h} - \frac{1}{h+3} = \frac{h(h+3)-(4-h)}{(4-h)(h+3)} \longleftarrow \textbf{M1}$$

$$= \frac{h^2+3h-4+h}{(4-h)(h+3)}$$

$$= \frac{h^2+4h-4}{(4-h)(h+3)} \longleftarrow \textbf{A1}$$

(ii)

$$\frac{h}{4-h} - \frac{1}{h+3} = \frac{4}{5}$$

$$\frac{h^2+4h-4}{(4-h)(h+3)} = \frac{4}{5}$$

$$5\left(h^2+4h-4\right) = 4\left(12+h-h^2\right) \longleftarrow \textbf{M1}$$

$$5h^2+20h-20 = 48+4h-4h^2$$

$$9h^2+16h-68=0$$

$$(9h+34)(h-2)=0 \longleftarrow \textbf{M1}$$

$$9h+34=0 \quad \text{or} \quad h-2=0$$

$$h = -3\frac{7}{9} \qquad h=2 \longleftarrow \textbf{A1}$$

6 **Answer the whole of this question on a sheet of graph paper.**

The variables x and y are connected by the equation

$$y = x + \frac{12}{x} - 5.$$

Some corresponding values of x and y are given in the table below.

x	1	1.5	2	3	4	5	6	7	8
y	8	p	3	2	2	2.4	3	3.7	4.5

(a) Calculate the value of p. [1]

(b) Using a scale of 2 cm to represent 1 unit, draw a horizontal x-axis for $0 \le x \le 8$.
Using a scale of 2 cm to represent 1 unit, draw a vertical y-axis for $0 \le y \le 8$.

On your axes, plot the points given in the table and join them with a smooth curve. [3]

(c) Use your graph to find the solutions of $x + \frac{12}{x} = 8\frac{1}{5}$. [1]

(d) By drawing a tangent, find the gradient of the curve at $(6,\ 3)$. [2]

(e) By drawing a suitable straight line on your graph, solve $2x^2 - 11x + 12 = 0$. [2]

Solutions:

(a) $\boxed{p = 4.5}$ ← **B1**

(b)
Correct scale **B1**
Correct plotting of points **B1**
Smooth curve **B1**

-1: missing labels (x, y, O)

(c)

$x + \frac{12}{x} = 8\frac{1}{5}$

$x + \frac{12}{x} - 5 = 3\frac{1}{5}$

Draw the line $y = 3\frac{1}{5}$.

$x = 1.9$ or $x = 6.3$ ← **B1 (with correct line drawn)**

(d)

Draw a tangent at $(6,\ 3)$. ← **B1**

$$\text{gradient} = \frac{4.3-1}{8-3} \quad \leftarrow \textbf{M1}$$

$$= 0.660 \quad (3\text{ s.f.})$$

(e)

$$2x^2 - 11x + 12 = 0$$

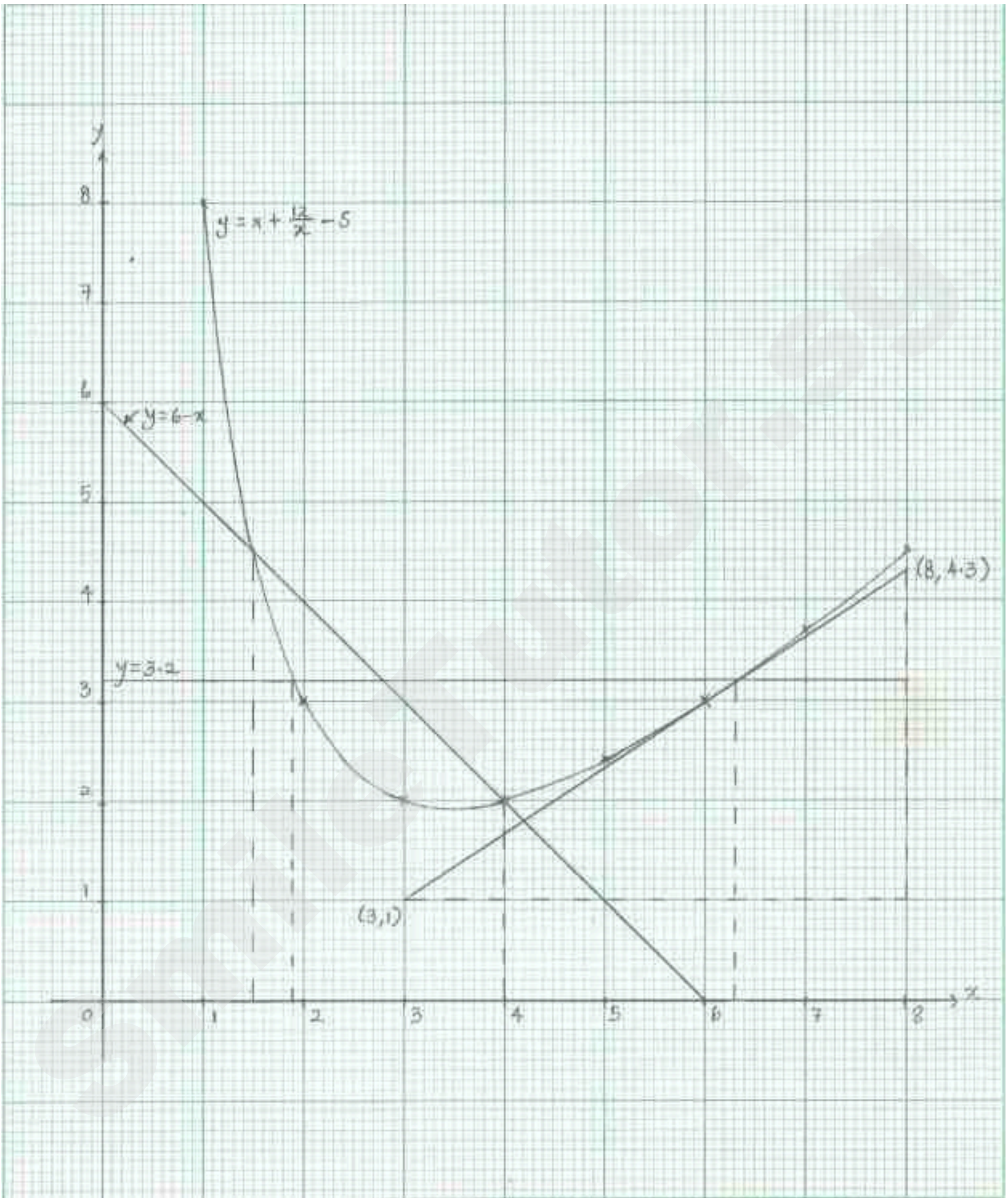
$$2x - 11 + \frac{12}{x} = 0$$

$$2x + \frac{12}{x} - 11 + \frac{12}{x} - x + 6 = -x + 6$$

$$x + \frac{12}{x} - 5 = 6 - x$$

Draw the line $y = 6 - x$. ← **B1**

$x = 1.5$ or $x = 4$ ← **B1 (with correct line drawn)**


y
8
7
6
5
4
3
2
1
0
1
2
3
4
5
6
7
8
x
y = x + 12/x − 5
y = 6 − x
y = 3.2
(8, 4.3)
(3, 1)

7 **(a)** A is a point $(-4, 1)$, $\overrightarrow{AB} = \begin{pmatrix} 5 \\ 4 \end{pmatrix}$ and $\overrightarrow{AC} = \begin{pmatrix} -3 \\ 8 \end{pmatrix}$.

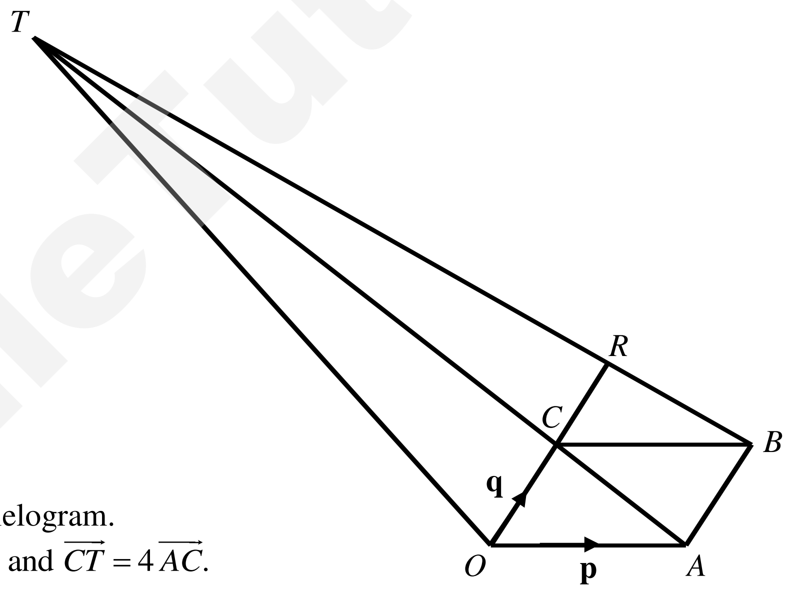
(i) Write down the column vector $\overrightarrow{BC}$. [1]

(ii) Find $\left|\overrightarrow{BC}\right|$. [2]

(iii) P is a point such that $\overrightarrow{BP} = 2\overrightarrow{PC}$.
Find the column vector $\overrightarrow{AP}$. [2]

(iv) Given $\overrightarrow{OQ} = \begin{pmatrix} \frac{2}{3} \\ 11\frac{2}{3} \end{pmatrix}$.
What type of quadrilateral is $APQB$?
Justify your answer using vectors. [3]

(b)



$OABC$ is a parallelogram.
$\overrightarrow{OA} = \mathbf{p}$, $\overrightarrow{OC} = \mathbf{q}$ and $\overrightarrow{CT} = 4\overrightarrow{AC}$.
ACT, BRT and OCR are straight lines.

(i) Express each of the following, as simply as possible, in terms of **p** and/or **q**,

(a) $\overrightarrow{OB}$, [1]

(b) $\overrightarrow{OT}$, [1]

(c) $\overrightarrow{BT}$. [1]

(ii) Given that $\overrightarrow{BR} = \frac{4}{5}\mathbf{q} - \mathbf{p}$, find k if $\overrightarrow{OC} = k\overrightarrow{CR}$. [1]

(iii) Find the value of $\dfrac{\text{area of } \Delta BCR}{\text{area of } \Delta OCT}$. [1]

Solutions:

7 (a) (i)

$$\overrightarrow{BC} = \overrightarrow{BA} + \overrightarrow{AC}$$
$$= \begin{pmatrix} -5 \\ -4 \end{pmatrix} + \begin{pmatrix} -3 \\ 8 \end{pmatrix}$$
$$= \begin{pmatrix} -8 \\ 4 \end{pmatrix} \longleftarrow \textbf{B1}$$

(ii)

$$\left|\overrightarrow{BC}\right| = \sqrt{(-8)^2 + 4^2} \longleftarrow \textbf{M1}$$
$$= \sqrt{80}$$
$$= 8.94 \text{ units } (3 \text{ s.f.}) \longleftarrow \textbf{A1}$$

(iii)

$$\overrightarrow{BP} = 2\,\overrightarrow{PC}$$
$$\overrightarrow{BA} + \overrightarrow{AP} = 2\left(\overrightarrow{PA} + \overrightarrow{AC}\right)$$
$$\overrightarrow{AP} - \overrightarrow{AB} = 2\left(\overrightarrow{AC} - \overrightarrow{AP}\right)$$
$$\overrightarrow{AP} - \overrightarrow{AB} = 2\,\overrightarrow{AC} - 2\,\overrightarrow{AP}$$
$$3\,\overrightarrow{AP} = 2\,\overrightarrow{AC} + \overrightarrow{AB} \longleftarrow \textbf{M1}$$
$$= 2\begin{pmatrix} -3 \\ 8 \end{pmatrix} + \begin{pmatrix} 5 \\ 4 \end{pmatrix}$$
$$= \begin{pmatrix} -1 \\ 20 \end{pmatrix}$$
$$\overrightarrow{AP} = \frac{1}{3}\begin{pmatrix} -1 \\ 20 \end{pmatrix}$$
$$= \begin{pmatrix} -\frac{1}{3} \\ 6\frac{2}{3} \end{pmatrix} \longleftarrow \textbf{A1}$$

$$\overrightarrow{AP} = \overrightarrow{AB} + \overrightarrow{BP}$$
$$= \overrightarrow{AB} + \frac{2}{3}\overrightarrow{BC}$$
$$= \begin{pmatrix} 5 \\ 4 \end{pmatrix} + \frac{2}{3}\begin{pmatrix} -8 \\ 4 \end{pmatrix}$$
$$= \begin{pmatrix} 5 \\ 4 \end{pmatrix} + \begin{pmatrix} -5\frac{1}{3} \\ 2\frac{2}{3} \end{pmatrix}$$
$$= \begin{pmatrix} -\frac{1}{3} \\ 6\frac{2}{3} \end{pmatrix}$$

Alternative method

7 (a) (iv)

$$\overrightarrow{AB} = \begin{pmatrix} 5 \\ 4 \end{pmatrix}$$

$$\overrightarrow{OB} - \overrightarrow{OA} = \begin{pmatrix} 5 \\ 4 \end{pmatrix}$$

$$\overrightarrow{OB} = \begin{pmatrix} 5 \\ 4 \end{pmatrix} + \begin{pmatrix} -4 \\ 1 \end{pmatrix}$$

$$= \begin{pmatrix} 1 \\ 5 \end{pmatrix}$$

$$\overrightarrow{BQ} = \overrightarrow{OQ} - \overrightarrow{OB}$$

$$= \begin{pmatrix} \frac{2}{3} \\ 11\frac{2}{3} \end{pmatrix} - \begin{pmatrix} 1 \\ 5 \end{pmatrix}$$

$$= \begin{pmatrix} \frac{-1}{3} \\ 6\frac{2}{3} \end{pmatrix}$$

$$\therefore \overrightarrow{AP} = \overrightarrow{BQ}$$

$$\overrightarrow{PQ} = \overrightarrow{PA} + \overrightarrow{AB} + \overrightarrow{BQ}$$

$$= \begin{pmatrix} \frac{1}{3} \\ -6\frac{2}{3} \end{pmatrix} + \begin{pmatrix} 5 \\ 4 \end{pmatrix} + \begin{pmatrix} \frac{-1}{3} \\ 6\frac{2}{3} \end{pmatrix}$$

$$= \begin{pmatrix} 5 \\ 4 \end{pmatrix}$$

$$\therefore \overrightarrow{AB} = \overrightarrow{PQ}$$

M1

$$\left|\overrightarrow{AP}\right| = \left|\overrightarrow{BQ}\right| = \sqrt{\left(\frac{-1}{3}\right)^2 + \left(6\frac{2}{3}\right)^2}$$

$$= \sqrt{\frac{401}{9}}$$

$$= 6.67 \text{ units (3 s.f)}$$

$$\left|\overrightarrow{AB}\right| = \left|\overrightarrow{PQ}\right| = \sqrt{(5)^2 + (4)^2}$$

$$= \sqrt{41}$$

$$= 6.40 \text{ units (3 s.f)}$$

M1

Thus, *APQB* is a parallelogram. ← **A1**

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7 (b) (i) (a)

$$\overrightarrow{OB} = \overrightarrow{OA} + \overrightarrow{AB}$$
$$= \overrightarrow{OA} + \overrightarrow{OC}$$
$$= \underset{\sim}{p} + \underset{\sim}{q} \longleftarrow \textbf{B1}$$

(b)

$$\overrightarrow{AC} = \overrightarrow{OC} - \overrightarrow{OA}$$
$$= \underset{\sim}{q} - \underset{\sim}{p}$$

$$\overrightarrow{OT} = \overrightarrow{OA} + \overrightarrow{AT}$$
$$= \underset{\sim}{p} + 5\overrightarrow{AC}$$
$$= \underset{\sim}{p} + 5\left(\underset{\sim}{q} - \underset{\sim}{p}\right)$$
$$= 5\underset{\sim}{q} - 4\underset{\sim}{p} \longleftarrow \textbf{A1}$$

(c)

$$\overrightarrow{BT} = \overrightarrow{OT} - \overrightarrow{OB}$$
$$= 5\underset{\sim}{q} - 4\underset{\sim}{p} - \underset{\sim}{p} - \underset{\sim}{q}$$
$$= 4\underset{\sim}{q} - 5\underset{\sim}{p} \longleftarrow \textbf{A1}$$

(ii)

$$\overrightarrow{BR} = \frac{4}{5}\underset{\sim}{q} - \underset{\sim}{p}$$
$$\overrightarrow{OR} - \overrightarrow{OB} = \frac{4}{5}\underset{\sim}{q} - \underset{\sim}{p}$$
$$\overrightarrow{OR} = \frac{4}{5}\underset{\sim}{q} - \underset{\sim}{p} + \underset{\sim}{p} + \underset{\sim}{q}$$
$$\overrightarrow{OR} = \frac{9}{5}\underset{\sim}{q}$$

$$\therefore \ \overrightarrow{OC} = \frac{5}{4}\overrightarrow{CR}$$
$$k = 1\frac{1}{4} \longleftarrow \textbf{A1}$$

(iii)

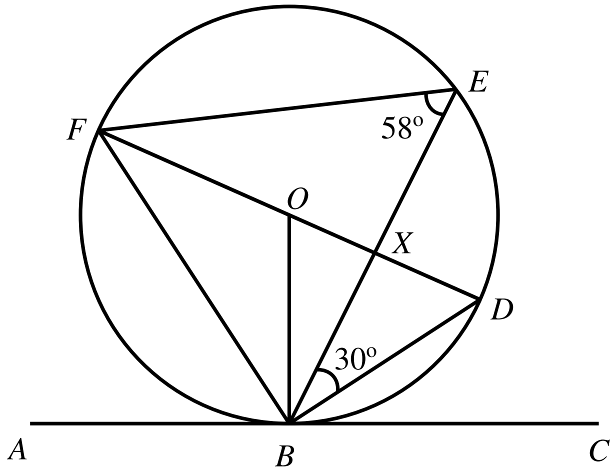
$$\overrightarrow{BR} = \frac{4}{5}\underset{\sim}{q} - \underset{\sim}{p}$$
$$= \frac{1}{5}\left(4\underset{\sim}{q} - 5\underset{\sim}{p}\right)$$
$$= \frac{1}{5}\overrightarrow{BT}$$

$$\frac{\text{area of } \Delta OCT}{\text{area of } \Delta CTR} = \frac{OC}{CR}$$
$$= \frac{5}{4}$$

$$\frac{\text{area of } \Delta BCR}{\text{area of } \Delta CTR} = \frac{RB}{TR}$$
$$= \frac{1}{4}$$

$$\therefore \quad \frac{\text{area of } \Delta BCR}{\text{area of } \Delta OCT} = \frac{1}{5}$$ **A1**

8 **(a)**



The line DF is a diameter of the circle $BDEF$ with centre O.
ABC is a tangent to the circle at B.
X is the point of intersection of DF and BE.
Angle $DBE = 30°$ and angle $BEF = 58°$.

(i) Find

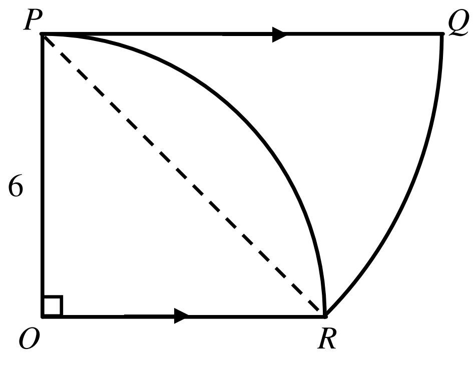
(a) angle FBO, [2]

(b) angle ABF, [1]

(c) angle DXE. [1]

(ii) Given that the radius of the circle is 140 cm, find the area of triangle BDF. [2]

(b)



In the diagram, POR is a quadrant of a circle with radius 6 cm.
OR and PQ are parallel.
QR is an arc of a circle with centre P.

Calculate the area and the perimeter of the shaded region. [4]

Solutions:

(a)(i)(a)

$\angle FOB = 2\times 58°$ ($\angle$ at centre $= 2\ \angle$ at circumference) ⟵ **M1**
$= 116°$

$\angle OFB = \angle OBF$ (base $\angle$s of isos. Δ)

$\angle FBO = \dfrac{180° - 116°}{2}$ ($\angle$ sum of Δ)
$= 32°$ ⟵ **A1**

(a)(i)(b)

$\angle OBA = 90°$ (tan $\perp$ rad)

$\angle ABF = 90° - 32°$ (complementary $\angle$s)
$= 58°$ ⟵ **A1**

Alternative working:
$\angle ABF = 58°$ ($\angle$s in alt. segment) ⟵ **B1**

(a)(i)(c)

$\angle DFE = 30°$ ($\angle$s in the same segment)

$\angle DXE = 30° + 58°$ (ext. $\angle$ of Δ)
$= 88°$ ⟵ **A1**

(a)(ii)

$\angle BDF = 58°$ ($\angle$s in the same segment)
$\angle DBF = 90°$ (rt. $\angle$ in a semicircle)

In $\Delta\ BDF$, $\cos 58° = \dfrac{BD}{DF}$ ⟵ **M1** ⟶ $\sin 58° = \dfrac{BF}{DF}$

$BD = 28\cos 58°$
≈ 14.84 cm

$BF = 28\sin 58°$
≈ 23.75 cm

Area of $\Delta\ BDF = \dfrac{1}{2}(14.84)(28)\sin 58°$ or Area of $\Delta\ BDF = \dfrac{1}{2}(14.84)(23.75)$

$= 176\ \text{cm}^2$ (3 s.f.) ⟵ **A1** ⟶ $= 176\ \text{cm}^2$ (3 s.f.)

(b)

$\angle PRO = \angle RPO$ (base $\angle$s of isos. Δ)

$\angle PRO = \dfrac{\pi - \frac{\pi}{2}}{2}$ ($\angle$ sum of Δ)

$= \dfrac{\pi}{4}$

$\angle RPQ = \dfrac{\pi}{4}$ (alt. $\angle$s , $PQ // OR$) ← **A1**

$PR = \sqrt{6^2 + 6^2}$ ← **A1**

$= \sqrt{72}$ cm

Area of shaded region

$= \frac{1}{2}\left(\sqrt{72}\right)^2\left(\frac{\pi}{4}\right) - \frac{1}{2}(6)^2\left(\frac{\pi}{2} - \sin\frac{\pi}{2}\right)$

$= 18 \text{ cm}^2$ ← **A1**

Perimeter of shaded region

$= \sqrt{72} + \left(\sqrt{72}\right)\left(\frac{\pi}{4}\right) + (6)\left(\frac{\pi}{2}\right)$

$= 24.6$ cm (3 s.f.) ← **A1**

9 **(a)** The ages of 50 employees in Company V is shown in the table below.

Age in years	$24 < x \le 28$	$28 < x \le 32$	$32 < x \le 36$	$36 < x \le 40$	$40 < x \le 44$
Number of employees	7	10	13	8	p

(i) State the value of p. [1]

(ii) Hence, calculate the

(a) mean age of the employees, [1]

(b) standard deviation. [1]

(iii) The age distribution of 50 employees in Company W is summarized below.

Mean	29.6 years
Standard deviation	7.13 years

Make two comparisons between the ages of employees in both companies. [2]

(b) A box contains 5 red flags and 8 yellow flags.
Two flags are taken from the bag at random without replacement.

(i) Draw a tree diagram to show the probabilities of the possible outcomes. [2]

(ii) Find, as a fraction in its simplest form, the probability that

(a) the first flag is red and the second flag is yellow, [1]

(b) both flags are the same colour, [1]

(c) at least one flag is yellow. [1]

Solutions:

(a) **(i)**

$p = 12$ ← **B1**

(ii) **(a)**

$$\text{Mean} = \frac{1732}{50}$$
$$= 34.64 \text{ years}$$ ← **A1**

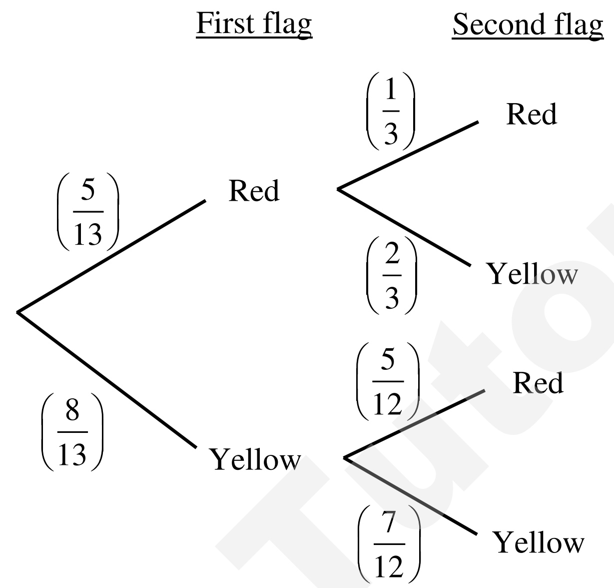
(b)

$$\text{Standard deviation} = \sqrt{\frac{61480}{50} - 34.64^2}$$
$$= 5.45 \text{ years} \quad (3 \text{ s.f.})$$ ← **A1**

(a) **(iii)** The employees in company *W* are younger than those in company *V* since the mean age of employees in company *W* is lower than that of company *V*. **[B1]**

The spread of ages of employees in company *W* is wider since the standard deviation of ages of employees in company *W* is larger than that of company *V*. **[B1]**

(b) **(i)** **[B1]** **[B1]**



(ii) **(a)**

$$\text{Probability} = \frac{5}{13} \times \frac{2}{3}$$
$$= \frac{10}{39} \longleftarrow \textbf{A1}$$

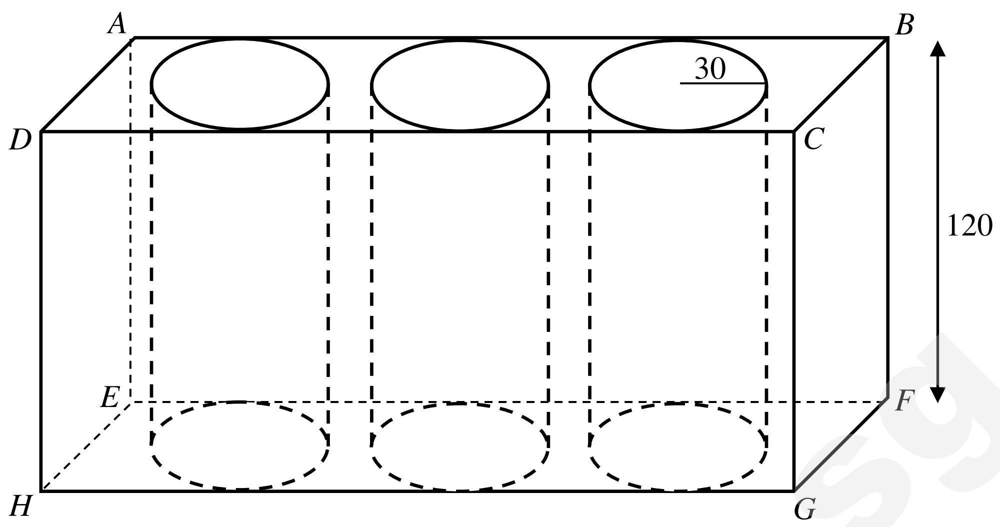
(b)

$$\text{Probability} = \left(\frac{5}{13} \times \frac{1}{3}\right) + \left(\frac{8}{13} \times \frac{7}{12}\right)$$
$$= \frac{19}{39} \longleftarrow \textbf{A1}$$

(c)

$$\text{Probability} = 1 - \left(\frac{5}{13} \times \frac{1}{3}\right)$$
$$= \frac{34}{39} \longleftarrow \textbf{A1}$$

10



Class 4*V* has chosen the 'Go Green' theme for their Social Innovation Project. The diagram above shows the recycling bins structure that they have built.

The whole structure consists of 3 open identical cylindrical plastic containers fit into a wooden cuboid crate. All the containers and the crate are of negligible thickness.

3 circles had to be cut from the top of the crate to fit the containers.
Each plastic container is placed in the crate such that they are 20 cm away from the sides of the crate, *ADHE* and *BCGF*, as well as 20 cm apart from each other.
Each plastic container touches the base and sides, *ABFE* and *DCGH*, of the crate too.
The radius and height of the plastic container are 30 cm and 120 cm respectively.

(a) Write down the dimensions of the crate. [1]

(b) Calculate the

(i) exact total surface area of the crate that was cut out, [1]

(ii) exact total internal surface area of each cylindrical container, [2]

(iii) total **exposed** external surface area of the crate. [2]

(c) The class would like to paint all the exposed external surfaces of the crate yellow. One tin of paint can cover an area of 3.75 m^2. How many tins do they need to purchase? Justify your answer. [2]

(d) If each cylindrical container is filled to the brim, what is the maximum volume of recyclables that can be collected by the class in a single collection? [2]

Solutions:

(a) Dimensions are 260 cm by 60 cm by 120 cm. ← **B1**

(b) (i)

Area that was cut out $= 3 \times \pi \times 30^2$

$= 2700\pi \text{ cm}^2$ ← **A1**

(ii)

Internal surface area of cylinder $= (\pi \times 30^2) + (2\pi \times 30 \times 120)$ ← **M1**

$= 900\pi + 7200\pi$

$= 8100\pi \text{ cm}^2$ ← **A1**

(iii)

Total exposed surface area of the crate

$= 2(260 \times 120) + 2(60 \times 120) + (260 \times 60 - 2700\pi)$ ← **M1**

$= 62400 + 14400 + 15600 - 2700\pi$

$= 92400 - 2700\pi$

≈ 83917.7

$= 83900 \text{ cm}^2$ (3 s.f.) ← **A1**

(c)

$\frac{8.3917}{3.75} \approx 2.2378$ ← **M1**

Number of tins of paint they need to buy is 3. ← **A1**

(d)

Maximum volume of recyclables $= 2700\pi \times 120$ ← **M1**

$= 1\,020\,000 \text{ cm}^3$ (3 s.f.) ← **A1**

End of Paper

Name:	Register No.:	Class:

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION

MATHEMATICS **4048/01**
Paper 1 **15 Aug 2016**
2 hours

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
Calculators should be used where appropriate.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total of the marks for this paper is 80.

For Examiner's Use
80

This document consists of **21** printed pages and a blank page.

[Turn over

Answer **all** the questions.

1 The lowest common multiple of 3 numbers is 9000.
Two of the numbers are 24 and 125.
Write down the least possible value of the third number.

Answer .... [2]

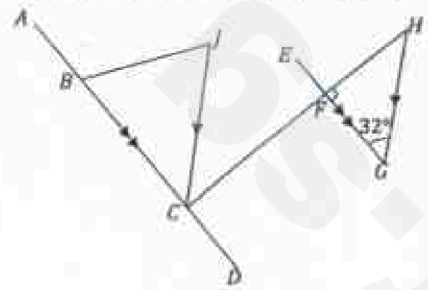
2 **(a)** Given that $6^a + 6^a + 6^a + 6^a = 5184$, find the value of a.

Answer (a) a = ... [2]

(b) The diameter of a human cell is 3×10^{-8} kilometres.
The diameter of a hydrogen atom is 2.4×10^{-4} micrometres.
How many times is the diameter of the human cell bigger than the diameter of the hydrogen atom? Give your answers in standard form.

Answer (b) .... [1]

3 In the diagram below, $ABCD$ is a straight line, $BC = JC$ and $\angle HGE = 32°$. AD is parallel to EG and HG is parallel to JC. HC cuts EG at F and HC is perpendicular to EG.



(a) Find $\angle JCH$.

Answer (a) $\angle JCH$ = ...° [1]

(b) Find $\angle JBA$.

Answer (b) $\angle JBA$ = ...° [1]

4 The table shows the number of accidents involving cars and motorcycles from April to June.

	April	May	June
Car	130	121	110
Motorcycles	74	87	107

Aminah concludes that it is more dangerous to drive a car than to ride a motorcycle because there are more accidents involving cars.
Do you agree with her? Give two reasons for your answer.

Answer ....

....

....

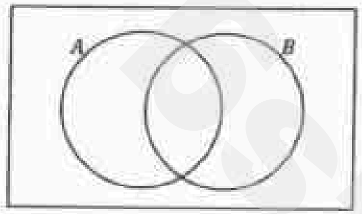
.... [2]

5 The amount of pressure is inversely proportional to the base area of a cube. The pressure is 100 Pa when the length of the cube is l cm. Find the new pressure when the length of the cube is increased by 300%.

Answer .... Pa [2]

6 (a) On the Venn Diagram shown in the answer space, shade the set of $(A \cap B')'$.

Answer



[1]

(b) $\varepsilon = \{x : x \text{ is an integer and } 0 \le x \le y\}$,
$P = \{x : x \text{ is a perfect square}\}$,
$Q = \{x : x \text{ is an even number}\}$,
$R = \{x : x \text{ is a multiple of } 3\}$.
Given that $n(P \cap Q) = 5$ and $n(Q \cap R) = 17$, list all the possible values of y.

Answer (b) .... [2]

---

7 Three of the exterior angles of an n-sided polygon are 35°, 40° and 60°. The other exterior angles are 45° each.

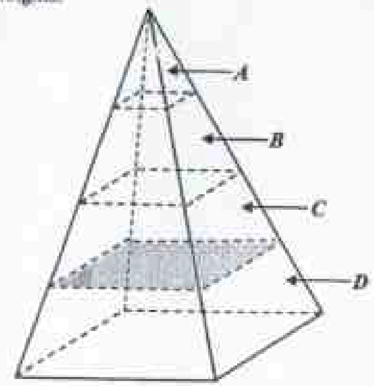
(a) Find the value of n.

Answer (a) n = ... [2]

(b) Name this polygon.

Answer (b) .... [1]

8 The diagram below shows a solid pyramid which is cut horizontally into four portions, A, B, C and D of equal heights.



(a) If the base area of A is 13 cm², find the shaded base area of portion C.

Answer (a) .... cm² [2]

(b) If the volume of portion C is 47.5 cm³, find the volume of the whole pyramid.

Answer (b) .... cm³ [2]

9 (a) Factorise completely $-x^2 + 3x - 2$.

Answer (a) .... [1]

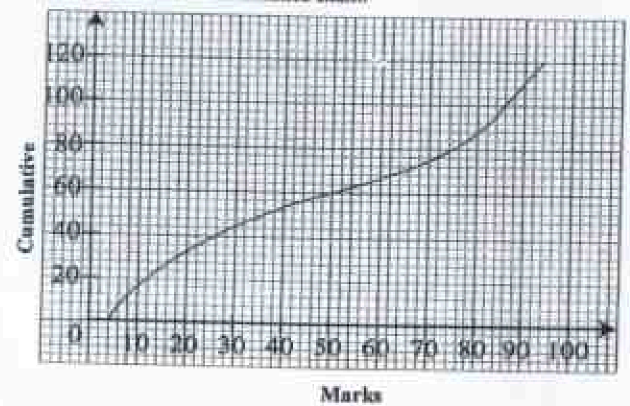
(b) Hence, factorise completely $12x^4 - 36x^2 + 24$.

Answer (b) .... [3]

10 Given that $x^2 + x - 4 = 0$.
Without solving for x, find the value of $x^3 + 5x^2 + 2016$.

Answer .... [3]

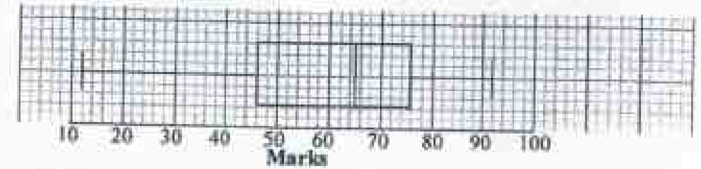
11 The cumulative frequency curve below shows the distribution of the marks scored by students in School X for a Mathematics exam.



(a) Use your graph to find the median mark.

Answer (a) .... [1]

(b) The box-and-whisker plot below shows the marks scored by students in School Y for the same Mathematics exam.



(i) Find the interquartile range for School Y.

Answer (b)(i) .... [1]

(ii) A greater proportion of students scored more than 80 marks in School X as compared to School Y.
Write whether you agree or disagree with the statement above and give a reason for your answer, stating clearly which statistic you use to make your decision.

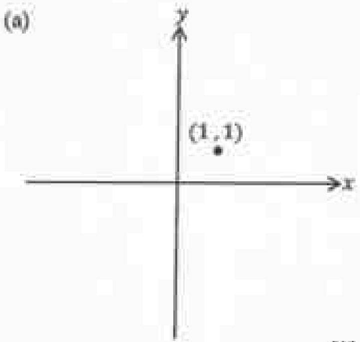
Answer ....because ....

.... [1]

12 In the axes provided below, the point (1, 1) has been marked. Indicating clearly any intercepts, sketch the graphs of
(a) $y + x^2 = 1$,
(b) $y + 1 = 7^x$.

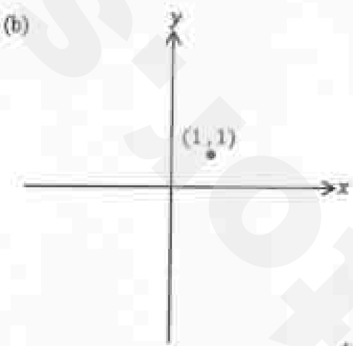
Answer

(a)



[1]

(b)

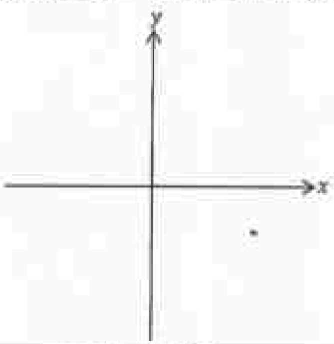


[1]

13 (a) Express $3x^2 - 24x + 37$ in the form of $a(x - h)^2 + k$.

Answer (a) .... [1]

(b) **Hence**, sketch the graph of $y = 3x^2 - 24x + 37$ in the space below, indicating clearly any intercepts.
Answer



[2]

14 A television set in a shop has a marked price of \$$y$.
It was finally sold at a discount of d%.
(a) Express the selling price in terms of y and d.

Answer (a) \$ .... [1]

The shopkeeper made a profit of 20% from the sale of the television set.
(b) Express the cost price as a single fraction in terms of y and d.

Answer (b) \$ .... [1]

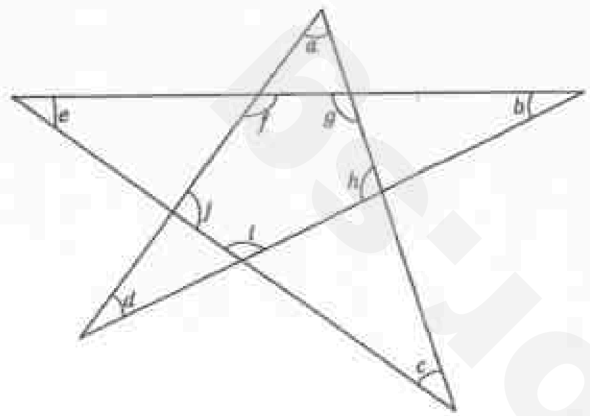
15 Mandy is planning to invest some money into EBS Bank that pays an annual interest rate of 2.5%, compounded monthly.
(a) Find the original amount of money Mandy invested if she received an interest of \$1330 at the end of 5 years, giving your answer correct to the nearest dollar.

Answer (a) \$ .... [2]

(b) ACBC Bank offers Mandy a simple interest rate of y % per annum. Using your answer in (a), find the value of y if Mandy earns the same amount of interest in 5 years.

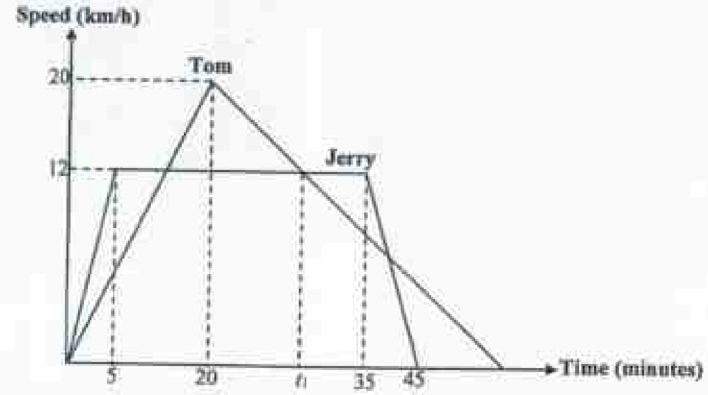
Answer (b) .... [2]

16 Calculate the sum of the angles $a, b, c, d, e, f, g, h, i$ and j in this diagram.



Answer .... [2]

17 The diagram below shows the distance time graph of Tom and Jerry's journey. They both start at the same time and at the same place.



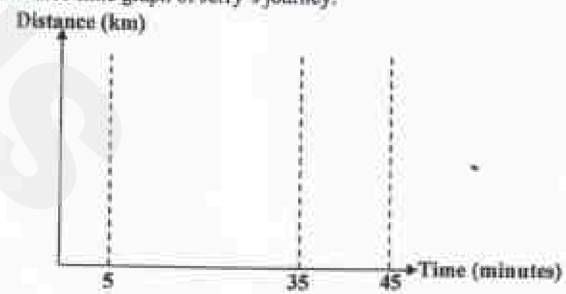
(a) If Tom overtakes Jerry at t_1, find the value of t_1.

Answer (a) t_1 = ... [2]

(b) Find Tom's speed at 25 minutes.

Answer (b) .... km/h [1]

(c) Sketch the distance-time graph of Jerry's journey.



[2]

18 Anna can either ride the horse, take the sled or walk to the ice castle.
The probability that Anna take the sled is $\frac{5}{8}$ and the probability that she walks is $\frac{1}{6}$.
If she rides the horse, the probability that she will reach the castle is $\frac{1}{2}$.
If she takes the sled, the probability that she will reach the castle is $\frac{4}{5}$.
If she walks, the probability that she will not reach the castle is $\frac{3}{4}$.
The letters in the box below represent all the different outcomes.

H: Ride the horse	S: Take the sled	W: Walk
R: Reach the castle	NR: Not reach the castle	

(a) In the space below, draw a probability tree diagram to show all the possible outcomes.
Answer

[2]

(b) Find the probability that Anna will reach the castle if she takes the sled.

Answer (b) .... [1]

(c) Find the probability that Anna will not reach the castle.

Answer (c) .... [1]

19 Three unbiased dice are thrown.
(a) Find the probability that at least one even number is obtained.

Answer (a) .... [1]

(b) Find the probability that all three dice show different numbers.

Answer (b) .... [1]

20 Benjamin ran along the perimeter of his town. The town has an area of 450 cm^2 on a map, and the scale of the map is 1 : 40 000.
(a) Calculate the actual area of the town that Benjamin ran in km^2.

Answer (a) .... km^2 [2]

(b) The length of his route is 110 cm on the map. If he ran at a constant speed of 15 km/h, find the total time he took to run along the perimeter of the town.
Leave your answers in hours and minutes.

Answer (b) .... hours .... minutes [2]

21 The following table shows the number of $2, $5 and $10 notes in the pockets of 4 students, Adam, Bob, Catherine and Dave.

	$2	$5	$10
Adam	4	5	1
Bob	2	5	2
Catherine	3	4	1
Dave	1	3	4

It is given that the information in the table above is represented by the matrix **R** and $\mathbf{P} = \begin{pmatrix} 2 \\ 5 \\ 10 \end{pmatrix}$.

(a) (i) Evaluate **RP**.

(ii) Explain what **RP** represent.

Answer (a) (i) **RP** = ... [1]

(ii) ....

....[1]

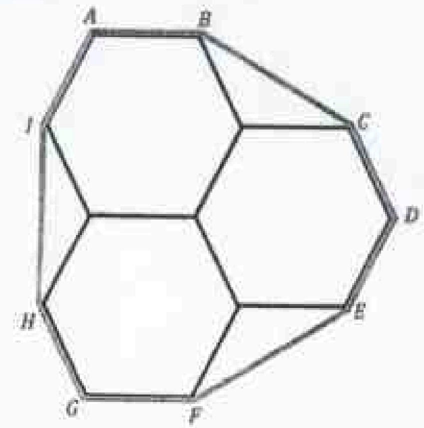
(b) If **RS** represent the number of notes each student has, write down the matrix **S**.

Answer (b) **S** = ... [1]

(c) Write down, but do not evaluate, a product of three matrices which will give the total amount of money the 4 students have altogether.

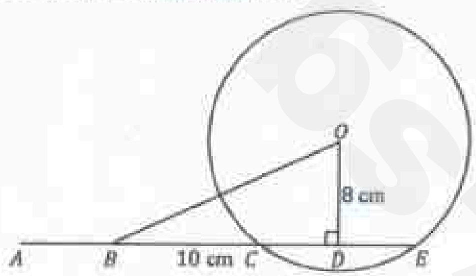
Answer (c) .... [1]

22 Three pencils with the cross-section in the shape of a regular hexagon are taped together as shown in the diagram below. The length of the side of each hexagon is 0.5 cm.
Find the area of $ABCDEFGHI$.



Answer .... cm^2 [3]

23 The diagram below shows a circle with centre O. It is given that $OD = 8$ cm, $BC = 10$ cm, $\angle ODB = 90°$ and C is the midpoint of BE.



(a) Find the exact value of

(i) $\tan \angle OBD$,

(ii) $\cos \angle OBA$.

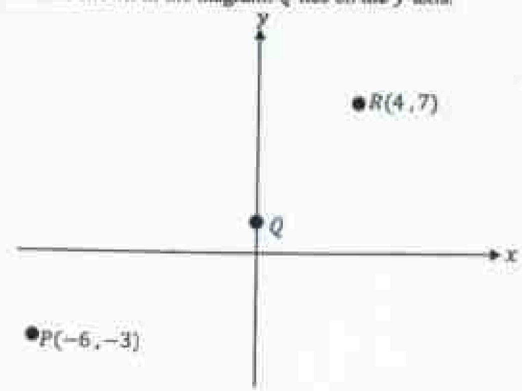
Answer (a) (i) .... [2]

(ii) .... [1]

(b) Find the radius of the circle.

Answer (b) .... [1]

24 The points P, Q and R are shown in the diagram. Q lies on the y-axis.



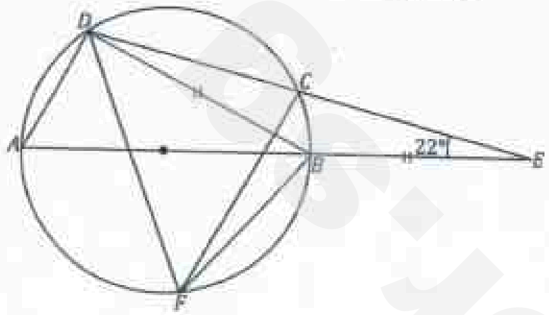
(a) If the equation of PQ is $3y - 2x = 3$, find the coordinates of Q.

Answer (a) Q = (.............. , ...) [1]

(b) (i) The coordinate of S is $(-1, y)$ and $PQRS$ is a trapezium. State the two possible coordinates of S.

Answer (b) (i) Coordinates of S = (......... , ...) or (......... , ...) [2]

25 In the diagram, AB is the diameter of the circle $AFBCD$. E is the point on AB produced where $DB = BE$ and $\angle AED = 22°$. The straight line ED cuts the circle at C.



(a) By explaining your answers clearly, find
(i) $\angle CFB$,
(ii) $\angle ABC$.

Answer (a)(i) .... [1]
(ii) .... [1]

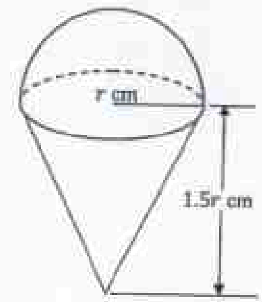
(b) X is a point in the circle such that $\angle DXB = 50°$. Find the position of X, stating your reasons clearly.

Answer (b) X is ....

because ....

.... [2]

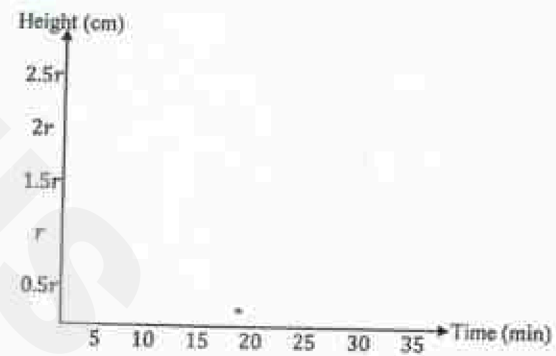
26 Liquid metal is poured into a mould in the shape of a cone and a hemisphere as shown in the diagram below. The radius of the cone and hemisphere is r cm and the height of the cone is $1.5r$ cm.



(a) It took 35 minutes for the liquid metal to completely fill up the mould. Find the time taken to fill up the cone.

Answer (a) .... minutes [1]

(b) On the answer grid given below, sketch the graph of the height of the liquid metal against time.



[2]

END OF PAPER

Name:	Register No.:	Class:

CRESCENT GIRLS' SCHOOL
SECONDARY FOUR
PRELIMINARY EXAMINATION 2016

MATHEMATICS **4048/02**
Paper 2
16 August 2016
2 hours 30 minutes

Additional Materials: Answer Paper
Graph Paper (1 sheet)
Mark Sheet

READ THESE INSTRUCTIONS FIRST

Write your name, register number and class on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** the questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
The use of an approved scientific calculator is expected, where appropriate.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
The use of a scientific calculator is expected, where appropriate.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total of the marks for this paper is 100.

For Examiner's Use
100

This document consists of **13** printed pages and **1** blank page.

[Turn over

Answer **all** the questions.

1 The heights of 180 girls from School X is shown in the table below.

Height, h (cm)	Frequency
$140 < h \le 145$	8
$145 < h \le 150$	15
$150 < h \le 155$	40
$155 < h \le 160$	50
$160 < h \le 165$	27
$165 < h \le 170$	30
$170 < h \le 175$	10

(a) Calculate

(i) the mean heights of the girls, [1]

(ii) the standard deviation. [2]

(iii) Jennifer says that the range of the heights of the 180 girls is 35 cm. Explain why she could be wrong. [1]

(b) The heights of a group of 175 girls in School Y are measured and summarised below.

Mean height	161.5 cm
Standard deviation	5.06 cm

Make two comparisons between the heights of the girls in School X and School Y. [2]

2 Miss Chong and Miss Noraini are clerks in a food factory in Jurong.
They are paid according to normal and overtime rates.
Based on company policy, all clerks are required to work 8 normal hours on weekdays and 4 normal hours on Saturdays.
Any extra hours put in by the clerks are considered overtime.

If Miss Chong works for 8 hours at normal rate and 2 hours at overtime rate on weekdays, she will be paid \$116.60 per weekday.
On Saturdays, if she works for 4 hours at normal rate and 3 hours at overtime rate, she will be paid \$90.10 per Saturday.

(a) Let \$$p$ per hour be Miss Chong's normal pay rate and \$$q$ per hour be her overtime pay rate.

Form 2 equations in terms of p and q. [2]

(b) Solve your simultaneous equations to find p and q. [2]

(c) Miss Noraini is paid the same overtime rate as Miss Chong.
Her normal pay rate is 10% less than Miss Chong's as she is junior to Miss Chong.
On a particular week, Miss Noraini is required to work 2.5 hours overtime every day on weekdays and 2 hour overtime on Saturday.

Calculate Miss Noraini's salary for the week. [3]

3 Study the number pattern below.

Row, n	Pattern, P_n	Sum, S_n	$S_n + 20$
1	5	5	25
2	5 , 6 , 5	16	36
3	5 , 6 , 7 , 6 , 5	29	49
4	5 , 6 , 7 , 8 , 7 , 6 , 5	S_4	$S_4 + 20$

(a) Write down the values of S_4 and $S_4 + 20$. [2]

(b) Name the type of numbers under the column $S_n + 20$. [1]

(c) Give a reason why 89 cannot appear in column $S_n + 20$. [1]

(d) Express $S_n + 20$ in terms of n. [1]

(e) **(i)** Given that
$5 + 6 + 7 + \ldots (k-1) + k + (k-1) \ldots + 7 + 6 + 5 = 269$.
Write down the value of k. [1]

(ii) Hence, find the sum of $25 + 30 + 35 + \ldots + 85 + \ldots + 35 + 30 + 25$. [2]

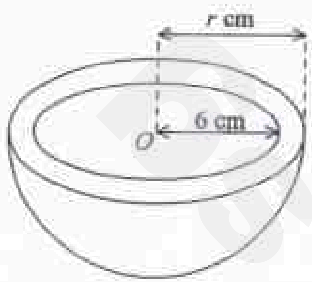
4 **(a)** **(i)** Given that $\dfrac{3}{y} = \sqrt{\dfrac{h^2 - 5}{y^2 + 8}}$, make y the subject. [3]

(ii) State the condition such that y is a real value. [1]

(b) Solve the equation $\dfrac{x}{x^2 - 6x + 9} - \dfrac{2x + 9}{2x^2 - x - 15} = 0$. [3]

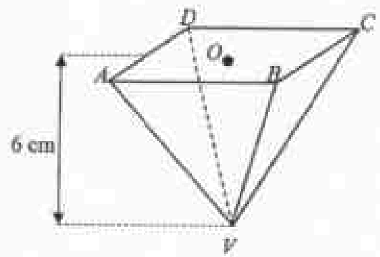
(c) Given that $6x^2 - xy = 7y^2$, $x > 0$ and $y > 0$.
Find the value of $\dfrac{12x}{y}$. [2]

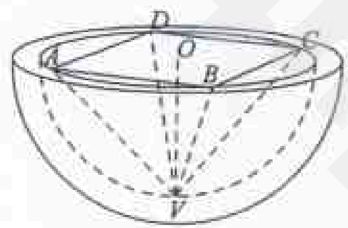
5 The diagram shows a hemispherical clay bowl with centre O.
The inner radius of the bowl is 6 cm and the outer radius is r cm



(a) Find the internal volume of the hemisphere with radius 6 cm. [2]

(b) Find the value of r if 408 cm^3 of clay is used to make the bowl. [2]





A solid pyramid with square base $ABCD$ and height OV, 6 cm, is placed in the bowl.
The points V, A, B, C and D touch the inner surface of the hemispherical bowl.

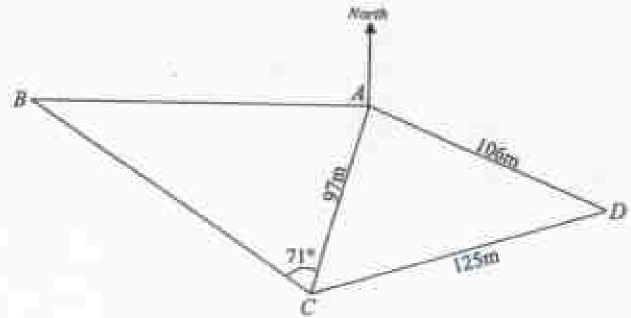
(c) **(i)** Show that $AB = 6\sqrt{2}$ cm. [1]

(ii) Calculate the volume of the pyramid. [2]

Water is poured into the bowl to fill up the space between the pyramid and the clay bowl.
The pyramid is then removed from the bowl.

(d) Jack said that the height of the water in the bowl can be easily calculated by comparing volumes of similar solids.
Explain why he could be wrong. [1]

6



A, B, C and D are points on level ground.
B is due west of A.
$AC = 97$ m, $AD = 106$ m and $CD = 125$ m.
$\angle BCA = 71°$ and the bearing of C from B is 122°.

(a) Calculate angle CAD, [2]

(b) Find the bearing of A from D, [3]

(c) Find the area of triangle ACD. [2]

(d) A vertical flagpole stands at D.
The angle of elevation of the top of the flagpole from A is 17.2°.

Calculate the angle of elevation of the top of the flagpole at a point along AC and furthest from D. [3]

7 **Answer the whole of this question on a sheet of graph paper.**

The volume of a solid is given by the equation $V-(x+2)^3=6(x-1)^2-14$. The table below gives some values of x and the corresponding values of V that satisfies the equation.

x (cm)	0	0.5	1	1.5	2	2.5	3	3.5
V (cm^3)	0	3.13	13	p	56	90.6	135	190

(a) Calculate the value of p. [1]

(b) Using a scale of 2 cm to represent 0.5 cm on the horizontal axis and 1 cm to represent 10 cm^3 on the vertical axis, draw the graph of $V-(x+2)^3=6(x-1)^2-14$ for the values of x shown in the table. [3]

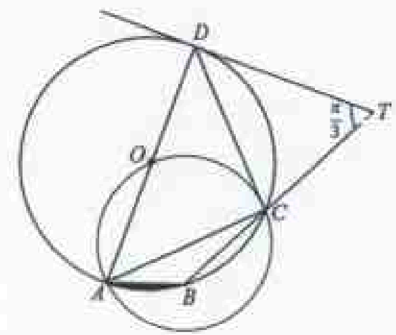
(c) Using your graph to estimate
(i) the volume of the solid when $x=2.3$, [1]
(ii) the value of x when the volume of the solid is 150 cm^3. [1]

(d) By drawing a suitable line, find the x-coordinate of the point of the curve where the gradient of the curve is 50. [2]

(e) This solid is melted down and made into a solid square pyramid of base area 120 cm^2.

By drawing a suitable straight line on the same axes, use your graph to find the height, x, of the pyramid. [2]

8



The line AD is a diameter of the larger circle $ABCD$ with centre O.
AC is a diameter of the smaller circle OAC.
The tangent at D meets BC produced at T.
Angle $DTC=\frac{\pi}{3}$ radians.

(a) Show that DC is an angle bisector of angle ADT. [2]

(b) Find, in terms of π,

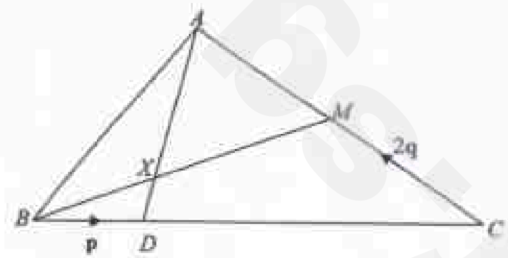
(i) angle DCT, [2]

(ii) angle AOB, [2]

(c) Given that the radius of the larger circle $ABCD$ is 5cm, find the length of tangent DT. [3]

(d) Calculate the area of the shaded segment AB. [2]

9 (a) ABC is a triangle such that $BC : BD = 4 : 1$ and $DA : DX = 5 : 1$.
M is the midpoint of AC.
$\overrightarrow{BD} = \mathbf{p}$ and $\overrightarrow{CM} = 2\mathbf{q}$.



(i) Express, as simply as possible, in terms of **p** and/or **q**.

(a) $\overrightarrow{DA}$, [1]

(b) $\overrightarrow{DX}$, [1]

(c) $\overrightarrow{BM}$. [1]

(ii) Show that $\overrightarrow{BX} = \frac{4}{5}(2\mathbf{p} + \mathbf{q})$. [1]

(iii) Find

(a) $\frac{BX}{BM}$, [1]

(b) $\frac{\text{Area of } \triangle ABX}{\text{Area of } \triangle AMX}$, [1]

(c) $\frac{\text{Area of } \triangle ABX}{\text{Area of } \triangle ABC}$. [2]

(b) P is the point $(3, -5)$. Another point Q is such that $\overrightarrow{PQ} = \begin{pmatrix} 1 \\ 8 \end{pmatrix}$.

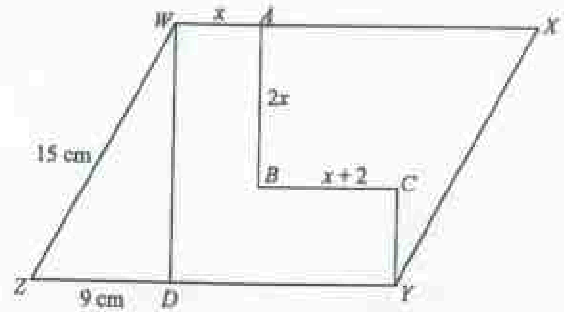
(i) Find the exact value of $|\overrightarrow{PQ}|$. [1]

(ii) Given that $R(-1, m)$. Find m if P, Q and R are collinear. [2]

10 (a) Given that $-\frac{x-3}{4} \leq \frac{3x}{2} - 1 \leq \frac{\sqrt{448}}{2}$, list down all the possible values of x where x is a prime number.

(b) Simplify $\frac{3m^2n}{8\sqrt{m}} \div \frac{15m^3}{24\sqrt{n}}$, giving your answer in the form km^bn^c where k, b and c are rational numbers.

(c)



The diagram above shows a parallelogram $WXYZ$ with $WZ = 15$ cm.
A vertical 'L' shape $WABCYD$ is marked inside the parallelogram such that $ZD = 9$ cm, $WA = x$ cm, $AB = 2x$ cm and $BC = (x + 2)$ cm.
BC is parallel to ZY and CY is parallel to WD.

(i) Show that $WD = 12$ cm. [1]

(ii) Given that the area of $WABCYD$ is 60 cm^2, write down an equation in x, and show that it simplifies to

$$x^2 - 10x + 18 = 0.$$ [2]

(iii) Solve the equation $x^2 - 10x + 18 = 0$, giving your answers correct to two decimal places. [2]

(iv) Hence, find the area of parallelogram $WXYZ$. [2]

11 Read the Straits Times article on video game addiction and answer the questions that follow:

The Straits Times • Thursday 9 December 2010

Stress may turn youngsters into video game addicts

by Chua Hian Hou & Poon Chian Hui

STRESS caused by academic and family pressure could be linked to the worrying number of young Singaporeans hooked on video games, researchers said yesterday.

The study of 3,000 students aged nine to 14 was published in the Annals of the Academy of Medicine Singapore, and was carried out by researchers from NUS, the National Institute of Education (NIE), Iowa State University and Hong Kong Polytechnic University. They are carrying out further studies to find out why nearly 9 per cent of youngsters are addicted to computer gaming, and how to help them. National University of Singapore (NUS) Assistant Professor Choo Hyekyung said school and family-related stress is one factor likely to feature prominently. She declined to give further details. The new research follows the release on Tuesday of Singapore's first comprehensive study of video game addiction.

Alarmingly, 7 per cent of all students polled had shoplifted games or stolen money to pay for them. And 24 per cent of those deemed addicts cut classes to play, while more than half quarrelled with their parents over their habit. The problem has prompted the Government to take action. In August, it announced it had set aside $10 million to fund cyber-wellness projects over the next five years.

Mr Daniel Koh of counselling practice Insights Mind Centre has this advice for parents: They must not "just cut off gaming". They also need to help their children take up another "good and fun" activity like sports to replace the habit, he said. "Many parents simply tell their children to stop playing, but to the child, the word 'stop' may mean they have to do something boring like homework... The child may take up other bad habits like smoking or drinking to kill time."

Dr Thomas Lee, head of the addiction medicine department at the Institute of Mental Health (IMH), said the danger of gaming, compared with other forms of addiction, is that a person can get far too immersed in the virtual world and, as a result, not realise he or she has a problem. "If the gaming addiction persists into adulthood, it may jeopardise the person's work, family and relationships," said Dr Lee.

ADDICTIVE GAMING IMPACT

Video-game addicts play 37.5 hours a week on average, compared with just 18.8 hours for those not addicted.

Behaviour exhibited in the past year	Non-addicts (%)	Addicts (%)
Has a video game system in the bedroom	61.7	70
Started arguing more with parents about games	14	62.1
Fought with parents over games	16	51.1
Hit someone or damaged something at home during argument over games	6.9	37.8
Got too little sleep	22.4	63.8
Been late for school	5.2	31.1
Skipped school to play games	4.2	24.4
Spent less time with friends or family	17.1	61.9
Skipped meals, baths, or toilet breaks to play games	10.3	52.3
Relied on friends to help with homework	9.5	40

Source: Annals Academy of Medicine

ST GRAPHICS

(a) Give a reason why the total percentage of all the behaviour exhibited in the past year does not add up to 100% for non-addicts. [1]

(b) Explain why it is not possible to represent the information above in a pie chart. [1]

(c) Calculate the number of survey participants who said that they have stolen money or shoplifted games to feed their gaming habit. [1]

(d) (i) Show that the number of young gaming addicts who participated in the survey is approximately 270. [1]

(ii) Hence, find the approximate number of

(a) young gaming addicts who have a video game system in the bedroom, [1]

(b) young non-gaming addicts who have not been late for school. Give your answer to the nearest whole number. [1]

(e) Based on the survey, the ratio of the number of non-addicts to the number of addicts who relied on friends to help with their homework is 19 : 80. Do you agree? Support your answer with mathematical reasoning. [2]

END OF PAPER

Answer Key

1. 9
2. (a) 4 (b) 1.25×10^5
3. (a) 58° (b) 110°
4. Do not agree
5. 6.25
6. (b) $y = 102, 103, 104, 105, 106, 107$
7. (a) 8 (b) Octagon
8. (a) 117 (b) 160cm²
9. (a) $(1-x)(x-2)$ (b) $-12(x^2-2)(1+x)(1-x)$
10. 2032
11. (a) 50 (b)(i) 30
12.
13. (a) $3(x-4)^2 - 11$
14. (a) $\$\frac{y(100-d)}{100}$ (b) $\$\frac{y(100-d)}{120}$
15. (a) \$10 000 (b) 2.66
16. 720°
17. (a) 22.5 (b) 4 km/h
18. (b) $\frac{1}{2}$ (b) $\frac{11}{24}$
19. (a) $\frac{7}{8}$ (b) $\frac{5}{9}$
20. (a) 72 (b) 2 hours 56 minutes
21. (a)(i) $\begin{pmatrix} 43 \\ 49 \\ 36 \\ 57 \end{pmatrix}$ (b) $\begin{pmatrix} 1 \\ 1 \\ 1 \end{pmatrix}$ (c) $\begin{pmatrix} 1 & 1 & 1 & 1 \end{pmatrix}\begin{pmatrix} 4 & 5 & 1 \\ 2 & 5 & 2 \\ 3 & 4 & 1 \\ 1 & 3 & 4 \end{pmatrix}\begin{pmatrix} 2 \\ 5 \\ 10 \end{pmatrix}$
22. 2.27
23. (a)(i) $\frac{8}{15}$ (ii) $-\frac{15}{17}$ (b) 9.43
24. (a) $(0, 1)$ (b) $(-1, 3\frac{2}{3})$ and $(-1, 4\frac{1}{2})$
25. (a)(i) 22° (ii) 68°
26. (a) 15

ANSWER KEY

1(a)(i)	158.1 cm
1(a)(ii)	7.51 cm
1(a)(iii)	Max value may not be 175cm
1(b)	The girls in school Y (mean 161.6 cm) are taller than the girls in school X (mean 158.1 cm) The heights of girls in school Y are more consistent (SD = 5.06 cm) than the height of girls in school X (SD = 7.51 cm)
2(a)	$8p + 2q = 116.60$ $4p + 3q = 90.10$
2(b)	$p = 10.60$; $q = 15.90$
2(c)	\$650.31
3(a)	44 ; 64
3(b)	Perfect squares
3(c)	89 is not a perfect square
3(d)	$(n+4)^2$
3(e)(i)	17
3(e)(ii)	1445
4(a)(i)	$y = \sqrt{\frac{72}{h^2 - 14}}$
4(a)(ii)	$h^2 > 14$
4(b)	$x = -13.5$
4(c)	14
5(a)	452 cm^3 or 144π cm^3
5(b)	7.43
5(c)(ii)	144 cm^2
5(d)	The water in the hemispherical bowl is not of the shape of a hemisphere
6(a)	75.9°
6(b)	297.1°
6(c)	4990 m^2
6(d)	14.7°
7(a)	$30\frac{3}{8}$ or 30.375
7(c)(i)	76 cm (± 0.1)
7(c)(ii)	3.15 (± 0.05)
7(d)	$x = 1.8$ (± 0.1)
7(e)	$x \approx 2.72$ cm (±0.1)
8(b)(i)	$\frac{5\pi}{12}$ radians
8(b)(ii)	$\frac{\pi}{6}$ radians
8(c)	7.89 cm
8(d)	0.295 cm^2
9(a)(i)(a)	$3\mathbf{p} + 4\mathbf{q}$
9(a)(i)(b)	$\frac{1}{5}(3\mathbf{p} + 4\mathbf{q})$
9(a)(i)(c)	$2(2\mathbf{p} + \mathbf{q})$
9(a)(ii)	$\frac{2}{5}$
9(a)(iii)(a)	$\frac{2}{3}$
9(a)(iii)(b)	$\frac{2}{5}$
9(a)(iii)(c)	$\frac{1}{5}$

9(b)(i)	$\sqrt{65}$ units
9(b)(ii)	-37
10(a)	2 , 3 , 5, 7
10(b)	$\frac{3}{5}n^{4}m^{-1}$
10(c)(iii)	2.35 , 7.65
10(c)(iv)	189 cm^2
11(a)	The 3000 participants of the survey were allowed to opt in more than one exhibited behaviour in the survey questions.
11(b)	The total percentage for either "non-addicts" or "addicts" does not add up to 100%. Pie chart is not suitable since it compares the sizes of these parts to the whole (100%).
11(c)	210
11(d)(ii)(a)	189
11(d)(ii)(b)	2588
11(e)	1729 : 720 instead of 19 : 80. NO

END OF ANSWER KEYS

聖嬰中學

HOLY INNOCENTS' HIGH SCHOOL

Name of Student		/80
Class		Index Number

PRELIMINARY EXAMINATION 2016
SECONDARY 4 EXPRESS / 5 NORMAL (ACADEMIC)
MATHEMATICS PAPER ONE 4016/01 & 4048/01

Date: 16 Aug 2016
Duration: 2 hours
Time : 11 00 – 13 00

Additional Materials: Nil
Students answer on Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use paper clips, glue or correction tape/fluid.

Answer **ALL** questions.
The number of marks is given in brackets [ ] at the end of each question or part question.

If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
The total number of marks for this paper is 80.

The use of an approved scientific calculator is expected, where appropriate.
If the degree of accuracy is not specified in the question and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

This document consists of 15 printed pages (including cover page).

Answer all questions.

1 (a) Calculate $\dfrac{\sqrt[3]{27.58}+17.9\times 2.08}{(60.69)^2}$.

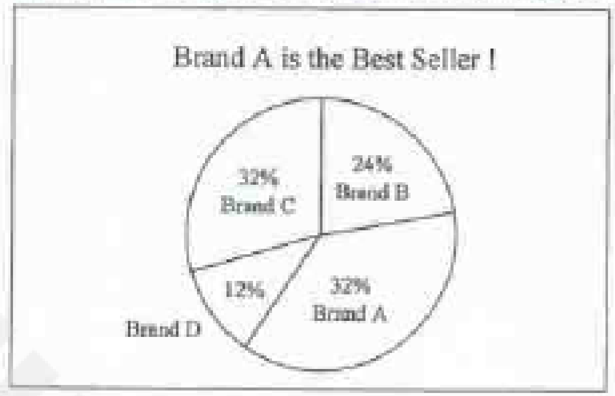
Write down the first seven digits on your calculator display.

Answer (a) .... [1]

(b) Write your answer to part (a) correct to 4 significant figures.

Answer (b) .... [1]

2 The pie chart shows the sales for 4 different brands of handphones.



Explain one way in which the pie chart is misleading.

Answer ....

....

....

.... [1]

An antique vase was auctioned off at \$1200 at a profit of 140%.
Find the original value of the vase.

Answer \$ .... [2]

Write the following in order of size, smallest first.

$$3.1\times10^{-1},\quad \pi,\quad 3.2,\quad -3.14.$$

Answer .... [2]

(a) Solve the inequality $1-\frac{1}{2}x \le 3 < 5-x$.

Answer (a) .... [2]

(b) Represent your solution on the number line below. [1]

Answer (b)

6 The volume of air, V cm^3, inside a bicycle pump is inversely proportional to the cube root of the air pressure, P units.

(a) If the air pressure is 343 units when 30 cm^3 of air is pumped, find an equation for V in terms of P.

Answer (a) .... [2]

(b) Find the volume of air when the air pressure is 999 units.

Answer (b) .... cm^3 [1]

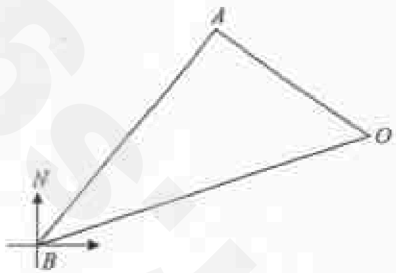
---

7 The diameter of a spherical micro-organism is 648 picometres.
Calculate the total surface area of this micro-organism in mm^2, giving your answer in standard form.

Answer .... mm^2 [4]

8 ABO is a triangle.
If A is on a bearing of 320° from O and the bearing of B from A is 245°, find the bearing of

(a) O from A,



Answer (a) ....° [1]

(b) A from B.

Answer (b) ....° [2]

9 (a) Solve the equation $\sqrt{625^x}=\frac{1}{5}$.

Answer (a) $x =$ .... [2]

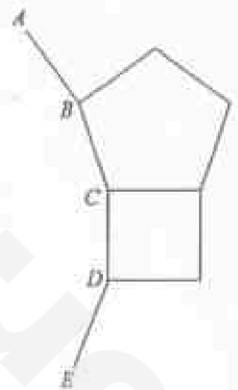
(b) Simplify $\left(49q^4\right)^{-\frac{1}{2}}\times 14q^2$.

Answer (b) .... [2]

10 The diagram is made up of a square, a regular pentagon and an incomplete regular polygon $ABCDE$ of n sides.

Find

(a) the value of obtuse $\angle BCD$,



Answer (a) $\angle BCD$ = ... ° [2]

(b) the value of each exterior angle of polygon $ABCDE$,

Answer (b) .... ° [1]

(c) the value of n.

Answer (c) n = ... [1]

11 It is given that $\frac{1}{5p} = \frac{1}{q} - \frac{1}{3r}$.

(a) Evaluate q when $p = 0.2$ and $r = \frac{1}{3}$.

Answer (a) q = ... [

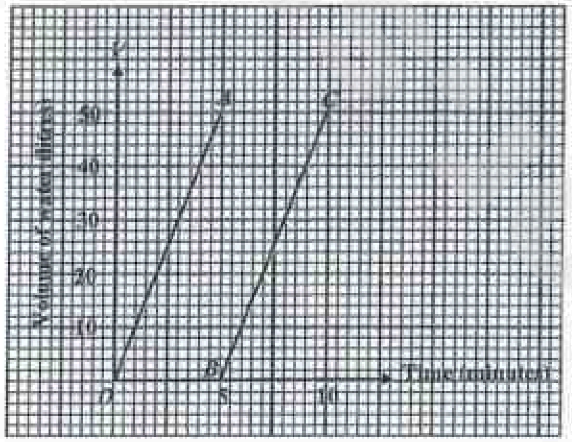
(b) Express r in terms of p and q.

Answer (b) r = ... [3]

12 In Singapore, giant tipping water buckets are one of the fun features in a water playground.

The bucket is filled with water at a constant rate.
When the bucket is full, the bucket tilts and all the water is poured out instantly.
The bucket then continues to be filled with water.

The graph shows the volume of water (V) in a water bucket for the first 10 minutes.



(a) What is the maximum volume of water that the water bucket can hold?

Answer *(a)* .... litres [1]

(b) (i) Find the gradient of the line BC.

Answer *(b)(i)* .... [1]

(ii) Briefly explain what has happened at each point A, B and C.

Answer *(b)(ii)* ....

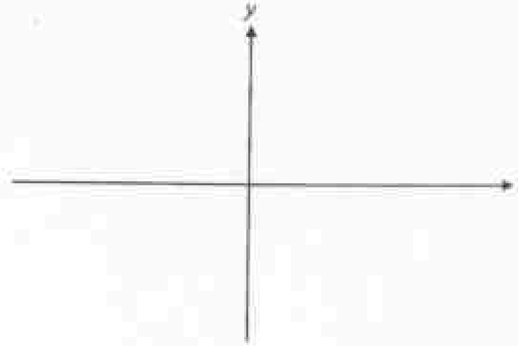
....

....

.... [1]

13 (a) (i) On the axes below, sketch the graph of $y = (x+1)(3-x)$.

Answer (a)(i) [2]



(ii) Write down the equation of the line of symmetry of $y = (x+1)(3-x)$.

Answer *(a)(ii)* .... [1]

(b) (i) Express $x^2 - 4x + 7$ in the form $(x-a)^2 + b$.

Answer *(b)(i)* .... [1]

(ii) Hence, write down the coordinates of the turning point of the curve $y = x^2 - 4x + 7$.

Answer *(b)(ii)* (........ , ...) [1]

14 $\varepsilon = \{x : x \text{ is an integer and } 1 \leq x < 10\}$
$A = \{\text{prime numbers}\}$
$B = \{\text{factors of } 6\}$

(a) List the elements in $A \cap B'$.

Answer (a) .... [1]

(b) List the elements in $(A \cup B)'$.

Answer (b) .... [1]

(c) Is $\{2, 3\} \in A$? Justify your answer.

Answer (c) ....

.... [1]

(d) Draw a Venn diagram to represent the sets ε, A and B.

Answer (d) [2]

ε

15 The information below shows the mass of 500 packets of sugar packed by two machines A and B.

Machine A

Mass (x grams)	$980 < x \leq 990$	$990 < x \leq 1000$	$1000 < x \leq 1010$	$1010 < x \leq 1020$
Frequency	62	120	270	48

Machine B

Mean = 1000.2 g
Standard Deviation = 9.8 g

(a) For machine A, calculate the mean and the standard deviation of the mass of the sugar packed.

Answer (a) Mean = ..., Standard deviation = ... [3]

(b) If you are tasked to purchase one of the machines, which one would you choose?
Justify your choice using appropriate statistical measures.

Answer (b) ....

....

....

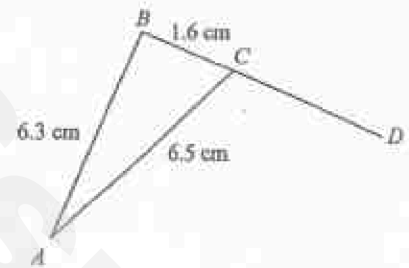
....

....

....

.... [2]

16 In the diagram, $AB = 6.3$ cm, $AC = 6.5$ cm and $BC = 1.6$ cm.
BCD is a straight line.



(a) Prove that triangle ABC is a right-angled triangle.

Answer (a) ....

....

....

....

.... [2]

(b) Express the following as a fraction in its simplest form.

(i) $\tan \angle BCA$,

Answer (b)(i) .... [1]

(ii) $\cos \angle ACD$.

Answer (b)(ii) .... [1]

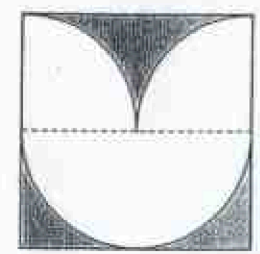
(c) Wayne claims that he can draw a triangle ACD with sides $AC = 6.5$ cm, $CD = 5$ cm and $AD = 12$ cm. Justify whether you agree with his claim.

Answer (c) ....

....

.... [1]

17 The diagram below shows a semicircle and 2 quadrants inscribed in a square of side $4kr$ cm.



(a) Show that the area of the semicircle is $2\pi k^2 r^2$.

Answer (a) ....

....

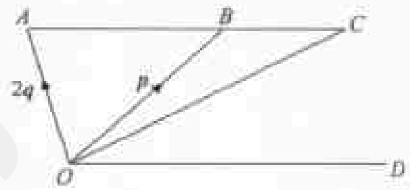
....

.... [1]

(b) Find, in terms of π and r, the difference in area between the shaded section and the unshaded section when $k = 2$.

Answer (b) .... cm^2 [4]

18 In the diagram, ABC is a straight line.
B is a point on AC such that $3AB = 2AC$.
$\overrightarrow{OA} = 2q$ and $\overrightarrow{OB} = p$.



(a) Express, in terms of p and/or q,

(i) $\overrightarrow{AB}$,

Answer (a)(i) .... [1]

(ii) $\overrightarrow{OC}$.

Answer (a)(ii) .... [2]

(b) It is given that $\overrightarrow{OD} = \frac{3}{2}p - 3q$.
Show that OD is parallel to line AB.

Answer (b) ....

....

.... [1]

(c) Using vectors, show that $OACD$ is a parallelogram.

Answer (c) ....

....

....

....

....

.... [2]

19 (a) Given that $\mathbf{N} = \begin{pmatrix} 1 & -2 \\ -3 & 4 \end{pmatrix}$, find the scalars a and b such that
$\mathbf{N}^2 + a\mathbf{N} - b\mathbf{I} = \mathbf{O}$.

Answer (a) $a =$ .... , $b =$ .... [4]

19 **(b)** A stall sells two different types of food.
They are apple pie and banana cake.
The total number of each item sold on three different days is given in the table below.

	apple pie	banana cake
Monday	22	30
Tuesday	35	27
Wednesday	18	22

The information can be represented by the matrix $\mathbf{S}=\begin{pmatrix}22 & 30\\ 35 & 27\\ 18 & 22\end{pmatrix}$.

(i) Given that $\mathbf{K}=\begin{pmatrix}1 & 1 & 1\end{pmatrix}$, calculate **KS**.

Answer (b)(i) **KS** = [2]

(ii) Explain what each element in **KS** represents.

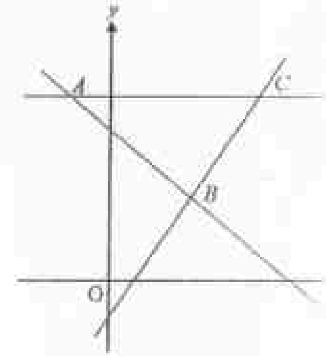
Answer (b)(ii) ....

....

.... [1]

20 The diagram, which is not drawn to scale, shows the three lines $y=5-x$, $y=2x-1$ and $y=6$.

The lines cut each other at points A, B and C.



(a) Find the coordinates of A and B.

Answer (a) A (.......... , ...) [1]
B (.......... , ...) [1]

(b) Find the area of triangle ABC.

Answer (b) .... sq units [1]

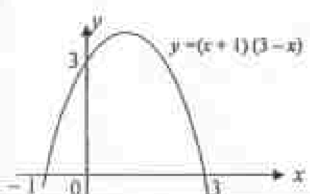
(c) Find the equation of the line which is parallel to AC and passes through $(-3, -1)$.

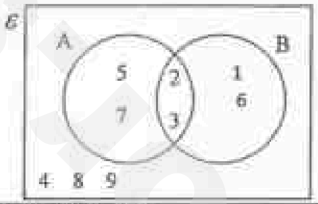
Answer (c) .... [1]

~~ End of Paper ~~

HHS Sec 4E/5N Prelim Examination Mathematics Paper 1 (4048/1 & 4016/1)

ONE PAGE ANSWER

Qn	Answer
1(a)	0.010928
(b)	0.01093
2	See end of next page
3	500
4	$-3.14,\ 3.1\times10^{-1},\ \pi,\ 3.2$
5(a)	$-4 \le x < 2$
(b)	
6(a)	$V = \dfrac{210}{\sqrt[3]{P}}$
(b)	21.0
7	1.32×10^{-11} mm^3
8(a)	140°
(b)	065°
9(a)	$x = -\dfrac{1}{2}$
(b)	2
10(a)	162°
(b)	18°
(c)	$n = 20$
11(a)	$q = \dfrac{1}{2}$
(b)	$r = \dfrac{5pq}{3(5p-q)}$
12(a)	50 litres
(bi)	10
(bii)	At point A, the bucket is full with water. At point B, the bucket is empty. At point C, the bucket is full with water again.
13(ai)	
(aii)	Line of symmetry is $x = 1$
(bi)	$(x-2)^2 + 3$
(bii)	(2, 3) is the turning point

Qn	Answer
14(a)	5, 7
(b)	4, 8, 9
(c)	No. $\{2, 3\} \notin A$ {2, 3} is a set. It should be a **subset** of set A.
(d)	
15(a)	Mean = 1001.08 g Standard deviation = 8.24 g
(b)	See end of next page
16(a)	$AC^2 = 6.5^2 = 42.25$ $AB^2 + BC^2 = 6.3^2 + 1.6^2 = 42.25$ Since $AC^2 = AB^2 + BC^2$, thus by converse of Pythagoras' theorem, $\triangle ABC$ is a right-angled triangle.
(bi)	$\tan\angle BCA = \dfrac{6.3}{1.6} = \dfrac{63}{16}$
(bii)	$\cos\angle ACD = -\dfrac{1.6}{6.5} = -\dfrac{16}{65}$
(c)	From triangle equality theorem, AD = 12 cm AC + CD = 6.5 + 5 = 11.5 < 12 The sum of any 2 sides should be more than the third side. Thus, I disagree with him.
17(a)	Area of semicircle $= \dfrac{\pi(2kr)^2}{2} = \dfrac{\pi 4k^2r^2}{2} = 2\pi k^2 r^2$
(b)	$32\pi r_*^2 - 64r^2$
18(ai)	$p - 2q$
(aii)	$\dfrac{3}{2}p - q$

Qn	Answer
18(b)	$\overrightarrow{OD} = \dfrac{3}{2}p - 3q = \dfrac{3}{2}(p - 2q)$ $= \dfrac{3}{2}\overrightarrow{AB}$ Thus, OD is parallel to line AB.
(c)	$\overrightarrow{DC} = \overrightarrow{DO} + \overrightarrow{OC}$ $= 3q - \dfrac{3}{2}p + \dfrac{3}{2}p - q$ $= 2q$ $= \overrightarrow{OA}$ $\therefore$ Since $\overrightarrow{DC} = \overrightarrow{OA}$, thus $OACD$ is a parallelogram. or $\overrightarrow{AC} = \overrightarrow{OD}$, thus, $OACD$ is a parallelogram.
20(a)	$A(-1, 6)$, $B(2, 3)$
(b)	6.75 units^2
(c)	$y = -1$

Qn	Answer
19(a)	$a = -5,\ b = 2$
(bi)	$\begin{pmatrix} 75 & 79 \end{pmatrix}_{1\times 2}$
(bii)	Each element represents the total number of apple pies and banana cakes sold respectively in all the 3 days. OR Each element represents the total number of each type of food sold in all the 3 days.

Answer to Q2

Misleading feature(s) : Brand A and Brand C have equal percentage but the proportion on the pie chart are not equal / title is biased

Effect of this feature on the graph : It mislead people into believing that Brand A is selling better than Brand C / It does not allow reader to make own judgement.

Answer to Q15b

The standard deviation for the mass of sugar packed by machine A is smaller, thus there is more consistency (or lesser variation) in the mass of each packet.

The mean mass of sugar packed by machine A is higher, indicating that the packets are heavier.

Thus, I will buy machine A.

— The End —

Answer all questions

1 (a) (i) Factorise completely $3m^2 - 12n^2$. [2]

(ii) Simplify $\dfrac{3m^2 - 12n^2}{6m^2 - 24mn + 24n^2}$. [2]

(b) Simplify

$\left(\dfrac{2}{xy^2}\right)^{-3} \div \left(\dfrac{2x}{3y}\right)$. [2]

(c) Express as a single fraction in its simplest form

$\dfrac{2x}{x-2} - \dfrac{3}{5}$. [2]

(d) Solve the equation $\sqrt{\dfrac{w}{3}} = 3w$. [3]

---

2 Eugene ran a marathon of 42 km.
For the first $\frac{2}{3}$ of his run, his average speed was x km/h.

(a) Write down an expression, in terms of x, for the time taken, in hours, for the first $\frac{2}{3}$ of his run. [1]

He then reduced his speed by 2 km/h for the remaining part of the run.

(b) Given that the total time taken by Eugene to complete the run was $4\frac{2}{5}$ hours, form and equation in x and show that it reduces to

$$11x^2 - 127x + 140 = 0.$$ [3]

(c) Solve this equation and hence find his average speed for the last part of the run, giving your answer correct to 1 decimal place. [4]

---

3 (a) The value of an antique clock increased by 115% from the year 2014 to the year 2015.
In 2015, the antique clock was valued at \$120 000.

Calculate the value of the clock in 2014. [2]

(b) The cash price of a new oven is \$1400.
Gordon buys the oven on hire purchase.
He pays a deposit of 40% of the cash price, followed by 10 monthly payments of \$90.

Calculate the interest that Gordon paid. [2]

(c) A sales agent is paid a basic salary of \$1000 plus 5% commission on all sales if the sales amount exceeds \$5000.
The agent's salary for June was \$1620.

Calculate his total sales for June. [2]

(d) A bank pays 2% interest compounded annually on all deposits.
At the start of 2010, Adrian deposited \$1000 into his account.
At the start of 2012, Adrian deposited a further \$800 into his account.
He withdrew all his money at the end of 2015.

Calculate the amount of money Adrian withdrew at the end of 2015. [3]

(e) On a particular day, the exchange rate between the Malaysian Ringgit (MYR) and the Singapore dollar (SGD) was 1 SGD = 2.97 MYR.
Jack purchased some herbs online for 2000 MYR.
The shipping rate for the herbs was 50 MYR.
For shipment into Singapore, a 7% Goods and Services Tax (GST) is payable on the cost of goods and shipment that exceeds 400 SGD

Calculate the amount of money, in Singapore dollars, that Jack had to pay to import the herbs. [3]

---

4 **Answer the whole of this question on a sheet of graph paper.**
The variables x and y are connected by the equation

$$y = Ax^2 + Bx + 18.$$

Some corresponding values of x and y are given in the table below.

x	0	1	2	3	4	5	6	7
y	18	26	30	30	26	18	6	-10

(a) Using a scale of 2 cm to represent 1 unit, draw a horizontal axis for $0 \le x \le 7$.
Using a scale of 2 cm to represent 5 units, draw a vertical axis for $-10 \le y \le 35$.
On your axes, plot the points given in the table and join them with a smooth curve. [3]

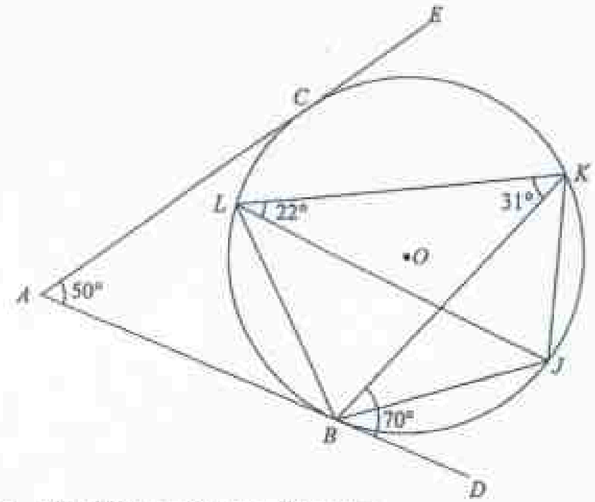
(b) Use your graph to find
(i) the value of y when $x = 4.5$, [1]
(ii) the values of x when $y = 20$. [1]

(c) By drawing a tangent, find the gradient of the curve at $x = 0.5$. [2]

(d) The line $y = k$ is a tangent to the curve.
By drawing this tangent on your graph, find the value of k. [2]

(e) Find the value of A and of B. [3]

5 The diagram shows a circle $BLCKJ$, centre O.
AE and AD are tangents to the circle.
Angle JLB is equal to angle JBD.
Angle $BAC = 50°$, angle $JLK = 22°$, angle $KBD = 70°$ and angle $BKL = 31°$.



(a) Find, giving reasons for each answer,

(i) angle JBK, [1]

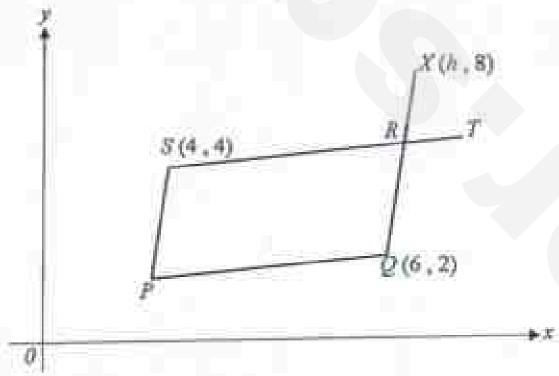
(ii) angle KBL, [2]

(iii) angle KOL, [1]

(iv) angle COB. [2]

(b) An arc of a circle, with centre A, is drawn through the points C, O and B.
The length of the arc COB is $\frac{35}{18}\pi$ cm.
Calculate the area of the sector $ACOB$, leaving your answer in terms of π. [3]

6 The diagram shows a parallelogram $PQRS$ not drawn to scale.
Q and S are the points (6, 2) and (4, 4) respectively.
T lies on SR produced and X lies on QR produced.
It is given that $\overrightarrow{PQ} = \begin{pmatrix} 4 \\ 1 \end{pmatrix}$.



(a) Given that $\overrightarrow{ST} = 5\overrightarrow{RT}$, find

(i) the column vector $\overrightarrow{ST}$, [1]

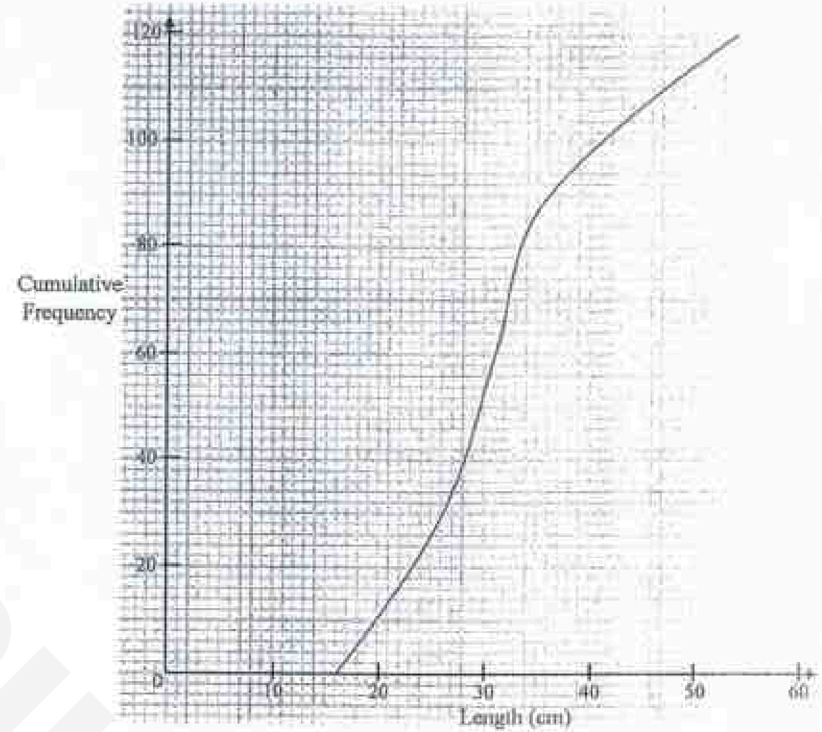
(ii) the coordinates of point T, [1]

(iii) the column vector $\overrightarrow{QS}$. [2]

(b) Find $\dfrac{\text{area of triangle } QTR}{\text{area of triangle } QTS}$. [1]

(c) Given that X is the point $(h\ ,\ 8)$ and $\overrightarrow{QR} = \begin{pmatrix} 2 \\ 3 \end{pmatrix}$, find the value of h. [2]

7 (a) The lengths of 120 fishes in a pond were measured.
The cumulative frequency curve below shows the distribution of their lengths.



(i) Use the curve to estimate

(a) the median length, [1]

(b) the interquartile range of the lengths, [2]

(c) the percentage of fishes which are at least 35 cm in length. [2]

(ii) It was discovered that the lengths were measured incorrectly.
The correct lengths should be 3 cm longer than those recorded.

Explain how the median and the interquartile range of the lengths would be affected by this error. [2]

7 (b) A survey is carried out on a group of 150 people.
72 of the people surveyed are men.
Find
(i) the probability that one person, chosen at random, will be a woman. [1]
(ii) the probability that two people, chosen at random, will be a man and a woman. [1]

8 The first six rows in a sequence of numbers, Row 1, Row 2, Row 3, Row 4, Row 5 and Row 6 are given below.

Row 1						2					
Row 2					4	6	8				
Row 3				10	12	14	16	18			
Row 4			20	22	24	26	28	30	32		
Row 5		34	36	38	40	42	44	46	48	50	
Row 6	52	54	56	58	60	62	64	66	68	70	72

The table below shows the row number, the number of terms, the first term and the last term for each row.

Row number, n	Number of terms in the n^{th} row, M_n	1st term in the n^{th} row, F_n	Last term in the n^{th} row, L_n
1	1	2	2
2	3	4	8
3	5	10	18
4	7	20	32
5	9	34	50
6	11	52	72
7	a	74	b

(a) Write down the values of a, and b for the 7th row. [2]

(b) Explain why 221 cannot appear in column L. [1]

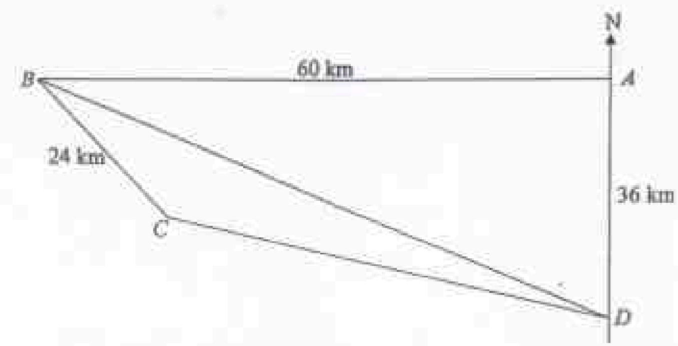
(c) Express M_n in terms of n. [1]

(d) (i) Express L_{n-1} in terms of n. [2]

(ii) Hence express F_n in terms of n. [1]

(e) Write down the first and the last term on row 15. [2]

9 $ABCD$ represents a plot of land.
A is due north of D, B is due west of A.
$AB = 60$ km, $BC = 24$ km, and $AD = 36$ km.
The bearing of C from B is 142.5°.



(a) (i) Show that angle $CBD = 21.5°$. [3]

(ii) Find the bearing of B from D. [1]

(b) Find
(i) BD, [2]

(ii) CD. [3]

(c) A hot air balloon floats 300 m above the ground.
It travels parallel to the ground from A to B.
Find the greatest possible angle of elevation of the balloon from C. [4]

10 Here is some information about a tank used to store gaseous chemicals.

Gas Tank

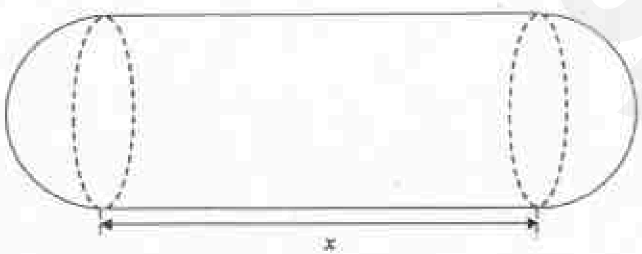
Length (l): 486 cm

Diameter (D): 105 cm

Maximum Pressure: 25 psi

*psi: pounds per square inch

In this question, the gas tank can be modelled as a cylinder joined to two hemispheres.



(a) Find the length of the cylindrical part, x, in cm. [1]

(b) The gas tank is to be painted.
A tin of 10 litres of paint can cover 9500 cm^2 of the surface of the tank.
Calculate the number of tins of paint that must be bought to paint the entire tank. [4]

(c) According to Boyle's Law, the product of the pressure and volume of a fixed mass of gas is a constant. 10 kg of chemical X has the following properties.

Mass (kg)	Volume (m^3)	Pressure (psi)
10	4.3	19

Determine if the tank can be filled with 10 kg of gaseous chemical X.
State your reasoning and calculations clearly. [5]

------------------- *End of Paper* -------------------

1(ai)	$3(m+2n)(m-2n)$
1(aii)	$\dfrac{m+2n}{2(m-2n)}$
1(b)	$\dfrac{3x^2y^7}{16}$
1(c)	$\dfrac{7x+6}{5(x-2)}$
1(d)	$w=0$ or $w=\dfrac{1}{27}$
2(a)	Time taken $=\dfrac{28}{x}$ hours
2(b)	$\dfrac{28}{x}+\dfrac{14}{x-2}=\dfrac{22}{5}$ $\dfrac{28x-56+14x}{x(x-2)}=\dfrac{22}{5}$ $210x-280=22x^2-44x$ $22x^2-254x+280=0$ $11x^2-127x+140=0$ (shown)
2(c)	Average Speed = 10.311 − 2 = 8.3 km/h
3(a)	\$55813.95
3(b)	Interest = \$1460 − \$1400 = \$60
3(c)	\$12400
3(d)	\$1992.11
3(e)	SGD738.55
4(b)(i)	22.5
4(b)(ii)	0.2, 4.8
4(c)	7.63
4(d)	$k=30.5$
4(e)	$A=-2,\ B=10$
5(a)(i)	22°
5(a)(ii)	79°
5(a)(iii)	158°
5(a)(iv)	130°
5(b)	$\dfrac{245}{36}\pi$ cm^3
6(a)(i)	$\begin{pmatrix}5\\1.25\end{pmatrix}$
6(a)(ii)	(9, 5.25)
6(a)(iii)	$\begin{pmatrix}-2\\2\end{pmatrix}$

6(b)	$\frac{1}{5}$
6(c)	$h = 10$
7(a)(i)(a)	31 cm
7(a)(i) (b)	10 cm
7(a)(i) (c)	27.5%
7(a)(ii)	The median would be 3 cm more. There would be no change in the interquartile range.
7(b)(i)	$\frac{13}{25}$
7(b)(ii)	$\frac{1872}{3725}$
8(a)	13, 98
8(b)	221 is odd while the numbers in the column are even.
8(c)	$M_n = 2n - 1$
8(d)(i)	$L_{n-1} = 2(n-1)^2$
8(d)(ii)	$2(n-1)^2 + 2$
(e)	$L_{15} = 2(15)^2 = 450$ $F_{15} = 2(15-1)^2 + 2 = 394$
9(a)(i)	$\angle ABD = \tan^{-1}\left(\frac{36}{60}\right)$ $= 30.963°$ $\angle CBD = 142.5° - 30.963° - 90°$ $= 21.536°$ $= 21.5°$ (shown)
9(a)(ii)	301°
9(b)(i)	By pythagoras' theorem, 70.0 km
9(b)(ii)	48.4 km
9(c)	$\theta = 0.9°$
10(a)	381 cm
10(b)	17 tins
10(c)	Constant $= 4.3 \times 19 = 81.7$ Volume of tank $= \frac{4}{3}\pi(0.525)^3 + \pi(0.525)^2(3.81)$ $= 1.24306875\pi$ Let Pressure be P $P(1.24306875\pi) = 81.7$ $P = 20.9$ Since the calculated pressure is less than 25, the tank is able to withstand 10 kg of gaseous chemical X.

Answer **all** the questions.

1 **(a)** Calculate $7\frac{1}{3}-\sqrt[3]{\frac{5.25+13.5^2}{\sin 28^\circ}}$.

Write down the first six digits on your calculator display.

(b) Write your answer to part **(a)** correct to 2 significant figures.

Answer **(a)** .... [1]

(b) .... [1]

---

2 **(a)** Arrange the following numbers in ascending order:

$\frac{1}{20}$, $5\frac{1}{4}\%$, 5.22×10^{-3}, $0.\dot{0}\dot{5}$.

Answer **(a)** .... [1]

(b) State which of the following number(s) is / are irrational:

$0.\dot{3}$, $\frac{\pi}{5}$, $\sqrt{7}\times2\sqrt{7}$, $3\sqrt{3}$.

Answer **(b)** .... [1]

---

3 The length of each side of a cube is increased by 40%.
Find the percentage increase in the total surface area of the cube.

Answer .... % [2]

4 Given that $(2x - 5)(x + a) = 2x^2 + bx - 5$ for all values of x, find the values of a and b.

Answer a = ………… , b = ………… [2]

---

5 Two numbers p and q, written as the products of their prime factors, are
$p = 2^2 \times 3^5 \times 5^6$ and $q = 2^2 \times 3^3$.

(a) Find the HCF of p and q.

(b) Find the smallest positive integer k such that $(p \times q \times k)$ is a perfect cube.

Answer **(a)** ………………………… [1]

(b) k = …………………… [1]

---

6 Local time in Singapore is 7 hours ahead of local time in London. Singapore Airlines SQ007 departed London on Monday at 19 16 London time. The flight arrived at Singapore on Tuesday at 15 51 Singapore time. Calculate how long the flight took, giving your answer in hours and minutes.

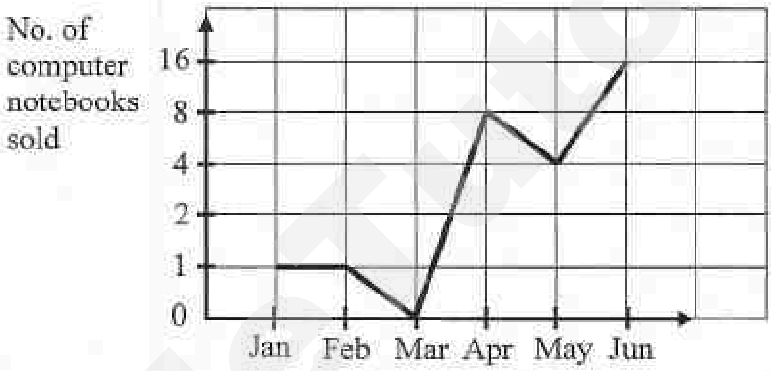
Answer ………. hours ………. minutes [2]

7 The diameter of a spherical micro-organism is 9.04 micrometres. Find the surface area in square millimetres, of the micro-organism, giving your answer in standard form.

Answer .... mm^2 [2]

---

8 The graph below shows the sales of computer notebooks made by Angie over a period of 6 months in 2016.



Explain why the graph is misleading.

Answer ....

....

....

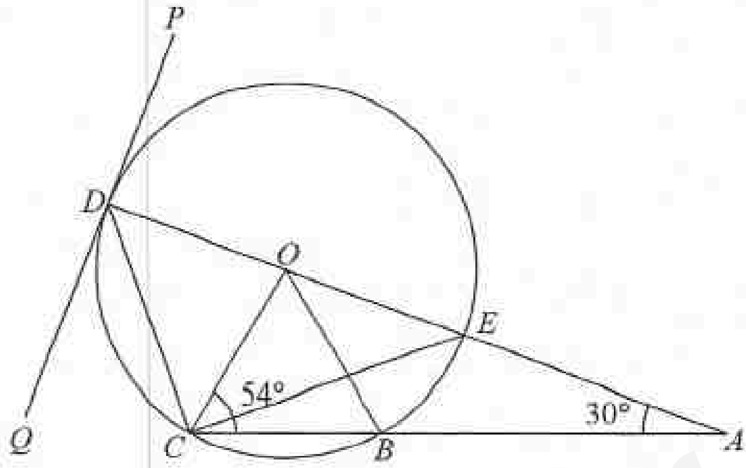
.... [2]

---

9 Two of the interior angles of a hexagon are $2x°$ and $(5x-200)°$. The remaining interior angles are $90°$ each. By forming an equation in x, find the value of x.

Answer $x =$ .... [2]

10 In the diagram, the points B, C, D and E lie on a circle with centre O. PQ is a tangent to the circle at D. ABC and $AEOD$ are straight lines. $\angle OCB = 54°$ and $\angle OAB = 30°$.



Find, giving reasons for each answer,

(a) $\angle ADC$,

(b) $\angle CDQ$,

(c) $\angle ACE$,

(d) $\angle CBE$.

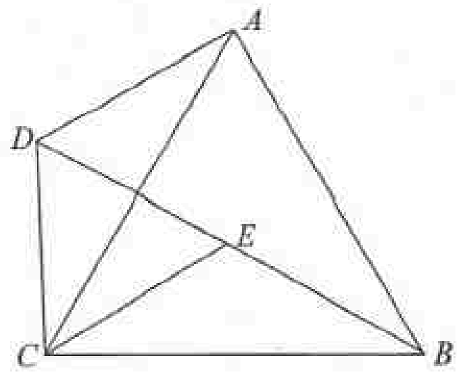
Answer **(a)**.......................... ° [2]

(b).......................... ° [1]

(c).......................... ° [2]

(d).......................... ° [1]

11 $ABCD$ is a quadrilateral. ABC and CDE are equilateral triangles. Using a pair of congruent triangles, show that $AD = BE$. State your reasons clearly.



Answer In triangles ....

....

....

....

....

....

....

....

.... [2]

---

12 Janet has \$50000 to invest for 3 years. She invests her money in a unit trust with returns equivalent to 2% per annum interest, compounded every 3 months. Calculate the amount of interest she will get at the end of 3 years.

Answer \$ .... [2]

13 **(a)** Given that $\left(\frac{1}{4}\right)^p \times 8 = 1$, find the value of p.

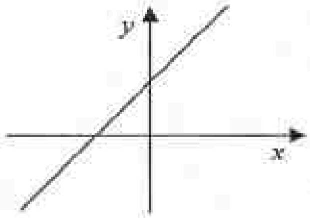
(b) Simplify $\left(\frac{2^{y+1}\sqrt{2}}{2^y}\right)^{-2}$.

Answer **(a)** p = ... [2]

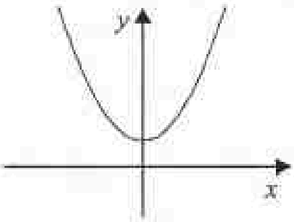
(b) .... [2]

14 The equations of the three graphs shown below are in the form $y = n + x^{n-1}$.
State the value of n for each of the following graph.

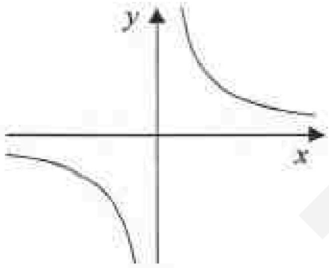
(a)



(b)



(c)



Answer **(a)** $n =$ .... [1]

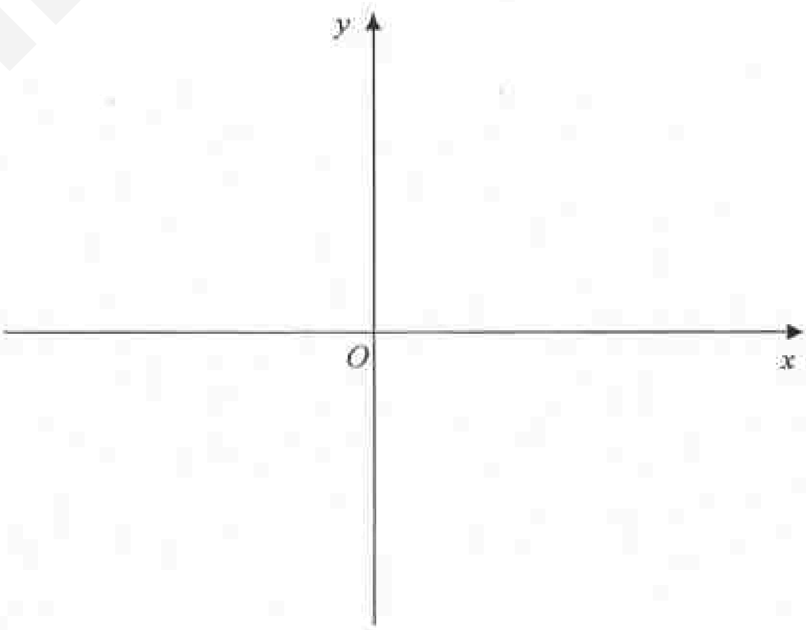
(b) $n =$ .... [1]

(c) $n =$ .... [1]

---

15 In the answer space, sketch the graph of $y = 5-(x+1)^2$, indicate clearly the turning point and the intercepts on the x and y-axes (if any).

Answer [2]



16 **(a)** $\varepsilon = \{ x : x \text{ is an integer and } 1 \leq x < 24 \}$

$A = \{ x : x \text{ is a perfect square} \}$

$B = \{ x : x \text{ is a factor of the number } 24 \}$

$C = \{ x : x + 1 \text{ is divisible by } 6 \}$

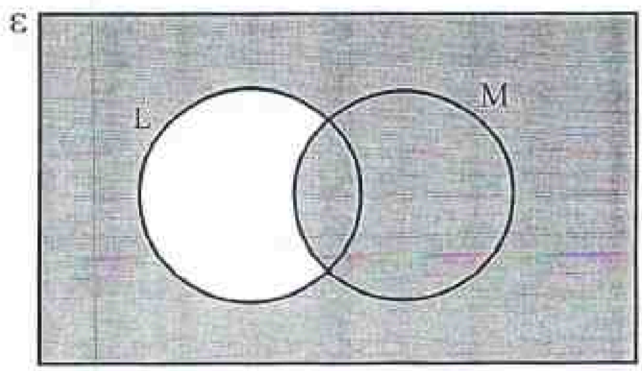
(i) List the elements in $A \cap C$.

(ii) Find $n\,(B' \cup C)$.

Answer **(a)(i)** .... [1]

(ii) .... [1]

(b) State the set notation of the shaded region in following Venn Diagram.



Answer **(b)**................................ [1]

17 Given that point $A(4, 2)$ and $\overrightarrow{AC} = \begin{pmatrix} -7 \\ 3 \end{pmatrix}$.

(a) Find $\left|\overrightarrow{CA}\right|$.

Answer **(a)** .... units [1]

(b) The point P lies on CA such that $\overrightarrow{PA} = k\,\overrightarrow{CA}$.

(i) Show that $\overrightarrow{OP} = \begin{pmatrix} 4-7k \\ 2+3k \end{pmatrix}$.

Answer **(b)(i)** [1]

(ii) Given that point P lies on the y-axis, find the coordinates of P.

Answer **(b)(ii)** P(......... , ...) [2]

18 Consider the number patterns in the table below. The first three terms of each column have been given.

Row, n	S	T	U
1	4	16	16
2	8	32	30
3	12	48	44
7	p	q	r
n			

(a) Find values of p, q and r.

(b) Write down the equation connecting S and T.

(c) Write down the equation connecting U and n.

(d) Betty said that 256 can be found in column U.
Write whether you agree or disagree with Betty. Give reason(s) for your answer.

Answer **(a)** $p =$ .... , $q =$ .... , $r =$ .... [1]

(b) .... [1]

(c) .... [1]

(d) I .... with Betty. This is because ....

....

....

....

.... [1]

19 The frequency table shows the number of countries that a group of students had visited.

Number of countries	0	1	2	3	4
Number of students	2	8	6	x	4

(a) Given that the mode is 1, state the largest possible value of x.

(b) Given that the median number of countries visited is 2, find the largest possible value of x.

(c) Given that the mean number of countries is more than 2, find the smallest possible value of x.

Answer (a) $x =$ .... [1]

(b) $x =$ .... [1]

(c) $x =$ .... [2]

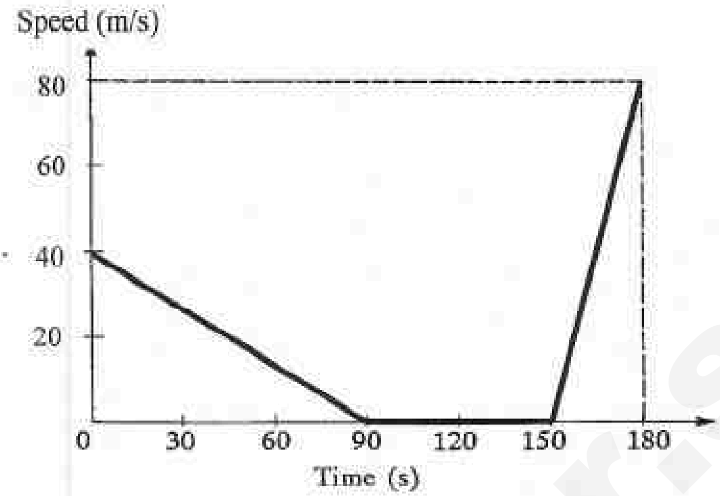
20 **(a)** The air resistance, R, is directly proportional to the square of the speed, V, of an object when it is falling. The air resistance is 24 newtons at a certain speed. Find the air resistance when the speed is increased by 50%.

(b) 48 men can build 2 huts in 60 hours. How many more men are needed if 3 huts are to be built in 72 hours?

Answer **(a)** .... newtons [2]

(b) .... men [2]

21 The diagram below shows the speed-time graph of the journey for the first 3 minutes of a train. The train slows down to a stop when entering station J. After a brief stop of 60 seconds, it starts to move off with acceleration for 30 seconds before it gets out of station J.



(a) Find the deceleration of the train as it enters station J.

(b) Calculate

(i) the total distance travelled by the train in the first 3 minutes,

(ii) the average speed of the train, in km/h, in the first 3 minutes.

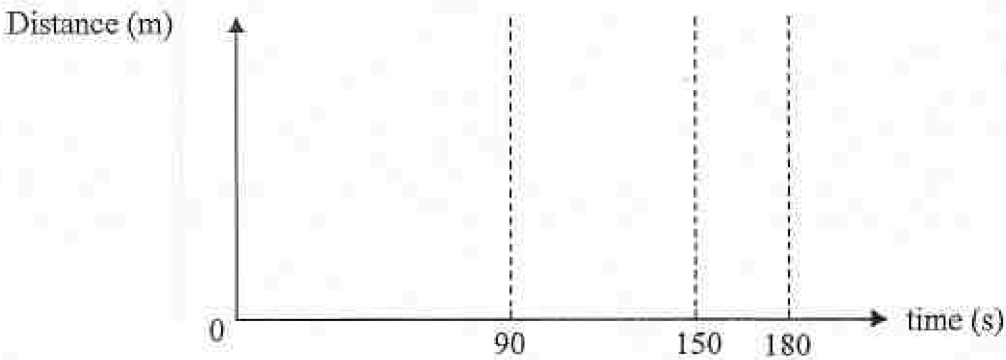
Answer **(a)** .... m/s^2 [1]

(b)(i) .... m [1]

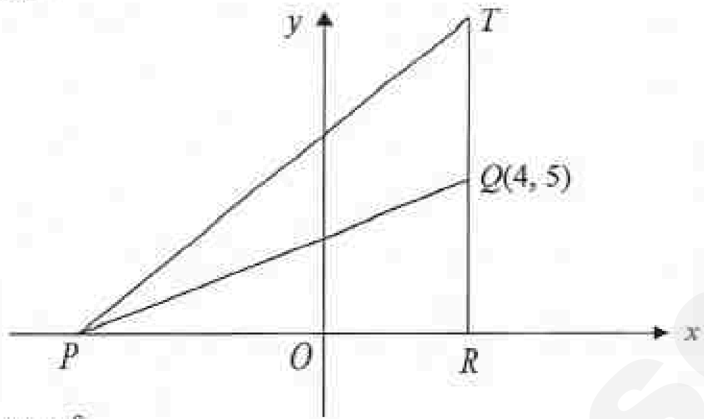
(ii) .... km/h [2]

(c) On the axes below, sketch the distance-time graph of the train for the first 3 minutes of its journey.

Answer **(c)** [2]



22 P and R are points on the x-axis. TQR is a straight line parallel to the y-axis.
Area of $\Delta PQR = 30$ units^2.



(a) Find the coordinates of
  (i) point R,
  (ii) point P.

(b) Find the length of PQ.

(c) Find $\cos\angle PQT$, giving your answer as a fraction.

(d) Given that $PR = TR$, find the equation of PT.

Answer **(a)(i)** R (……… , ………) [1]

(ii) P (……… , ………) [2]

(b) …………………… units [1]

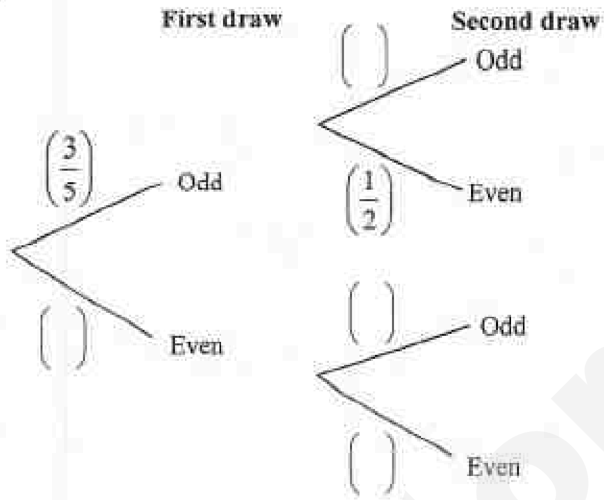
(c) ………………………… [1]

(d) ………………………… [1]

23 Five discs numbered 1, 3, 4, 6 and 7 are placed in a bag. A disc is drawn out of the bag at random. Without replacing the first disc into the bag, a second disc is drawn.

(a) Complete the following probability tree diagram.

Answer **(a)** [2]



(b) Find

(i) the probability that one disc is odd and the other is even,

(ii) the probability that both numbers drawn are smaller than 4.

(c) By drawing a possibility diagram in the space below, find the probability that the sum of both numbers is a prime number.

Answer **(b)(i)** .... [1]

(ii) .... [1]

(c) .... [2]

24 The diagram below shows a horizontal field ABC.
A is due north of B and C is due west of B.
Use a scale of 1 cm to 40 m, show all the constructions clearly.

(a) A lamp post, L, is located on a bearing of 290° from A, and 300 m from A.

(i) By construction, mark and label clearly the position of the lamp post L. [1]

(ii) Measure and write down the bearing of the lamp post L from point C.

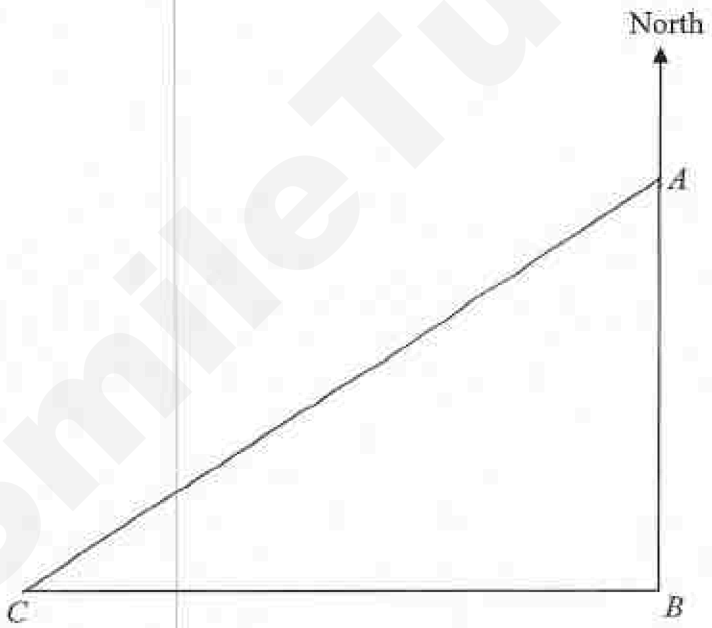
(b) A gate, G, is located along the path of BC, equidistant from B and C.
By construction, mark and label clearly the position of the gate G. [1]

(c) A circular flower bed is built such that it touches each side of the field at one point.

(i) By constructing two angle bisectors, draw the circular flower bed and label its centre O. [2]

(ii) Hence, measure and write down the actual radius of the flower bed.

Answer **(a)(i)**
(b)
(c)(i)



Answer **(a)(ii)** ………………… ° [1]

(c)(ii) ………………… m [1]

End of Paper 1

Class | Index Number

Name : ______________________________

METHODIST GIRLS' SCHOOL

Founded in 1887

PRELIMINARY EXAMINATION 2016
Secondary 4

Thursday
4 August 2016

MATHEMATICS
Paper 1 (Solutions)

4048/01
2 h

INSTRUCTIONS TO CANDIDATES
Write your name, class and index number on the question paper.
Write in dark blue or black ink on both sides of the paper.
You may use a pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

Answer **all** questions.

If working is needed for any question, it must be shown with the answer.
Omission of essential working will result in loss of marks.
Calculators should be used where appropriate.

If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give your answer in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

INFORMATION FOR CANDIDATES
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 80.

Marks
80

Mathematical Formulae

Compound Interest

$$\text{Total amount} = P\left(1+\frac{r}{100}\right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi rl$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3}\pi r^3$$

$$\text{Area of a triangle} = \frac{1}{2}ab\sin C$$

$$\text{Arc length} = r\theta\text{, where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2}r^2\theta\text{, where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

Answer **all** the questions.

1 **(a)** Calculate $7\frac{1}{3}-\sqrt[3]{\frac{5.25+13.5^2}{\sin 28^\circ}}$.

Write down the first six digits on your calculator display.

(b) Write your answer to part **(a)** correct to 2 significant figures.

B1

Answer **(a)** ......**−0.03095**...... [1]

B1

(b) ......**−0.031**...... [1]

---

2 **(a)** Arrange the following numbers in ascending order:

$\frac{1}{20}$, $5\frac{1}{4}\%$, 5.22×10^{-3}, $0.\dot{0}\dot{5}$.

0.05 **0.0525** **0.00522** **0.050505…**

B1

Answer **(a)** ......5.22×10^{-3}, $\frac{1}{20}$, $0.\dot{0}\dot{5}$, $5\frac{1}{4}\%$...... [1]

(b) State which of the following number(s) is / are irrational:

$0.\dot{3}$, $\frac{\pi}{5}$, $\sqrt{7}\times2\sqrt{7}$, $3\sqrt{3}$.

B1

Answer **(b)** ......$\frac{\pi}{5}$, $3\sqrt{3}$...... [1]

---

3 The length of each side of a cube is increased by 40%.
Find the percentage increase in the total surface area of the cube.

$$\%\text{ increase in surface area} = \frac{6(1.4l)^2-6l^2}{6l^2}\times100\% \qquad \textbf{M1}$$
$$=\frac{11.76-6}{6}\times100\%$$
$$=96\%$$

A1

Answer ......**96**...... % [2]

4 Given that $(2x-5)(x+a) = 2x^2 + bx - 5$ for all values of x, find the values of a and b.

$$2x^2 + 2ax - 5x - 5a = 2x^2 + bx - 5$$

$-5a = -5$

$a = 1$

$2a - 5 = b$

$b = 2(1) - 5$

$= -3$

B1 B1

Answer $a = $ ....1...... , $b = $ ....−3...... [2]

---

5 Two numbers p and q, written as the products of their prime factors, are
$p = 2^2 \times 3^5 \times 5^6$ and $q = 2^2 \times 3^3$.

(a) Find the HCF of p and q.

(b) Find the smallest positive integer k such that $(p \times q \times k)$ is a perfect cube.

(a) HCF $= 2^2 \times 3^3 = 108$

(b) $(p \times q \times k) = 2^4 \times 3^5 \times 5^6 \times k$

$k = 2^2 \times 3$

$= 12$

B1

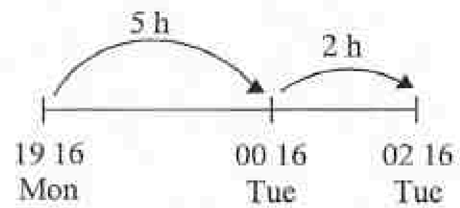
Answer **(a)** ....108.................. [1]

B1

(b) $k = $ ....12................ [1]

---

6 Local time in Singapore is 7 hours ahead of local time in London. Singapore Airlines SQ007 departed London on Monday at 19 16 London time. The flight arrived at Singapore on Tuesday at 15 51 Singapore time. Calculate how long the flight took, giving your answer in hours and minutes.



Departure time from London (Singapore time)
= 02 16 Tuesday M1

Arrival time at Singapore (Singapore time)
= 15 51 Tuesday

	h	min
	15	51
−	02	16
	13	35

Duration of Journey
= 13 h 35 min

A1

Answer ....13...... hours ....35...... minutes [2]

7 The diameter of a spherical micro-organism is 9.04 micrometres. Find the surface area in square millimetres, of the micro-organism, giving your answer in standard form.

$$\begin{aligned} \text{Radius} &= \frac{1}{2} \times 9.04 \times 10^{-6} \text{ m} \\ &= 4.52 \times 10^{-6} \times 10^{3} \text{ mm} \\ &= 4.52 \times 10^{-3} \text{ mm} \qquad \textbf{M1} \end{aligned}$$

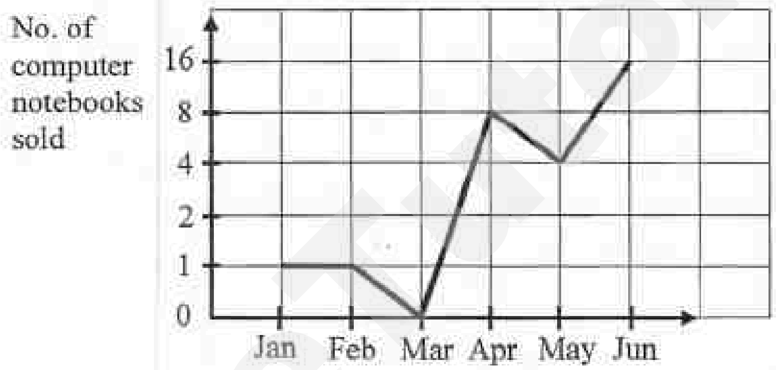
$$\begin{aligned} \text{Surface area} &= 4\pi (4.52 \times 10^{-3})^{2} \\ &= 2.57 \times 10^{-4} \text{ mm}^2 \end{aligned}$$

A1

Answer ...... 2.57×10^{-4} ...... mm^2 [2]

---

8 The graph below shows the sales of computer notebooks made by Angie over a period of 6 months in 2016.



Explain why the graph is misleading.

B1

Answer The scale of the vertical axis is **not consistent.**

This distorts the graph, making the **sales from May to June** (16 – 4 = 12 units)

seemed to be **less than** the **sales from March to April** (8 – 0 = 8 units).

.... [2]

---

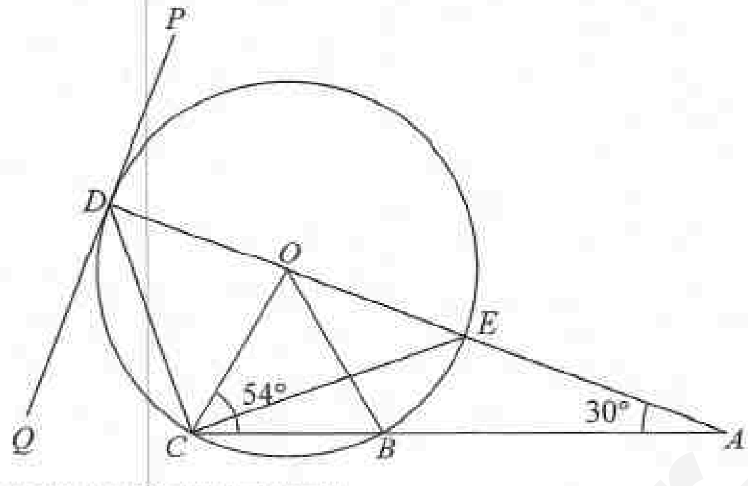
9 Two of the interior angles of a hexagon are $2x°$ and $(5x-200)°$. The remaining interior angles are $90°$ each. By forming an equation in x, find the value of x.

$$\begin{aligned} 2x + (5x-200) + 4(90) &= (6-2) \times 180 \qquad \textbf{M1} \\ 7x + 160 &= 720 \\ 7x &= 560 \\ x &= 80 \end{aligned}$$

A1

Answer $x =$ ...... 80 ...... [2]

10 In the diagram, the points B, C, D and E lie on a circle with centre O. PQ is a tangent to the circle at D. ABC and $AEOD$ are straight lines. $\angle OCB = 54°$ and $\angle OAB = 30°$.



Find, giving reasons for each answer,

(a) $\angle ADC$,

(b) $\angle CDQ$,

(c) $\angle ACE$,

(d) $\angle CBE$.

(a) $\left.\begin{aligned}\angle COD &= 54° + 30° \text{ (Ext } \angle \text{ of } \Delta \text{)} \\ &= 84°\end{aligned}\right\}$ **M1**

$\left.\begin{aligned}\angle ADC &= \frac{180° - 84°}{2} \text{ (Base } \angle\text{s of isos. } \Delta \text{)} \\ &= 48°\end{aligned}\right\}$ **A1**

(b) $\left.\begin{aligned}\angle CDQ &= 90° - 48° \text{ (tan } \perp \text{ rad)} \\ &= 42°\end{aligned}\right\}$ **A1**

(c) $\angle DCE = 90°$ (Rt. $\angle$ in semi-circle) **M1**

$\left.\begin{aligned}\angle ADC &= 180° - 90° - 48° - 30° \text{ (} \angle \text{ sum of } \Delta\text{)} \\ &= 12°\end{aligned}\right\}$ **A1**

or $\angle COE = 48° \times 2$ ($\angle$ at centre = 2 $\angle$ at circumferen)

$= 96°$

$\angle ACE = \frac{180° - 96°}{2}$ (Base $\angle$s of isos. Δ)

$= 42°$

$\angle ADC = 54° - 42°$

$= 12°$

(d) $\left.\begin{aligned}\angle CBE &= 180° - 48° \text{ (} \angle\text{s in opp segments are supp)} \\ &= 132°\end{aligned}\right\}$ **A1**

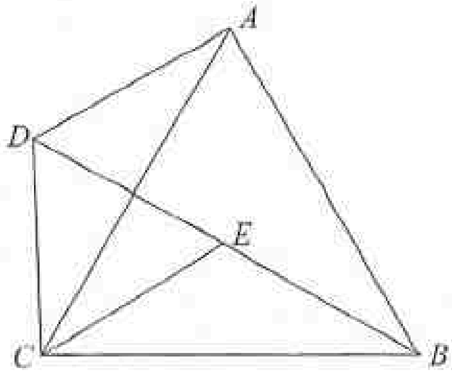
Answer (a)..........48.......... ° [2]

(b)..........42.......... ° [1]

(c)..........12.......... ° [2]

(d)..........132.......... ° [1]

11 *ABCD* is a quadrilateral. *ABC* and *CDE* are equilateral triangles. Using a pair of congruent triangles, show that $AD = BE$. State your reasons clearly.



Answer In triangles ACD and BCE,

CD and CE (sides of equil. ΔCDE)

AB and BC (sides of equil. ΔABC)

$\angle ACD = 60° - \angle ACE$ ($\angle$ of equil. Δ CDE)

$\angle BCE = 60° - \angle ACE$ ($\angle$ of equil. Δ ABC)

$\therefore \angle ACD = \angle BCE$

M1
(all criteria must be correct)

B1

$\therefore \Delta ACD = \Delta BCE$ (SAS) **(criteria must tally with test)**

Hence, $AD = BE$

[2]

---

12 Janet has \$50000 to invest for 3 years. She invests her money in a unit trust with returns equivalent to 2% per annum interest, compounded every 3 months. Calculate the amount of interest she will get at the end of 3 years.

$$\text{Amount} = 50000\left(1+\frac{0.02}{4}\right)^{12} \quad \textbf{M1}$$
$$= \$53083.8905$$

$$\text{Interest} = \$53083.8905 - \$50000$$
$$= \$3083.89 \text{ (to 2 dp)}$$

A1

Answer \$ $3083.89 [2]

13 **(a)** Given that $\left(\frac{1}{4}\right)^p \times 8 = 1$, find the value of p.

$$\left(2^{-2}\right)^p \times 2^3 = 2^0$$

$$2^{-2p+3} = 2^0 \qquad \textbf{M1}$$

$$-2p+3=0$$

$$p=1\frac{1}{2}$$

(b) Simplify $\left(\frac{2^{y+1}\sqrt{2}}{2^y}\right)^{-2}$.

$$\left(\frac{2^{y+1}\sqrt{2}}{2^y}\right)^{-2}$$

$$=\left(2^{y+1+\frac{1}{2}-y}\right)^{-2} \qquad \textbf{M1}$$

$$=\left(2^{\frac{3}{2}}\right)^{-2}$$

$$=2^{-3}$$

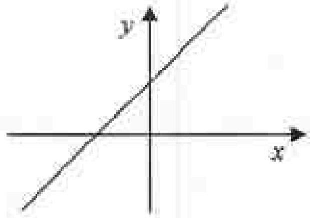
$$=\frac{1}{8}$$

Answer **(a)** p = $1\frac{1}{2}$ **A1** [2]

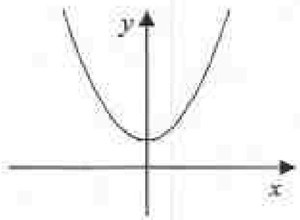
(b) $\frac{1}{8}$ **A1** [2]

14 The equations of the three graphs shown below are in the form $y = n + x^{n-1}$.
State the value of n for each of the following graph.

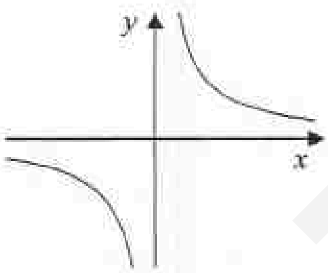
(a)



(b)



(c)



Answer **(a)** $n =$ ......2...... **B1** [1]

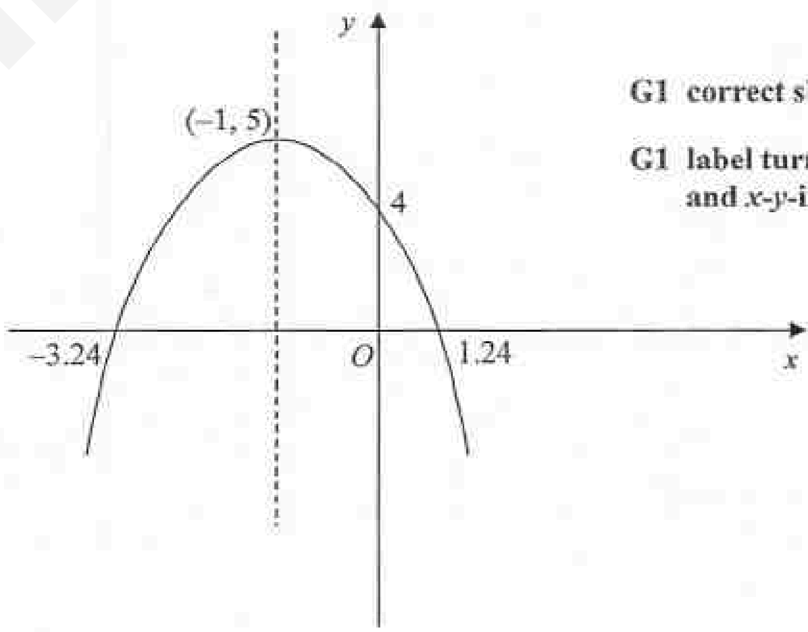
(b) $n =$ ......3...... **B1** [1]

(c) $n =$ ......0...... **B1** [1]

---

15 In the answer space, sketch the graph of $y = 5 - (x+1)^2$, indicate clearly the turning point and the intercepts on the x and y-axes (if any).

Answer [2]



G1 correct shape

G1 label turning point and x-y-intercepts

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16 **(a)** $\varepsilon = \{ x : x \text{ is an integer and } 1 \le x < 24 \} = \{ 1, 2, 3, \ldots\ 23 \}$

$A = \{ x : x \text{ is a perfect square} \} = \{ 1, 4, 9, 16 \}$

$B = \{ x : x \text{ is a factor of the number } 24 \} = \{ 1, 2, 3, 4, 6, 8, 12 \}$

$C = \{ x : x + 1 \text{ is divisible by } 6 \} = \{ 5, 11, 17, 23 \}$

(i) List the elements in $A \cap C$.

(ii) Find $n(B' \cup C)$.

(a) (ii) $B' = \{ 5, 7, 9, 10, 11, 13, 14, 15, 16, \ldots\ 23 \}$

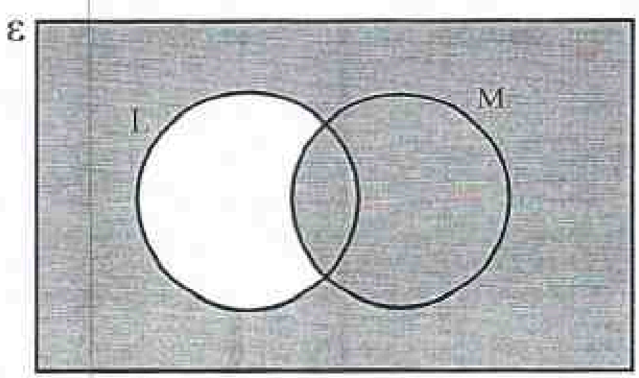
$$\begin{aligned} n(B' \cup C) &= n(B') \\ &= n(\varepsilon) - n(B) \\ &= 23 - 7 \end{aligned}$$

or { }

Answer **(a)(i)** ϕ **B1** [1]

(ii) 16 **B1** [1]

(b) State the set notation of the shaded region in following Venn Diagram.



Answer **(b)** $L' \cup M$ **B1** [1]

17 Given that point $A(4, 2)$ and $\overrightarrow{AC} = \begin{pmatrix} -7 \\ 3 \end{pmatrix}$.

(a) Find $\left|\overrightarrow{CA}\right|$.

$\overrightarrow{CA} = \begin{pmatrix} 7 \\ -3 \end{pmatrix}$

$\left|\overrightarrow{CA}\right| = \sqrt{7^2 + (-3)^2}$

$= 7.62$ (to 3 sf)

B1

Answer **(a)** ......7.62...... units [1]

(b) The point P lies on CA such that $\overrightarrow{PA} = k\,\overrightarrow{CA}$.

(i) Show that $\overrightarrow{OP} = \begin{pmatrix} 4-7k \\ 2+3k \end{pmatrix}$.

Answer **(b)(i)** [1]

$\overrightarrow{AP} = \overrightarrow{OP} - \overrightarrow{OA}$

$\overrightarrow{OP} = \overrightarrow{OA} + \overrightarrow{AP}$

$= \begin{pmatrix} 4 \\ 2 \end{pmatrix} + k\,\overrightarrow{AC}$

$= \begin{pmatrix} 4 \\ 2 \end{pmatrix} + k\begin{pmatrix} -7 \\ 3 \end{pmatrix}$ A1

$= \begin{pmatrix} 4-7k \\ 2+3k \end{pmatrix}$ (shown)

(ii) Given that point P lies on the y-axis, find the coordinates of P.

$4 - 7k = 0$

$k = \frac{4}{7}$ B1

$2 + 3\left(\frac{4}{7}\right) = 3\frac{5}{7}$

A1

Answer **(b)(ii)** $P($ ......0...... , ...$3\frac{5}{7}$...... $)$ [2]

18 Consider the number patterns in the table below. The first three terms of each column have been given.

Row, n	S	T	U
1	4	16	16
2	8	32	30
3	12	48	44
7	p	q	r
n			

(a) Find values of p, q and r.

(b) Write down the equation connecting S and T.

(c) Write down the equation connecting U and n.

(d) Betty said that 256 can be found in column U.
Write whether you agree or disagree with Betty. Give reason(s) for your answer.

(d) $14n + 2 = 256$

$$14n = 254$$

$$n = \frac{254}{14}$$

$$= 18\frac{1}{7}$$

B1
(All 3 must be correct)

Answer **(a)** $p =$ 28 , $q =$ 112 , $r =$ 100 [1]

(b) $T = 4S$ **B1** [1]

(c) $U = 14n + 2$ **B1** [1]

(d) I **disagree** with Betty. This is because

If $N = 256$, $n = 18\frac{1}{7}$ which is not a natural number.

(is not a positive integer). **B1**

OR

When 2 is deducted from 256, the result 254 is not divisible by 14.

(is not a multiple of 14). [1]

19 The frequency table shows the number of countries that a group of students had visited.

Number of countries	0	1	2	3	4
Number of students	2	8	6	x	4

(a) Given that the mode is 1, state the largest possible value of x.

(b) Given that the median number of countries visited is 2, find the largest possible value of x.

(c) Given that the mean number of countries is more than 2, find the smallest possible value of x.

(b)
$$\begin{aligned} 2+8+(6-1) &= x+4 \\ 15 &= x+4 \\ x &= 11 \end{aligned}$$

(c)
$$\text{Mean} = \frac{0(2)+1(8)+2(6)+3x+4(4)}{2+8+6+x+4} > 2$$

$$\frac{3x+36}{x+20} > 2 \qquad \textbf{M1}$$

$$3x+36 > 2(x+20)$$

$$3x+36 > 2x+40$$

$$x > 4$$

smallest $x = 5$

Answer **(a)** $x =$ 7 **B1** [1]

(b) $x =$ 11 **B1** [1]

(c) $x =$ 5 **B1** [2]

20 **(a)** The air resistance, R, is directly proportional to the square of the speed, V, of an object when it is falling. The air resistance is 24 newtons at a certain speed. Find the air resistance when the speed is increased by 50%.

(b) 48 men can build 2 huts in 60 hours. How many more men are needed if 3 huts are to be built in 72 hours?

(a) $R = kV^2$, k constant

$24 = kV^2 \Rightarrow k = \dfrac{24}{V^2}$ **M1**

$R_{new} = k(1.5V)^2$

$= \dfrac{24}{V^2} \times 2.25V^2$

$= 54$ newtons

(b) No. of men required to build 3 huts in 72 h

$= \dfrac{3}{2} \times \dfrac{60}{72} \times 48$

$= 60$

$\therefore$ Extra no. of men needed $= 60 - 48$

$= 12$

OR

48 men ---- 2 huts ---- 60 h

48 men ---- 1 hut ---- 30 h

1 man ---- 1 hut ---- 1440 h **M1**

1 man ---- 3 huts ---- 4320 h

60 men ---- 3 huts ---- 72 h

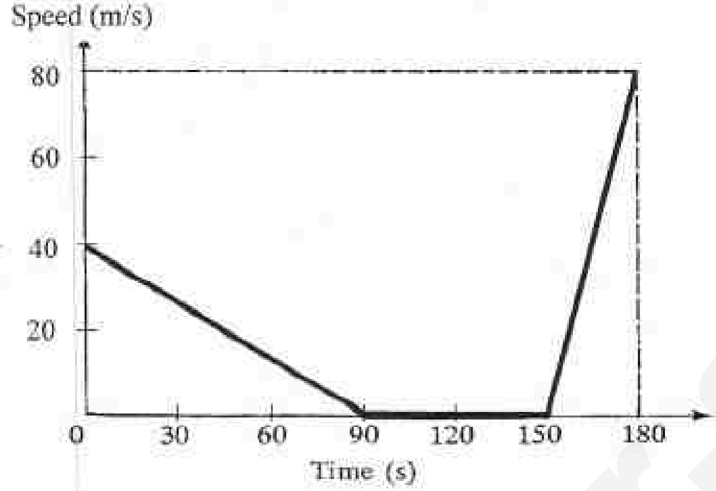
$\therefore$ Extra no. of men needed $= 60 - 48$

$= 12$

Answer **(a)** ....54........ newtons [2] **A1**

(b) ....12........ men [2] **A1**

21 The diagram below shows the speed-time graph of the journey for the first 3 minutes of a train. The train slows down to a stop when entering station *J*. After a brief stop of 60 seconds, it starts to move off with acceleration for 30 seconds before it gets out of station *J*.



(a) Find the deceleration of the train as it enters station *J*.

(b) Calculate

(i) the total distance travelled by the train in the first 3 minutes,

(ii) the average speed of the train, in km/h, in the first 3 minutes.

(a) Acceleration $= \frac{40-0}{0-90} = -\frac{4}{9}\text{m/s}^2$ $\quad\therefore$ Deceleration $= \frac{4}{9}$ m/s^2

(b) (i) Total distance $= \frac{1}{2}(90)(40)+\frac{1}{2}(30)(80)$

$= 1800 + 1200$

$= 3000$ m

(ii) Average speed $= \frac{3000\text{ m}}{3\text{ min}}$ M1

$= \frac{3\text{ km}}{\left(\frac{3}{60}\text{h}\right)}$

$= 60$ km/h

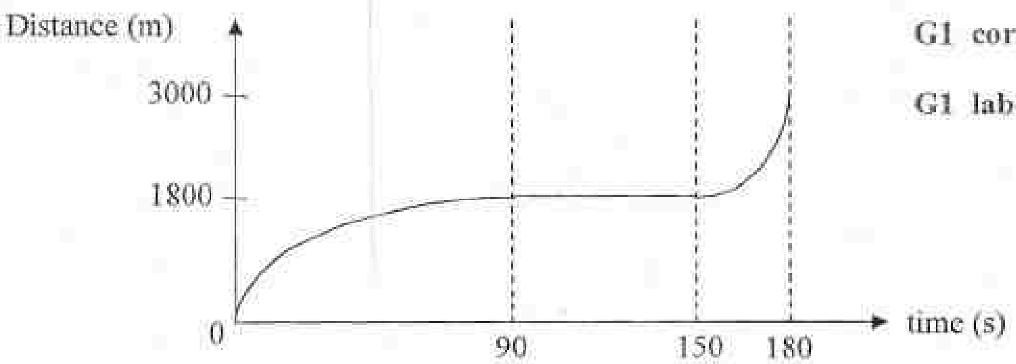
Answer **(a)** ....$\frac{4}{9}$........ B1 m/s^2 [1]

(b)(i) ....3000........ A1 m [1]

(ii) ....60........ A1 km/h [2]

(c) On the axes below, sketch the distance-time graph of the train for the first 3 minutes of its journey.

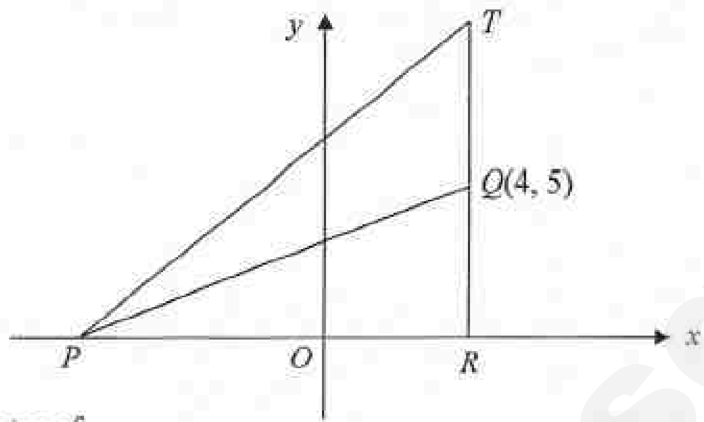
Answer **(c)** [2]



G1 correct shape

G1 label correct distance

22 P and R are points on the x-axis. TQR is a straight line parallel to the y-axis.
Area of $\Delta PQR = 30$ units^2.



(a) Find the coordinates of
 (i) point R,
 (ii) point P.

(b) Find the length of PQ.

(c) Find $\cos\angle PQT$, giving your answer as a fraction.

(d) Given that $PR = TR$, find the equation of PT.

(a)(i) $R\,(4, 0)$

(ii) $\frac{1}{2} \times PR \times 5 = 30$ M1

$PR = \frac{2 \times 30}{5} = 12$ units

$\therefore P\,(-8, 0)$

(b) $P\,(-8, 0)$ $Q\,(4, 5)$

$PQ = \sqrt{[4-(-8)]^2 + (5-0)^2}$

$= \sqrt{144 + 25}$

$= 13$ units

(c) $\cos\angle PQT = -\cos\angle PQR$

$= -\frac{5}{13}$

(d) $P\,(-8, 0)$ $T\,(4, 12)$

$m = \frac{12-0}{4-(-8)} = 1$

Equation of PT is

$y - 0 = 1\,[x - (-8)]$

$y = x + 8$

Answer **(a)(i)** R (......4...... , ...0......) [1] **B1**

(ii) P (......-8...... , ...0......) [2] **A1**

(b) ....13.......... units [1] **B1**

(c) ....$-\frac{5}{13}$.......... [1]

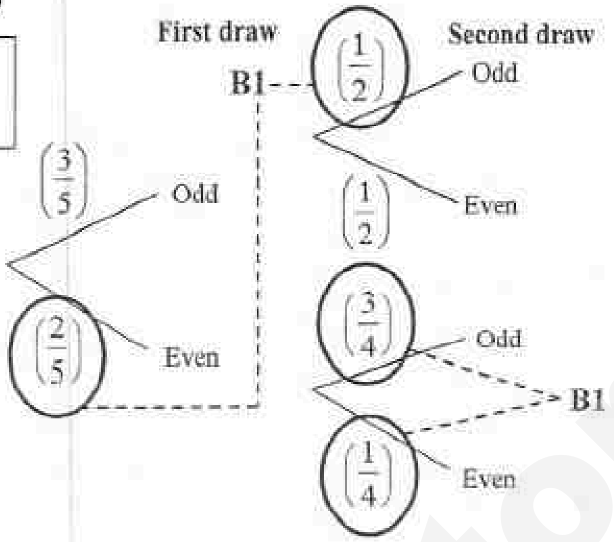
(d) ....$y = x + 8$.......... [1] **A1**

23 Five discs numbered 1, 3, 4, 6 and 7 are placed in a bag. A disc is drawn out of the bag at random. Without replacing the first disc into the bag, a second disc is drawn.

(a) Complete the following probability tree diagram.

Answer **(a)** [2]

1, 3, 4, 6, 7
3 odd nos. , 2 even nos.



(b) Find

(i) the probability that one disc is odd and the other is even,

(ii) the probability that both numbers drawn are smaller than 4.

(c) By drawing a possibility diagram in the space below, find the probability that the sum of both numbers is a prime number.

(b) (i) P(odd, even) + P(even, odd) $= \frac{3}{5}\times\frac{1}{2} + \frac{2}{5}\times\frac{3}{4}$ or $= 2\times\frac{3}{5}\times\frac{1}{2}$

$= \frac{3}{5}$

(ii) P(both nos. < 4) $= \frac{2}{5}\times\frac{1}{4}$

$= \frac{1}{10}$

(c)

B1

+	1	3	4	6	7
1		4	5	7	8
3	4		7	9	10
4	5	7		10	11
6	7	9	10		13
7	8	10	11	13	

P(sum = prime no.) $= \frac{10}{20}$

$= \frac{1}{2}$

Answer **(b)(i)** $\frac{3}{5}$ B1 [1]

(ii) $\frac{1}{10}$ B1 [1]

(c) $\frac{1}{2}$ B1 [2]

24 The diagram below shows a horizontal field ABC.
A is due north of B and C is due west of B.
Use a scale of 1 cm to 40 m, show all the constructions clearly.

(a) A lamp post, L, is located on a bearing of 290° from A, and 300 m from A.

(i) By construction, mark and label clearly the position of the lamp post L. [1]

(ii) Measure and write down the bearing of the lamp post L from point C.

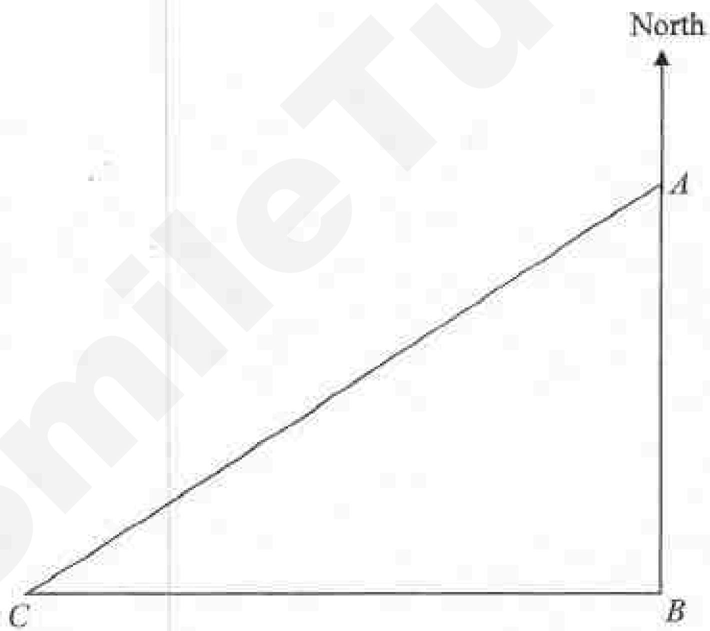
(b) A gate, G, is located along the path of BC, equidistant from B and C.
By construction, mark and label clearly the position of the gate G. [1]

(c) A circular flower bed is built such that it touches each side of the field at one point.

(i) By constructing two angle bisectors, draw the circular flower bed and label its centre O. [2]

(ii) Hence, measure and write down the actual radius of the flower bed.

Answer **(a)(i)**
(b)
(c)(i)



Answer **(a)(ii)** …………………. ° [1]

(c)(ii) …………………. m [1]

End of Paper 1

Answer **all** the questions.

1 **(a)** Given that $-8 \le x \le 4$ and $-3 \le y \le 2$, find

(i) the least value of xy, [1]

(ii) the greatest value of $x^2 - y^2$. [1]

(b) Express as a single fraction in its simplest form

(i) $\dfrac{x-y}{xy} + \dfrac{y-z}{yz}$, [2]

(ii) $\dfrac{2x^3}{x+y+z} \times \dfrac{(x+y)^2 - z^2}{6x}$. [2]

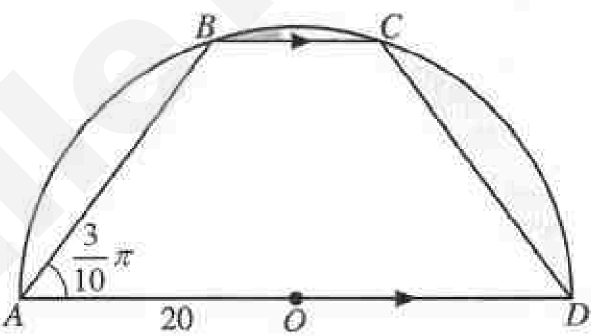
(c) It is given that $2pq = \sqrt{\dfrac{4q^2 + p^2}{2}}$.

Express q in terms of p. [3]

---

2 In the diagram, $OABCD$ is a semicircle with centre at O.

AD // BC, angle CDA = angle $BAD = \dfrac{3}{10}\pi$ radians and $OA = 20$ mm.



(a) Show that angle $BOA = \dfrac{2}{5}\pi$ rad. [1]

(b) Find the length of arc AB, leaving your answer in terms of π. [1]

(c) Find angle BOC. [1]

(d) Calculate the area of the shaded region. [3]

(e) Find angle BOA in degrees. [1]

(f) The unshaded region forms a company logo. An enlarged copy of the logo is made. In the enlargement, $AD = 60$ mm. Find the area of the enlarged logo. [2]

---

3 The cash price of a car is \$74 000. Mr Smith is introduced to two types of payment schemes.

	Scheme A	**Scheme B**
Down payment	40%	60%
Simple interest rate (per annum)	3.28%	R %
Loan period (years)	5	5

(a) Find the total amount that Mr Smith has to pay for the car, if he chose **Scheme A**. [2]

(b) If Mr Smith chose **Scheme B**, the monthly instalment he has to pay over 5 years is \$572.76. Calculate the value of R. [3]

(c) One day the exchange rate between US dollar (US\$) and Singapore dollars (S\$) was US\$1 = S\$1.27 .

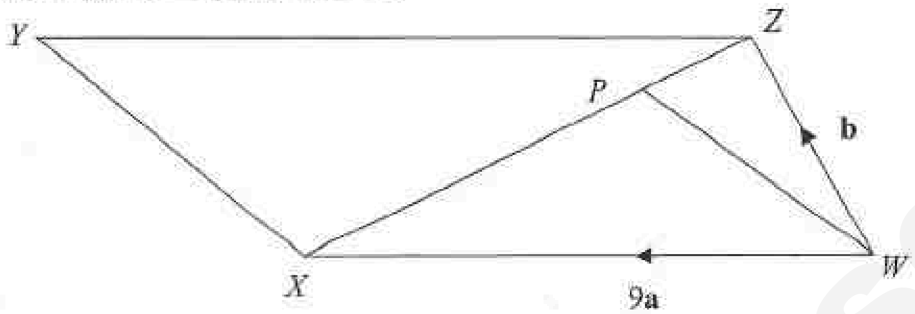
On the same day, the exchange rate between British pound (£) and US dollar was £1 = US\$1.33.

Calculate the cash price of the car in pounds, correct to the nearest pound. [2]

4 In the diagram, $WXYZ$ is a trapezium and WX is parallel to ZY.

The point P on XZ is such that $ZP : PX = 1 : 3$ and $WX : ZY = 3 : 4$.

It is given that $\overrightarrow{WX} = 9\mathbf{a}$ and $\overrightarrow{WZ} = \mathbf{b}$.



(a) Express, as simply as possible, in terms of **a** and **b**,

(i) $\overrightarrow{ZX}$, [1]

(ii) $\overrightarrow{WP}$, [1]

(iii) $\overrightarrow{YW}$. [1]

(b) Show that the line XY is parallel to the line WP. [2]

(c) Find, as a fraction in its simplest form,

(i) $\dfrac{\text{area of } \Delta WZP}{\text{area of } \Delta WXP}$, [1]

(ii) $\dfrac{\text{area of } \Delta WZP}{\text{area of } \Delta YXZ}$. [2]

5 **Answer the whole of this question on a sheet of graph paper.**

A group of friends founded a new social networking website. The table below shows the number of members at the beginning of each week over a period of 7 weeks.

Week (x)	0	1	2	3	4	5	6	7
Total number of members (y)	5	15	35	p	90	145	230	400

(a) Using a scale of 2 cm to 1 week, draw a horizontal x-axis for $0 \le x \le 7$. Using a scale of 2 cm to 50 members, draw a vertical y-axis for $0 \le y \le 400$. On your axes, plot the points given in the table and join them with a smooth curve. [3]

(b) Use your graph to estimate

(i) the value of p, [1]

(ii) the week that the total number of members reaches 300. [1]

(c) **(i)** By drawing a tangent, find the gradient of the curve at $x = 4$. [2]

(ii) What does this gradient represent? [2]

(d) The group of friends wish to estimate what the total number of members will be in one year's time. They propose to extend the graph line up to week, $x = 52$. Explain why is it not possible to estimate the total number of members in this way. [1]

6 The distance between two houses, P and Q, is 200 km. Joe travelled by car from P to Q at an average speed of x km/h.

(a) Write down an expression, in terms of x, for the number of hours he took to travel from P to Q. [1]

(b) He returned from Q to P at an average speed of which was 5 km/h more than the first journey.
Write down an expression, in terms of x, for the number of hours he took to travel from Q to P. [1]

(c) The difference between the two times was 24 minutes.
Write down an equation in x to represent this information, and show that it reduces to

$$x^2 + 5x - 2500 = 0.$$ [3]

(d) Solve the equation $x^2 + 5x - 2500 = 0$, giving each answer correct to three decimal places. [3]

(e) Calculate the time that Joe took to travel from P to Q, giving your answer in hours, minutes and seconds, correct to the nearest second. [2]

7 (a) Jim exercises on Monday and Wednesday.

On Monday, he jogs for 10 minutes, cycles for 20 minutes and swims for 30 minutes.

On Wednesday, he jogs for 20 minutes, cycles for 10 minutes and swims for 15 minutes.

This information can be represented by the matrix $\mathbf{Q} = \begin{array}{c} \begin{array}{ccc} J & C & S \end{array} \\ \begin{pmatrix} 10 & 20 & 30 \\ 20 & 10 & 15 \end{pmatrix} \end{array} \begin{array}{l} \text{Mon} \\ \text{Wed} \end{array}$.

(i) Evaluate the matrix $\mathbf{P} = 60\mathbf{Q}$. [1]

(ii) Jim's exercising speeds are the same for Monday and Wednesday.

His jogging speed is 4 m/s, cycling speed is 5.5 m/s and swimming speed is 1.3 m/s.

Represent his exercising speeds in a 3×1 column matrix **S**. [1]

(iii) Evaluate the matrix $\mathbf{R} = \mathbf{PS}$. [2]

(iv) State what the elements of **R** represent. [1]

(b) The cost of a shirt is $\$C$. If the shirt is sold at \$60, a shop makes a profit of $x\%$ on the cost price.

(i) Write down an equation in C and x to represent this information and show that it simplifies to

$$6000 - 100C = Cx.$$ [1]

If the shirt is sold at \$24, the shop makes a loss of $2x\%$ on the cost price.

(ii) Write down an equation in C and x to represent this information. [1]

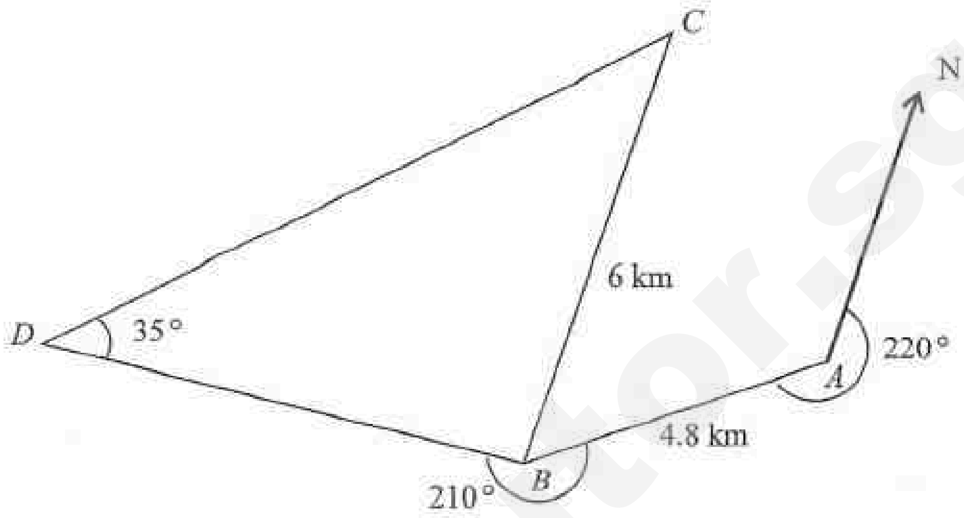
(iii) Solve these two equations to find the value of C and the value of x. [3]

(iv) Calculate the selling price of the shirt if the profit is 45% of the cost price. [2]

8 The diagram shows a triangular park BCD and the route that Ali has cycled.

Ali cycles from his home, A, on a bearing of $220°$ towards point B of the park. The distance from A to B is 4.8 km. From B, he cycles to C, which is 6 km away, and he continues to D.

C is due north of B. Reflex angle $ABD = 210°$ and angle $BDC = 35°$.



(a) Show that ΔBCD is an isosceles triangle. [1]

(b) Calculate the

(i) distance of AC, [3]

(ii) area of the park BCD, [2]

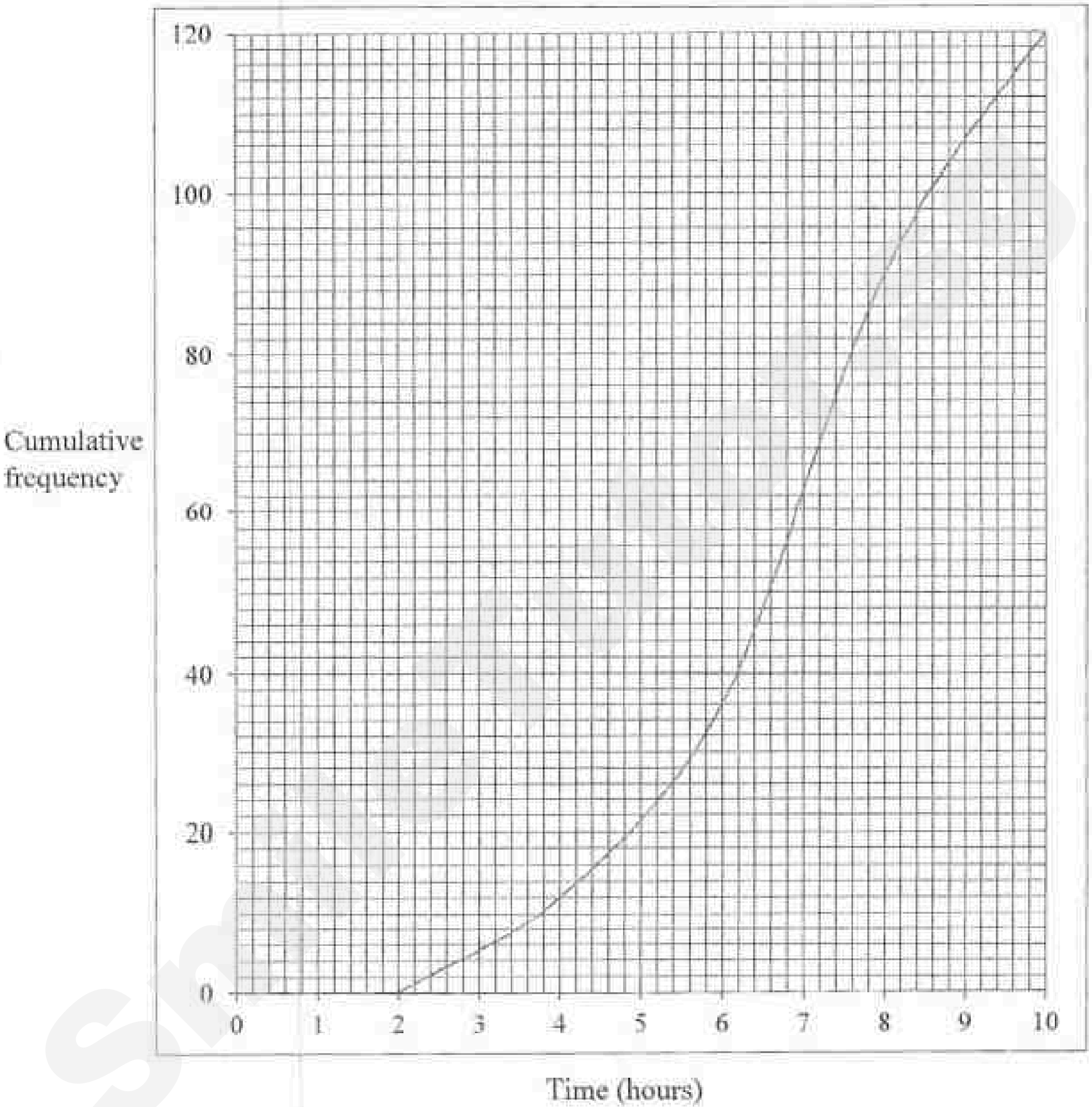
(iii) angle BAC, [2]

(iv) shortest distance from B to CD. [2]

(c) A building stands vertically at B. The angle of depression of C when viewed from the top of the building is $40°$. Find the height of the building. [2]

9 120 visitors took a survey on the number of hours they spent at the Gardens by the Bay in February 2016.

The cumulative frequency curve below shows the distribution of the time spent.



(a) Use the curve to estimate

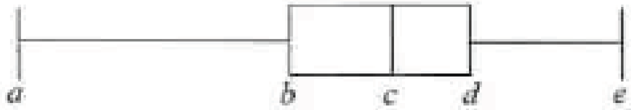
(i) the median time, [1]

(ii) the interquartile range of the times, [2]

(iii) the percentage of visitors who spent at least 4 hours at the Gardens by the Bay. [2]

(b) It was discovered that the number of hours has been recorded incorrectly. The correct number of hours was all 1 hour less than those recorded.

The box-and-whisker plot shows the correct distribution of hours.



Find the value of

(i) c, [1]

(ii) $e - a$. [1]

(c) The table below shows the results of the survey conducted on another 120 visitors on the number of hours they spent at the Gardens by the Bay in June 2016.

Number of hours spent (x h)	Number of visitors
$2 < x \le 4$	33
$4 < x \le 6$	46
$6 < x \le 8$	30
$8 < x \le 10$	11

Calculate an estimate of the

(i) mean time that the visitors spent in June, [1]

(ii) standard deviation. [2]

(d) The programme management team at the Gardens by the Bay commented that the visitors generally spent longer hours in February 2016 than in June 2016. Justify if the comment is valid. [2]

10 A solid cone is cut into 2 parts, X and Y, by a plane parallel to the base.
The length of AB = the length of BC.

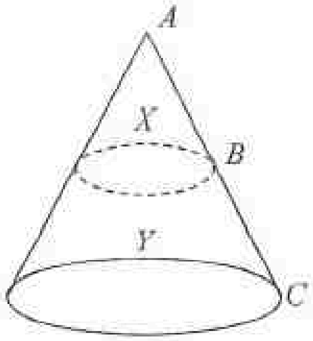


Diagram I

(a) Given that the volume of the solid cone is $\frac{64}{3}\pi$ m^3, find the volume, in terms of π, of the frustum, Y. [3]

(b) In **Diagram II**, a rocket can be modelled from a cylinder of height, h, 94.2 m with a cone, X, on top and a frustum, Y, at the bottom. The cone, X, has a diameter, d_2, of 4 m and the frustum, Y, has a base diameter, d_1, of 8 m. The parts X and Y are taken from **Diagram I** above.

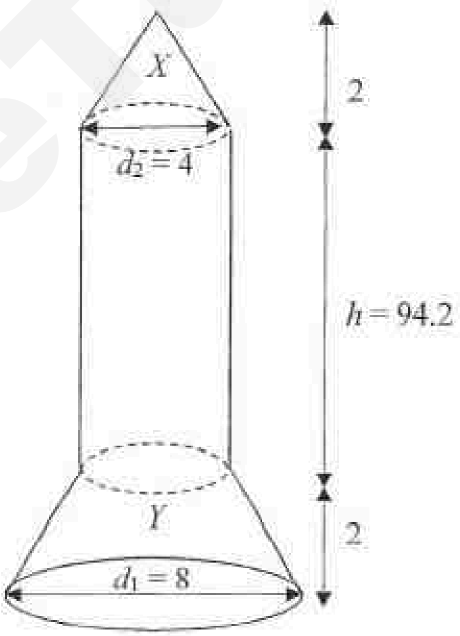


Diagram II

(i) Calculate the total surface area of the rocket. Give your answer correct to the nearest square meter. [3]

(ii) Calculate the volume, in cubic metres, of the rocket. [1]

(iii) The rocket is designed to launch to the moon.

Useful information
• Distance of moon from earth: 384 400 km • Speed of rocket: 800 km /minute • $1\text{ m}^3 = 264$ gallon • The rocket is filled with liquid fuel to a maximum of 95% of its volume. • Rate of fuel consumption: 20 000 gallons /minute • Capacity of each external fuel tank: 3.2×10^6 gallons

How many external fuel tanks will the rocket require to sustain its journey to the moon?

Justify your answer with calculations. [4]

Class | Index Number

Name : ______________________________

METHODIST GIRLS' SCHOOL

Founded in 1887

PRELIMINARY EXAMINATION 2016
Secondary 4

Tuesday
16 August 2016

MATHEMATICS
Paper 2

4048/02
2 h 30 mins

INSTRUCTIONS TO CANDIDATES

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

Answer **all** questions.

If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to 3 significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

INFORMATION FOR CANDIDATES

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 100.

Mathematical Formulae

Compound interest

$$\text{Total amount} = P\left(1+\frac{r}{100}\right)^n$$

Mensuration

$$\text{Curved surface area of a cone} = \pi rl$$

$$\text{Surface area of a sphere} = 4\pi r^2$$

$$\text{Volume of a cone} = \frac{1}{3}\pi r^2 h$$

$$\text{Volume of a sphere} = \frac{4}{3}\pi r^3$$

$$\text{Area of triangle } ABC = \frac{1}{2}ab\sin C$$

$$\text{Arc length} = r\theta, \text{ where } \theta \text{ is in radians}$$

$$\text{Sector area} = \frac{1}{2}r^2\theta, \text{ where } \theta \text{ is in radians}$$

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

Statistics

$$\text{Mean} = \frac{\sum fx}{\sum f}$$

$$\text{Standard deviation} = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2}$$

Answer **all** the questions.

1	(a)	Given that $-8 \le x \le 4$ and $-3 \le y \le 2$, find		
		(i)	the least value of xy, **Least value of $xy = (-8)(2) = -16$ ---- B1**	[1]
		(ii)	the greatest value of $x^2 - y^2$. **Greatest value of $x^2 - y^2 = (-8)^2 - 0 = 64$ ---- B1**	[1]
	(b)	Express as a single fraction in its simplest form		
		(i)	$\frac{x-y}{xy} + \frac{y-z}{yz}$, $\frac{xz - yz + xy - xz}{xyz}$ ------ M1 $= \frac{xy - yz}{xyz}$ $= \frac{y(x-z)}{xyz}$ $= \frac{x-z}{xz}$ ----- A1	[2]
		(ii)	$\frac{2x^3}{x+y+z} \times \frac{(x+y)^2 - z^2}{6x}$. $\frac{2x^3}{x+y+z} \times \frac{(x+y-z)(x+y+z)}{6x}$ ------ M1 $= \frac{x^2(x+y-z)}{3}$ ---- A1	[2]
	(c)	It is given that $2pq = \sqrt{\frac{4q^2 + p^2}{2}}$. Express q in terms of p.		[3]

$$2pq = \sqrt{\frac{4q^2 + p^2}{2}}$$

$$4p^2q^2 = \frac{4q^2 + p^2}{2} \quad \text{----- M1}$$

$$8p^2q^2 = 4q^2 + p^2$$

$$8p^2q^2 - 4q^2 = p^2$$

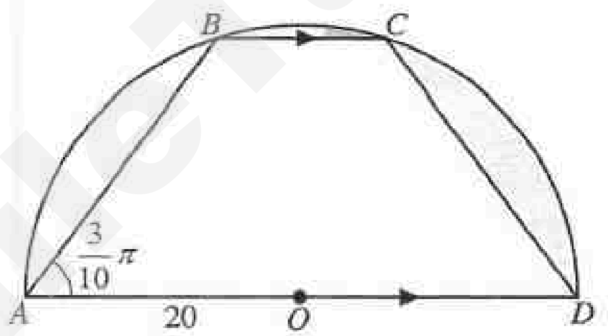
$$q^2\left(8p^2 - 4\right) = p^2 \quad \text{----- M1}$$

$$q^2 = \frac{p^2}{\left(8p^2 - 4\right)}$$

$$q = \pm\sqrt{\frac{p^2}{4\left(2p^2 - 1\right)}} \quad \text{---- A1} \quad \text{or} \quad q = \pm\frac{p}{2\sqrt{2p^2 - 1}} \quad \text{or} \quad q = \pm\sqrt{\frac{p^2}{8p^2 - 4}}$$

2 In the diagram, $OABCD$ is a semicircle with centre at O.

$AD \parallel BC$, angle CDA = angle $BAD = \frac{3}{10}\pi$ radians and $OA = 20$ mm.



(a) Show that angle $BOA = \frac{2}{5}\pi$ rad. [1]

ΔBOA is an isosceles triangle

$$\angle BOA = \pi - 2\left(\frac{3\pi}{10}\right) \quad \text{----- B1}$$

$$= \frac{2\pi}{5} \text{ rad}$$

(b) Find the length of arc AB, leaving your answer in terms of π. [1]

$$\text{arc length } AB = (20)\left(\frac{2\pi}{5}\right)$$

$$= 8\pi \text{ mm ----- B1}$$

(c) Find angle BOC. [1]

		$\angle BOC = \pi - 2\left(\frac{2\pi}{5}\right)$ (adj $\angle$s on a st line) $= \frac{\pi}{5}$ rad ----- B1 (or 0.628 rad (3 s.f.) or 36°)	
	(d)	Calculate the area of the shaded region. $\angle BOD = \pi - \frac{2\pi}{5}$ $= \frac{3\pi}{5}$ rad area of sector $BOD = \frac{1}{2}(20)^2\left(\frac{3\pi}{5}\right)$ ----- M1 $= 120\pi$ mm^2 area of ΔBOD and $\Delta COD = \frac{1}{2}(20)^2\left(\sin\frac{\pi}{5} + \sin\frac{2\pi}{5}\right)$ ----- M1 shaded area $= 120\pi - 200\left(\sin\frac{\pi}{5} + \sin\frac{2\pi}{5}\right)$ $= 69.2$ mm^2 (3 s.f.) ----- A1 OR shaded area $= \frac{1}{2}(20)^2\left(\frac{\pi}{5} - \sin\frac{\pi}{5}\right) + \frac{1}{2}(20)^2\left(\frac{2\pi}{5} - \sin\frac{2\pi}{5}\right)$ ----- M1+M1 $= 69.2$ mm^2 (3 s.f.) ----- A1	[3]
	(e)	Find angle BOA in degrees. $\angle BOA = \frac{2\pi}{5}$ $= 72°$ ----- B1	[1]
	(f)	The unshaded region forms a company logo. An enlarged copy of the logo is made. In the enlargement, $AD = 60$ mm. Find the area of the enlarged logo.	[2]

unshaded area $= \frac{1}{2}\pi(20)^2 - 69.22276$ ----- M1

$= 559.0957 \text{ mm}^2$

$\left(\frac{AD}{AO}\right)^2 = \frac{\text{area of enlarged logo}}{559.0957}$

$\left(\frac{60}{40}\right)^2 = \frac{\text{area of enlarged logo}}{559.0957}$

$\frac{9}{4} = \frac{\text{area of enlarged logo}}{559.0957}$

area of enlarged logo $= \frac{9}{4} \times 559.0957$

$= 1260 \text{ mm}^2$ (3 s.f.) ----- A1

or by using enlarged radius = 30

3 The cash price of a car is \$74 000. Mr Smith is introduced to two types of payment schemes.

	Scheme *A*	**Scheme *B***
Down payment	40%	60%
Simple interest rate (per annum)	3.28%	*R* %
Loan period (years)	5	5

(a) Find the total amount that Mr Smith has to pay for the car, if he chose **Scheme *A***. [2]

Amount loaned $= 0.6 \times 74000$

$= \$44400$

Simple interest $= 44400 \times \frac{3.28}{100} \times 5$ ----- M1

$= \$7281.60$

Total amount $= 7281.60 + 74000$

$= \$81281.60$ ----- A1

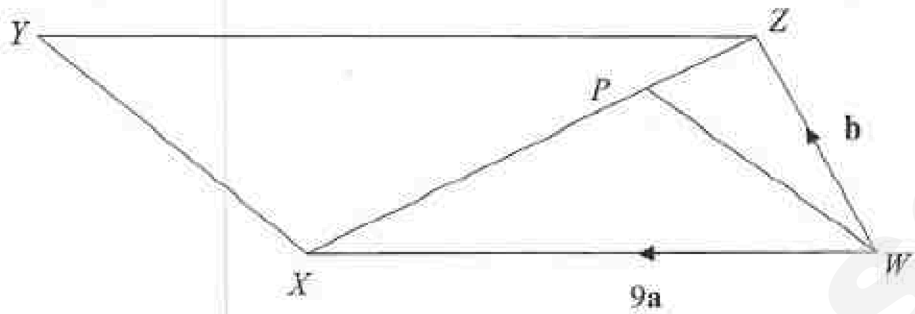
(b) If Mr Smith chose **Scheme *B***, the monthly instalment he has to pay over 5 years is \$572.76. Calculate the value of *R*. [3]

		Amount loaned $= 0.4 \times 74000$ $= \$29600$ $572.76 \times 12 \times 5 = 29600 + 29600 \times \frac{R}{100} \times 5$ M1- instalments paid (LHS) + M1- simple interest (RHS) $R = 3.22$ ----- A1	
	(c)	One day the exchange rate between US dollar (US\$) and Singapore dollars (S\$) was US\$1 = S\$1.27 . On the same day, the exchange rate between British pound (£) and US dollar was £1 = US\$1.33. Calculate the cash price of the car in pounds, correct to the nearest pound. Amount in US\$ $= 74000 \div 1.27$ ------- M1 here $= US\$58267.71654$ Amount in pounds $= 58267.71654 \div 1.33$ ----- or M1 here $= £43810$ (to nearest pound) ----- A1 *or* $£1 = US\$1.33 \times 1.27$ ----- M1 $= US\$1.6891$ cost of car in pounds $= \frac{74000}{1.6891}$ $= £43810$ (to nearest pound)	[2]

4 In the diagram, $WXYZ$ is a trapezium and WX is parallel to ZY.

The point P on XZ is such that $ZP : PX = 1 : 3$ and $WX : ZY = 3 : 4$.

It is given that $\overrightarrow{WX} = 9\mathbf{a}$ and $\overrightarrow{WZ} = \mathbf{b}$.



(a) Express, as simply as possible, in terms of **a** and **b**,

(i) $\overrightarrow{ZX}$, [1]

$\overrightarrow{ZX} = -\mathbf{b} + 9\mathbf{a}$ ---- **B1**

(ii) $\overrightarrow{WP}$, [1]

$\overrightarrow{WP} = \mathbf{b} + \overrightarrow{ZP}$

$= \mathbf{b} + \frac{1}{4}(-\mathbf{b} + 9\mathbf{a})$

$= \frac{3}{4}(\mathbf{b} + 3\mathbf{a})$ ---- **B1**

(iii) $\overrightarrow{YW}$. [1]

$\overrightarrow{WY} = \mathbf{b} + \overrightarrow{ZY}$

$= \mathbf{b} + \frac{4}{3}(9\mathbf{a})$

$= \mathbf{b} + 12\mathbf{a}$

$\overrightarrow{YW} = -\mathbf{b} - 12\mathbf{a}$ ---- **B1**

or

$\overrightarrow{YW} = \overrightarrow{YZ} - \mathbf{b}$

$= -\mathbf{b} - 12\mathbf{a}$

(b) Show that the line XY is parallel to the line WP. [2]

$\overrightarrow{XY} = \overrightarrow{XW} + \overrightarrow{WY}$

$= -9\mathbf{a} + 12\mathbf{a} + \mathbf{b}$

$= 3\mathbf{a} + \mathbf{b}$ ------ M1

$\overrightarrow{WP} = \frac{9}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}$

$= \frac{3}{4}(3\mathbf{a} + \mathbf{b})$

Since $\overrightarrow{WP} = \frac{3}{4}\overrightarrow{XY}$ ------ A1

XY is parallel to WP.

(c) Find, as a fraction in its simplest form,

(i) $\dfrac{\text{area of } \Delta WZP}{\text{area of } \Delta WXP}$, [1]

$= \frac{1}{3}$

(ii) $\dfrac{\text{area of } \Delta WZP}{\text{area of } \Delta YXZ}$. [2]

WZP	:	WXZ	:	YXZ
1	:	4		
		3	:	4
3	:	12	:	16

------ M1

$\dfrac{\text{area of } \Delta WZP}{\text{area of } \Delta YXZ} = \dfrac{3}{16}$ ------ A1

Or

$\dfrac{\text{area of } \Delta WZP}{\text{area of } \Delta YXZ} = \dfrac{1}{4} \times \dfrac{3}{4} = \dfrac{3}{6}$

5 **Answer the whole of this question on a sheet of graph paper.**

A group of friends founded a new social networking website. The table below shows the number of members at the beginning of each week over a period of 7 weeks.

Week (x)	0	1	2	3	4	5	6	7
Total number of members (y)	5	15	35	p	90	145	230	400

(a) Using a scale of 2 cm to 1 week, draw a horizontal x-axis for $0 \leq x \leq 7$. Using a scale of 2 cm to 50 members, draw a vertical y-axis for $0 \leq y \leq 400$. On your axes, plot the points given in the table and join them with a smooth curve. [3]

(b) Use your graph to estimate

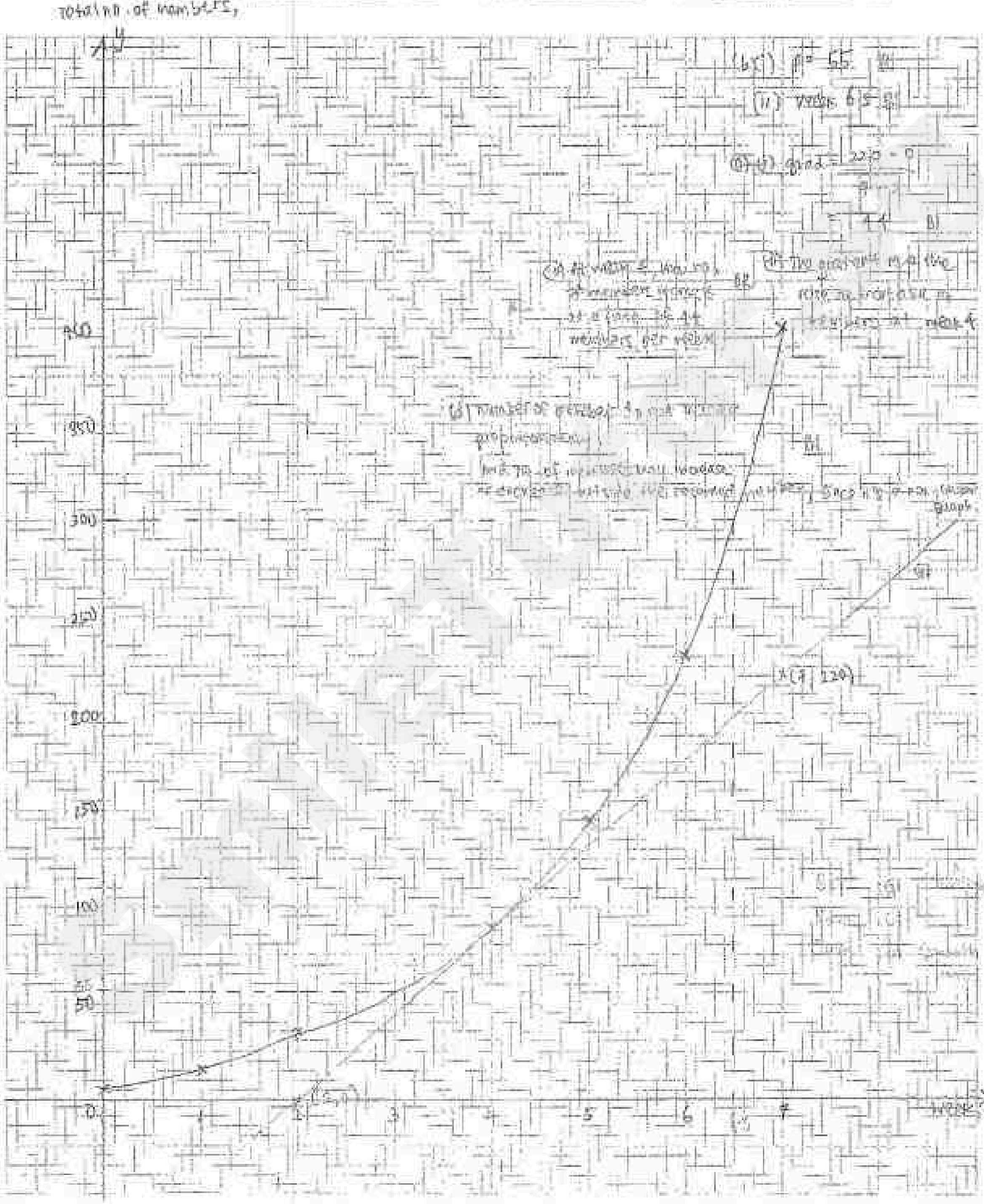
(i) the value of p, [1]

(ii) the week that the total number of members reaches 300. [1]

(c) **(i)** By drawing a tangent, find the gradient of the curve at $x = 4$. [2]

(ii) What does this gradient represent? [2]

(d) The group of friends wish to estimate what the total number of members will be in one year's time. They propose to extend the graph line up to week, $x = 52$. Explain why is it not possible to estimate the total number of members in this way. [1]


total no. of members, y
(b)(i) p = 55
(ii) week 6.5
x (7, 220)
(2, 0)
week x
0
1
2
3
4
5
6
7
50
100
150
200
250
300
350
400

6	The distance between two houses, P and Q, is 200 km. Joe travelled by car from P to Q at an average speed of x km/h.		
	(a)	Write down an expression, in terms of x, for the number of hours he took to travel from P to Q. time $= \frac{200}{x} h$	[1]
	(b)	He returned from Q to P at an average speed of which was 5 km/h more than the first journey. Write down an expression, in terms of x, for the number of hours he took to travel from Q to P. time $= \frac{200}{x+5} h$	[1]
	(c)	The difference between the two times was 24 minutes. Write down an equation in x to represent this information, and show that it reduces to $x^2+5x-2500=0$. $\frac{200}{x}-\frac{200}{x+5}=\frac{24}{60}$ ----- M1 $200(x+5)-200x=\frac{2}{5}(x)(x+5)$ ----- M1 $1000(x+5)-1000x=2x^2+10x$ $1000x+5000-1000x=2x^2+10x$ $2x^2+10x-5000=0$ ----- M1 $x^2+5x-2500=0$	[3]
	(d)	Solve the equation $x^2+5x-2500=0$, giving each answer correct to three decimal places. $x=\frac{-5\pm\sqrt{5^2-4(1)(-2500)}}{2(1)}$ ----- M1 $=47.562$ or -52.562 ----- A1 +A1	[3]
	(e)	Calculate the time that Joe took to travel from P to Q, giving your answer in hours, minutes and seconds, correct to the nearest second. time $=\frac{200}{47.562}=$ 4h 12min 18sec (nearest sec) ---- M1 + A1	[2]

7	(a)	Jim exercises on Monday and Wednesday. On Monday, he jogs for 10 minutes, cycles for 20 minutes and swims for 30 minutes. On Wednesday, he jogs for 20 minutes, cycles for 10 minutes and swims for 15 minutes. This information can be represented by the matrix $\mathbf{Q} = \begin{array}{cc} \begin{array}{ccc} J & C & S \end{array} & \\ \begin{pmatrix} 10 & 20 & 30 \\ 20 & 10 & 15 \end{pmatrix} & \begin{array}{l} \text{Mon} \\ \text{Wed} \end{array} \end{array}$.		
		(i)	Evaluate the matrix $\mathbf{P} = 60\mathbf{Q}$. $P = 60\begin{pmatrix} 10 & 20 & 30 \\ 20 & 10 & 15 \end{pmatrix}$ $= \begin{pmatrix} 600 & 1200 & 1800 \\ 1200 & 600 & 900 \end{pmatrix}$ **B1**	[1]
		(ii)	Jim's exercising speeds are the same for Monday and Wednesday. His jogging speed is 4 m/s, cycling speed is 5.5 m/s and swimming speed is 1.3 m/s. Represent his exercising speeds in a 3×1 column matrix **S**. $\mathbf{S} = \begin{pmatrix} 4 \\ 5.5 \\ 1.3 \end{pmatrix}$ **B1**	[1]
		(iii)	Evaluate the matrix $\mathbf{R} = \mathbf{PS}$. $\mathbf{R} = \begin{pmatrix} 600 & 1200 & 1800 \\ 1200 & 600 & 900 \end{pmatrix}\begin{pmatrix} 4 \\ 5.5 \\ 1.3 \end{pmatrix}$ **M1** $= \begin{pmatrix} 11340 \\ 9270 \end{pmatrix}$ **A1**	[2]
		(iv)	State what the elements of **R** represent. The elements of **R** represent the distance, in metres, that Jim has exercised on Monday and Wednesday, respectively. **A1**	[1]

(b) The cost of a shirt is \$$C$. If the shirt is sold at \$60, a shop makes a profit of x% on the cost price.

(i) Write down an equation in C and x to represent this information and show that it simplifies to

$$6000-100C=Cx.$$

[1]

Percentage profit $= x$ %

$$\left.\begin{aligned}&\frac{60-C}{C}\times 100=x\\&100(60-C)=Cx\end{aligned}\right\}\text{ M1}$$

$6000-100C=Cx$ (shown)

If the shirt is sold at \$24, the shop makes a loss of $2x$ % on the cost price.

(ii) Write down an equation in C and x to represent this information. [1]

$$2x=\frac{C-24}{C}\times 100$$

$$2x=\frac{100C-2400}{C}$$

$100C-2400=2Cx$ A1

(iii) Solve these two equations to find the value of C and the value of x. [3]

$6000-100C=Cx$ --- (1)

$100C-2400=2Cx$ --- (2)

(1) × 2 − (2),

$$\left.\begin{aligned}&(12000-200C)-(100C-2400)=0\\&1400=300C\end{aligned}\right\}\text{ M1}$$

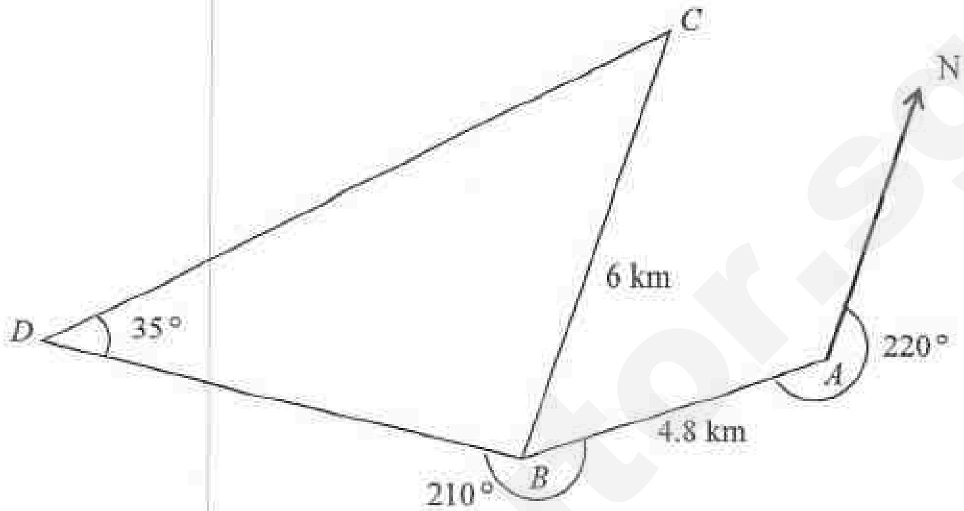
$C=48$

$x=25$ A1+A1

(iv) Calculate the selling price of the shirt if the profit is 45% of the cost price. [2]

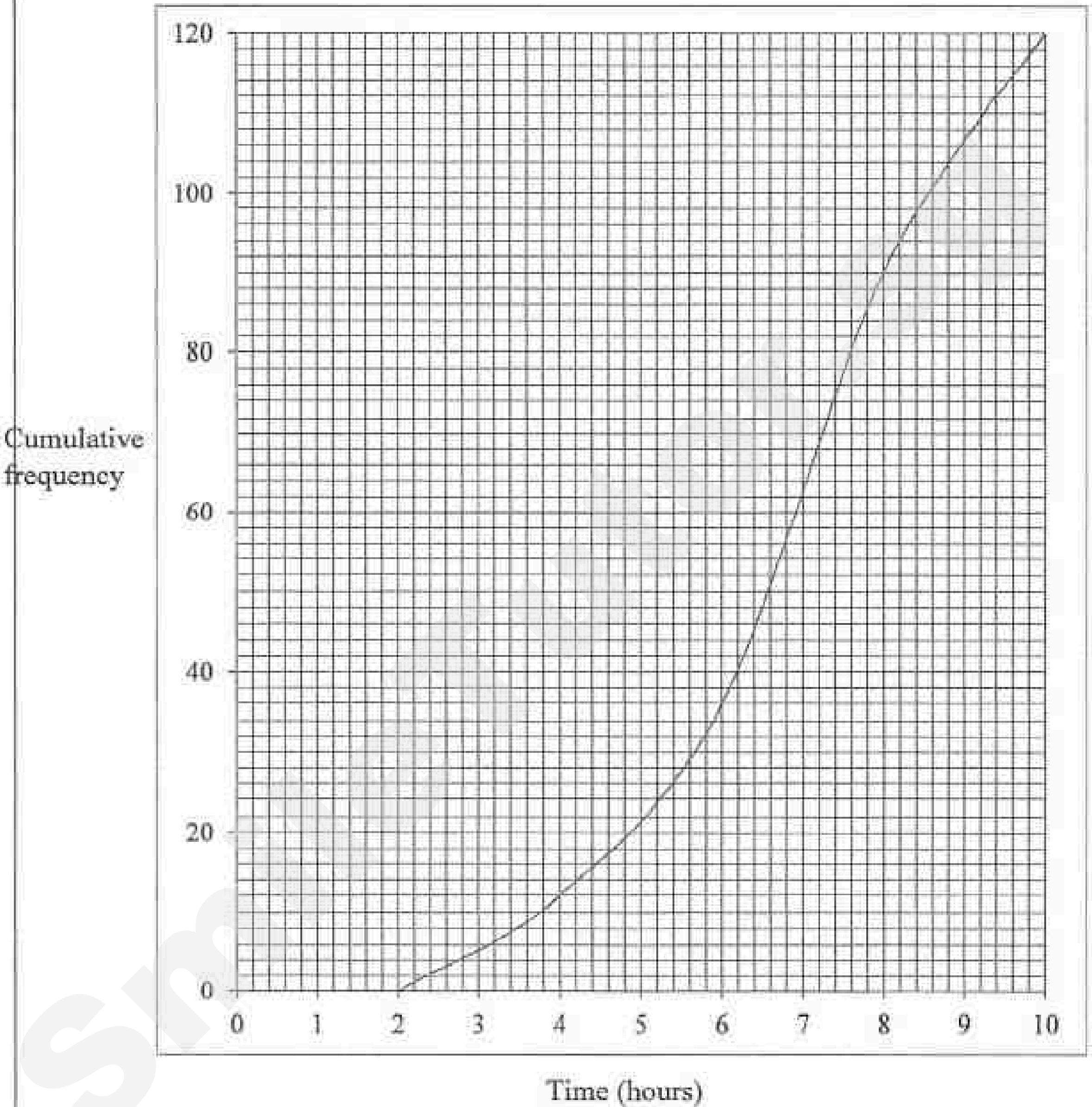
Selling price $=1.45\times 48$ M1

$=\$69.60$ A1

8	The diagram shows a triangular park BCD and the route that Ali has cycled. Ali cycles from his home, A, on a bearing of $220°$ towards point B of the park. The distance from A to B is 4.8 km. From B, he cycles to C, which is 6 km away, and he continues to D. C is due north of B. Reflex angle $ABD = 210°$ and angle $BDC = 35°$.  			
	(a)	Show that ΔBCD is an isosceles triangle. $\angle CBA = 180° - (360° - 220°)$ (int $\angle$s, $\angle$s at a point) $= 40°$ $\angle DBC = 360° - 210° - 40°$ ($\angle$s at a point) $= 110°$ $\angle DCB = 180° - 35° - 110°$ ($\angle$ sum of Δ) $= 35°$ Since $\angle DCB = \angle CDB = 35°$, ΔBCD is an isosceles triangle. B1		[1]
	(b)	Calculate the		
		(i)	distance of AC, $AC^2 = 6^2 + 4.8^2 - 2(6)(4.8)\cos 40°$ M2, 1 $AC = \sqrt{14.91584008}$ $= 3.86\ \text{km}^2$ (to 3 sf) A1	[3]
		(ii)	area of the park BCD. Area of $\Delta BCD = \frac{1}{2}(6)(6)\sin 110°$ M1 $= 16.9\ \text{km}^2$ (to 3 sf) A1	[2]
		(iii)	angle BAC,	[2]

			$\frac{\sin\angle BAC}{6}=\frac{\sin 40°}{3.862103}$ M1 $\angle BAC=\sin^{-1}\left(\frac{\sin 40°}{3.862103}\times 6\right)$ $=87.0°$ (to 1 dp) A1	
		(iv)	shortest distance from B to CD. Shortest distance $=60\times\sin 35°$ M1 $=3.44$ km (to 3 sf) A1	[2]
	(c)	A building stands vertically at B. The angle of depression of C when viewed from the top of the building is $40°$. Find the height of the building. Height of the building $=6\times\tan 40°$ M1 $=5.03$ km (to 3 sf) A1		[2]

9	120 visitors took a survey on the number of hours they spent at the Gardens by the Bay in February 2016. The cumulative frequency curve below shows the distribution of the time spent.			



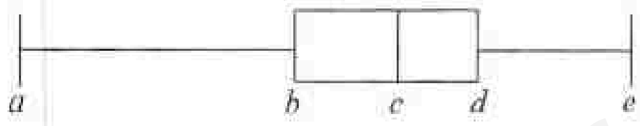
	(a)	Use the curve to estimate		
		(i)	the median time, **median = 6.9 hours B1**	[1]
		(ii)	the interquartile range of the times, **IQR = 8 − 5.7 M1** **= 2.3 hours A1**	[2]
		(iii)	the percentage of visitors who spent at least 4 hours at the Gardens by the Bay.	[2]

$percentage = \frac{120-12}{120} \times 100\%$ M1

$= 90\%$ A1

(b) It was discovered that the number of hours has been recorded incorrectly. The correct number of hours was all 1 hour less than those recorded.

The box-and-whisker plot shows the correct distribution of hours.



Find the value of

(i) c, [1]

$c = 5.9$ **hours B1**

(ii) $e - a$. [1]

$e - a = 8$ **hours B1**

(c) The table below shows the results of the survey conducted on another 120 visitors on the number of hours they spent at the Gardens by the Bay in June 2016.

Number of hours spent (x h)	Number of visitors
$2 < x \le 4$	33
$4 < x \le 6$	46
$6 < x \le 8$	30
$8 < x \le 10$	11

Calculate an estimate of the

(i) mean time that the visitors spent in June, [1]

$mean = \frac{3\times 33 + 5\times 46 + 7\times 30 + 9\times 11}{120}$

$= 5.32$ hours (to 3 sf) B1

(ii) standard deviation. [2]

standard deviation $= 1.86$ hours (to 3 sf) B2 or M1+A1

	(d)	The programme management team at the Gardens by the Bay commented that the visitors generally spent longer hours in February 2016 than in June 2016. Justify if the comment is valid. Median in June is $4 < x \leq 6$. M1 The comment is invalid as median is in February (5.9 hours) is within the median class in June ($4 < x \leq 6$). A1	[2]

10 A solid cone is cut into 2 parts, X and Y, by a plane parallel to the base.

The length of AB = the length of BC.

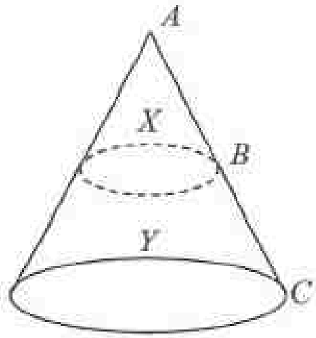


Diagram I

(a) Given that the volume of the solid cone is $\frac{64}{3}\pi$ m^3, find the volume, in terms of π, of the frustum, Y. [3]

$$\left(\frac{\text{length of } AB}{\text{length of BC}}\right)^2 = \frac{\text{vol of } X}{\text{vol of } X+Y}$$

$$\left(\frac{1}{2}\right)^2 = \frac{\text{vol of } X}{\frac{64}{3}} \quad \text{M1}$$

$$\text{Vol of } X = \frac{8\pi}{3}$$

$$\text{Vol of } Y = \frac{64\pi}{3} - \frac{8\pi}{3} \quad \text{M1}$$

$$= \frac{56}{3}\pi \text{ m}^3 \quad \text{A1}$$

(b) In **Diagram II**, a rocket can be modelled from a cylinder of height, h, 94.2 m with a cone, X, on top and a frustum, Y, at the bottom. The cone, X, has a diameter, d_2, of 4 m and the frustum, Y, has a base diameter, d_1, of 8 m. The parts X and Y are taken from **Diagram I** above.

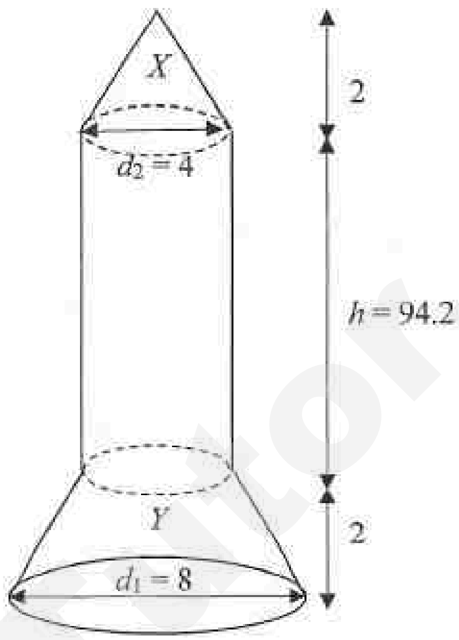


Diagram II

(i) Calculate the total surface area of the rocket. Give your answer correct to the nearest square meter. [3]

total surface area $= \pi(4)(\sqrt{4^2+4^2}) + 2\pi(2)(94.2) + \pi(4)^2$ M2

$=1305.1037...$

$=1305\text{ m}^2$ (to nearest square metre) A1

(ii) Calculate the volume, in cubic metres, of the rocket. [1]

$\text{vol} = \frac{1}{3}\pi(4)^2(4) + \pi(2)^2(94.2)$

$=1250.7727...$

$=1250\text{ m}^3$ (to 3 sf) A1

(iii) The rocket is designed to launch to the moon.

Useful information

- Distance of moon from earth: 384 400 km
- Speed of rocket: 800 km /minute
- $1\ m^3 = 264$ gallon
- The rocket is filled with liquid fuel to a maximum of 95% of its volume.
- Rate of fuel consumption: 20 000 gallons /minute
- Capacity of each external fuel tank: 3.2×10^6 gallons

How many external fuel tanks will the rocket require to sustain its journey to the moon?

Justify your answer with calculations. [4]

Amount of fuel in rocket
$= 0.95 \times 1250.7727$
$= 1188.234\ m^3$

Gallons of fuel
$= 1188.234 \times 264$
$= 313693.807$ gallons

M1

Time taken to travel to moon
$= \dfrac{384400\ \text{km}}{800\ \text{km/min}}$
$= 480.5$ min

Amount of fuel needed
$= 20000 \times 480.5$ A1
$= 9610000$ gallons

number of tanks
$= \dfrac{9610000 - 313693.807}{3.2 \times 10^6}$ M1
$\approx 2.905...$
$= 3$ A1 (must arrive 2.905...)
Therefore, number of external tanks required is 3.

<u>Answer scheme</u>

1a)

1b)

=

=

1ci) Let x be the tens digit and y be the units digit.

Solving : $x = 2$, $y = 3$

1cii) Therefore number is 23 (Answer can also be 32)

1di)

1dii)

2a)

2b)

2c)

2d) $x = 1.20$, $x = -36$

3a(i) 1st Draw 2nd Draw

3a(ii)(a) P(both discs are yellow) =

3a(ii)(b) P(one is blue and one is red)

=

3a(ii)(c) P(both discs are of different colour)

= 1 – P(both blue) – P (both yellow) – P(both red)

=

3b(i) Mean = 54.6

SD = 13.6

3b(ii) Mega Sec performed better as their mean is greater than mean for Faith Sec.

Results for Faith Sec is more consistent as their SD is less than SD for Mega Sec.

4a) $a = 21$, $b = 1$

4c) $x = 0.6$, 4.3

4d)

4e) Draw line

$x = 6.1$

5a(i) = 2**b** + **a**

5a(ii) = = (2**b** + **a**)

5a(iii) = (6**b** + **a)**

5a(iv) =**a**

5(b) , where is a scalar and FE is parallel to BC.

5c(i)

5c(ii)

5c(iii)

6a)

6b)

6c) The total amount collected from the sales of the four types of doughnuts in each of the outlet respectively.

7(a) ∠BAC = 120°

= 153m (3sf)

7(b) Area = 3390 m^2

7(c) $\angle ADC = 40.2°$

7(d) length of mast = 92tan27°

Angle of elevation = 17.0°

8a(i) Median = 68 marks

8a(ii) 65th percentile mark = 76 marks

8(b)

8(c) P(both obtained more than 88 marks)

=

9(a)(i) No of apprentices = 425

9(a)(ii) number of workers = 1020

9a(iii) 12.5% increase

9bi(a) Amount owed after first payment

=

9bi(b) Amount owed after second payment

=

9b(ii) Final settlement =

9b(iii) The final settlement will be different. This is because if $2000 is paid at the end of the first month, the principal sum used to calculate the next payment will be different and will eventually lead to a different final settlement.

10a) Perimeter =

Area =

=

= 11.3 cm^2

10b(i) Vol of spherical ball = 4.19cm^3

10b(ii) Depth of water = 17.9cm

10b(iii) Depth of water = 3.51 cm

11

11(i) From the distance time graph, the police car and the speeding car will meet somewhere between the 2nd and 3rd minute. Hence the police car will be able to overtake the speeding car and arrest the driver.

11(ii) Possible assumptions :

- The flow of traffic on the expressway is smooth
- Both cars did not stop along the way
- Both cars are travelling on the same expressway

ST. MARGARET'S SECONDARY SCHOOL

Preliminary Examinations 2016

CANDIDATE NAME

CLASS REGISTER NUMBER

MATHEMATICS **4048/02**

Paper 2 **22 August 2016**

Secondary 4 Express **2 hours 30 minutes**

Additional Materials: Writing Paper
Graph Paper (1 sheet)

READ THESE INSTRUCTIONS FIRST

Write your name, registration number and class on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** the questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
The use of an approved scientific calculator is expected, where appropriate.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place. For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total of the marks for this paper is 100.

Mathematical Formulae

Compound Interest

Total amount =

Mensuration

Curved surface area of a cone =

Surface area of a sphere =

Volume of a cone =

Volume of a sphere =

Area of triangle *ABC* =

Arc length = , where is in radians

Sector area = , where is in radians

Trigonometry

Statistics

Mean =

Standard deviation =

Answer all the questions.

1. (a) Factorise completely. [2]

Express as a single fraction in its simplest form.

[3]

(c) For a two-digit number, the sum of the units digit and tens digit is 5 and the difference between the units digit and tens digit is 1.

(i) Form two simultaneous equations and solve them. [3]

(ii) Hence state the two-digit number. [1]

Make m the subject of the formula .

[2]

(ii) Hence find the value of m, given that $s = 2$, $r = 1$ and $p = 3$. [1]

---

2. Peter bought some lychees for \$360. He paid \$$x$ for each kilogram of lychees.

(a) Write down an expression, in terms of x, for the number of kilogram of lychees that he bought. [1]

During the delivery, 5 kilogram of his lychees were squashed. He sold the remainder of the lychees at 60 cents more per kilogram than he paid for.

(b) Write down, in terms of x, for the sum of money he received for the remaining lychees. [1]

He made a profit of \$171.

(c) Write down an equation in x to represent this information and show that it reduces to $5x^2 + 174x - 216 = 0$. [3]

(d) Solve the equation and hence find the price that he paid for each kilogram of lychees. [3]

3. (a) A bag contains 20 coloured discs. Out of these 20 discs, 8 are blue, 7 are red and 5 are yellow. Jane draws two discs from the bag at random.

(i) Draw a tree diagram to show the probabilities of the possible outcomes. [2]

(ii) Find, as a fraction in its simplest form, the probability that

(a) both discs are yellow, [1]

(b) one disc is red and the other is blue, [1]

(c) both discs are of different colour. [2]

(b) 120 students from Mega Secondary School took a Science Test and their marks are given in the following table.

Marks	**Frequency**
$0 < x \leq 20$	2
$20 < x \leq 30$	5
$30 < x \leq 40$	8
$40 < x \leq 50$	35
$50 < x \leq 80$	70

(i) Calculate an estimate of the mean and standard deviation. [3]

(ii) The mean mark for another group of student from Faith Secondary School is 42 and the standard deviation is 12.8 mark. Make two comparisons between the marks for the 2 different groups of students. [2]

---

4. **Answer the whole of this question on a sheet of graph paper.**
This following is a table of values for the graph of.

x	0	1	2	3	4	5	6	7	8
y	15	19	21	a	19	15	9	b	-9

(a) Calculate the value of a and of b. [1]

(b) Using a scale of 2 cm to 1 unit on the x axis and 2 cm to 5 unit on the y axis, draw the graph of for. [3]

(c) Use your graph to find the values of x when $y = 18$. [2]

(d) By drawing a tangent, find the gradient of the curve where $x = 4.5$. [2]

(e) By drawing a suitable straight line on the same axes, use your graph to find the solutions of the equation . [3]

5.

ABCD is a rectangle. = 2***b*** and= ***a***.
M is the midpoint of *AC* and *AC* = 2*CE*.
F is a point on *AB* extended such that *AF*: *AB* = 3:2.

(a) Express each of the following, as simply as possible, in terms of ***a*** and/or ***b***.

(i) [1]

(ii) [1]

(iii) [1]

(iv) [1]

(b) Write down 2 facts about *BC* and *FE*. [2]

(c) Calculate the value of

(i) [1]

(ii) [1]

(iii) [1]

6 The number of doughnuts sold by a bakery in three of its most popular outlets for the first week of June is shown in the table below.

	Outlet A	Outlet B	Outlet C
Salted Caramel	300	280	250
Chocolate	450	385	355
Sugared coated	255	275	310
Strawberry	150	140	185

(a) Write down a 4 × 3 matrix N that represents the information given in the table. [1]

(b) The selling price of salted caramel doughnuts, chocolate doughnuts, sugared coated doughnuts and strawberry doughnuts are \$2, \$1.80, \$1.30 and \$1.40 respectively. Write down a matrix P that represents this information and hence evaluate PN. [3]

(c) Explain what the elements of matrix PN represents. [1]

---

7 In the diagram below, A, B, C and D are points on level ground. $AB = 85$ m , $AC = 92$ m and . B is due North of A and the bearing of D from A is 205°.

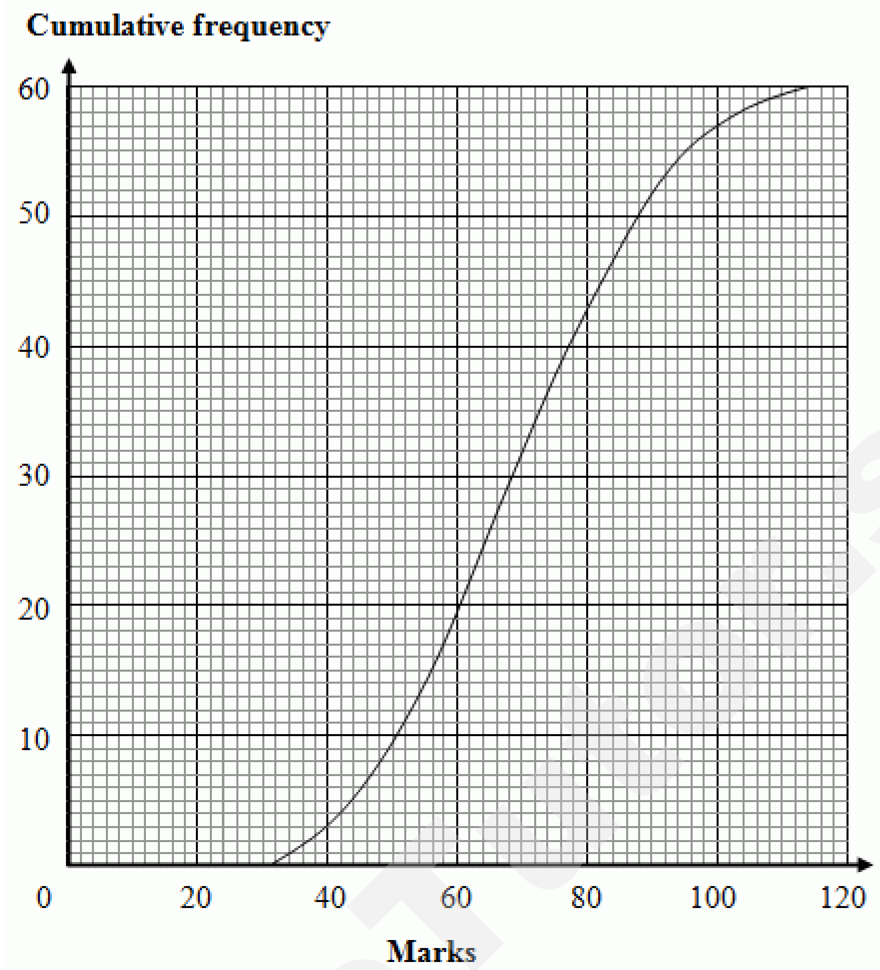
(a) Find BC. [3]

(b) Calculate the area of triangle ABC. [1]

(c) Calculate . [2]

(d) A vertical mast is at C. The angle of elevation of the top of the mast from A is 27°. Calculate the angle of elevation of the top of the mast from B. [3]

8 The cumulative frequency graph shows the distribution of marks of 60 students in a spelling test.



(a) Find

(i) the median mark. [1]

(ii) 65^{th} percentile mark. [1]

(b) Find the percentage of students who obtained more than 48 marks. [2]

(c) Two students are chosen at random to go through to the next round of competition. Find the probability that both students obtain more than 88 marks. [2]

9 In 2014, a factory employed 1275 workers consisting of Foreman, Craftsman and Apprentice in the ratio 1:9:5.

Find the number of Apprentices employed in 2014. [1]

The number of workers employed in 2014 was 25% more than it was in 2013. Find the number of workers employed in 2013. [1]

70% of the factory's total expense are for wages and the rest is for raw materials. In 2015, wages increased by 8% and the cost of the raw material increased by 23%. Calculate the percentage increase in the total expense, assuming that the number of workers employed remained the same. [3]

Tom borrowed \$4000 from a bank at the interest rate of 15% per annum compounded monthly. He repaid \$1500 at the end of the first month, \$2000 at the end of the second month, and made a final settlement at the end of the third month.

How much did he owe the bank just after

the first payment, [2]

the second payment? [2]

How much was the final settlement payment? [2]

If Tom has repaid \$2000 at the end of the first month and \$1500 at the end of the second month, would the final settlement payment at the end of the third month remain the same? Explain briefly. [1]

10 In the diagram, each circle centered A, B and C is of the same radius of 4 cm. Calculate the perimeter and the area of the shaded region.

[6]

10 A spherical ball of radius 1 cm is completely submerged in a cylindrical container of height 30 cm and radius 3 cm. Water is then poured into the container to a depth of 18 cm. Calculate

the volume of the spherical ball, [1]

the depth of water in the container if the spherical ball is removed from the container. [3]

If the water in the cylindrical container is poured into a rectangular trough of length 18 cm and breadth 8 cm, what is the depth of the water in the trough? [2]

11 During a routine operation along an expressway one night, a car drove through a police road block without stopping. The police signalled for the car to stop but it accelerated and the police gave chase.
The speed and the time of the speeding car and the police car during the 3-minute high-speed chase along the expressway are recorded in the table below.

Time	Speed of Speeding Car (km/h)	Speed of Police Car (km/h)
1st minute	105	90
2nd minute	140	135

3rd minute	155	180

(a) Based on the information given, using a distance-time graph, determine whether the police car will be able to overtake the speeding car and arrest the driver during the high-speed chase. Show how you arrive at your conclusion. [4]

(b) Are there any assumptions that you may have to make? [1]

ST. MARGARET'S SECONDARY SCHOOL

Preliminary Examinations 2016

CANDIDATE NAME

CLASS

REGISTER NUMBER

MATHEMATICS **4048/01**

Paper 1 **19 August 2016**

Secondary 4 Express **2 hours**

Additional Materials: NIL

READ THESE INSTRUCTIONS FIRST

Write your name, registration number and class on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** the questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
The use of an approved scientific calculator is expected, where appropriate.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place. For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total of the marks for this paper is 80.

This document consists of 18 printed pages

Mathematical Formulae

Compound Interest

Total amount =

Mensuration

Curved surface area of a cone =

Surface area of a sphere =

Volume of a cone =

Volume of a sphere =

Area of triangle *ABC* =

Arc length = , where is in radians

Sector area = , where is in radians

Trigonometry

Statistics

Mean =

Standard deviation =

1 Factorise each of the following expressions completely

(a) ,

Answer (a) ____________________ [2]

(b) .

Answer (b) ____________________ [2]

2 (a) Petrol costs y cents per litre. Desmond buys some petrol and it costs him x dollars. Find an expression, in terms of x and y, for the number of litres that he buys.

Answer (a) ________________litres [1]

(b) Rashid's best timing for 2.4 km run was 9 minutes and 34 seconds. Convert his speed into metres per second.

Answer (b) ________________m/s [1]

3 Express the following expressions in their simplest form

(a) ’

Answer (a) ______________________ [2]

(b)

Answer (b) ______________________ [2]

4 Solve the equation,

Answer $x =$ ______________________ [3]

5 (a) Solve the equation

Answer (a) $x =$ ____________________ [2]

(b) Given that and , find the value of .

Answer (b) ______________________ [2]

6 The speed of light is .

(a) Express this speed in km/h, giving your answer in standard form.

Answer (a) ________________ km/h [1]

(b) Find the time taken in nanoseconds, for light to travel one kilometre.

Answer (b) ____________________ns [2]

7 (a) Given find the smallest possible value of x if x is a perfect

square.

Answer (a) $x =$ ____________________ [2]

(b) Given that $-3 \leq x \leq 4$ and where x and y are integers, find

(i) the least value of

Answer (b)(i) ____________________ [1]

(ii) the greatest value of .

Answer (b)(ii) ____________________ [1]

8 (a) Express 504 as the product of its prime factors.

Answer (a) ____________________ [1]

(b) Find the smallest positive integer value of k for which $504k$ is a multiple of 240.

Answer (b) $k =$ ____________________ [1]

8 (c) Given that the lowest common multiple of 504 and n is 12 600, find the smallest value of n.

Answer (c) $n =$ ____________________ [1]

9 The first five terms of a sequence are

0, 3, 8, 15, 24

Find

(a) the next term,

Answer (a) ______________________ [1]

(b) an expression for the n^{th} term,

Answer (b) ______________________ [1]

(c) the 50^{th} term.

Answer (c) ______________________ [1]

10 In the figure, $QRST$ is a straight line. Angle = 90°, PS = 5 cm, RS = 2 cm and the area of triangle PRS = 3 cm^2.

(a) Calculate

(i) PQ,

Answer (a)(i)__________________cm [1]

(ii) PR.

Answer (a)(ii)_________________ cm [2]

(b) Express, as a fraction in the lowest term, the value of

Answer (b) ____________________ [1]

11 A scale of 2 cm to 1 km is used for a map.

(a) Express the scale in the form $1 : n$.

Answer (a) 1 : __________ [1]

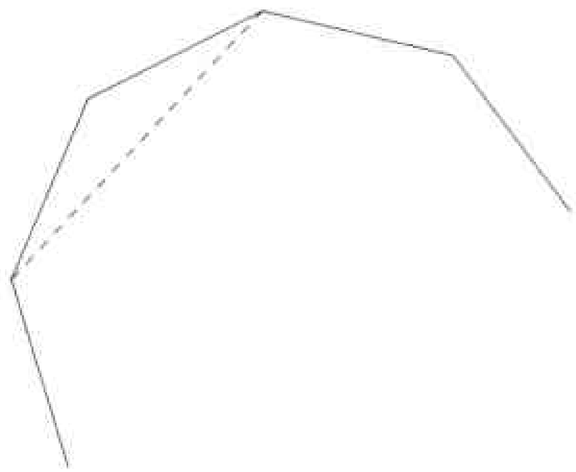
(b) The distance between town A and town B measures 16 cm on the map.
Find the actual distance, in metres, between the two towns.

Answer (b) __________________m [1]

(c) A playground covers an actual area of 8 km^2. Find the area of the playground on the map, leaving your answer in cm^2.

Answer (c) ________________ cm^2 [2]

12



The diagram shows part of a regular polygon with n sides. Given that $\angle BAC = 12°$ and E is the point where the lines BD and AC intersect.

Calculate

(a) the value of n,

Answer (a) $n =$ __________________ [2]

(b) $\angle AED$.

Answer (b) ____________________ ° [1]

13 Solve the simultaneous equations below giving your answers in exact values.

Answer $x =$ ________, $y =$ _________ [3]

14 (a) Given that ,
$P = \{x : x \text{ is a multiple of } 4\}$,
$Q = \{x : x \text{ is an even number}\}$ and
$R = \{x : x \text{ is a number less than } 7\}$.

(i) List the elements in set P.

Answer (a)(i)____________________ [1]

(ii) Find .

Answer (a)(ii)___________________ [1]

(iii) State the value of $n(R)$.

Answer (a)(iii)___________________ [1]

(b) On the Venn diagram shown in the answer space, shade the set . [1]

15 *AB* is the diameter of the circle *AFBCD* shown in the diagram. *E* is the point on *AB* produced, where *BD* = *BE* and angle.
The straight line *ED* cuts the circle at *C*.

(a) Explain why angle.

____

____

____ [2]

(b) Find angle.

Answer (b)____________________ ° [1]

(c) Show that *BD* bisects angle.

____

____

____

____ [1]

(d) Given also that angle, calculate angle.

Answer (d) ____________________ ° [1]

16 Given that *A* is the point (1, 1), and that *D* is the

midpoint of *BC*. Find

(a)

Anwser (a)______________________ [1]

(b) ,

Answer (b)__________________units [2]

(c) the coordinates of the point *P* such that *ABPC* is a parallelogram using vector method.

Answer (c) (_________, ________) [2]

17 A container is a prism with a triangular cross-section. The container has a height of 30 cm. Jamie pours water into the empty container at a constant rate. She takes 9 seconds to fill the container with water. After *t* seconds, the depth of the water is *d* cm.

(a) Find the value of d when $t = 4$.

Answer (a) ______________________ [2]

(b) Given that the volume of the container is 1350 cm^3. Find the volume of the water when $t = 4$.

Answer (b) ____________________ cm^3 [2]

17 (c) On the axes in the answer space, sketch the graph showing how the
(i) depth varies during the 9 seconds, [1]

(ii) volume varies during the 9 seconds. [1]

18 The times (in seconds) taken by 12 boys to complete the shuttle run are given below.

9 14 12 17 16 10 10 18 12 15 13 12

Find,

(a) (i) the median,

Answer (a)(i)__________________ [1]

(ii) the interquartile range.

Answer (b)(ii)__________________ [1]

(b) The times (in seconds) taken by 12 girls to complete the shuttle run are given below.

10	18	19	12	12	14	21	21	22	15	13	15

Compare the results of the boys and girls.

____

____

____

____

____

____ [2]

19 (a) Express in the form and sketch
in the space provided showing the turning point and
y-intercept.

[2]

Answer (a) $y =$ ________________ [1]

(b) The diagram below shows a quadratic function in the form of .

Equation of line of symmetry is . Find the values of *a*, *b* and *c*.

Answer (b) ______ $b =$ ______

$c =$ ______ [3]

20 In the diagram below, *O* is the origin, *A* is and *B* is . *C* is a variable point with the coordinates and *D* is the point of intersection of the lines *AB* and *OC*.

(a) Prove that triangles *OBD* and *CAD* are similar for all values of *m*.

____

____

____

____ [2]

(b) Find

(i) the equation of the line *AB*,

Answer (b)(i)____________________ [1]

(ii) the value of *m* when the length of *OC* is given as units,

Answer (b)(ii) m = ______________ [1]

(iii) using the value of *m* in (ii), find the coordinates of *D*.

Answer (b)(iii) (_______ , _______) [2]

Answer Key

1 (a) (b)

2 (a) litres (b) 4.18 m/s

3 (a) (b)

4

5 (a) (b)

6 (a) km/h (b) 3330 ns

7 (a) (b) (i) (ii) 16

8 (a) (b) (c)

9 (a) 35 (b) (c) 2499

10 (a) (i) 3 cm (ii) 3.61 cm (b)

11 (a) 1 : 50000 (b) 8000 m (c) 32 cm

12 (a) (b) 156 °

13 $x =$, $y =$

14 (a) (i) { 8, 12, 16 } (ii) 6 (iii) 0 (b) ---

15 (a) (base angles isosceles triangle), (b) 72°

(angles in the same segment),

shown

(c) 18 + 18 (exterior angle of a triangle) (d) 111°

= 36°

= 72 – 36 = 36°

BD bisects

16 (a) (b) (c) (3, 9)

17 (a) $d = 20$ (b) 600 cm

(c) (i) (c) (ii)

18 (a) (i) 12.5 (ii) 4.5

(b) median of girls = 15 and IQR of girls = 4.5

Boys are faster because median is smaller. Boys' performance more consistent as IQR is smaller.

19 (a) (b) a =

20 (a) AC is horizontal, hence parallel to OB (b) (i)

(alternate angles, AC //OB) (ii) m = 3 (iii) (2,) (alternate angles, AC//OB)

Since 2 corresponding angles are equal, are similar.

For Examiner's use

1. Write the following in order of size, smallest first.

$$-\frac{25}{41} \qquad -\sqrt{0.36} \qquad -0.22^{\frac{1}{3}}$$

Answer .... , ... , ... [2]
smallest largest

2. Raja is travelling from Singapore to Sweden.
Raja wants to change 2000 Singapore Dollars into Swedish Krona.
How many more Swedish Krona will he get by changing his money in Sweden? Give your answer to the nearest Swedish Krona.

<u>In Singapore</u>
$\boxed{\text{S\$1} = 6.373 \text{ Swedish Krona}}$

<u>In Sweden</u>
$\boxed{1 \text{ Swedish Krona} = \text{S\$0.1563}}$

Answer .... Swedish Krona [2]

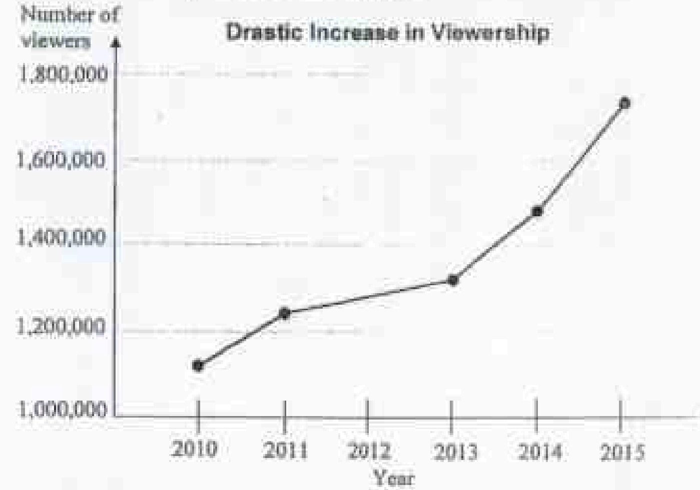
3. The sine of an angle is 0.1786.
Give two possible values for the angle in degrees, correct to two significant figures.

Answer ....° or ....° [2]

For Examiner's use

For Examiner's use

4. The following chart showing the average number of viewers watching the evening news broadcast was published in a newspaper.



List **two** ways in which the graph is misleading.

Answer 1 ....

....

....

2 ....

....

....

5. A holiday camp is planned for 30 children and food is bought to last for 12 days.
If the number of children increases to 37 children, how many whole days do you expect the food to last?

Answer .... days

Given that $3 \div 81^n = \sqrt{3^{-1}}$, find the value of n.

Answer n = ... [2]

Two cones, made of the same material, have the same height.
The smaller cone has a mass of 1 kilogram and the larger cone has a mass of 3 kilograms.
Calculate the radius of the smaller cone as a percentage of the larger cone.

Answer .... % [2]

For Examiner's use

For Examiner's use

8. y varies inversely with the square root of x. Describe the change in x when y is halved.

Answer x .... by .... % [2]

9. The table below shows information about a group of animals in a pet shop.

	Cat	Dog
Long-haired	8	3
Short-haired	5	2

Two animals are selected at random.
Find, as a fraction in its lowest terms, the probability that

(a) they are both cats,

Answer (a) .... [1]

(b) neither are short-haired dogs.

Answer (b) .... [1]

For Examiner's use

For Examiner's use

10. A high-speed train travels at an estimated speed of 660 kilometres per hour.

(a) Find the train's speed in m/s.
Express your answer in standard form.

Answer (a) .... m/s [1]

(b) Calculate the time taken for the train to travel 100 kilometres.
Give your answer in minutes and seconds, to the nearest second.

Answer (b) .... minutes .... seconds [1]

11. Each term in this sequence is found by adding a constant to the previous term.

$a,\quad 25,\quad b,\quad 37,\quad \ldots$

(a) Find the value of a.

Answer (a) .... [1]

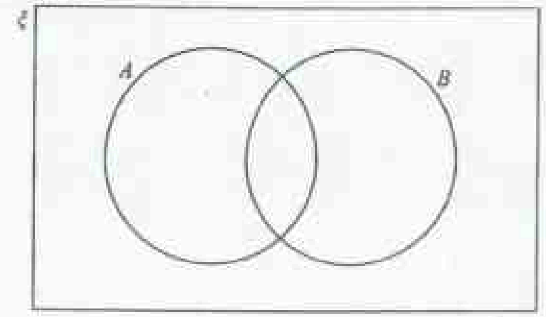
(b) Find an expression to represent the nth term.

Answer (b) .... [2]

For Examiner's use

12. (a) On the Venn Diagram shown in the answer space, shade the set $A' \cap (A \cup B)$

Answer (a)



(b) 40 students sat for an oral test and Listening Comprehension test. The following table shows the results.

Test	Pass	Fail
Oral	26	14
Listening Comprehension	37	3

Given that two students failed both tests, find the number of students who passed both tests.

Answer (b) .... students

13. When written as the product of its prime factors,

$$168 = 2^3 \times 3 \times 7$$

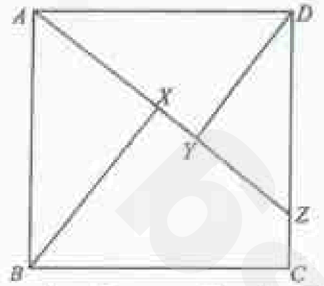
(a) Find the smallest possible integer value of k such that $\frac{168}{k}$ is a perfect square.

Answer (a) k = ...

(b) Find the smallest possible integer value of A, given that the highest common factor and lowest common multiple of 168 and A is 24 and 2520 respectively.

Answer (b) A = ...

14.



A, B, C and D are the vertices of a square. The point Z lies on CD such that A, X, Y and Z are collinear.

Given that $A\hat{X}B = D\hat{Y}A = 90°$, prove that triangles ABX and DAY are congruent.

Answer

[3]

For Examiner's use

For Examiner's use

15. On a particular map, two train stations are shown to be 6 cm apart.

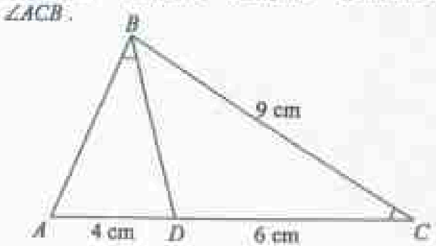
(a) If the actual distance between the stations is 3 km, express the map scale in the form $1 : n$.

Answer (a) 1 : ………………………… [1]

(b) On the same map, a rectangular field occupies an area of 24 cm^2. Find the actual area of the field in km^2.

Answer (b) ………………………… km^2 [2]

16. In the triangle ABC, $AD = 4$ cm, $DC = 6$ cm, $BC = 9$ cm and D is a point on AC such that $\angle ABD = \angle ACB$.



Find the length of BD.

Answer ………………………… cm [3]

For Examiner's use

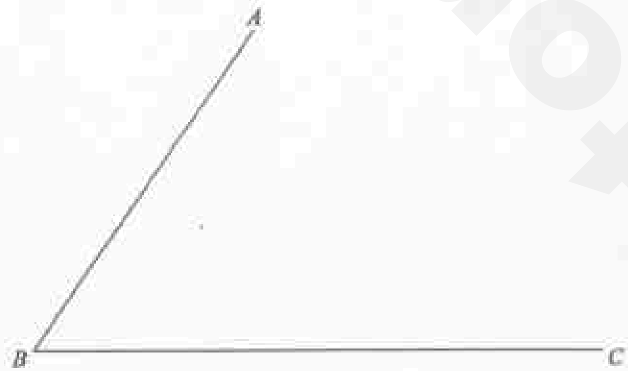
For Examiner's use

17. The diagram in the answer space below shows three points, A, B and C.

(a) Construct the perpendicular bisector of BC. [1]

(b) Construct the angle bisector of angle ABC. [1]

Answer



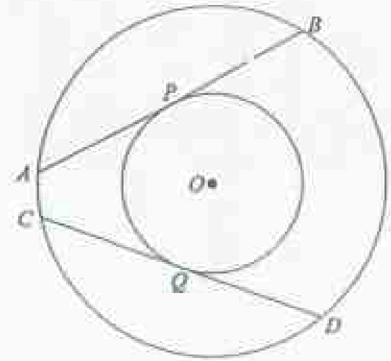
(c) These two bisectors meet at X.
Complete the statement below.
The point X is equidistant from the lines ………………… and …………………

and equidistant from the points …………… and …………… . [1]

For Examiner's use

For Examiner's use

18. The diagram below shows two concentric circles, with centre O.
A, B, C and D lie on the circumference of the larger circle.
AB and CD are tangents to the smaller circle at points P and Q respectively.



(a) Explain, with reasons, why $AB = CD$.

Answer (a) ……………………………………………………………………

……………………………………………………………………

……………………………………………………………………

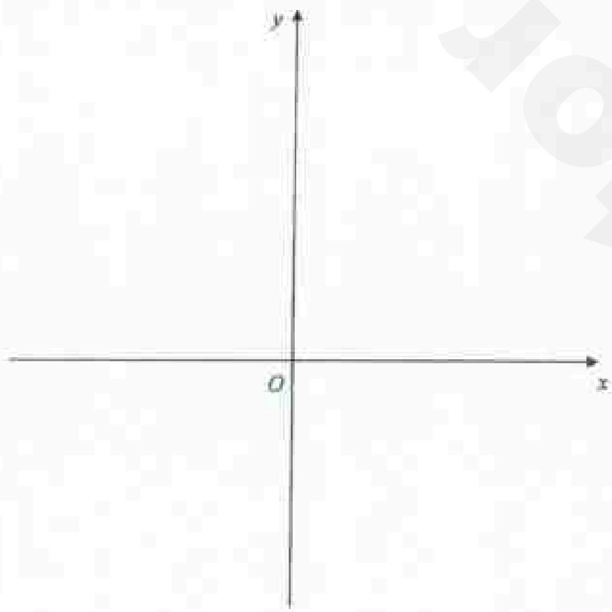
(b) Given that the radius of the smaller and larger circle are 4 cm and 7 cm respectively, find AB.

Answer (b) ………………………… cm

19. (a) Express $y = x^2 - 4x + 5$ in the form $y = (x+a)^2 + b$.

Answer (a) .... [1]

(b) Sketch the graph of $y = x^2 - 4x + 5$ on the axes provided below.



[2]

(c) Using your graph, explain why $x^2 - 4x + 5 = 0$ has no solution.

Answer (c) .... [1]

20. (a) The cash price of a computer is \$2500.
The hire-purchase price of the computer is \$2775.
The hire-purchase price is a deposit of x% of the cash price plus 12 equal monthly payments of \$200.

Calculate x.

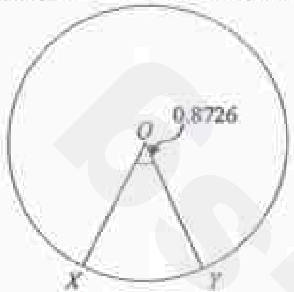
Answer (a) x = ... [2]

(b) Ali invested some money in a savings account for 5 years.
The rate of compound interest was fixed at 6% per annum and interest was compounded quarterly.
At the end of the 5 years there was \$2693.71.

How much did Ali invest in the account?

Answer (b) \$ .... [3]

21. In the diagram, O is the centre of a wheel of circumference 150 cm.
The points X and Y lie on the circumference of the wheel and $\angle XOY = 0.8726$ radians.



(a) Calculate the number of complete revolutions the wheel would make in travelling a distance of 1 km.

Answer (a) .... revolutions [1]

(b) Find the length of the minor arc XY.

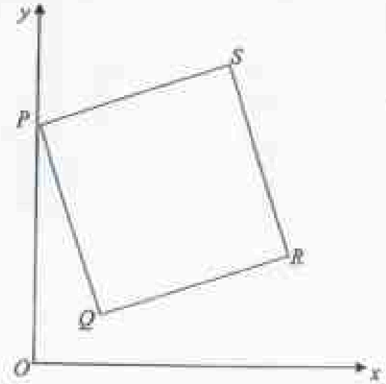
Answer (b) .... cm [2]

(c) Calculate the area of the minor sector XOY.

Answer (c) .... cm^2 [2]

For Examiner's use

22. In the diagram, $PQRS$ is a square. P is the point (0, 8), Q is the point (2, 2) and R is the point (8, 4).



(a) Write down the coordinates of S.

Answer (a) (............ , ...)

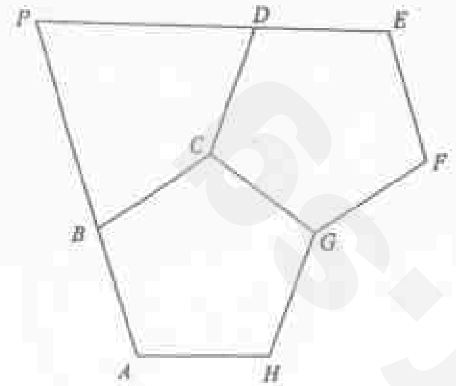
(b) Find the equation of PQ.

Answer (b) ....

(c) Calculate the area of the square.

Answer (c) .... units^2

The diagram shows two regular pentagons $ABCGH$ and $CDEFG$. AB and ED are produced to meet at point P.



(a) Calculate reflex angle BCD.

Answer (a) .... [2]

(b) Explain why BCE is a straight line.

Answer (b) ....

....

....

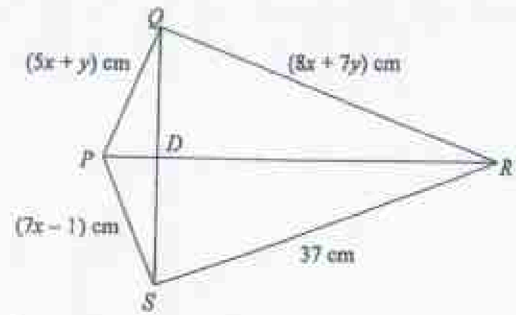
....

....

....

.... [3]

24.



A piece of wire is bent into the shape of a kite $PQRS$ as shown.

(a) Find the value of x and y.

Answer (a) $x =$ ...., $y =$ .... [3]

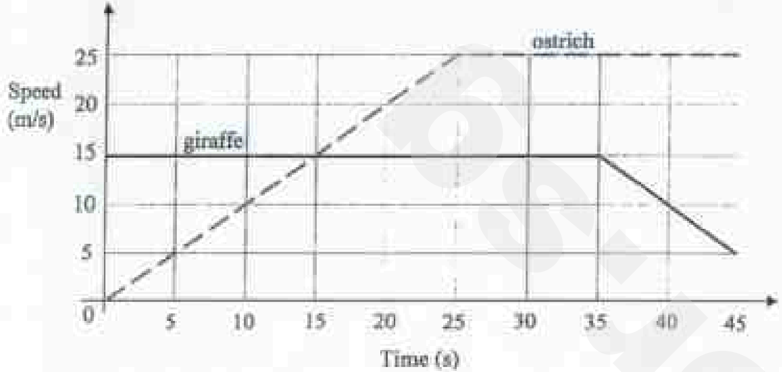
(b) Given that the diagonals intersect at D and that $PD : DR = 1:7$, show that the area of the kite is 480 cm^2.

Answer (b)

[3]

For Examiner's use

25. The diagram shows the speed-time graph of a giraffe and an ostrich running for a period of 45 seconds. The giraffe and ostrich travel from the same starting point and in the same direction.



(a) Given that the giraffe decelerates uniformly to a speed of 5 m/s in the last 10 seconds, calculate

(i) its deceleration,

Answer (a)(i) .... m/s^2 [1]

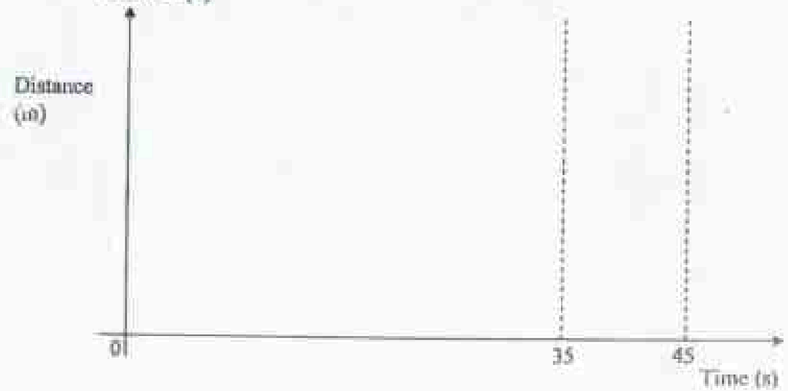
(ii) its average speed during the 45 seconds.

Answer (a)(ii) .... m/s [2]

For Examiner's use

(b) Sketch a distance-time graph for the giraffe.

Answer (b)

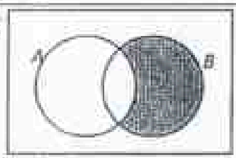


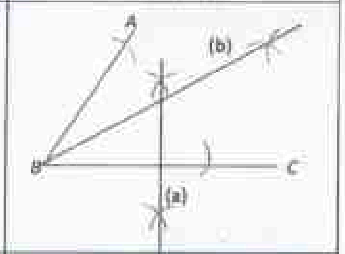
(c) Find the time when the giraffe and ostrich meet again.

Answer (c) .... s [3]

End of Paper

TKGS 2016 Mathematics Prelim Paper 1 Answer Key

Q	Answer
	$-\frac{25}{41}$, $-0.22^{\frac{1}{3}}$, $-\sqrt{0.36}$
	50 Swedish Krona
	10°, 170°
	Misleading feature (of graph) / **Effect** Vertical axis does not start from zero. / It exaggerates the difference between the number of viewers. Title is biased / Does not allow readers to make own judgment / Misguides readers who are not discerning Missing data from 2012 / Misrepresents the trend / there could be a drop in viewership from 2012 to 2013
	9 days
	$\frac{3}{8}$
	57.7%
	x <u>increases</u> by <u>300%</u>
)	$\frac{26}{51}$
	$\frac{40}{51}$
(a)	1.83×10^{7}
(b)	9 minutes 5 seconds
(a)	19
(b)	$6n + 13$
(a)	
(b)	25
(a)	42
(b)	360
(a)	1 : 50 000
(b)	6 km²
	5.69 cm

Q	Answer
17(a) & (b)	
17(c)	The point X is equidistant from the lines <u>AB</u> and <u>BC</u> and equidistant from the points <u>B</u> and <u>C</u>.
18(a)	$OP = OQ$ (radii of same circle) $AB = CD$ (equal chords)
18(b)	11.5 cm
19(a)	$y = (x-2)^2 + 1$
19(b)	
19(c)	The graph does not cut the x-axis.
20(a)	15
20(b)	$2000.00
21(a)	666
21(b)	20.8 cm
21(c)	249 cm²
22(a)	(6, 10)
22(b)	$y = -3x + 8$
22(c)	40 units²
23(a)	216°
24(a)	$x = 2$, $y = 3$
25(a)(i)	1 m/s²
25(a)(ii)	$13\frac{8}{9}$ m/s
25(b)	
25(c)	31.25 s

Answer all questions on the writing paper provided.

1. (a) (i) Express $\dfrac{3}{b-a}-\dfrac{3a-b}{a^2-b^2}$ as a single fraction in its simplest form. [2]

(ii) Given that $T=\dfrac{1}{4}\sqrt{\dfrac{h}{h-K}}$, express h in terms of T and K. [3]

(b) (i) Given that $4p^2-12pq+9q^2=0$, find the value of $\dfrac{3q}{2p}$. [2]

(ii) Solve the inequality $\dfrac{1}{2}-3x<\dfrac{3}{4}(2x+1)$. [2]

2. Mr. Tan bought a laptop for \$1000 and a mobile phone for \$800. He sold them to a shop a week later. He sold the laptop at a profit of P% and the mobile phone at a loss of L% on their respective cost prices.

(a) (i) Express the profit for the sale of the laptop in terms of P. [1]

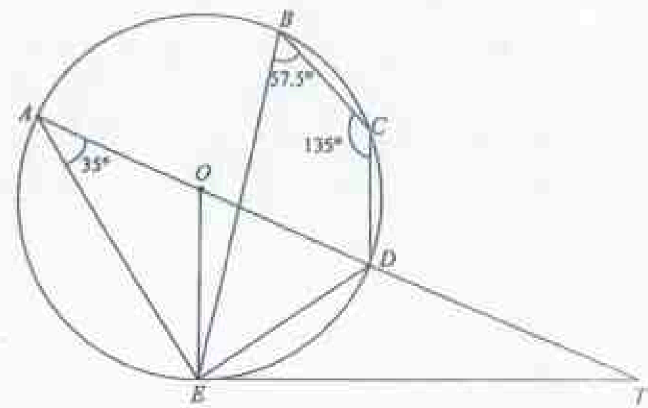
(ii) Express the loss for the sale of the mobile phone in terms of L. [1]

(iii) Hence, calculate and determine if there is an overall profit or loss for the sales made to the shop when the percentage loss of selling the mobile phone is the same as the percentage profit of selling the laptop. [2]

(b) (i) If the overall profit of the sales is exactly 2% of the total cost price, show that $10P=8L+36$. [2]

(ii) Find the values of P and L when the percentage profit from the sale of the laptop is twice that of the percentage loss from the sale of the mobile phone. [2]

3.



The diagram shows a circle, $ABCDE$, centre O.
ET is the tangent to the circle at E and $AODT$ is a straight line.
Angle $EAD=35°$ and angle $BCD=135°$.

(a) Find, giving reasons for each answer,

(i) angle EOD, [1]

(ii) angle ADE, [1]

(iii) angle ETA. [1]

(b) Show that BE bisects angle AED. [2]

(c) Given also that angle $EBC=57.5°$. Determine whether $BC=DC$. Give reasons for your answer. [2]

4. (a) ξ = {integers x: $1 \le x \le 9$}
A = {x: x is an odd number and $x^2 \ge 9$}
B = {x: x is not a multiple of 3}

(i) Draw a Venn diagram to illustrate this information. [2]

(ii) Write down n(A). [1]

(iii) List the element(s) contained in the set $(A \cup B)'$. [1]

(b) A factory produces large and small sizes sofas. The following table is used in calculating the cost of producing the sofas.

	Manpower (Hours)	Raw Material (Boxes)	Electricity (Units)
Large	6	4	0.5
Small	5	2	0.2

(i) Represent the above information in a 2 × 3 matrix A. [1]

Manpower costs $8.50 per hour, the raw material used costs $2 per box and the electricity costs 70 cents per unit.

(ii) Represent the above information in a 3 × 1 matrix **B**. [1]

(iii) Evaluate the matrix **C** = **AB** and state what the elements of **C** represent. [2]

(iv) If **D** = $(10 \quad 25)$, evaluate **DC** and interpret the results. [2]

5. **Answer the whole of this question on a sheet of graph paper.**

The variables x and y are connected by the equation

$$y = x + \frac{4}{x} - 5.2.$$

Some corresponding values of x and y, correct to 2 decimal places, are given in the table below.

x	0.7	1.0	1.5	2.0	3.0	4.0	5.0	7.0	7.5
y	1.21	−0.20	−1.03	−1.2	p	−0.20	0.60	2.37	2.83

(a) Calculate the value of p. [1]

(b) Using a scale of 2 cm to represent 1 unit, draw a horizontal x-axis for $0 < x \le 8$.
Using a scale of 4 cm to represent 1 unit, draw a vertical y-axis for $-2 \le y \le 3$.

On your axes, plot the points given in the table and join them with a smooth curve. [3]

(c) Use your graph to solve the equation $x^2 - 4x + 4 = 0$. [1]

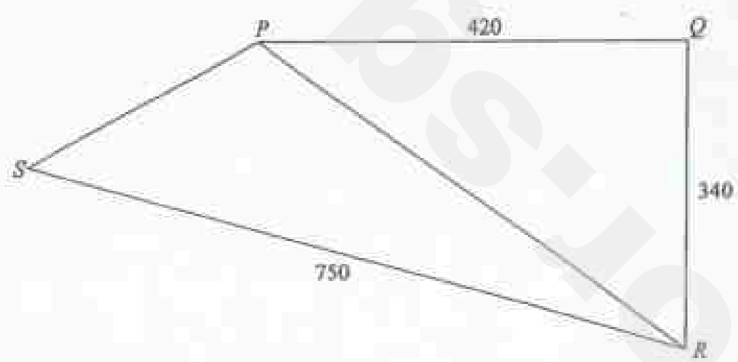
(d) By drawing a tangent, find the value of x where the gradient of the curve is 0.75. [2]

(e) (i) On the same axes, draw the line $y = \frac{3}{2}x - 2$ for $0 < x \le 8$. [1]

(ii) Write down the x-coordinate of the point where this line intersects the curve. [1]

(iii) This value of x is a solution of the equation $x^2 + Ax + B = 0$. Find the value of A and the value of B. [2]

6. The diagram shows four transmission towers, P, Q, R and S of identical height 40 m, on level ground. P is 420 m due west of Q and R is 340 m due south of Q. S is 750 m and on a bearing of 280° from R.



Calculate

(a) the distance PR, [2]

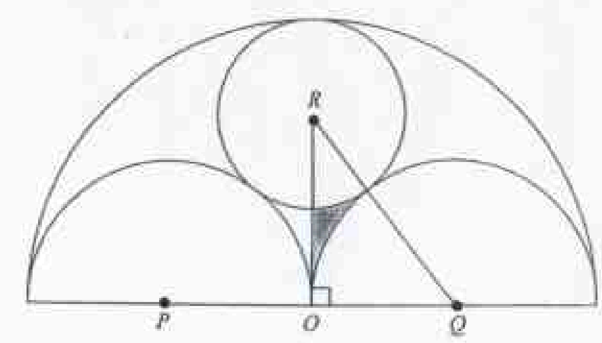
(b) $\angle PRS$, [3]

(c) area of triangle PRS, [2]

(d) the shortest distance of P from RS, [2]

(e) the largest angle of elevation of the top of the transmission tower at P when viewed from a point on RS. [2]

7. In the diagram, O is the centre of the largest semicircle. The circle with centre R has a radius of $(3r + 2)$ cm. Two identical semicircle, with centres P and Q, each has radius of $(6r + 1)$ cm.



(a) Write down an expression, in terms of r, for

(i) QR, [1]

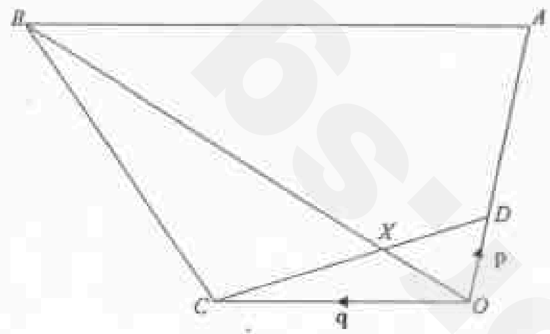
(ii) OR. [2]

(b) Form an equation in r and show that it reduces to $18r^2 - 21r - 4 = 0$. [illegible]

(c) Solve the equation $18r^2 - 21r - 4 = 0$. [illegible]

(d) Given that the area of the right-angled triangle OQR is 54 cm², find the area of the shaded region. [illegible]

8. $OABC$ is a trapezium where $\overrightarrow{OD} = \mathbf{p}$ and $\overrightarrow{OC} = \mathbf{q}$. OB and CD meet at X. $AB = 2OC$ and $OD = \frac{1}{3}OA$.



(a) Express, in terms of $\mathbf{p}$ and $\mathbf{q}$,

(i) $\overrightarrow{CD}$, [1]

(ii) $\overrightarrow{OB}$. [1]

(b) Given that $\overrightarrow{CX} = h\overrightarrow{CD}$, show that $\overrightarrow{OX} = h\mathbf{p} + (1-h)\mathbf{q}$. [2]

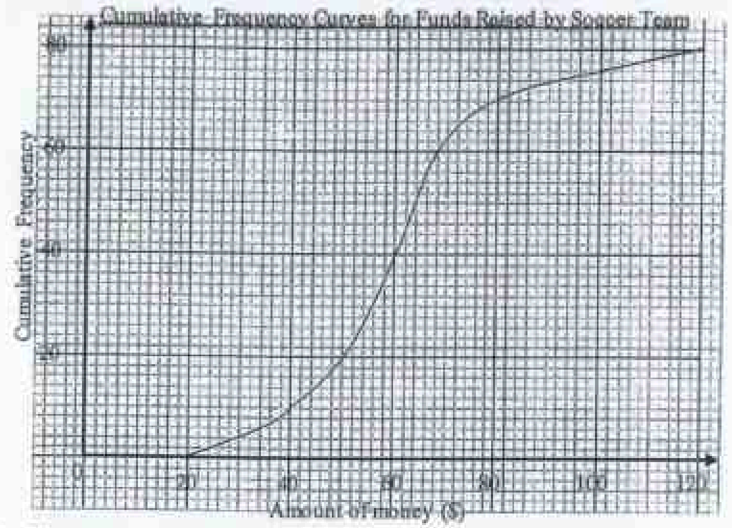
(c) Given further that $\overrightarrow{OX} = k\overrightarrow{OB}$, find the value of h and of k. [3]

(d) Find the numerical value of

(i) $\dfrac{\text{area of } \Delta OBC}{\text{area of } \Delta OXC}$, [1]

(ii) $\dfrac{\text{area of trapezium } OABC}{\text{area of } \Delta OXC}$. [2]

9. The amount collected by 80 members of the school soccer team for a fundraising event is distributed as shown in the cumulative frequency curve below.



(a) Use your curve to estimate

(i) the median amount of money raised, [1]

(ii) the interquartile range. [2]

(b) (i) Copy and complete the grouped frequency table of the amount of money collected by the soccer team.

Amount of money ($)	$20 \le x < 40$	$40 \le x < 60$	$60 \le x < 80$	$80 \le x < 100$	$100 \le x < 120$
Frequency					

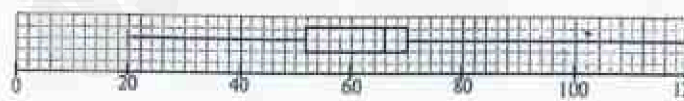
[2]

(ii) Using your grouped frequency table, calculate an estimate of

(a) the mean amount of money collected, [2]

(b) the standard deviation. [2]

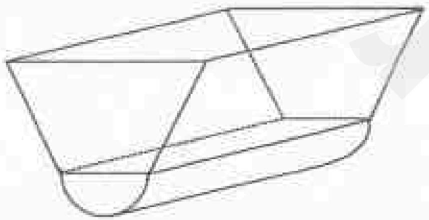
(c) 80 members from the school outdoor club also raised funds for the same event. The box-and-whisker plot shows the distribution of the amount collected by them.



What can you conclude about the amounts collected by the two co-curriculum activity groups? [2]

10. Drains are common in Singapore to regulate water flow to prevent floods from occurring.

In this question, the drain can be modelled as a trapezoid attached to the top of half a cylinder as shown:



The cross section of the drain is made up of a trapezium and a semicircle. The radius of the semicircle is 50 cm and the vertical height measured from the bottom of the semicircle to the top of the trapezium is 200 cm. The length of one of the parallel sides of the trapezium is twice the length of the other.

(a) Find the lengths of the parallel sides and the vertical height of the trapezium. [2]

(b) Calculate the volume of the drain, in cubic metres, which stretches for 10 m. [4]

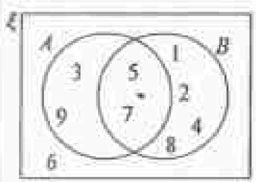
(c) A drain must be able to channel away 90% of the rain water within 30 seconds, if not preventive measures need to be set up to curb the flood.

> **Useful Information**
>
> - The rate of flow of water for this drain during a particular rainstorm is 48000 litres per minute
> - 1 m^3 is equivalent to 1000 litres

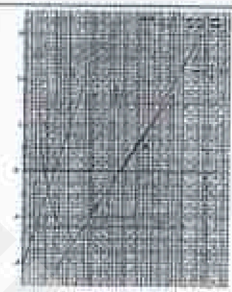
Decide whether preventive measures need to be set up for that particular rainstorm. Show your working and give reasons to justify your answer. [4]

—End of Paper —

Sec 4 Mathematics Prelim 2016 Paper II Answer Key

S/No.		Answer
(a)	(i)	$\dfrac{6a+2b}{b^2-a^2}$
	(ii)	$h=\dfrac{16T^2K}{16T^2-1}$
(b)	(i)	$\dfrac{3q}{2p}=1$
	(ii)	$x>-\dfrac{1}{18}$
(a)	(i)	$10P
	(ii)	$8L
	(iii)	$2P > 0 ∴ there is an overall profit
(b)	(i)	Show question
	(ii)	$P=6$, $L=3$
(a)	(i)	70°
	(ii)	55°
	(iii)	20°
(b)		Show question
(c)		Show question
(a)	(i)	

S/No.			Answer
6.	(a)		PR = 540 m (3.sf)
	(b)		$\angle PRS = 29.0°$ (1 d.p.)
	(c)		Area of $\Delta PRS = 98200$ m^2 (3 s.f.)
	(d)		262 m (3 s.f.)
	(e)		8.7° (1 d.p.)
7	(a)	(i)	$RQ = 9r + 3$
		(ii)	$OR = 9r$
	(b)		Show question
	(c)		$1\frac{1}{3}$ or $-\frac{1}{6}$
	(d)		4.86 cm^2
8	(a)	(i)	$\mathbf{p}-\mathbf{q}$
		(ii)	$3\mathbf{p}+2\mathbf{q}$
	(b)		Show question
	(c)		$k=\frac{1}{5}$, $h=\frac{3}{5}$
	(d)	(i)	5
		(ii)	15
9	(a)	(i)	Median = $60
		(ii)	IQR =$18
	(b)	(i)	10, 30, 30, 6, 4
		(ii)	(a) Mean = $61

S/No.			Answer
		(ii)	$n(A)=4$
		(iii)	$(A\cup B)'=\{6\}$
	(b)	(i)	$\begin{pmatrix}6 & 4 & 0.5\\ 5 & 2 & 0.2\end{pmatrix}$
		(ii)	$\begin{pmatrix}8.5\\ 2\\ 0.7\end{pmatrix}$
		(iii)	$C=\begin{pmatrix}59.35\\ 46.64\end{pmatrix}$ The elements represent the cost to produce one large sofa and one small sofa respectively.
		(iv)	$DC=(1759.5)$ The element represents the total cost to produce 10 large sofa and 25 small sofas.
5	(a)		$p=-0.87$
	(b)		
	(c)		$x=2$
	(d)		$x=4$
	(e)	(i)	See graph
		(ii)	$x=1.1$
		(iii)	$\therefore A=6.4$ and $B=-8$

S/No.		Answer
(ii)	(b)	S.D = $19.47 (2 d.p.)
(c)		The outdoor club collected mo[...] money on average because t[...] median amount of money collecte[...] by the outdoor club is $66 which [...] higher than the median amount [...] $60 collected by the soccer team [...] $6.
10	(a)	Vertical height = 150 cm or 1.5 m Length of short side = 100 cm or 1[...] Length of long side = 200 cm or 2[...]
	(b)	26.4 m^3
	(c)	Since the time taken to chang[...] water is 29.73s which is < 30s, there is **no** need to set up preventive measures.

Name ______________ Class ______ Register Number ______

4048/01 **16/S4PR2/EM/1**

MATHEMATICS **PAPER 1**

Friday **29 July 2016** **2 hours**

VICTORIA SCHOOL

PRELIMINARY EXAMINATION TWO
SECONDARY FOUR

Candidates answer on the Question Paper.

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

Answer **all** the questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
You are expected to use a scientific calculator to evaluate explicit numerical expressions.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 80.

This paper consists of 15 printed pages, including the cover page.

[Turn over

1 Calculate $\dfrac{\sqrt{0.00234 \times 9.45}}{29.5}$, giving your answer correct to

(a) 5 decimal places,

Answer (a) .... [1]

(b) 5 significant figures.

Answer (b) .... [1]

2 A sequence of numbers is given as follows:

1^{st} line:	$1^2 + 1 - 1 = 1$
2^{nd} line:	$2^2 + 2 - 1 = 5$
3^{rd} line:	$3^2 + 3 - 1 = 11$
4^{th} line:	$4^2 + 4 - 1 = 19$

(a) Write down an expression, in terms of n, for the nth term in the sequence.

Answer (a) .... [1]

(b) Calculate the value of the 67^{th} term of the sequence.

Answer (b) .... [1]

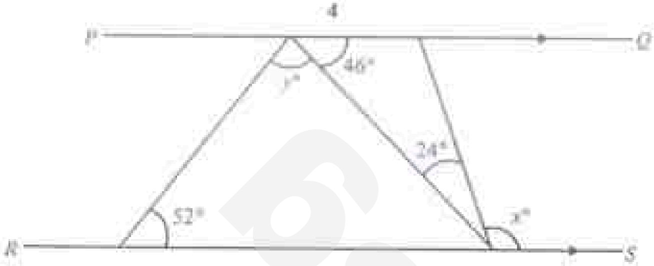
3 (a) Given that $3^4 \times 3^{\frac{2}{x}} = 3^{-\frac{1}{3}}$, find the value of x.

Answer (a) $x =$ .... [1]

(b) Light travels 1 metre in 3.3 nanoseconds.
Find the total distance, in metres, that light will travel in 6.6 microseconds.

Answer (b) .... m [1]

4



PQ is parallel to RS.

(a) Find x.

Answer (a) $x =$ ____________ [1]

(b) Find y.

Answer (b) $y =$ ____________ [1]

---

5 A group of students were asked to determine which of the following allows more water to flow through in a given time:

A	Two hoses with diameters of 5 cm each.	OR	**B**	A hose with a diameter of 8 cm.

Paul chooses A. His reasoning is that the two hoses have a bigger combined diameter of $5+5=10>8$. Is Paul right? Explain.

Answer ....

....

.... [2]

---

6 Simplify $36b^2 - 25(1-b)^2$.

Answer .... [2]

7 Some students were interviewed to find out the languages they spoke at home.

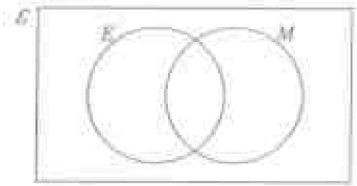
$\mathcal{E}$ = {The set of students who were interviewed}
E = {The set of students who spoke English}
M = {The set of students who spoke their Mother Tongue}

(a) Describe, as simply as possible, in words, the set $M \cap E'$.

Answer (a) ....

.... [1]

(b) On the Venn Diagram, shade the region which represents $E \cup (M \cup E)'$.



[1]

It is given that $n(\mathcal{E}) = 256$, $n(E) = 195$ and $n(M) = 123$.

(c) If $M \subset E$, find the number of students who did not speak either English or their Mother Tongue.

Answer (c) .... [1]

---

8 (a) Factorise $x^2 - 2xy + y^2$.

Answer (a) .... [1]

(b) Factorise completely $x^3 - 3x^2 - 4x + 12$.

Answer (b) .... [2]

9 Boris and Bram jog on a circular track with radius 15 m. Boris jogs with a constant speed of 0.15π ms^{-1} and Bram jogs with a constant speed of 0.25π ms^{-1}. If both boys start jogging in the opposite direction from point A at 08 10, when will they meet again at A?

Answer .... [3]

10 Two similar marbles made from the same material have radii in the ratio of $2 : 5$.

(a) If it costs \$2 to paint the small marble, calculate the cost to paint the large marble using the same paint.

Answer (a) \$ .... [1]

(b) If the mass of the larger marble is 250 g, what is the mass of the smaller marble?

Answer (b)..............................g [2]

11 A painter takes 4 days to paint a house. His apprentice takes 2 more days to paint the same house.

(a) Find the number of similar houses that the apprentice can paint in 30 days.

Answer (a).....................houses [1]

(b) If the painter and the apprentice paint the house together, how many days will it take the both of them to complete painting 1 house?

Answer (b).......................days [2]

12 (a) Sketch the graph of $y = 2 - \frac{1}{2}(x+2)^2$.

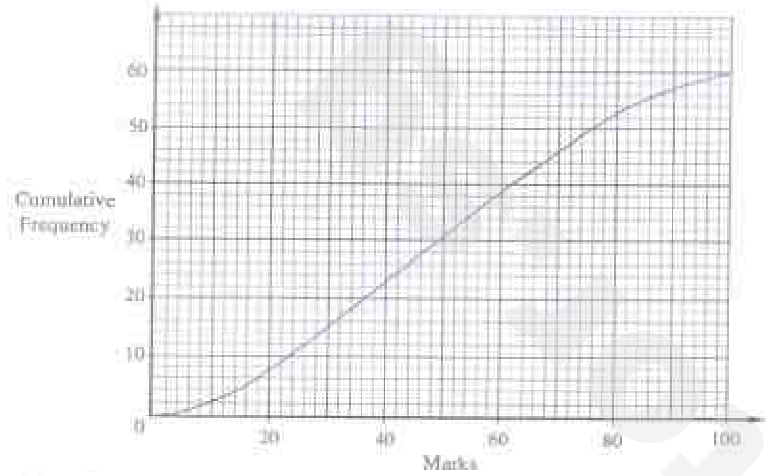
Answer (a)

[2]

(b) Write down the equation of the line of symmetry of the graph of $y = 2 - \frac{1}{2}(x+2)^2$.

Answer (b).............................. [1]

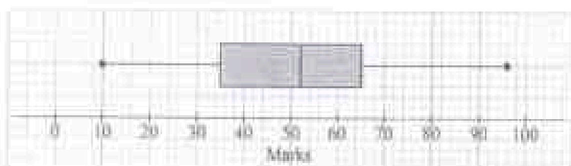
13 The cumulative frequency curve below shows the marks obtained, out of 100, by 60 students in an Elementary Mathematics paper.



(a) Find interquartile range of the distribution.

Answer (a) .... marks [1]

(b) The same 60 students also sat for the Additional Mathematics paper. The box-and-whisker diagram below illustrates the marks obtained. The maximum mark was again 100.



A parent commented that the Elementary Mathematics paper was easier than the Additional Mathematics paper.

Do you agree? Give a reason for your answer.

Answer (b) .... because ....

....

.... [2]

14 The period of oscillation, T seconds of a string varies directly as the square root of the length of the string, l cm. When the length of the string is 36 cm, the period of the oscillation is 0.3 seconds.

(a) Find the length of the string when the period of oscillation is 0.4 seconds.

Answer (a) .... cm [2]

(b) Calculate the percentage change in l if T is decreased by 30%.

Answer (b) .... % [2]

15 (a) The lowest point of a quadratic curve is $(-4,-6)$. It intersects the y-axis at -5. Write down the equation of the curve in the form $y = a(x+b)^2 + c$, where a, b, c are integers.

Answer (a) $y =$ .... [2]

(b) Hence solve the equation $a(x+b)^2 + c = 0$, giving your answers correct to two decimal places.

Answer (b) $x =$ .... [2]

16 (a) Is it possible to draw a regular polygon whose exterior angle is $7°$?
Give a reason for your answer.

Answer (a) ....

.... [2]

(b)

In the diagram above, ABC... is part of a polygon. $\angle ABC$ is $148°$. The size of the remaining interior angles are each equal to $139°$. Find the number of sides of this polygon.

Answer (b) .... [2]

---

17 Vernon travels to school either by bus or by car. The probability of being late for school is $\frac{1}{5}$ if he travels by bus and $\frac{1}{20}$ if he travels by car.

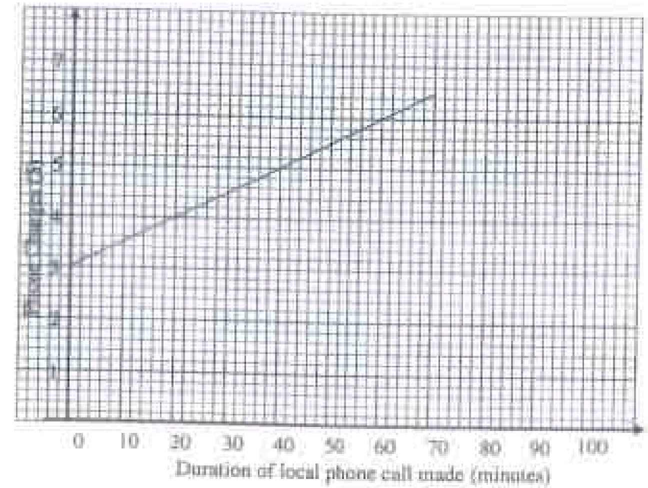
(a) Find the probability that he will be late on just two out of three days if he travels by bus on three consecutive days.

Answer (a) .... [2]

(b) If the probability that he travels by bus is $\frac{2}{3}$, find the probability that he will be late for school on any given day.

Answer (b) .... [2]

18 The graph shows the charges made by a telecommunication company for making local phone calls lasting up to 70 minutes. The total cost is made up of a fixed charge, \$3.00, together with a charge of \$$x$ per minute for making local phone calls.



(a) State the cost of making 44 minutes of local phone call.

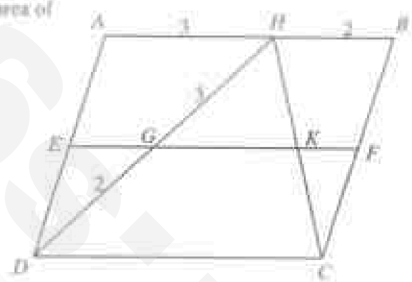
Answer (a) \$ .... [1]

(b) (i) A second telecommunication company that does not have a fixed charge, charges 8¢ per minute for the first 50 minutes and 15¢ per minute after that.
Draw a graph, on the same axes, to represent the charge made by this second company.

(ii) Find the range of times, T, for which it would be cheaper to subscribe to the second company.

Answer (b)(ii) .... [1]

19 In the diagram, $ABCD$ is a parallelogram with $EF \parallel AB$, $AH = GH = 3$ cm and $HB = DG = 2$ cm. EF intersects HD and HC at G and K respectively.
If the area of $\triangle GHK = 18\text{ cm}^2$, find the area of



(a) triangle DHC,

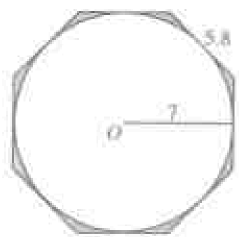
Answer (a)............................ cm^2 [2]

(b) triangle BCH.

Answer (b)............................ cm^2 [2]

---

20 The diagram shows a circle with centre O and radius 7 cm inscribed in a regular octagon of sides 5.8 cm each.



(a) Calculate the area of the octagon.

Answer (a)............................ cm^2 [2]

(b) Find the total area of the shaded region between the circle and the octagon.

Answer (b)............................ cm^2 [2]

21 (a) Solve the equation $\frac{x-3}{2} - 5 = \frac{7}{2}x$.

Answer (a) $x =$ ____________ [2]

(b) 216 cubes, each having edges of 2.6 cm, measured to the nearest 0.1 cm, fit exactly into a larg

(i) greatest possible length of the cubic box.

Answer (b)(i) ____________ cm [2]

(ii) least possible volume of the cubic box.

Answer (b)(ii) ____________ cm^3 [1]

---

22 The equation of a straight line is $\frac{x}{3} - \frac{y}{4} = 1$.

(a) Find the gradient of the line.

Answer (a) ____________ [1]

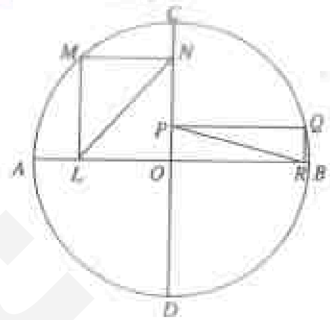
(b) Find the equation of the line, parallel to $\frac{x}{3} - \frac{y}{4} = 1$, which passes through the point $\left(1\frac{1}{2}, \frac{1}{2}\right)$.

Answer (b) ____________ [2]

(c) Find the distance between the points at which these two lines cut the x-axis.

*Answer (c)*____________ units [2]

23 (a) In the diagram, O is the centre of the circle $ADBC$. AB and CD are two perpendicular diameters. L and R are points on AB. N and P are points on CD. M and Q are points on the circumference of the circle. $LMNO$ and $OPQR$ are two rectangles.



Explain briefly why LN and PR are equal in length.

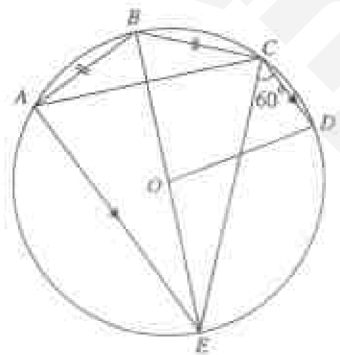
Answer (a) ....

....

.... [2]

(b) In the diagram, the points A, B, C, D and E lie on a circle, centre O.
BOE is a diameter, $AB = BC$, $\angle ECD = 60°$.
AE is parallel to CD.

(i) Find $\angle AEB$.



Answer (b)(i) $\angle AEB =$ .... ° [2]

(ii) Hence show that triangle ACE is an equilateral triangle.

Answer (b)(ii) ....

....

....

.... [1]

24 The point H represents the position of a harbour located along a coastline. Another point J represents the position of a jetty situated along the same coastline. The point L represents the position of a lighthouse.
It is given that $HJ = 1800$ m, $\angle LHJ = 26°$ and $\angle HJL = 93°$.

(a) Using a scale of 1 : 20000, construct the ΔHJL. [2]

Answer (a) and (c)

H•

(b) Measure and write down the distance LH.

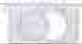
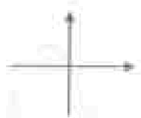
Answer (b) .... m [1]

(c) A yacht sails directly from H to L. By drawing a suitable line, measure and write down its closest distance to the jetty.

Answer (c) .... m [2]

End of Paper

2016 Victoria School Prelim 2 Mathematics Paper 1 Answer Key

1a	0.00504
1b	0.0050408
2a	n^2+n-1
2b	4555
3a	$x=-\frac{4}{9}$
3b	2000 m
4a	$x=110$
4b	$y=82$
5	No, Paul is wrong. The hose in B with a larger cross sectional area allows more water to flow through than in A.
6	$(11b-5)(b+5)$
7a	$M\cap E'$ is the set of students who spoke only in their Mother Tongue at home
7b	
7c	61 students
8a	$(x-y)^2$
8b	$(x-2)(x+2)(x-3)$
9	0820
10a	$12.50
10b	16g
11a	5 days
11b	$2\frac{2}{5}$ days
12a	
12b	$x=-2$
13a	39 marks
13b	Disagree. Median marks in Elementary Mathematics paper is lower.
14a	64
14b	Increase by 69%
15a	$y=x^2+2x-5$
15b	$x=-3.45$ or $x=1.45$
16a	No. 360° is not divisible by 7
16b	9 sides
17a	$\frac{12}{125}$
17b	$\frac{3}{20}$
18a	$5.20
18bii	$0\le T<65$
19i	50

19ii	20
20a	162.4
20b	8.4
21a	$-2\frac{1}{6}$
21bi	15.9
21bii	3581.577
22a	$1\frac{1}{3}$
22b	$6y=8x-9$
22c	$1\frac{7}{8}$
23b	30°
24a	Constructions
24b	2055 m
24c	790 m

Name ______________________

Class	Register Number

4048/02 **16/S4PR2/EM/2**

MATHEMATICS **PAPER 2**

Tuesday **2 August 2016** **2 hours 30 minutes**

VICTORIA SCHOOL

PRELIMINARY EXAMINATION TWO
SECONDARY FOUR

Additional Materials: Answer Paper
Graph Paper

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
You are expected to use a scientific calculator to evaluate explicit numerical expressions.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is 100.

This paper consists of 10 printed pages, including the cover page.

[Turn over

Answer **all** the questions.

1 (a) Victor and Gloria are in an organic farm in Murai Farmway with their families.
Victor buys five pieces of tofu and four packets of mushroom for $23.55.
Gloria buys four pieces of tofu and three packets of mushroom.
She pays with two $10 notes and receives change of $1.80.

(i) Write down a pair of simultaneous equations to represent this information.
Use t to represent the cost, in dollars, of a piece of tofu
and m to represent the cost, in dollars, of a packet of mushrooms. [2]

(ii) Solve your simultaneous equations to find t and m. [2]

(iii) Calculate the total cost of buying two pieces of tofu and five packets of mushroom. [1]

(b) Solve the equation $3+13x-4x^2=0$, giving the answers correct to three decimal places. [4]

2 (a) (i) Express 8064 as the product of its prime factors. [1]

(ii) Find the value of k such that $\frac{8064}{k}$ is the largest possible perfect cube. [1]

Given that $p = 2^3 \times 3^4 \times 7$. Write down the

(iii) lowest common multiple of 8064 and p, giving your answer as the product of its prime factors, [1]

(iv) greatest integer that will divide both 8064 and p exactly. [1]

(b) When n is a whole number, $2n+1$ is an odd number.

(i) Write down an expression for the next two consecutive odd numbers after $2n+1$. [1]

(ii) Find and simplify an expression for the difference between the squares of the two consecutive odd numbers found in **(b)(i)**. [2]

(iii) Hence, explain why the difference between the squares of two consecutive odd numbers is always a multiple of 8. [1]

3 The table below shows the ticket prices at the Singapore Garden Festival held at Gardens by the Bay.

Ticket	Price
Adult	\$20
Child	\$12
Senior Citizen	\$15

(a) Represent the ticket price for adult, child and senior citizen by a column matrix $\mathbf{Q}$. [1]

(b) Mr Ang bought 4 adults, 2 children and 1 senior citizen tickets to the festival. Write down a matrix $\mathbf{P}$ such that the matrix multiplication $\mathbf{R} = \mathbf{PQ}$ gives the total amount Mr Ang paid for the tickets. Hence, find $\mathbf{R}$. [2]

(c) The table below shows the number of tickets sold at the festival.

	Number of tickets sold		
Day	Adult	Child	Senior Citizen
Monday	81	c	36
Tuesday	85	42	x

(i) The ticket sales collected on Monday and Tuesday was \$2724 and \$2744 respectively.
Represent these ticket sales in a 2×1 matrix $\mathbf{T}$. [1]

(ii) Form a matrix multiplication such that the product will be $\mathbf{T}$. [1]

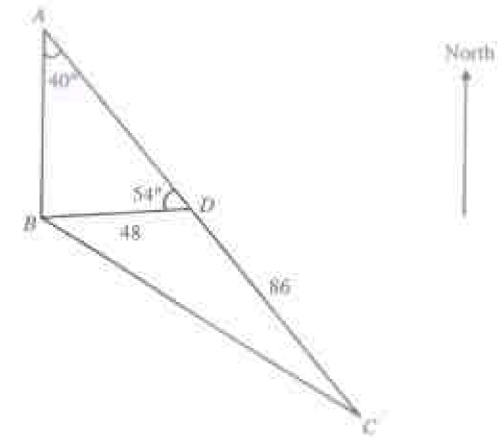
(iii) Find the value of c and of x. [2]

Gardens by the Bay donated part of their ticket sales to a charity organization. $\mathbf{U}$ represents the total amount of money donated to the organization on Monday and Tuesday.

(iv) Evaluate the matrix $\mathbf{U} = \begin{pmatrix} 0.15 & 0.1 \end{pmatrix}\mathbf{T}$. [1]

(v) Explain what the elements of the matrix $\begin{pmatrix} 0.15 & 0.1 \end{pmatrix}$ represent. [1]

4



ABD and BCD are two horizontal triangular plots of land.
$BD = 48$ m and $CD = 86$ m.
Angle $BAD = 40°$ and angle $BDA = 54°$.
A is due north of B and ADC is a straight line.

(a) Calculate

(i) AD, [2]

(ii) the total area of the plots of land $ABCD$, [2]

(iii) BC. [2]

(b) Given that Z is a point on CD such that $ZD = 48$ m, calculate the bearing of B from Z. [2]

(c) The base of a vertical mast is at B.
The greatest angle of elevation of the top of the mast from a point on AC is 17.4°.

Calculate the angle of depression of C when viewed from the top of the mast. [3]

5 (a) Simplify $\frac{16a^3b^4}{7c^4} \div \frac{4ab^2}{21c^3} \times \frac{27a^{n+1}}{8a^{n+2}}$. [2]

(b) Simplify $\frac{2u+18v}{(u+4v)^2-25v^2}$. [2]

(c) (i) Solve the inequality $\frac{6x}{7}-\frac{3}{8} \le x+2\frac{1}{4}$. [1]

(ii) Hence, state the smallest integer value of x such that $\frac{6x}{7}-\frac{3}{8} \le x+2\frac{1}{4}$. [1]

(d) (i) Express as a single fraction in its simplest form $\frac{h}{4-h}-\frac{1}{h+3}$. [2]

(ii) Solve the equation $\frac{h}{4-h}-\frac{1}{h+3}=\frac{4}{5}$. [3]

---

6 **Answer the whole of this question on a sheet of graph paper.**

The variables x and y are connected by the equation

$$y = x+\frac{12}{x}-5.$$

Some corresponding values of x and y are given in the table below.

x	1	1.5	2	3	4	5	6	7	8
y	8	p	3	2	2	2.4	3	3.7	4.5

(a) Calculate the value of p. [1]

(b) Using a scale of 2 cm to represent 1 unit, draw a horizontal x-axis for $0 \le x \le 8$.
Using a scale of 2 cm to represent 1 unit, draw a vertical y-axis for $0 \le y \le 8$.

On your axes, plot the points given in the table and join them with a smooth curve. [3]

(c) Use your graph to find the solutions of $x+\frac{12}{x}=8\frac{1}{5}$. [1]

(d) By drawing a tangent, find the gradient of the curve at $(6, 3)$. [2]

(e) By drawing a suitable straight line on your graph, solve $2x^2-11x+12=0$. [2]

7 (a) A is a point $(-4, 1)$, $\overrightarrow{AB}=\begin{pmatrix}5\\4\end{pmatrix}$ and $\overrightarrow{AC}=\begin{pmatrix}-3\\8\end{pmatrix}$.

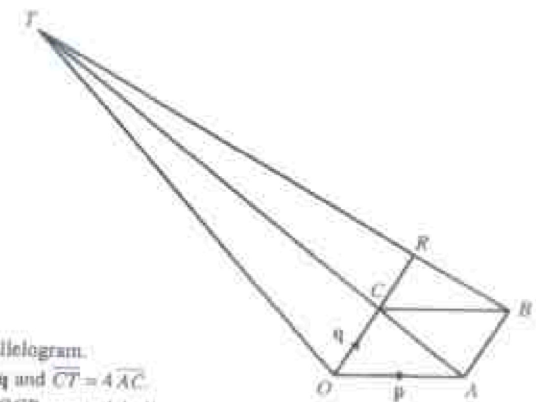
(i) Write down the column vector $\overrightarrow{BC}$. [1]

(ii) Find $|\overrightarrow{BC}|$. [2]

(iii) P is a point such that $\overrightarrow{BP}=2\overrightarrow{PC}$.
Find the column vector $\overrightarrow{AP}$. [2]

(iv) Given $\overrightarrow{OQ}=\begin{pmatrix}\frac{2}{3}\\ 11\frac{2}{3}\end{pmatrix}$.
What type of quadrilateral is $APQB$?
Justify your answer using vectors. [3]

(b)



$OABC$ is a parallelogram.
$\overrightarrow{OA}=\mathbf{p}$, $\overrightarrow{OC}=\mathbf{q}$ and $\overrightarrow{CT}=4\overrightarrow{AC}$.
ACT, BRT and OCR are straight lines.

(i) Express each of the following, as simply as possible, in terms of $\mathbf{p}$ and/or $\mathbf{q}$.

(a) $\overrightarrow{OB}$. [1]

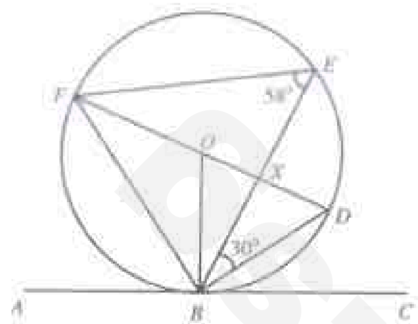
(b) $\overrightarrow{OT}$. [1]

(c) $\overrightarrow{BT}$. [1]

(ii) Given that $\overrightarrow{BR}=\frac{4}{5}\mathbf{q}-\mathbf{p}$, find k if $\overrightarrow{OC}=k\overrightarrow{CR}$. [1]

(iii) Find the value of $\frac{\text{area of } \Delta BCR}{\text{area of } \Delta OCT}$. [1]

8 (a)



The line DF is a diameter of the circle $BDEF$ with centre O.
ABC is a tangent to the circle at B.
X is the point of intersection of DF and BE.
Angle $DBE = 30°$ and angle $BEF = 58°$.

(i) Find

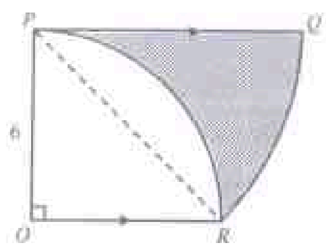
(a) angle FBO, [2]

(b) angle ABF, [1]

(c) angle DXE. [1]

(ii) Given that the radius of the circle is 14 cm, find the area of triangle BDF. [2]

(b)



In the diagram, POR is a quadrant of a circle with radius 6 cm.
OR and PQ are parallel.
QR is an arc of a circle with centre P.

Calculate the area and the perimeter of the shaded region. [4]

9 (a) The ages of 50 employees in Company V is shown in the table below.

Age in years	$24 < x \le 28$	$28 < x \le 32$	$32 < x \le 36$	$36 < x \le 40$	$40 < x \le 44$
Number of employees	7	10	13	8	p

(i) State the value of p. [1]

(ii) Hence, calculate the

(a) mean age of the employees, [1]

(b) standard deviation. [1]

(iii) The age distribution of 50 employees in Company W is summarized below.

Mean	29.6 years
Standard deviation	7.13 years

Make two comparisons between the ages of employees in both companies. [2]

(b) A box contains 5 red flags and 8 yellow flags.
Two flags are taken from the bag at random without replacement.

(i) Draw a tree diagram to show the probabilities of the possible outcomes. [2]

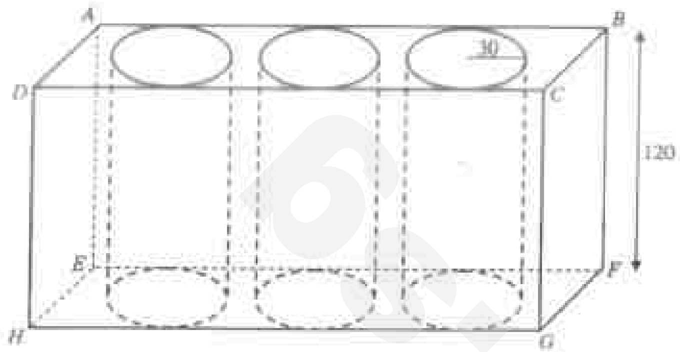
(ii) Find, as a fraction in its simplest form, the probability that

(a) the first flag is red and the second flag is yellow, [1]

(b) both flags are the same colour, [1]

(c) at least one flag is yellow. [1]

10



Class 4V has chosen the 'Go Green' theme for their Social Innovation Project. The diagram above shows the recycling bins structure that they have built.

The whole structure consists of 3 open identical cylindrical plastic containers fit into a wooden cuboid crate. All the containers and the crate are of negligible thickness.

3 circles had to be cut from the top of the crate to fit the containers.
Each plastic container is placed in the crate such that they are 20 cm away from the sides of the crate, *ADHE* and *BCGF*, as well as 20 cm apart from each other.
Each plastic container touches the base and sides, *ABFE* and *DCGH*, of the crate too.
The radius and height of the plastic container are 30 cm and 120 cm respectively.

(a) Write down the dimensions of the crate. [1]

(b) Calculate the

(i) exact total surface area of the crate that was cut out, [1]

(ii) exact total internal surface area of each cylindrical container, [2]

(iii) total **exposed** external surface area of the crate. [2]

(c) The class would like to paint all the exposed external surfaces of the crate yellow. One tin of paint can cover an area of $3.75\ m^2$. How many tins do they need to purchase? Justify your answer. [2]

(d) If each cylindrical container is filled to the brim, what is the maximum volume of recyclables that can be collected by the class in a single collection? [2]

End of Paper

2016 Victoria School Prelim 2 Mathematics Paper 2 Answer Key

1a(i)	$5t + 4m = 23.55$ $4t + 3m = 18.20$
1a(ii)	$t = 2.15$ and $m = 3.20$
1a(iii)	\$ 20.30
1b	$x = -0.216$ (3 d.p.) or $x = 3.466$ (3 d.p.)
2a(i)	$8064 = 2^7 \times 3^2 \times 7$
2a(ii)	$k = 126$
2a(iii)	$2^7 \times 3^4 \times 7$
2a(iv)	504
2b(i)	$(2n+3)$ and $(2n+5)$
2b(ii)	$8(n+2)$
2b(iii)	Since 8 is a factor of $8(n+2)$, the difference between two consecutive odd numbers will always be a multiple of 8.
3(a)	$\mathbf{Q} = \begin{pmatrix} 20 \\ 12 \\ 15 \end{pmatrix}$
3(b)	$\mathbf{P} = \begin{pmatrix} 4 & 2 & 1 \end{pmatrix}$ $\mathbf{R} = \begin{pmatrix} 4 & 2 & 1 \end{pmatrix}\begin{pmatrix} 20 \\ 12 \\ 15 \end{pmatrix}$ $= \begin{pmatrix} 119 \end{pmatrix}$
3(c)(i)	$\mathbf{T} = \begin{pmatrix} 2724 \\ 2744 \end{pmatrix}$
3(c)(ii)	$\begin{pmatrix} 81 & c & 36 \\ 85 & 42 & z \end{pmatrix}\begin{pmatrix} 20 \\ 12 \\ 15 \end{pmatrix} = \begin{pmatrix} 2724 \\ 2744 \end{pmatrix}$
3(c)(iii)	$c = 47$ and $z = 36$
3(c)(iv)	$\begin{pmatrix} 683 \end{pmatrix}$
3(c)(v)	Elements of $\begin{pmatrix} 0.15 & 0.1 \end{pmatrix}$ represent the **percentage** of the **total ticket sales** that Gardens by the Bay had **donated** to the charity organization on **Monday and Tuesday respectively**
4(a)(i)	74.5 m (3 s.f.)
4(a)(ii)	$3120\ m^2$ (3 s.f.)
4(a)(iii)	121 m (3 s.f.)
4(b)	293°
4(c)	5.8° (1 d.p.)

5(a)	$\frac{81a^3b^3}{2c}$
5(b)	$\frac{2}{u-v}$
5(c)(i)	$x \geq -18\frac{3}{8}$
5(c)(ii)	-18
5(d)(i)	$\frac{h^2+4h-4}{(4-h)(h+3)}$
5(d)(ii)	$h=-3\frac{7}{9}$ or $h=2$
6(a)	$p=4.5$
6(c)	$x=1.9$ or $x=6.3$
6(d)	0.660 (3 s.f.)
6(e)	$x=1.5$ or $x=4$
7(a)(i)	$\begin{pmatrix} -8 \\ 4 \end{pmatrix}$
7(a)(ii)	8.94 units (3 s.f.)
7(a)(iii)	$\begin{pmatrix} -\frac{1}{3} \\ 6\frac{2}{3} \end{pmatrix}$
7(a)(iv)	$\overrightarrow{AP}=\overrightarrow{BQ}$ and $\overrightarrow{AB}=\overrightarrow{PQ}$ $\lvert\overrightarrow{AP}\rvert=\lvert\overrightarrow{BQ}\rvert$ and $\lvert\overrightarrow{AB}\rvert=\lvert\overrightarrow{PQ}\rvert$ Thus, $APQB$ is a parallelogram.
7(b)(i)(a)	$p+q$
7(b)(i)(b)	$5q-4p$
7(b)(i)(c)	$4q-5p$
7(b)(ii)	$k=1\frac{1}{4}$
7(b)(iii)	$\frac{1}{5}$
8(a)(i)(a)	32°
8(a)(i)(b)	58°
8(a)(i)(c)	88°
8(a)(ii)	176 cm^2 (3 s.f.)
8(b)	Area of shaded region = 18 cm^2 Perimeter of shaded region = 24.6 cm (3 s.f.)

9(a)(i)	$p=12$
9(a)(ii)(a)	34.64 years
9(a)(ii)(b)	5.45 years (3 s.f.)
9(a)(iii)	The employees in company W are younger than those in company V since the mean age of employees in company W is lower than that of company V. The spread of ages of employees in company W is wider since the standard deviation of ages of employees in company W is larger than that of company V.
9(b)(i)(a)	$\frac{10}{39}$
9(b)(i)(b)	$\frac{19}{39}$
9(b)(i)(c)	$\frac{34}{39}$
10(a)	260 cm by 60 cm by 120 cm
10(b)(i)	2700π cm^2
10(b)(ii)	8100π cm^3
10(b)(iii)	83900 cm^3 (3 s.f.)
10(c)	3
10(d)	1 020 000 cm^3 (3 s.f.)

Answer all the questions.

1 Write the following in order of size, starting with the smallest.

$$7.3\dot{5},\ \frac{22}{3},\ 7.\dot{3}\dot{5},\ \sqrt{54}$$

Answer ...., ..., ..., ... [1]

2 (a) Calculate $\sqrt{\dfrac{27.38-3.42^2}{0.076421}}$ and write down the first six digits on your calculator display.

Answer .... [1]

(b) Write your answer to part (a) correct to 2 decimal places.

Answer .... [1]

3 Gary just bought a new iPhone which has a hard disk space of 128 gigabytes. Given that each application download takes up about 212 megabytes of disk space, find the number of applications he is able to download, giving your answer in standard form.

Answer .... [2]

4 The following are the first 4 terms in a sequence

37, 33, 29, 25.

(a) Write down the 6^{th} term of the sequence.

Answer .... [1]

(b) Write down an expression, in terms of n, for the n^{th} term in the sequence.

Answer .... [1]

5 (a) Express 600 as a product of its prime factors.

Answer .... [1]

(b) Given $126 = 2 \times 3^2 \times 7$, find the highest common factor of 126 and 600. Give your answer as the product of its prime factors.

Answer .... [1]

(c) The smallest positive integer value of n such that $126n$ is a multiple of 600.

Answer .... [2]

6 Given x and y are integers such that $2 \le x \le 5$ and $-4 < y < 3$, find

(a) the greatest possible value of $x^2 - y^2$,

Answer .... [1]

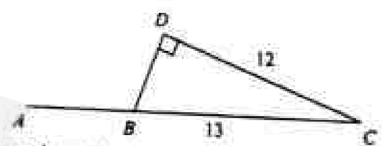
(b) the least possible value of $\frac{x}{y}$,

Answer .... [1]

(c) the greatest possible value of $(x-y)^3$.

Answer .... [1]

7



The diagram above shows triangle BCD. Given that $BC = 13$ cm, $CD = 12$ cm, $\angle BDC = 90°$ and ABC is a straight line.

(a) Find BD.

Answer ....cm [1]

(b) Write down $\cos \angle ABD$.

Answer .... [1]

8 Given that y is inversely proportional to the square of x, find the percentage decrease in y when x is increased by 400%.

Answer ....% [3]

9 (a) Factorise completely $75x^4 - 147x^2$.

Answer .... [2]

(b) Factorise completely $2x + 8xy - 6a - 24ay$.

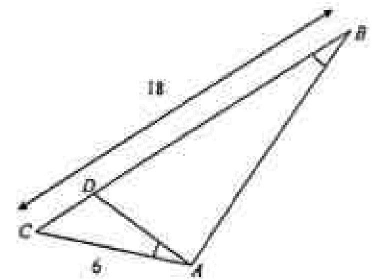
Answer .... [2]

7

10 Given that $3^3 \times 3^{k+1} \div 3^{2k} = 729$, find the value of k.

Answer k = ... [2]

11



The diagram shows a triangle ABC such that $BC = 18$ cm and $AC = 6$ cm.

D is a point on BC such that $\angle DAC = \angle ABC$.

(a) Show that triangle ABC is similar to triangle DAC, stating your reasons clearly.

Answer

....

....

....

....

....

....

.... [3]

8

(b) Hence calculate

(i) CD,

Answer .... cm [1]

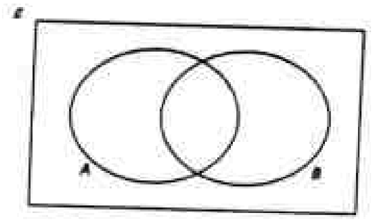
(ii) $\dfrac{\text{area of } \Delta DAC}{\text{area of } \Delta ABC}$,

Answer .... [1]

(iii) $\dfrac{\text{area of } \Delta DAC}{\text{area of } \Delta ADB}$.

Answer .... [1]

12 (a) On the Venn Diagram below, shade the set $A' \cap B'$.



[1]

(b)

$\varepsilon = \{x : x \text{ is an integer such that } 1 \le x \le 20\}$
$A = \{x : x \text{ is a prime number}\}$
$B = \{x : x \text{ is a perfect square}\}$
$C = \{x : x \text{ is mutiple of } 4\}$

(i) List the elements found in the set $B \cap C$.

Answer .... [1]

(ii) Find $n(A \cap B)'$.

Answer .... [1]

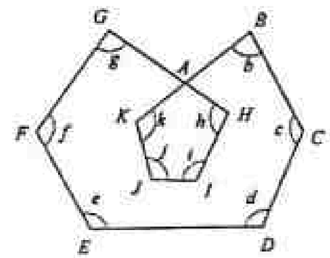
13 (a) Simplify $\frac{3a^2b^4}{4c^3d} \div \left(\frac{6a^3b}{cd}\right)^2$.

Answer .... [2]

(b) Simplify $(3k-2)(4k+5)+(k-4)^2$.

Answer .... [3]

14 The diagram below shows a figure $ABCDEFG$ and a pentagon $AHIJK$. Given that GAH and BAK are straight lines, calculate the sum of $\angle b+\angle c+\angle d+\angle e+\angle f+\angle g+\angle h+\angle i+\angle j+\angle k$.



Answer ....° [2]

15 (a) Express $-x^2+6x-7$ in the form $-(x-a)^2+b$.

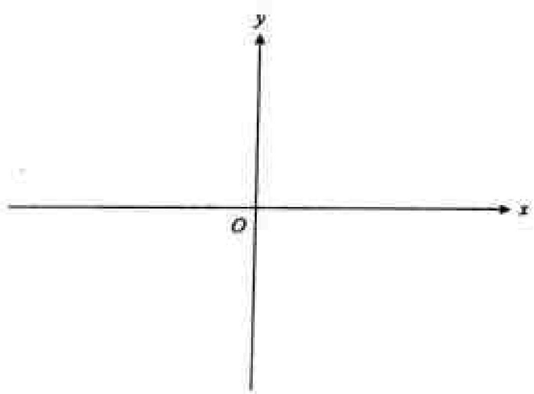
Answer .... [2]

(b) Hence or otherwise, solve $-x^2+6x-7=0$, showing your workings clearly. Give your answers correct to three decimal places.

Answer $x=$ .... or .... [2]

(c) Hence, sketch the graph of $y=-x^2+6x-7$, labeling all x intercepts and turning points.

Answer



[2]

(d) Write down the equation of the line of symmetry of the graph $y=-x^2+6x-7$.

Answer .... [1]

16 The line $5x+2y=22$ cuts the x-axis at A and the y-axis at B.

(a) Find the coordinates of A and B.

Answer A(...... , ...), B (...... , ...) [2]

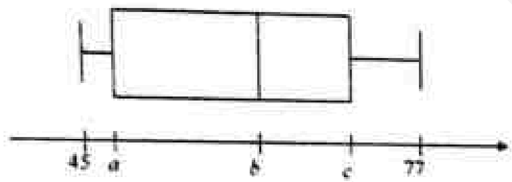
(b) Find the length of AB.

Answer ....units [2]

(c) Another line L is parallel to $5x+2y=22$ and passes through the point $(2,4)$. Find the equation of the line L.

Answer $y=$ .... [2]

17 A box-and-whisker diagram below shows the points scored in 10 basketball games. The results were 45, 77, 60, 47, 63, 69, 71, 48, 73, and 55.



(a) Find the values of a, b and c.

Answer a = ..., b = ..., c = ... [2]

(b) The score 60 was accidentally left out. Using the remaining results from the 9 basketball games, find the new interquartile range of the 9 basketball games.

Answer .... [2]

18 The cash price of a new laptop is $1500. Ash bought the laptop on hire purchase and paid a deposit of 20% of the cash price followed by 24 months installment at 2.5% per annum compound interest. Calculate

(a) the total amount of interest,

Answer $................................ [3]

(b) the monthly installment.

Answer $................................ [2]

19 The table below shows the tax rates on chargeable income for the year of assessment 2016.

Chargeable Income ($)	Tax Rate (%)	Tax payable ($)
On the first 20,000	0	0
On the next 10,000	2	200
On the first 30,000	-	200
On the next 10,000	3.5	350
On the first 40,000	-	550
On the next 40,000	7	2800
On the first 80,000	-	3350
On the next 40,000	11.5	4600

Michael paid a total of $5 937.50 in 2016 for his income tax. He received a 3 months bonus and his tax reliefs amount to $10 000. (Chargeable income = Annual income – total tax relief)

Calculate

(a) Michael's chargeable income,

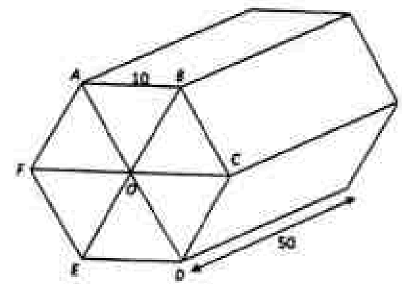
Answer $ .... [3]

(b) Michael's monthly salary

Answer $ .... [2]

17

20 The diagram shows a closed hexagonal prism. The cross section of the prism is a regular hexagon made up of six equilateral triangles, with sides of length 10 cm. The length of the prism is 50 cm.



Calculate

(a) the volume of the prism,

Answer .... cm³ [2]

(b) the surface area of the prism.

Answer .... cm² [2]

18

(c) A manufacturer wants to produce a geometrically similar giant hexagonal prism. The cross-section of the giant prism has sides of length 2 m. Given that the cost of producing one small hexagonal prism is \$20, calculate the cost of producing the giant hexagonal prism (assume that cost is directly proportional to volume).

Answer \$............................... [2]

21

(a) Construct a quadrilateral $ABCD$ where $BC = 7.3$ cm, $CD = 9.2$ cm and $AD = 8.1$ cm and $\angle BAD = 105°$. AB has already been drawn.

(b) Construct,

(i) the perpendicular bisector of AD,

(ii) the angle bisector of $\angle ABC$.

(c) Mark clearly a possible point which is inside the quadrilateral $ABCD$, equidistant from A and D, and is nearer to AB than BC.
Label this point T.

Answer

[6]

– End of Paper –

1	$\frac{22}{3}, \sqrt{54}, 7.\dot{3}\dot{5}, 7.3\dot{5}$	12a	ε 
2a	14.3257	12bi	$\{4, 16\}$
2b	14.33	12bii	20
3	6.03×10^{2}	13a	$\frac{b^3 d}{48a^2 c}$
4a	17	13b	$13k^2 - k + 6$
4b	$41 - 4n$	14	1080°
5a	$2^3 \times 3 \times 5^2$	15a	$-(x-3)^2 + 2$
5b	2×3	15b	4.414 or 1.586
5c	100	15d	$x = 3$
6a	25	16a	$A(4.4, 0)$, $B(0, 11)$
6b	-5	16b	11.8 units
6c	64	16c	$y = -\frac{5}{2}x + 9$
7a	5	17a	$a = 48, b = 61.5, c = 71$
7b	$-\frac{5}{13}$	17b	24.5
8	96%	18a	\$60.75
9a	$3x^2(5x-7)(5x+7)$	18b	\$52.53
9b	$2(x-3a)(1+4y)$	19a	\$102500

10	-2	19b	\$7500
11a	$\angle ABC = \angle DAC$ (Given) $\angle BCA = \angle ACD$ (Common angle) $\angle BAC = \angle ADC$ (Angles sum of triangle) $\therefore \Delta ABC$ is similar to ΔDAC (AAA Similarity)	20a	13000 cm^3
11bi	2	20b	3520 cm^2
11bii	$\frac{1}{9}$	20c	\$160000
11biii	$\frac{1}{8}$	21	

Answer questions 1 to 5 in Booklet A.

1 (a) Given that $\frac{2m}{3m+y}=\frac{x}{5n}$,

(i) find the value of x when $m=3$, $n=-2$ and $y=1$, [2]

(ii) express m in terms of n, x and y. [2]

(b) Express as a single fraction in its lowest term, $\frac{10}{2a-3}-\frac{7}{9-6a}$. [2]

(c) (i) Factorise completely $8p^3-2p$. [1]

(ii) Hence, simplify $\frac{8p^3-2p}{-2p^2+7p-3}$. [2]

---

2 In 2014, Mr Lim paid an average of $350 for his monthly petrol bill when the price of petrol was $ x per litre. In 2015, the price of petrol had risen by 25 cents per litre. By cutting down on usage, Mr Lim still managed to pay an average of $350 for his petrol bill in 2015.

(a) Write down an expression, in terms of x, for the number of litres of petrol used by Mr Lim in 2014. [1]

(b) Write down an expression, in terms of x, for the number of litres of petrol used by Mr Lim in 2015. [1]

(c) If the number of litres of petrol used in 2015 is 20 less than that used in 2014, form an equation in x and show that it reduces to $8x^2+2x-35=0$. [3]

(d) Solve the equation $8x^2+2x-35=0$, giving your answer correct to 3 decimal places. [3]

(e) Use the results found in part (d) to find the number of litres of petrol used by Mr Lim in 2015, giving your answer correct to the nearest 0.1 litre. [1]

[Turn over

3 Two key ingredients in a cereal bar consists of rolled oats and cocoa solids. Jessica made two types of cereal bars, Type A and Type B. In total, she made 25 cups of Type A and 32.5 cups of Type B. The table below shows the number of cups of rolled oats and cocoa solids found in one cup of each type.

	Rolled Oats (cups)	Cocoa solids (cups)
Type A	1.5	2
Type B	2.5	1.5

(a) Write down a 2x2 matrix **P** to represent the above table. [1]

Given a matrix $\mathbf{Q}=\begin{pmatrix}x\\y\end{pmatrix}$, $\begin{pmatrix}1.5 & 2\\2.5 & 1.5\end{pmatrix}$

(b) find **PQ** in terms of x and y. $\begin{pmatrix}1.5x+2y\\2.5x+1.5y\end{pmatrix}$ [2]

(c) use $\mathbf{PQ}=\begin{pmatrix}25\\32.5\end{pmatrix}$ to find the values of x and y. [3]

(d) explain what the elements in **Q** represent. [1]

---

4 (a) A survey was carried out to find out how many television programmes a group of 50 teenagers watched during a week in June. The results collected is shown in the table below.

Number of programmes	0	1	2	3	4
Number of teenagers	7	10	12	8	13

(i) Calculate

(a) the mean number of programmes watched, 2.2 [1]

(b) the standard deviation. [1]

(ii) The results for another group of teenagers are summarised below.

Mean	2.46
Standard deviation	3

Make two comparisons between the number of programmes watched by the two groups of teenagers. [2]

(b) Five cards are numbered 1, 4, 6, 7 and 9 respectively. Two cards are drawn, one by one without replacement, and the sum of the numbers are recorded.

(i) Show all the possible outcomes in a possibility diagram. [1]

Hence, find the probability that the sum is

(ii) an even number, [1]

(iii) a multiple of 3. [1]

A third card is drawn.

(iv) Find the probability that the sum of the three cards is 14. [2]

---

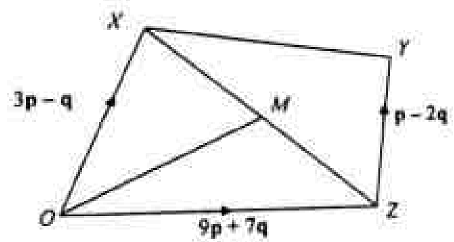
5 (a) R is the point (3, 5) and S is the point $(-2, 6)$.

(i) Write down the column vector $\overrightarrow{RS}$. [1]

(ii) Find $|\overrightarrow{RS}|$. [2]

(iii) If $\overrightarrow{PR} = \begin{pmatrix} 8 \\ -5 \end{pmatrix}$, find the coordinates of the point P. [2]

(b) In the diagram, M is the midpoint of XZ, $\overrightarrow{OX} = 3\mathbf{p} - \mathbf{q}$, $\overrightarrow{OZ} = 9\mathbf{p} + 7\mathbf{q}$ and $\overrightarrow{ZY} = \mathbf{p} - 2\mathbf{q}$.



(i) Express as simply as possible in terms of **p** and/or **q**.

(a) $\overrightarrow{XZ}$, [1]

(b) $\overrightarrow{XM}$, [1]

(c) $\overrightarrow{OM}$, [1]

(d) $\overrightarrow{MY}$. [2]

(ii) Show that OM, when produced, will pass through Y. [2]

[Turn over

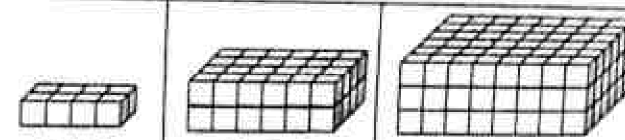
Answer questions 6 to 8 in Booklet B

6 In a large warehouse, cubical boxes of identical sizes are stacked in a particular pattern. The length of each side of a box is 40 cm.

On Day 1, 8 boxes are placed to form a rectangular block at the centre of the warehouse, as shown in the diagram below.

On Day 2, the rectangular block is enlarged by adding boxes to surround the previous day's block, as show below.

Similar arrangement are carried out in Day 3 and subsequent days.



The total number of boxes in the rectangular block formed after completion of each day's stacking is calculated and recorded in the table below.

Day	Total number of boxes	Number of boxes added
1	$4\times2\times1=8$	8
2	$6\times4\times2=48$	40
3	$8\times6\times3=144$	96
4	T_4	a
...	...	...

(a) Find

(i) T_4, [1]

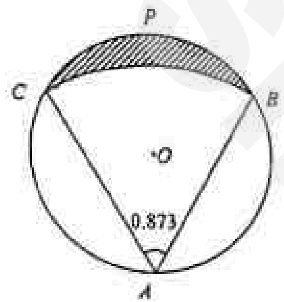
(ii) an expression in terms of n, for T_n. [1]

(b) (i) Find the value of a. [1]

(ii) Show that the formula for the number of boxes added on Day n is $4n(3n-1)$. [3]

(iii) Given that the total number of boxes added on Day n is 1408, calculate the value of n. [2]

7 The diagram shows a circle $ABPC$ with centre O and radius 10 cm. A sector ABC with centre A is inscribed in the circle as shown.



Given that $\angle BAC = 0.873$ radians, find

(a) AC, [2]

(b) the area of the shaded region. [6]

---

8 **Answer the whole of this question on a sheet of graph paper.**

The variables x and y are connected by the equation

$$y = \frac{x^3}{4} - \frac{3x^2}{2} + x + 1$$

Some corresponding values of x and y are given in the table below.

x	-1	0	1	2	3	4	5	6
y	-1.75	1	0.75	-1	-2.75	-3	p	7

(a) Calculate the value of p. [1]

(b) Using a scale of 2 cm to represent 1 unit, draw a horizontal x-axis for $-2 \le x \le 6$.
Using a scale of 2 cm to represent 1 unit, draw a vertical y-axis for $-4 \le y \le 7$.
On your axes, plot the points given in the table and join them with a smooth curve. [3]

(c) Use your graph to find the solutions of the equation $\frac{x^3}{4} - \frac{3x^2}{2} + x + 1 = 0$. [2]

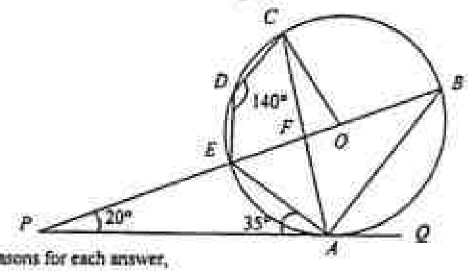
(d) Find the x-coordinates of the point(s) where the curve has a gradient of 1. [2]

(e) By drawing a suitable straight line on your graph, solve $\frac{x^3}{4} - \frac{3x^2}{2} + 2x - 1 = 0$. [2]

[Turn over

Answer questions 9 to 11 in Booklet C.

9 The diagram shows a circle with centre O and passes through A, B, C, D and E.
PAQ is a tangent to the circle.
The diameter BE is extended to meet the tangent at P.
Angle $CDE = 140°$, angle $BPQ = 20°$ and angle $PAE = 35°$.



Find, giving reasons for each answer,

(a) angle BAE, [1]

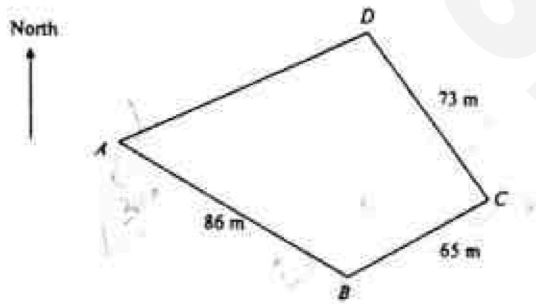
(b) angle CAE, [1]

(c) angle COE, [1]

(d) angle ACB. [2]

(e) A point X, is to be marked on the diagram, on the same side of BE as A so that angle $CXE = 30°$. Deduce whether X lies on the circumference of the circle, inside the circle or outside the circle, giving a reason for your answer. [2]

10



In the diagram, $ABCD$ is a horizontal plot of land.
$AB = 86$ m, $BC = 65$ m and $CD = 73$ m.

The bearing of B from A is 143°, the bearing of C from B is 051° and the bearing of D from C is 314°.

(a) Calculate AC. [3]

(b) Find the bearing of C from A. [3]

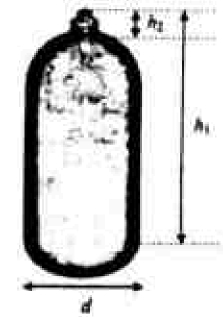
(c) Calculate the area of ΔACD. [3]

(d) The base of a vertical mast is at B.
The angle of elevation of the top of the mast from A is 15.6°.
Calculate the angle of elevation of the top of the mast from C. [3]

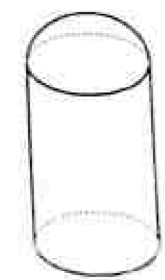
11 Information about a container for a liquid is given below.

Container

Mass of empty container: 500 g
Bottle Diameter (d): 131 mm
Bottle Height (h_1): 366 mm
Neck Height (h_2): 36 mm



The above container, excluding the neck, can be modelled as a cylinder with a hemisphere on top as shown in the diagram below.



(a) Work out

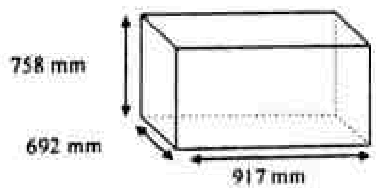
(i) the height, in centimetres, of the cylinder, [1]

(ii) the volume, in cubic centimetres, of the container, excluding the neck. [2]

(b) The container is filled up with a liquid of density 0.75 g/cm^3 until the bottom of the neck.
Calculate the total mass of the liquid. [2]

(c) A transport basket is used to transport the containers filled with the liquid. The containers will be placed lying down in the basket. The maximum load that the transport basket can carry is 150 kg.

Assume that the basket can be modelled in the form of a cuboid below.



Find the maximum number of containers filled with liquid that can be transported by the basket at any one time. Justify your decision with calculations. [4]

END OF PAPER

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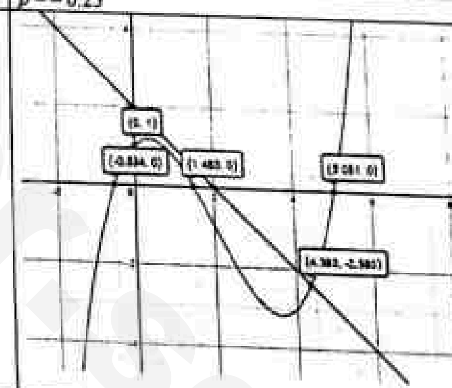
CHS 2016 Prelim 3

E Math Paper 2 – Answer Key

1. (a)	(i)	$x=-6$
	(ii)	$m=\dfrac{xy}{10n-3x}$
(b)		$\dfrac{37}{3(2n-3)}$
(c)	(i)	$2p(2p+1)(2p-1)$
	(ii)	$\dfrac{2p(2p+1)}{3-p}$ or $\dfrac{-2p(2p+1)}{p-3}$
2. (a)		$\dfrac{350}{x}$
(b)		$\dfrac{350}{x+0.25}$
(d)		1.970 or −2.220
(e)		157.7 litres
3. (a)		$\begin{pmatrix}1.5 & 2\\ 2.5 & 1.5\end{pmatrix}$
(b)		$\begin{pmatrix}1.5x+2y\\ 2.5x+1.5y\end{pmatrix}$
(c)		
		$x=10$, $y=5$
(d)		The total number of cups of oats used is x (10) and total number of cups of cocoa solids used is y (5).
4. (a)	(i) (a)	Mean = 2.2
	(b)	Std dev = 1.39
	(ii)	1. The second group of teenagers watched more programmes than the first group as its mean (2.46) is larger than that of the first group (2.2). 2. However, the data for the first group is more consistent as it has a smaller standard deviation (2.6) than that of the second group (3).
(b)	(i)	(table below)
	(ii)	$\dfrac{2}{5}$
	(iii)	$\dfrac{1}{10}$

		1st Draw				
	+	1	4	6	7	9
2nd Draw	1		5	7	8	10
	4	5		10	11	13
	6	7	10		13	15
	7	8	11	13		16
	9	10	13	15	16	

	(iv)	$\dfrac{1}{5}$
5. (a)	(i)	$\begin{pmatrix}-5\\ 1\end{pmatrix}$
	(ii)	$\sqrt{(-5)^2+1^2}=\sqrt{26}$ or 5.10 units
	(iii)	$P(-5,10)$
(b)	(i) (a)	$6\underset{\sim}{p}+8\underset{\sim}{q}$ or $2(3\underset{\sim}{p}+4\underset{\sim}{q})$
	(b)	$3\underset{\sim}{p}+4\underset{\sim}{q}$
	(c)	$6\underset{\sim}{p}+3\underset{\sim}{q}$ or $3(2\underset{\sim}{p}+\underset{\sim}{q})$
	(d)	$4\underset{\sim}{p}+2\underset{\sim}{q}$ or $2(2\underset{\sim}{p}+\underset{\sim}{q})$
6. (a)	(i)	$T_4=10\times8\times4=320$
	(ii)	$4n^2(n+1)$
(b)	(i)	176
	(ii)	$4n(3n-1)$ or $12n^2-4n$
	(iii)	$n=11$
7. (a)		18.1 cm
(b)		20.5 cm²
8. (a)		$p=-0.25$
(b)		
(c)		−0.53, 1.48, 5.05
(d)		$x=0$ or 4
(e)		4.38
9. (a)		90°
(b)		40°
(c)		80°
(d)		55°
(e)		X must lie outside the circle.

1

10.(a)		106 m
(b)		105.2°
(c)		1860 m^2
(d)		20.3°
11.(a)	(i)	26.45 cm
	(ii)	4150 cm^3
(b)		3120 g
(c)		41

Answer all the questions.

1 (a) Express as a single fraction in its simplest form $1-\frac{2x}{2x-7}+\frac{7}{(2x-7)^2}$. [3]

(b) Simplify $5a^{-3}b^3 \div \frac{10}{9}a^3b^{-2}$. [2]

(c) Factorise fully

(i) $11p^2-44pq+4q-p$, [2]

(ii) $30m^2+14mn-4n^2$. [2]

(d) Solve the equation $\frac{1}{x}-\frac{x-5}{2x-3}=1$. [3]

---

2 Twenty five boys took a quiz.
The marks are shown in the stem-and-leaf diagram.

1	4 7
2	3 5 7 7 9
3	0 1 2 3 3 5 7 7 8 9 9 9
4	3 4 6 6 7
5	0

Key
1 | 4 means 14 marks

(a) Find

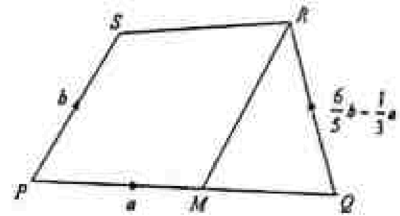
(i) the median mark, [1]

(ii) the interquartile range. [3]

Twenty five girls took the same quiz.
The median mark and interquartile range of the girls' marks are 35 and 6 respectively.

(b) Compare and comment on the performance of the boys and girls in this quiz. [2]

3 $PQRS$ is a quadrilateral. M is the mid-point of PQ.
$\overrightarrow{PQ}=a$, $\overrightarrow{PS}=b$ and $\overrightarrow{QR}=\frac{6}{5}b-\frac{1}{3}a$.

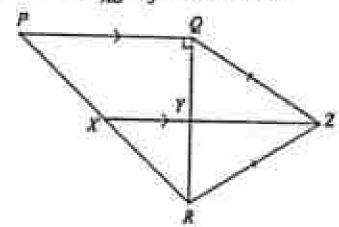


(a) Find $\overrightarrow{SR}$ in terms of a and b. [1]

(b) Use vectors to show that PS and MR are not parallel. [2]

---

4 In the diagram, PXR, QYR, and XYZ are straight lines.
PQ is parallel to XZ, $QZ = RZ$, $\frac{YZ}{XZ}=\frac{3}{5}$ and $P\hat{Q}R = 90°$.



(a) Show that triangles QYZ and RYZ are congruent. [3]

(b) Show that triangles PQR and XYR are similar. [2]

(c) Find

(i) $\frac{\text{area of } \Delta XYR}{\text{area of } \Delta RYZ}$, [1]

(ii) $\frac{\text{area of } \Delta XYR}{\text{area of } \Delta PQR}$. [1]

5 Jeannie bought some health drink for \$6400. She paid \$$x$ for each litre of the drink.

(a) Find, in terms of x, an expression for the number of litres she bought. [1]

(b) She gave away 8 litres of the drink to her friends. She sold the remainder of the drink for \$50 per litre more than she paid for it. Write down an expression, in terms of x, for the sum of money she received. [1]

(c) She made a profit of \$2960.

(i) Write down an equation in x to represent this information, and show that it reduces to $x^2 + 420x - 40\,000 = 0$. [2]

(ii) Solve the equation $x^2 + 420x - 40\,000 = 0$. [3]

(d) Find the number of litres of drink Jeannie sold. [1]

---

6 Two satay stalls sell 3 types of satay.
The number of sticks of each type of satay sold per day is given by the matrix S.

$$\begin{array}{cc} & \begin{array}{ccc} \text{Chicken} & \text{Mutton} & \text{Beef} \end{array} \\ \mathbf{S} = & \begin{pmatrix} 400 & 300 & 200 \\ 200 & 500 & 300 \end{pmatrix} \end{array} \begin{array}{l} \text{Stall A} \\ \text{Stall B} \end{array}$$

(a) The price of each stick of chicken, mutton and beef satay is \$0.35, \$0.45 and \$0.40 respectively.

Represent these prices in a 3×1 column matrix P. [1]

(b) Evaluate the matrix $\mathbf{T} = \mathbf{SP}$. [1]

(c) State what the elements of T represent. [1]

(d) In June 2016, Stall A operated 20 days and Stall B operated 25 days.

Use matrix multiplication to find the total amount of money collected by the two stalls in June 2016. [2]

(e) In July, the number of sticks of each type of satay sold per day is increased by 10%. The information is given by the matrix Q.

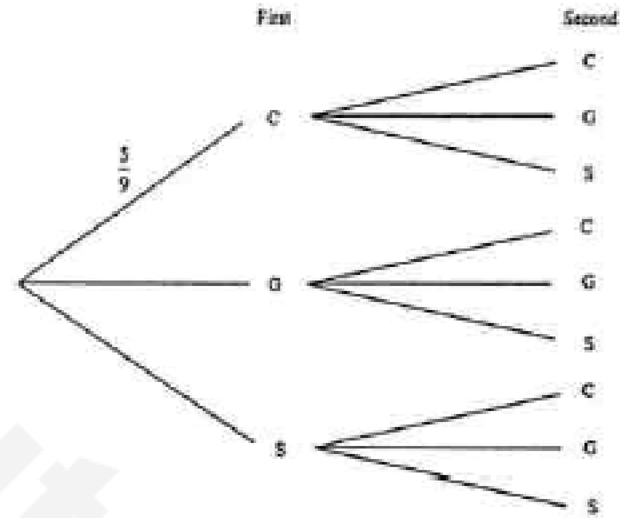
$$\begin{array}{cc} & \begin{array}{ccc} \text{Chicken} & \text{Mutton} & \text{Beef} \end{array} \\ \mathbf{Q} = & \begin{pmatrix} 440 & 330 & 220 \\ 220 & 550 & 330 \end{pmatrix} \end{array} \begin{array}{l} \text{Stall A} \\ \text{Stall B} \end{array}$$

Write down the matrix R such that $\mathbf{Q} = \mathbf{SR}$. [1]

7 A box contains 5 Chocolate doughnuts, 3 Glazed doughnuts and 1 Strawberry doughnut.

(a) Two doughnuts were taken out of the box at random, without replacement.

Copy and complete the tree diagram to show this information. [3]

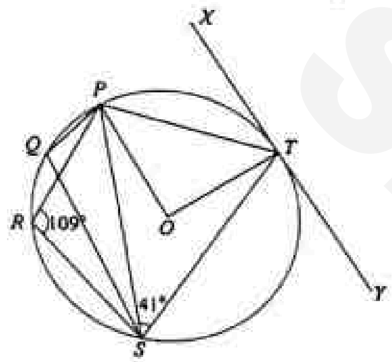


(b) Find, as a fraction in its simplest form, the probability that

(i) the two doughnuts are the same flavour, [3]

(ii) at least one of the doughnuts is Chocolate. [2]

8 In the diagram, the points P, Q, R, S and T lie on a circle, centre O. XTY is a tangent to the circle. Angle $PRS = 109°$ and angle $PST = 41°$.



(a) Find, giving reasons for each answer,

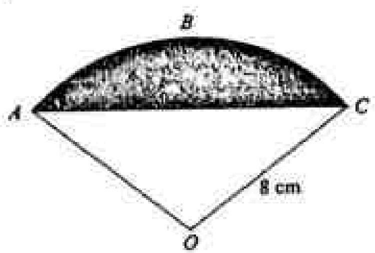
(i) $P\hat{Q}S$, [1]

(ii) $P\hat{T}S$, [1]

(iii) $Y\hat{T}S$, [2]

(iv) $O\hat{T}P$. [2]

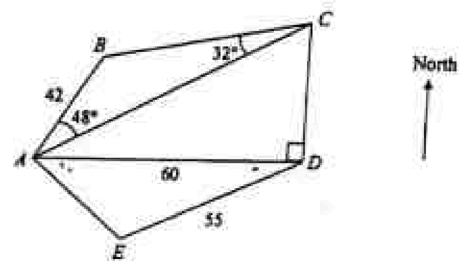
(b) $OABC$ is a sector of a circle, centre O and radius 8 cm. The perimeter of the sector is 30 cm.



(i) Show that angle $AOC = 1.75$ radians. [1]

(ii) Calculate the area of the shaded region. [3]

9



The diagram shows a field, $ABCDE$, which is crossed by two paths, AC and AD. AD is perpendicular to CD. $AB = 42$ m, $AD = 60$ m, $DE = 55$ m, angle $BAC = 48°$ and angle $ACB = 32°$.

(a) Show that $AC = 78.05$ m, correct to four significant figures. [2]

(b) Calculate CD. [2]

(c) A bird is at P, which is 8 m vertically above E.
Calculate the angle of depression of D from P. [2]

(d) Given that the area of triangle ADE is 1300 m^2, calculate angle ADE. [2]

(e) D is due east of A.
Calculate the bearing of E from A. [3]

10 Answer the whole of this question on a sheet of graph paper.

The variables x and y are connected by the equation $y = \frac{5x^2}{4} + \frac{60}{x} - 40$.

Some corresponding values of x and y are given in the following table.

x	1	1.5	2	3	3.5	4	4.5	5	6
y	p	2.81	−5	−8.75	−7.54	−5	−1.35	3.25	15

(a) Find the value of p. [1]

(b) Using a scale of 2 cm to represent 1 unit, draw a horizontal x-axis for $1 \le x \le 6$.
Using a scale of 2 cm to represent 5 units, draw a vertical y-axis for $-15 \le y \le 25$.
On your axes, plot the points given in the table and join them with a smooth curve. [2]

(c) Using your graph, find the range of values of x for which $\frac{5x^2}{4} + \frac{60}{x} - 40 < 0$. [3]

(d) By drawing a tangent, find the gradient of the curve at the point where $x = 4$. [2]

(e) Draw the tangent to the curve at the point where the gradient is -10.
Write down the equation of this tangent. [2]

(f) The line l intersects the curve $y = \frac{5x^2}{4} + \frac{60}{x} - 40$ at $x = 2$ and $x = 6$.

(i) Find the equation of l. [2]

It is given that $x = 2$ and $x = 6$ are solutions of the equation $5x^3 + Ax^2 + Bx + 240 = 0$.

(ii) By using your answer from (f)(i), find the value of A and of B. [3]

11 **Diagram I** shows a pencil before it is sharpened. It is made up of a piece of cylindrical carbon encased in wood. The length of the pencil is 19 cm.
Diagram II shows the cross-sectional area of the pencil. $ABCDEF$ is a regular hexagon with side 0.45 cm. The diameter of the carbon is 0.2 cm.

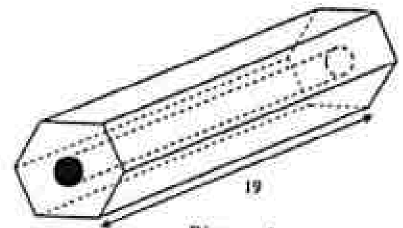


Diagram I

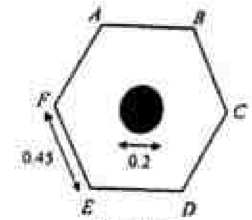


Diagram II

(a) Find

(i) the interior angle of the regular hexagon $ABCDEF$, [2]

(ii) CF. [1]

(b) Show that $AE = 0.7794$ cm. [2]

(c) Calculate the area of the regular hexagon $ABCDEF$. [2]

(d) Calculate the volume of the carbon as a percentage of the volume of the pencil. [2]

Diagram III shows ten of these pencils which just fit into a rectangular box which is open on one side.
Diagram IV shows ten of these pencils which just fit into a box whose cross-sectional area is an equilateral triangle which is open on one side.

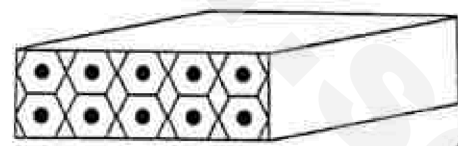


Diagram III

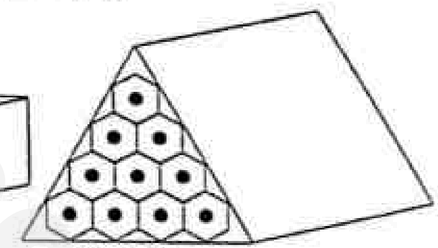


Diagram IV

(e) The boxes are made of cardboard which cost \$10 per m^2.
Determine which box will be cheaper to produce for 1000 boxes.
Justify your decision with calculations. [5]

1a)	$\frac{56-14x}{(2x-7)^2}$
1b)	$\frac{9b^7}{2a^6}$
1c)	(i) $(11p-1)(p-4q)$
	(ii) $2(3m+2n)(5m-n)$
1d)	$x=\frac{1}{3}$ or 3
2a)	35 marks
2b)	13 marks
3a)	$\frac{2}{3}a+\frac{1}{5}b$
4c)	(i) $\frac{\text{area of } \Delta XYR}{\text{area of } \Delta RYZ}=\frac{2}{3}$
	(ii) $\frac{\text{area of } \Delta XYR}{\text{area of } \Delta PQR}=\left(\frac{1}{2}\right)^2=\frac{1}{4}$
5a)	$\frac{6400}{x}$
5b)	$\left(\frac{320\,000}{x}-8x+6000\right)$
5c)	(ii) $x=-500$ or $x=80$
5d)	72
6a)	$\begin{pmatrix}0.35\\0.45\\0.40\end{pmatrix}$
6b)	$\begin{pmatrix}355\\415\end{pmatrix}$
6c)	The total amount of money collected by each stall (per day from the selling the satay)
6d)	$17 475
6e)	$\begin{pmatrix}1.1&0&0\\0&1.1&0\\0&0&1.1\end{pmatrix}$
7b)	(i) $\frac{5}{6}$
	(ii) $\frac{13}{36}$
8a)	(i) 109°
	(ii) 71°
	(iii) 68°
	(iv) 49°

8b)	(ii) 24.5 cm^2
9b)	49.9 cm
9c)	8.3°
9d)	52.0°
9e)	148.9°
10a)	21.25
10c)	$1.65 < x < 4.65$
10d)	m = 6.25
10e)	y = -10x+15
10f)	(i) y=5x-15
	(ii) A=-20 & B=-100
11a)	(i) 120°
	(ii) 0.9 cm
11c)	0.526 cm^2
11d)	5.97%
11e)	Design IV will be cheaper to produce for 1000 boxes

Answer all the questions.

1 Write the following numbers in order of size, starting with the smallest.

$$-\frac{4}{7},\ -\frac{4}{5},\ -0.8^2,\ -0.\dot{8}$$

Answer ………, ………, ………, ……… [1]
smallest largest

2 During a children's day celebration, a charity organization distributed 825 files, 495 pens and 660 pencils equally among the children in a children's home. Each child received the same number of files, pens and pencils.

(a) Find the largest possible number of children.

Answer (a) ……………………… [2]

(b) Hence, find the number of files, pens and pencils each child received.

Answer (b) ………files, ………pens, ………pencils [1]

3 It is given that $\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$.

(a) Find f when $u=1.2$ and $v=0.4$.

Answer (a) $f=$ ……………………… [1]

(b) Express u in terms of f and v.

Answer (b) ……………………… [2]

4 A restaurant charges $27.80 per person for buffet lunch. On a particular day, 114 people dined in the restaurant.
By approximating both the charge and the number of diners to 2 significant figures, estimate the total amount received by the restaurant on that particular day.

Show your working and give your answer to a reasonable degree of accuracy.

Answer $ .... [2]

5 A piece of metal is heated to 375 °C and then left to cool for 15 minutes.
The temperature of the metal decreases at a rate of 18 °C/min for the first 5 minutes and then decreases at a rate of 7 °C/min for the next 10 minutes.

Find the time taken for the metal to cool to a temperature of 250 °C.

Answer .... min [2]

6 (a) Solve the inequality $1-x \le 4+x < 13-2x$.

Answer (a) .... [2]

(b) Write down all the integers which satisfy $1-x \le 4+x < 13-2x$.

Answer (b) .... [1]

7 The current, I amperes, passing through a circuit is inversely proportional to its resistance, R ohms. When the resistance of the circuit is 3 ohms, the current passing through it is 2 amperes.

(a) Find an equation connecting I and R.

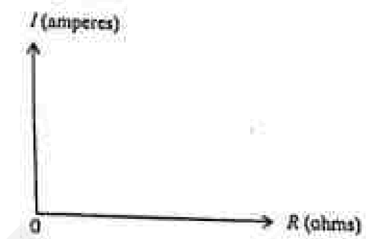
Answer (a) .... [2]

(b) Calculate the resistance of the circuit when 1.5 amperes of current passes through it.

Answer (b) .... ohms [1]

(c) Sketch the graph of I against R.

Answer (c)



[1]

8 Two containers are geometrically similar.
The surface area of the larger container is 63 cm^2 and the surface area of the smaller container is 28 cm^2.
The height of the smaller container is 5 cm.

Calculate the height of the larger container.

Answer .... cm [2]

9 Between 2014 and 2015, the number of pupils who applied for a particular school as their first choice increased by 25%.
In 2015, the number of applicants for that school was 425.

Calculate the number of applicants in 2014.

Answer .... [2]

10 The probability that it will rain on any particular day is 0.3.

Calculate the probability that on two consecutive days, it will rain on only one of the days.

Answer .... [2]

11 The table below shows the number of internet-connected devices in some households.

Number of devices	1	2	3	4	5	6
Number of households	2	4	x	7	5	3

(a) If the modal number of devices is 4, state the maximum possible value of x.

Answer (a) .... [1]

(b) If the mean number of devices is 3.6, calculate the value of x.

Answer (b) .... [2]

(c) If the median number of devices is 4, write down all the possible values of x.

Answer (c) .... [1]

12 Peter drove from Town X to Town Z, passing by Town Y along the way.
He took 40 minutes to drive from Town X to Town Y at an average speed of 72 km/h.
He rested in Town Y for 10 minutes before continuing his journey to Town Z.
The distance between Town Y and Town Z is 52 km.
His average speed for the whole journey was 60 km/h.

Calculate

(a) the distance between Town X and Town Y,

Answer (a) .... km [1]

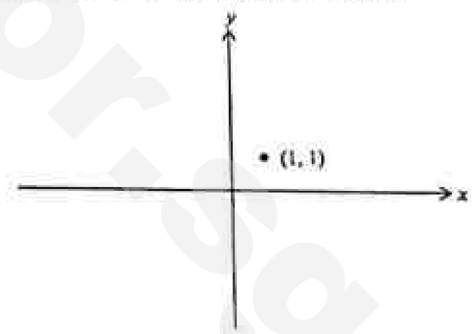
(b) the average speed for the journey between Town Y and Town Z.

Answer (b) .... km/h [3]

13 The point (1, 1) is marked on the diagram.

Sketch the graph of $y = 8 - x^3$ in the answer space below.

Answer



[1]

14 David wants to invest \$500 for 3 years.
Company A offers 8% simple interest per year.
Company B offers 6% interest per year compounded quarterly.

In which company should David invest his money? Justify your answer.

Answer ....

.... [3]

15 $\xi = \{x : x \text{ is an integer, } 1 \le x \le 100\}$
$A = \{x : x \text{ is divisible by } 11\}$
$B = \{x : x \text{ is divisible by } 22\}$
$C = \{x : x \text{ is divisible by } 33\}$

(a) List the elements of $A \cap (B \cup C)'$.

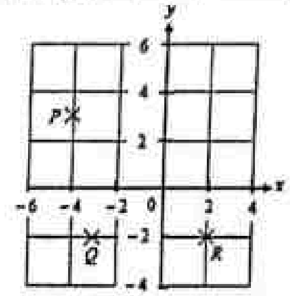
Answer (a) .... [1]

(b) Draw, in the answer space, a clearly labelled Venn diagram to illustrate the three sets A, B and C.

Answer (b) ξ

[2]

16 On the axes shown, P is $(-4, 3)$, Q is $(-3, -2)$ and R is $(2, -2)$.



Find

(a) the gradient of PQ,

Answer (a) .... [1]

(b) $\tan P\hat{R}Q$,

Answer (b) .... [1]

(c) the equation of the line PR,

Answer (c) .... [2]

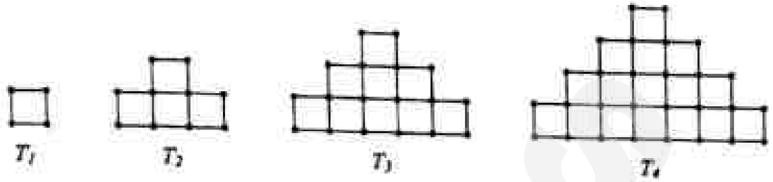
(d) the area of triangle PQR,

Answer (d) .... units^2 [1]

(e) the coordinates of two possible points S, such that the four points P, Q, R and S are the four vertices of a parallelogram.

Answer (e) (.........., ...) or (.........., ...) [2]

17



The figures T_1, T_2, T_3 ….. are made up of squares.
N is the number of rows of squares in each shape.
S is the number of squares in each shape.
D is the number of dots in each shape.
The values of N, S and D in T_1, T_2, T_3 and T_4 are recorded in the table below.

Figure	T_1	T_2	T_3	T_4
N	1	2	3	4
S	1	4	p	16
D	4	10	q	28
$D-N^2$	3	6	r	s

(a) Find the values of p, q, r and s.

Answer (a) p = ………… , q = ………… , r = ………… , s = ………… [2]

(b) Express S in terms of N.

Answer (b) ………………………………… [1]

(c) Express D in terms of N.

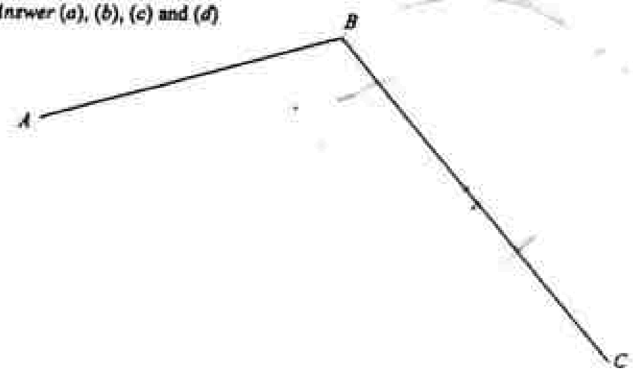
Answer (c) ………………………………… [1]

(d) Explain why the number of dots cannot be 42.

Answer ……………………………………………………………… [1]

18 Three points A, B and C are shown below.

Answer (a), (b), (c) and (d)



(a) Construct the perpendicular bisector of BC. [1]

÷2 times

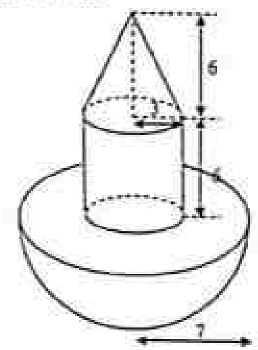
(b) Construct the bisector of angle ABC. [1]

(c) Mark clearly the point, P, which is equidistant from the lines AB and BC, and equidistant from B and C. [1]

(d) The point D is such that $ABCD$ is a parallelogram. Find and label the position of D. [1]

[Turn over

19 A gold solid is formed by joining the plane faces of a cone, a cylinder and a hemisphere.
The cone and cylinder have a base radius of 3 cm and height 6 cm.
The hemisphere has a radius of 7 cm.



Calculate

(a) the length of the slant height of the cone,

Answer (a) .... cm [2]

(b) the surface area of the gold solid,

Answer (b) .... cm^2 [3]

(c) the volume of the gold solid.

Answer (c) .... cm^3 [2]

The density of gold is 19.32 g/cm³.

A gold bar has length 25 cm, width 7 cm and height 3.5 cm.
Five gold bars were melted down and all the gold was used to make a large number of these gold solids.

(d) Calculate the mass of gold that remains after the gold solids are made, giving your answer correct to two significant figures.

Answer (d) .... g [4]

20 O is the origin. A is the point $(3, p)$. B is the point $(-4, 5)$. $\overrightarrow{BC} = \begin{pmatrix} 6 \\ 5 \end{pmatrix}$.

(a) If $\overrightarrow{BC}$ is parallel to $\overrightarrow{OA}$, find the value of p.

Answer (a) $p =$ .... [2]

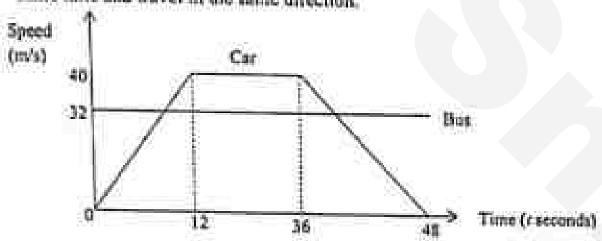
(b) Find the ratio $OA : BC$.

Answer (b) .... [1]

(c) Find the position vector of M such that $OAMB$ is a parallelogram.

Answer (c) .... [2]

21 The diagram, not drawn to scale, shows the speed-time graph of a car and a bus during a period of 48 seconds. The car and the bus start from the same point, at the same time and travel in the same direction.



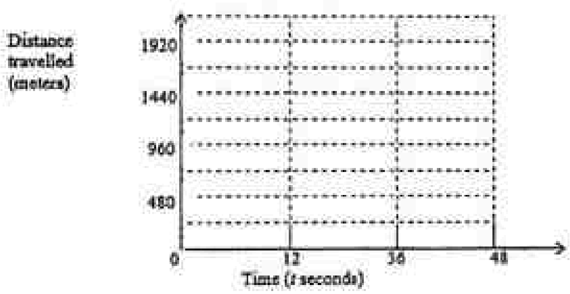
(a) Calculate the value(s) of t when the car and bus have the same speed.

Answer (a) .... [3]

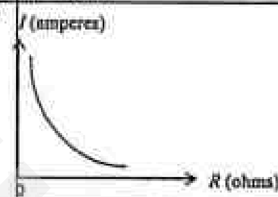
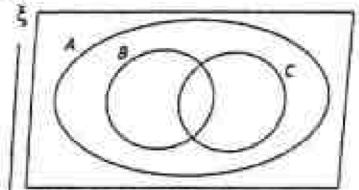
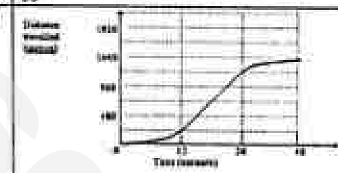
(b) Find the value of t when the car overtakes the bus.

Answer (b) .... seconds [3]

(c) Use the grid below to sketch the distance-time graph of the car for the same journey.



[3]

1	$-0.\dot{8}, -\frac{4}{5}, -0.8^2, -\frac{4}{7}$
2a)	165
2b)	5 files, 3 pens, 4 pencils
3a)	$f = 0.3$
3b)	$u = \frac{fv}{v-f}$
4	\$3100
5	10 min
6a)	$-1\frac{1}{2} \le x < 3$
6b)	$-1, 0, 1, 2$
7a)	$I = \frac{6}{R}$
7b)	$R = 4$ ohms
7c)	
8	$h_1 = 7.5$ cm
9	340
10	0.42
11a)	6
11b)	9
11c)	0, 1, 2, 3, ..., 8
12a)	48 km
12b)	62.4 km/h
13	
14	Company A
15a)	$A \cap (B \cup C)' = \{11, 55, 77\}$
15b)	
16a)	-5
16b)	$\frac{5}{6}$
16c)	$y = -\frac{5}{6}x - \frac{1}{3}$
16d)	12.5 square units
16e)	$S(1,3)$ or $S(3,-7)$ or $S(-9,3)$
17a)	$p = 9, q = 18, r = 9, s = 12$
17b)	$S = N^2$
17c)	$D = 3N + N^2$
17d)	$N = \frac{-3 \pm \sqrt{9+168}}{2}$ which is no a whole number
19a)	6.71 cm
19b)	610 cm³
19c)	945 cm³
19d)	4400 g
20a)	$p = 2.5$
20b)	$OA : BC = 1 : 2$
20c)	$\begin{pmatrix} -1 \\ 7.5 \end{pmatrix}$
21a)	38.4
21b)	30
21c)	

Answer **all** the questions.

1 Calculate the value of $\dfrac{\sqrt{0.99}\times 59.98}{24.9-1.01^2}$, giving your answer correct to 3 significant figures.

Answer .... [1]

2 If a man sells an art piece at \$250, he would make a loss of 20%. Evaluate the selling price of the art piece if he wants to make a profit of 15%.

Answer .... [2]

3 Given that $\left(\frac{1}{3}\right)^{-2x} = 27^{\frac{1}{3}} + 9^x$, find the value of x.

Answer .... [2]

4 Given that $\dfrac{3a-b}{2b} = \dfrac{1}{4}$, find the value of $\dfrac{a}{b}$.

Answer .... [2]

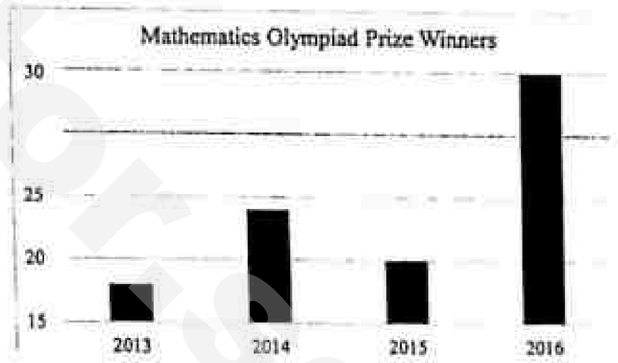
5 A set of four even numbers has a mean of 13, median of 14 and mode of 18. Find the four numbers.

Answer .... , ... , ... , ... [2]

6 Factorise $15ax-21bx-10ay+14by$.

Answer .... [2]

7 The graph shows the number of prize winners from Chung Cheng High School (Main) at the Mathematics Olympiad over a number of years.



Explain one way in which the graph is misleading.

Answer ....

....

.... [1]

8 Solve the equation $x(x-2)=3$.

Answer $x =$ .... and .... [2]

9 The scale of a map is 1 : 60 000. A park is represented by an area of 4 cm^2 on the map. Calculate the actual area of the park in square kilometres.

Answer .... km^2 [2]

10 The table shows the battery lifespan of 40 laptops.

Time (x in hours)	No. of laptops
$0 \le x < 1$	2
$1 \le x < 2$	3
$2 \le x < 3$	12
$3 \le x < 4$	16
$4 \le x < 5$	6
$5 \le x < 6$	1

(a) Find the percentage of laptops that have battery lifespan of at least 4 hours.

Answer (*a*) .... [1]

(b) Find the mean and standard deviation of the battery lifespan of the laptops.

Answer (*b*) Mean = ... hours [1]

Standard Deviation = ... hours [2]

11 Benson has 480 strawberry-flavoured lollipops and 560 cola-flavoured lollipops. He puts them into packets, each containing the same number of each type of lollipops and with no remainder. If he would like to pack the lollipops in as many packets as possible, find the total number of lollipops in each packet.

Answer .... [2]

12 Consider the sequence $1^3-4,\ 2^3-6,\ 3^3-8,\ 4^3-10, \ldots$

(a) Write down the 5th term of the sequence.

Answer (*a*) .... [1]

(b) Write down and simplify, in terms of n, an expression for the n^{th} term of the sequence.

Answer (*b*) .... [1]

(c) Evaluate the 20th term of the sequence.

Answer (*c*) .... [1]

13 It is given that $\overrightarrow{AB} = \begin{pmatrix} 4 \\ 5 \end{pmatrix}$, $\overrightarrow{OC} = \begin{pmatrix} 2 \\ p \end{pmatrix}$ and the position vector of A is $\begin{pmatrix} -2 \\ 1 \end{pmatrix}$.

(a) Find $\left|\overrightarrow{AB}\right|$.

Answer (*a*) .... [2]

(b) Find the coordinates of B.

Answer (*b*) .... [2]

(c) Given that AB and OC are the opposite parallel sides of a trapezium $OCBA$, find the value of p.

Answer (*c*) p = ... [1]

14 **(a)** Solve the inequalities $x - 2 \le \frac{2x}{5} < \frac{x}{2} + \frac{1}{5}$.

Answer (*a*) .... [3]

(b) Write down all the integers that satisfy $x - 2 \le \frac{2x}{5} < \frac{x}{2} + \frac{1}{5}$.

Answer (*b*) .... [1]

15 **(a)** The universal set, ε, contains three sets, A, B and C. The three sets satisfy the following conditions:

$A \subset B$ and $B \cap C = \varnothing$

Draw a Venn diagram to illustrate these sets. [2]

Answer (*a*)

(b) It is given that
ε = {x : x is a whole number and $1 \le x < 10$}
P = {x : x is a prime number}
Q = {x : x is a factor of 20}

(i) List the elements of $P \cap Q'$.

Answer (*b*)(*i*) .... [1]

(ii) Find $n(P \cup Q)$.

Answer (*b*)(*ii*) .... [1]

16 Two interior angles of a n-sided polygon are $160°$ and $40°$ while the remaining interior angles are each $140°$. Find the value of n.

Answer .... [2]

17 A quadratic curve $y=(h-x)(x+k)$ meets the x-axis at $(-0.5, 0)$ and $(6, 0)$.

(a) Find the equation of the curve.

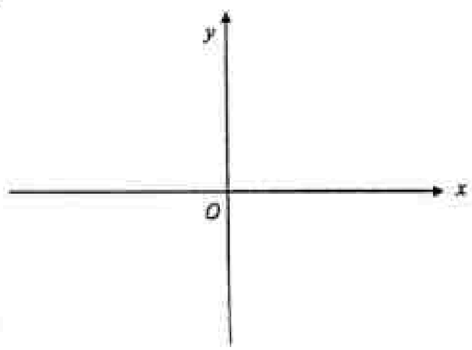
Answer (a) .... [1]

(b) Write down the equation of the line of symmetry of the graph.

Answer (b) .... [1]

(c) Hence, sketch the graph of $y=(h-x)(x+k)$.

Answer



[2]

18 Alex has $ x and Ben has $ y. If Ben gives Alex $5, Alex will have twice as much money as Ben.

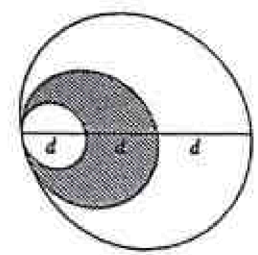
(a) Form an equation in x and y.

Answer (a) .... [1]

(b) If they have a total of $48, form another equation in x and y. Hence, find the values of x and y.

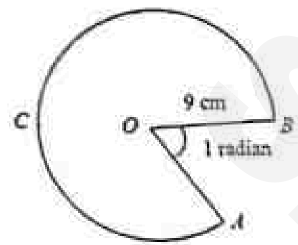
Answer (b) x =.........., y =.......... [3]

19 The diagram shows three circles with diameters d cm, $2d$ cm and $3d$ cm respectively. Find, in terms of π and d, the difference in area between the unshaded region and the shaded region.



Answer .... cm^2 [3]

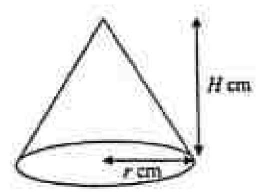
20 $OACB$ is a sector of a circle with centre O and radius 9 cm, angle $AOB = 1$ radian.



(a) Find the length of arc ACB.

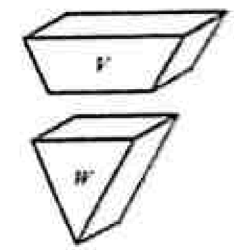
Answer .... cm [2]

(b) The edges OA and OB are joined together to form the cone below.
Find r, the radius, and H, the height, of the cone.



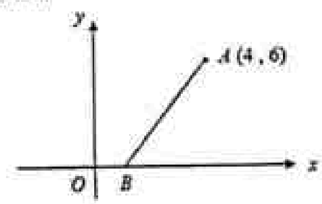
Answer r = ..., H = ... [4]

21 The diagram shows the top part V of a prism with a triangular cross-section being cut horizontally across and removed to leave the lower part W.
The vertical heights of V and W are in the ratio of 2 : 3 respectively.
If the volume of W is 54 m^3, find the volume of the solid V.



Answer .... m^3 [2]

22 In the figure, O is the origin and A is the point (4, 6). B is a point on the x-axis such that the gradient of AB is 2.



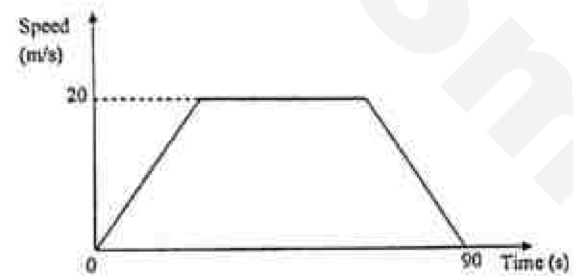
(a) Find the coordinates of B.

Answer (a) .... [2]

(b) C is another point on the x-axis such that $AB = AC$. Find the coordinates of C.

Answer (b) .... [1]

23 The speed time graph shows the journey of a train over a period of 90 s from Paya Lebar Station to Eunos Station. The train reaches a maximum speed of 20 m/s.



(a) Express 20 m/s in km/h.

Answer (a) .... km/h [1]

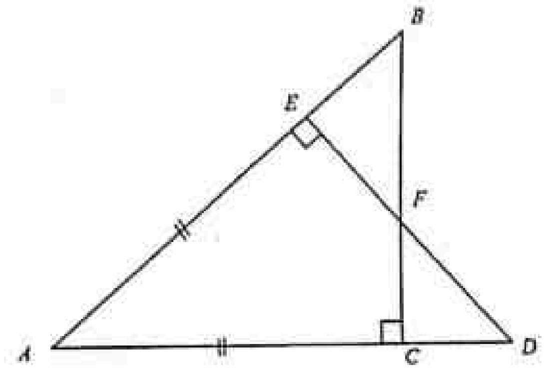
(b) Given that the acceleration in the first part of the journey was 0.8 m/s^2, calculate the time taken, in seconds, for the train to reach its maximum speed.

Answer (b) .... seconds [2]

(c) The total distance travelled during the 90 s was 1300 m. Calculate the duration that the train was travelling at its maximum speed.

Answer (c) .... seconds [2]

24 In the diagram, $AE = AC$, and triangles ACB and AED are right angled triangles. Show that triangles ACB and AED are congruent.



Answer ....

....

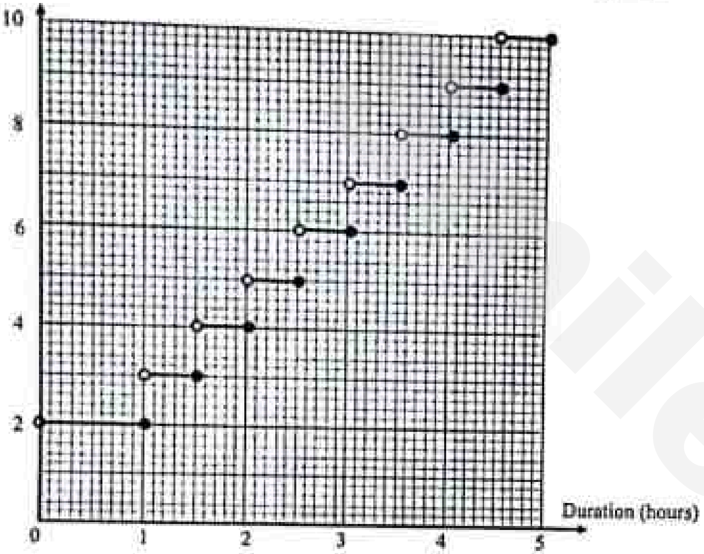
....

....

....

.... [2]

25 The step-function graph shows the parking charges for the first 5 hours at Carpark A.



(a) Write down the parking charges for a car that is parked at Carpark A for

(i) 4 hour 15 minutes (ii) $2\frac{1}{2}$ hours.

Answer (a) (i) $ .... (ii) $ .... [2]

(b) Another nearby carpark, Carpark B, offers the parking charges.

$1 upon entry,
3 cents per minute thereafter
(Maximum charges of $8.20)

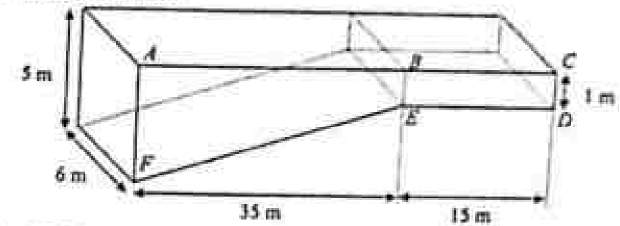
Kate wishes to park her car for $2\frac{1}{2}$ hours at one of these carparks.

(i) On the same axes, draw the graph of parking charges offered at Carpark B. [2]

(ii) State the carpark Kate should choose to park her car.

Answer (b)(ii) .... [1]

26 The diagram shows a swimming pool, with its cross section consisting of a trapezium, $ABEF$, and a rectangle, $BCDE$. The pool is initially empty. *Water is pumped into the pool at a constant rate, and it takes 6 hours to fill the empty pool completely with water.*



(a) Calculate the volume of the pool.

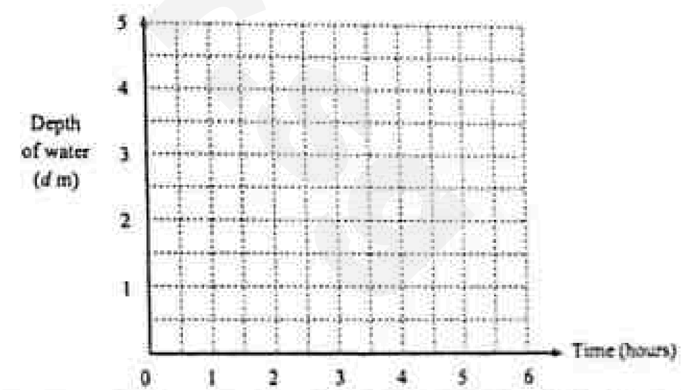
Answer (a) .... m^3 [2]

(b) Find the time taken to fill the pool to a depth of 4 m at the deep end.

Answer (b) .... hours [2]

(c) On the axes in the answer space, sketch a graph to represent how the depth of water at the deep end of the pool changes with time.

Answer

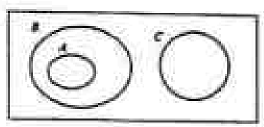


[2]

Answer Key

1. 2.50
2. \$359.38
3. $x=\frac{3}{8}$
4. $\frac{1}{2}$
5. 6 , 10 , 18 , 18
6. $(3x-2y)(5a-7b)$
7. The y-axis (does not start at 0) starts at 15 OR The scale of the y-axis is not uniform so the length of each bar is not representative of the number of prize winners.
8. $x=3$ or $x=-1$
9. 1.44 km²
10. (a) 17.5% (b) 3.1 hrs ; 1.07 hrs
11. 13
12. (a) 5^3-12 (b) n^3-2n-2 (c) 7958
13. (a) 6.40 units (b) (2, 6) (c) 2.5
14. (a) $-2<x\le 3\frac{1}{3}$ (b) $-1, 0, 1, 2, 3$
15. (a) (b) (i) $P\cap Q'=\{3, 7\}$ (b) (ii) 6

ε



16. 7
17. (a) $y=-x^2+5.5x+3$ (b) $x=2.75$ (c) graph sketch
18. (a) $2y-x=15$ (b) $x=27,\ y=21$
19. $\frac{3}{4}\pi d^2$
20. (a) 47.5 cm (b) $r=7.57$; $H=4.87$
21. 96
22. (a) $B(1, 0)$ (b) $C(7, 0)$
23. (a) 72 km / h (b) 25 (c) 40
25. (a)(i) \$9 (ii) \$5 (b)(ii) Carpark A
26. (a) 720 m³ (b) 3.5 hrs

Answer all the questions.

1 (a) Simplify $\frac{4y}{3x^3}\div\frac{12y^4}{x}$. [1]

(b) Simplify $\frac{4x-8}{7x^2-12x-4}$. [2]

(c) Factorise completely $20m^2-45n^2$. [2]

(d) Solve the equation $\frac{4x+5}{3x-2}=4$. [2]

(e) The volume, V m³, of a certain object is given by the formula $V=\frac{b^2}{2}(a+3h)$, where h is the height of the object in metres and a and b are constants.

(i) Make b the subject of the formula. [2]

(ii) Hence find b, when the volume and height of the object are 15 m³ and 2.5 m respectively, and $a=0.25$. [2]

2 (a) The annual tuition fees for a three-year Business degree at a local university in Singapore is \$12 000.

(i) Wayne receives a bursary of \$5 000 per year for 3 years. Find the remaining amount that Wayne has to pay. [1]

Wayne decides to take a study loan from the bank to pay the remaining tuition fees. There are two loan packages available for him to choose.

Package A	Compound interest of 4.7% per annum, repayment period of 5 years
Package B	Simple interest of 4.9% per annum, repayment period of 6 years.

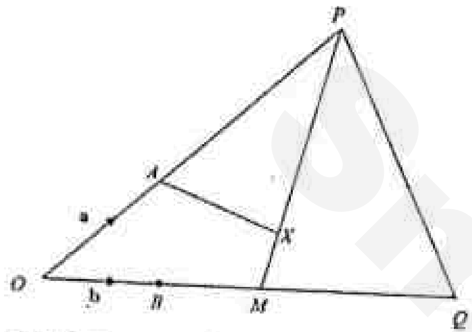
(ii) Find the total repayment amount for Package A. [2]

(iii) Find the total repayment amount for Package B. [2]

(iv) Wayne is able to afford a maximum repayment of \$400 per month. Explain, with working, which package Wayne should choose. [3]

(b) In this part, use the fact that 1 light year = 9.46×10^{15} metres. The distance of the star Sirius from the Sun is 8.6 light years. A space probe travels at 70 000 km/h. Calculate the time taken for the probe to travel from the Sun to Sirius. Give your answer in years, correct to three significant figures. [3]

3



In the diagram, $\overrightarrow{OA} = \frac{1}{3}\overrightarrow{OP}$, and $\overrightarrow{OB} = \frac{1}{4}\overrightarrow{OQ}$. M is the midpoint of OQ, and $MX = \frac{1}{5}MP$.

(a) Given that $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$, express in terms of **a** and /or **b**,

(i) $\overrightarrow{AQ}$, [1]

(ii) $\overrightarrow{MP}$, [1]

(iii) $\overrightarrow{MX}$, [1]

(iv) $\overrightarrow{AX}$. [2]

(b) Prove that AX, when produced, will pass through Q. [2]

(c) Given that the area of triangle OPQ is 40 cm^2, calculate the area of

(i) triangle PMQ, [1]

(ii) triangle PQX, [1]

(iii) triangle OAB. [2]

4 A Mercedo car uses x litres of petrol to travel 240 km from Singapore to Malacca. A Yotamo car uses 5 litres less than a Mercedo car to travel the same route.

(a) Write down an expression, in terms of x, for

(i) the distance travelled per litre by the Mercedo car, [1]

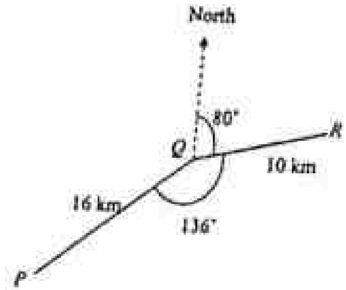
(ii) the distance travelled per litre by the Yotamo car. [1]

(b) The mean value of the distance travelled per litre by both cars is 10 km/litre. Form an equation in x to represent this information, and show that it reduces to $x^2 - 29x + 60 = 0$. [3]

(c) Solve the equation $x^2 - 29x + 60 = 0$, giving your answers correct to 2 decimal places. [3]

(d) Hence, find the distance travelled per litre by the Mercedo car. [2]

5



A ship sails 16 km from P to Q. It then sails 10 km from Q to R on a bearing of 080°.

(a) Given that angle $PQR = 136°$, calculate

(i) the bearing of Q from P, [2]

(ii) the distance PR. [2]

(b) The ship finally sails from R to a position T, which is due North of Q. Given that angle $QTR = 35°$, calculate

(i) the distance RT, [2]

(ii) the shortest distance between the point Q and the ship as it sails from R to T. [2]

(c) A helicopter is hovering vertically above point R, 2 km from sea level. Calculate the angle of depression of P from the helicopter. [1]

6 A group of students took a multiple choice test containing 40 questions.
The mean number of questions correctly answered, wrongly answered and unattempted are 28, 4 and 4 respectively.

Ashley attempted all questions with $(40-x)$ questions answered correctly and x questions answered wrongly. Compared to Ashley, Benny answered 2 more questions correctly, answered 5 fewer questions wrongly and left 3 more questions unattempted.

The information can be represented by the matrix $\mathbf{Q} = \begin{array}{c} \begin{array}{ccc} \text{Mean} & \text{A} & \text{B} \end{array} \\ \begin{pmatrix} 28 & 40-x & 2 \\ 4 & x & -5 \\ 4 & 0 & 3 \end{pmatrix} \end{array} \begin{array}{c} \\ \text{C} \\ \text{W} \\ \text{U} \end{array}$.

(a) For every correct answer, 2 marks were awarded and for every wrong answer 1 mark was deducted.
No mark was awarded or deducted for unattempted questions.
Write down a 1×3 matrix $\mathbf{R}$ to represent this information. [1]

(b) Find $\mathbf{S} = \mathbf{RQ}$, leaving your answer in terms of x. [2]

(c) Benny claims that his score is better than Ashley's. Is his claim correct?
Justify your answer. [1]

(d) Ashley's score is 4 marks higher than the mean mark. Find the value of x. [2]

7 **Answer the whole of this question on a sheet of graph paper.**

The variables x and y are connected by the equation $y = 0.25x^2(x-6)+3$.
The table below shows the corresponding values of x and y.

x	-1	0	1	2	2.5	3	4	5	5.5	6
y	1.25	3	1.75	-1	-2.47	-3.75	-5	h	-0.78	3

(a) Calculate the value of h. [1]

(b) Using a scale of 2 cm to represent 1 unit, draw a horizontal axis for $-1 \le x \le 6$.
Using a scale of 2 cm to represent 1 unit, draw a vertical axis for $-5 \le y \le 3$.

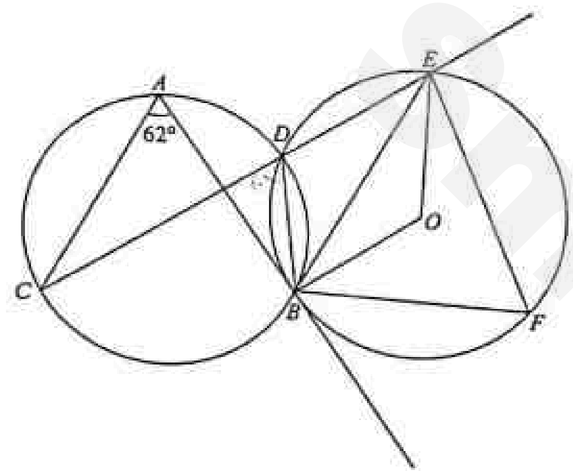
On your axes, plot the points given in the table and join them with a smooth curve. [3]

(c) Use your graph to find the solutions of the equation $0.25x^2(x-6) = -1$. [2]

(d) By drawing a tangent, find the gradient of the curve at the point $x = 1$. [2]

(e) By drawing a suitable straight line on your graph, find the solutions of the equation $0.25x^2(x-6)+x+1=0$. [3]

In the diagram, AB is a tangent to the circle with centre O, angle $CAB = 62°$ and CDE is a straight line.



(a) Stating your reasons clearly, find

(i) angle CDB, [1]

(ii) angle BDE, [1]

(iii) angle EFB, [1]

(iv) angle BOE, [2]

(v) angle EBO. [2]

(b) Find angle ABE. Hence, write a statement about the lines CA and BE. Give a reason for your answer. [3]

9 (a) The stem-and-leaf diagram shows the mass of 20 Secondary Four Judo students.

3	8	9					
4	1	2	4	5	5	8	9
5	0	1	1	2	3	5	m
6	0	1	2	6			

Key **4 | 1 means 41 kg**

(i) The interquartile range of the above distribution is 11.5 kg.
Show that the value of m is 7. [3]

(ii) It was discovered that the masses of the students were recorded wrongly.
The correct masses were all 2 kg more than those recorded.
Explain how the interquartile range and the standard deviation of the mass have been affected by this error. [2]

(b) The 20 Secondary Four Judo students are divided into 2 groups.

Group A	Students whose mass is not more than 51 kg
Group B	Students whose mass is more than 51 kg

Mr Ng, the Judo instructor, selects two students at random, one after the other.

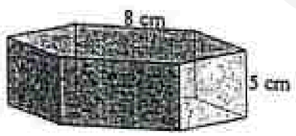
(i) Draw a tree diagram to show the probabilities of the possible outcomes. [2]

(ii) Find, as a fraction in its simplest form, the probability that

(a) the first student is from Group B and the second student from Group A, [2]

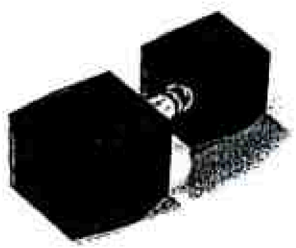
(b) at most one of the students is from Group B. [2]

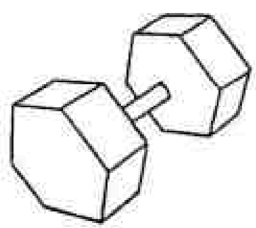
10 The diagram shows a prism with a cross-section in the shape of a regular hexagon with sides 8 cm.
The prism has thickness 5 cm.



(a) Show that the volume of the prism is 831.4 cm^3, correct to 4 significant figures. [3]

(b) A dumbbell can be modelled using a cylinder and two prisms from (a).
The dumbbell shown in the diagram below is made entirely of cast iron.
The density of cast iron is 7000 kg/m^3.
1 kg is 2.204 pounds.





(i) Given that the cylinder has radius 1.5 cm and the total length of the dumbbell is 25 cm, calculate the total volume of the dumbbell. [2]

(ii) Shawn wants to do weight-lifting and his physical trainer advises him not to carry more than 25 pounds.

Determine if Shawn is able to use this dumbbell. Justify your decision with calculations. [5]

End of Paper

Answer Key

1. (a) $\frac{1}{9x^3y^3}$ (b) $\frac{4}{7x+2}$ (c) $5(2m+3n)(2m-3n)$ (d) $x=1\frac{5}{8}$

1. (e)(i) $b=\pm\sqrt{\frac{2v}{a+3h}}$ (e)(ii) 1.97 or −1.97 (3 s.f.)

2. (a)(i) \$21 000 (ii) \$26421.21 (iii) \$27174 (iv) Package B (b) 133 000

3. (a)(i) $4b-a$ (ii) $3a-2b$ (iii) $\frac{1}{5}(3a-2b)$ (iv) $\frac{2}{5}(4b-a)$

3. (c)(i) 20 cm^2 (ii) 16 cm^2 (iii) $3\frac{1}{3}$ cm^2

4. (a)(i) $\frac{240}{x}$ km/litre (ii) $\frac{240}{x-5}$ km/litre (c) 26.76 or 2.24 (d) 8.97 km

5. (a)(i) 036° (ii) 24.2 km (b)(i) 17.2 km (b)(ii) 9.06 km (c) 4.7°

6. (a) $(2 \quad -1 \quad 0)$ (b) $(52 \quad 80-3x \quad 9)$ (c) Yes. Benny's score is 9 marks higher than Ashley's.

6. (d) $x=8$

7. (a) −3.25 (c) −0.75, 0.9, 5.85 (d) -2.23 (e) −0.55, 1.45, 5.05

8. (a)(i) 62° (ii) 118° (iii) 62° (iv) 124° (v) 28°

9. (a)(ii) Both are not affected by the error. (b)(ii)(a) $\frac{24}{95}$ (b)(ii)(b) $\frac{81}{95}$

10.(b)(i) 1770 cm^3 (ii) Shawn cannot use the dumbbell.

1 (a) Calculate $\dfrac{-5+7\times\sqrt[3]{-8}+10+3}{3}$, giving your answer correct to 1 decimal place.

Answer .... [1]

(b) Express 0.00106 in standard form.

Answer .... [1]

(c) Round off 8999 to 3 significant figures.

Answer .... [1]

---

2 $\xi = \{x : x = 0.\dot{3},\ 1,\ 2,\ \sqrt{5},\ \sqrt{9},\ \pi,\ 33,\ 2^3\}$

$A = \{x : x$ is a prime number$\}$

$B = \{x : x$ is a factor of 16$\}$

List the elements in

(a) A,

Answer .... [1]

(b) B,

Answer .... [1]

(c) $(A \cap B)'$.

Answer .... [1]

3 These are the first five terms in a sequence.

1.2 2.3 3.4 4.5 5.6

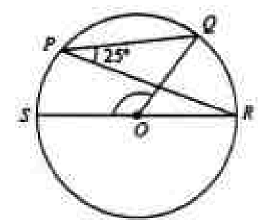
(a) Write down the ninth term in the sequence.

Answer .... [1]

(b) Write down an expression, in terms of n, for the nth term in the sequence.

Answer .... [1]

4



In the diagram, P, Q, R and S are points on the circumference of a circle, centre O. SR is the diameter of the circle. Angle $QPR = 25°$.

Find angle QOS. State your reasons clearly.

Answer $\angle QOS =$ .... ° [2]

5 (a) Express x^2-3x-4 in the form $(x-p)^2+q$.

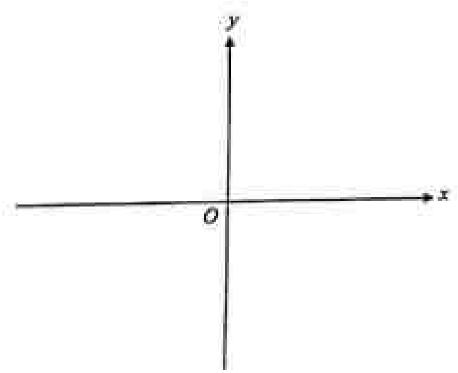
Answer .... [2]

(b) State the coordinates of the turning point of the graph $y=x^2-3x-4$.

Answer (............ , ...) [1]

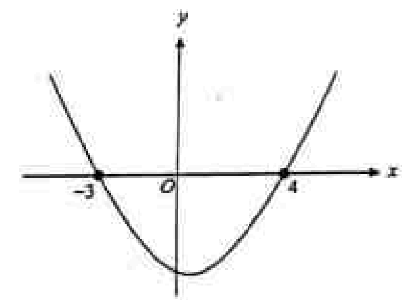
(c) Sketch the graph of $y=x^2-3x-4$. [2]

Answer (c)



6 The diagram shows a sketch of the graph of $y=x^2-px-q$.

Answer (c)



(a) Calculate the values of p and q.

Answer $p=$ .... , $q=$ .... [2]

(b) Write down the equation of the line of symmetry of the graph $y=x^2-px-q$.

Answer .... [1]

(c) Sketch on the same diagram, the graph of $y=-x^2+px+q$. [2]

7 Factorise completely

(a) $9x^3 - 25xy^2$,

Answer .... [2]

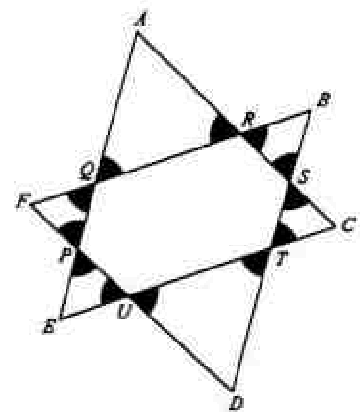
(b) $x^2 + 2xy + y^2 - 4$.

Answer .... [2]

8 Solve the equation $\frac{3x}{2} - \frac{15-4x}{3} - 7 = 0$.

Answer $x =$ .... [3]

9 The diagram shows two triangles *AEC* and *DBF*.



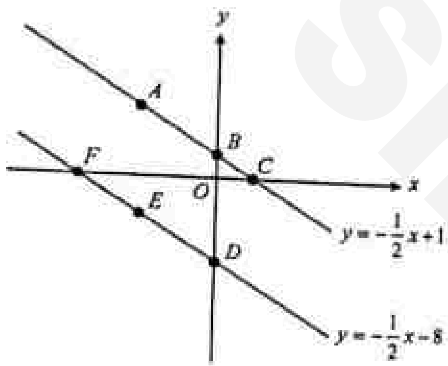
(a) Calculate the sum of the shaded angles.

Answer .... ° [2]

(b) Name the geometrical figure, *PQRSTU*, formed by the overlap of triangles *AEC* and *DBF*.

Answer .... [1]

10 The diagram shows the sketches of two straight lines $y=-\frac{1}{2}x+1$ and $y=-\frac{1}{2}x-8$.



(a) What are the coordinates of point F?

Answer F(............ , ...) [1]

(b) Calculate the length of the line segment FB.

Answer .... units [2]

(c) Show that triangle OCB is similar to triangle OFD.
State your reasons clearly.

Answer (c)

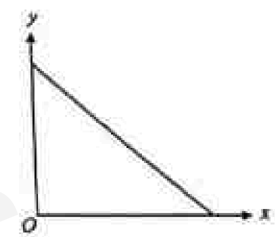
[2]

11 Given that $1<y<2$, simplify and arrange the following expressions in *ascending order of magnitude*.

$$\frac{1}{y^{-2}}+\frac{1}{y^{2}} \quad , \quad \frac{1}{(y-3)^{3}}\times\frac{(y-3)^{2}}{1} \quad , \quad \frac{y^{-4}}{4y^{-3}} \quad .$$

Answer .... [4]

12 The diagram shows a graph of y against x.



Sally concludes from the graph that "y is inversely proportional to x".
Do you agree with Sally? Give a reason for your answer.

Answer .... because ....
....
.... [2]

13 Two bottles have capacities of 1.5 litres and 2 litres respectively.
The height of the smaller bottle is 75% that of the height of the larger bottle.
Show that the two bottles are not geometrically similar.

Answer

[2]

14 Four candidates took part in an election.
The tables below represent the polling results from two polling stations.
The candidate with the highest number of total votes from both polling stations wins the election.

Candidate	Votes received
1	28%
2	22%
3	20%
4	30%

Polling Station 1

Candidate	Votes received
1	50%
2	15%
3	25%
4	10%

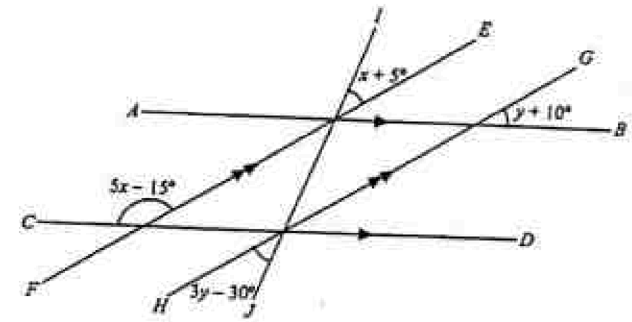
Polling Station 2

Do you agree that Candidate 1 has the most number of votes? Explain your answer.

Answer ....

.... [2]

15 In the diagram, AB is parallel to CD and EF is parallel to GH.
IJ is a straight line.



(a) Write down a pair of simultaneous equations in terms of x and y.

Answer ....

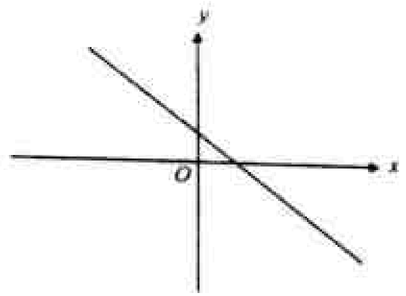
.... [2]

(b) Hence solve for the values of x and y.

Answer $x =$ ....°, $y =$ ....° [3]

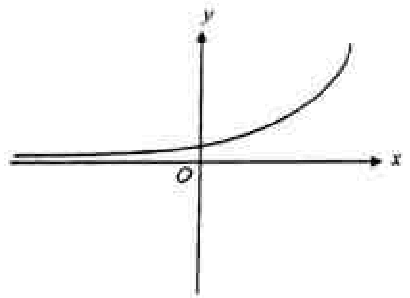
16 Write down a possible equation for each of the following graphs.

(a)



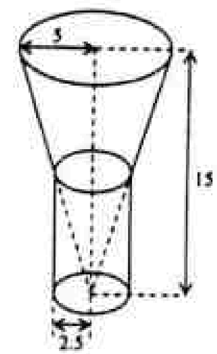
Answer .... [2]

(b)



Answer .... [2]

17 A container is made up of a cylinder and a conical frustum.
The height of the container is 15 cm, and the radii of the cylinder and conical frustum are 2.5 cm and 5 cm respectively.

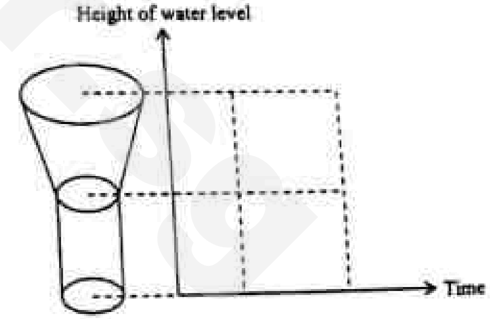


(a) Calculate the volume of the container.

Answer .... [3]

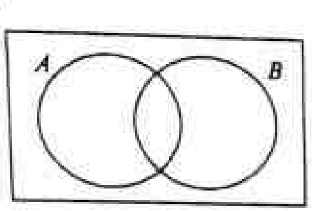
(b) Water is poured at a constant rate into the container from the top.
On the axes provided, sketch the graph of the change in height of water level over time. [2]

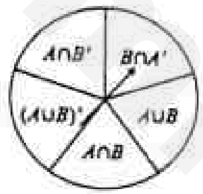
Answer (b)



17

18 The Venn diagram shows a universal set ξ and two sets A and B.
A circular card is divided into 5 equal sectors. The card has a pointer pivoted at its centre. Each time the pointer is spun, it is equally likely to stop at any of the sectors.

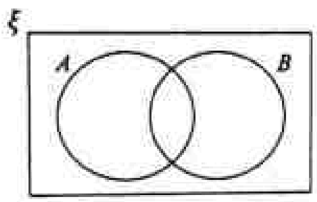




Andrea spins the wheel twice and shades the corresponding region(s) where the pointer stops.

(a) Given that the pointer lands on $A \cap B'$ and $B \cap A'$ on the first and second spin respectively, shade the region(s) in the Venn diagram below.

Answer (a) [1]



Giving your answer as a fraction in its simplest form, find the probability that Andrea shades the following regions.

(b) $A \cap B$.

Answer .... [1]

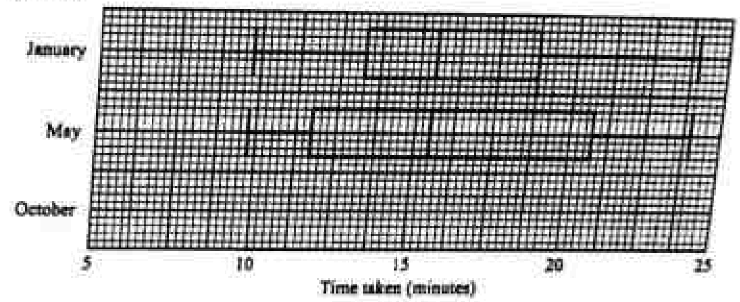
(c) $A \cup B'$.

Answer .... [1]

18

19 The box plot represents the distributions of the time taken by a group of students to complete their fitness run in January and May.

Answer (c)



(a) Find the interquartile range for May.

Answer .... mins [2]

(b) Do you agree that the students' performance has improved from January to May? Justify your answer.

Answer .... because ....
.... [2]

In order to pass the fitness run, students have to attain timing of 12 minutes and below.

(c) It is given that more than 50% of the students passed the test in October. Sketch a possible box plot in the grid above for the distribution of the time taken by the group of students to complete their run in October. [1]

20 The cash price of a television is \$2899. During the Great Singapore Sale, there was a 20% discount provided. The hire-purchase price of the television is a deposit of 15% of the selling price and a monthly instalment of \$90.50 for 2 years.

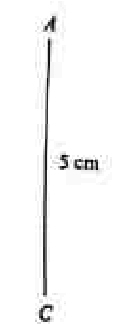
Calculate the hire-purchase price.

Answer \$ .... [3]

21 A plot of land in the shape of a kite has been selected for housing development. An architect is constructing a scale drawing of the land by drawing two circles of radii 2 cm and 5 cm, centre at points A and C respectively.

(a) Construct the kite $ABCD$, labelling the vertices in an anti-clockwise direction.

Answer (a)



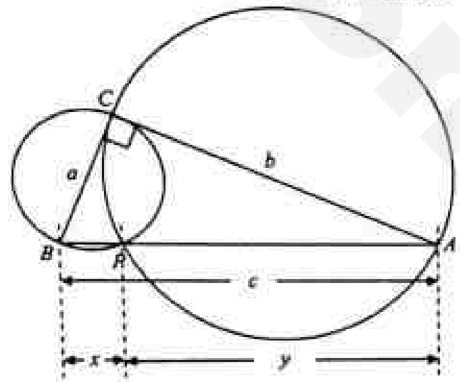
[3]

It is given that A is north of C.

(b) Measure the bearing of B from C.

Answer .... [2]

22 The diagram shows two circles with diameters AC and BC.
Angle ACB is a right angle. The two circles intersect at points C and P.



(a) By considering the angle properties of circle, show that BPA forms a straight line.

Answer (a)

[2]

(b) State two triangles similar to triangle ABC.

Answer .... and .... [1]

(c) Using (b), show that $a^2 = xc$ and $b^2 = yc$ and hence show that $a^2 + b^2 = c^2$.

Answer (c)

[2]

- END OF PAPER -

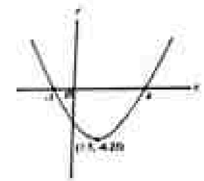
1 (a) -5.2
(b) 1.06×10^{-3}
(c) 9000

2 (a) 2, $\sqrt{9}$
(b) 1, 2, 2^3
(c) $0.\dot{3}$, 1, $\sqrt{5}$, $\sqrt{9}$, π, 33, 2^3

3 (a) 10
(b) $1.1n + 0.1$ o.e.

4 130°

5 (a) $(p =)$ 1.5 o.e.
$(q =)$ -6.25 o.e.
(b) (1.5, -6.25)
(c)



6 (a) $(p =)$ 1, $(q =)$ 12
(b) $x = \frac{1}{2}$
(c)

7 (a) $x(3x - 5y)(3x + 5y)$
(b) $(x + y - 2)(x + y + 2)$

8 $x = 4\frac{4}{17}$

9 (a) 720°
(b) Hexagon

10 (a) (-16, 0)
(b) 16.0 units

11 $\frac{1}{(y-3)^3} \times \frac{(y-3)^2}{1}$, $\frac{y^{-3}}{4y^{-1}}$, $\frac{1}{y^{-2}}$, $\frac{1}{y^2}$

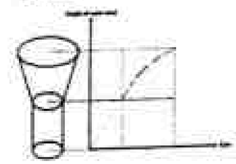
12 Disagree
If y is inversely proportional to x, then $y = \frac{k}{x}$, where k is a constant. The graph will be a curve not touching the axes.

14 Percentage is used to represent data – Does not allow for accurate judgement of which candidate has more votes absolutely.

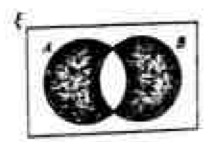
15 (a) $x + 5° = 3y - 30°$ --- Eq^n 1
$(5x - 15°) + (y + 10°) = 180°$ --- Eq^n 2
(b) $y = 22.5°$, $x = 32.5°$

16 (a) $y = -2x + 3$ or any equation of the form $y = mx + c$, where $m < 0, c > 0$
(b) $y = 2^x$ or any equation of the form $y = ka^{bx} + c$, where $k > 0, a > 1, b > 0, c \geq 0$

17 (a) 491 cm³
(b)



18 (a)



(b) $\frac{1}{25}$
(c) 0

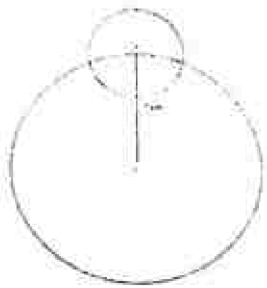
19 (a) 9 mins

(b) Do not agree.
Median remains the same.

(c) Q_3 is drawn before 12 mins.

20 \$2519.88

21 (a)

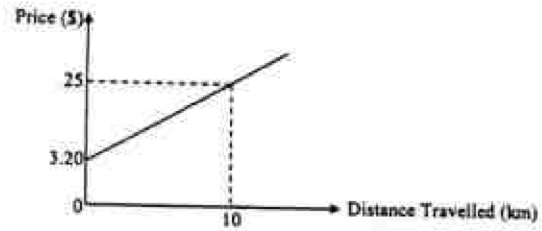


(b) Measure from construction
Bearing = $360° - \angle ACB$

22 (b) CBP and ACP

Answer all questions.

1. (a) The price charges of Rushford Taxi Company can be represented in the graph below.



(i) Using P to represent the price in dollars and S to represent the distance travelled in kilometres, write down an equation to represent the pricing of Rushford Taxi Company. [2]

(ii) Speedton Taxi Company charges their customers an initial fee of \$2.30. In addition, they charge \$3.10 per kilometre travelled.
Find the minimum distance that a customer must travel such that Rushford Taxi Company charges will be at least equivalent or cheaper than Speedton Taxi Company charges. [3]

(b) The selling price of each taxi, excluding goods and services tax (GST), is \$95000.

A 7% GST is chargeable on the selling price of the taxi.

Speedton Taxi Company intends to buy 15 taxis on hire purchase.

The company pays a downpayment of 20% and the remaining will be paid by monthly instalments for the next 5 years at a simple interest rate of 2.5% per annum.

Calculate the monthly instalment. [4]

2. **(a)** Simplify $\sqrt[3]{64m^9n^{\frac{1}{3}}}$. [1]

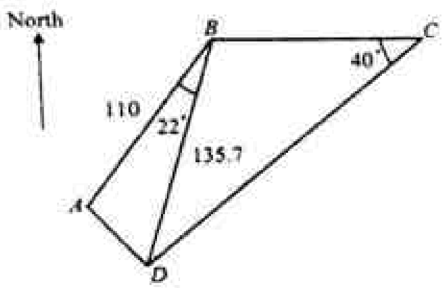
(b) Simplify $\frac{2x+5}{4x^2-2x-30}+\frac{x+1}{3x^2-27}$. [3]

(c) Solve the inequality $\frac{2x-3}{4}\le\frac{3x+1}{5}$. [2]

(d) Solve the equation

$$\frac{4}{x-3}-\frac{8x-1}{2x^2-5x-3}=\frac{1}{3}.$$ [5]

3.



$ABCD$ is the search area for a hiker missing in the forest.

$AB = 110$ km, $BD = 135.7$ km, $\angle ABD = 22^\circ$ and $\angle BCD = 40^\circ$.

C is due east of B and the bearing of B from A is 043°.

(a) Calculate AD. [3]

(b) Calculate the bearing of D from B. [2]

(c) Calculate BC. [3]

(d) Calculate the search area $ABCD$. [2]

(e) The hiker used a red flare to signal his position.

The red flare shoots vertically upwards to a maximum height of 400 m.

A rescuer at D measured that the maximum angle of elevation of the red flare from D is 6°.

Calculate the shortest distance that the rescuer needs to travel in order to reach the survivors. [2]

4. **(a)** Eric bought a new car.

His car comes with two different drive modes.

An Eco-Mode which saves fuel and a Sport-Mode which consumes more fuel.

The fuel consumption of the car is also dependent on whether the car is cruising along an expressway or in city traffic.

This information can be represented by the following table.

	Distance Travel per Litre of Fuel (km/l)	
	Expressway	City
Eco-Mode	25	14
Sport-Mode	15	9

(i) Represent the information on the table by a 2×2 matrix $\mathbf{F}$. [1]

(ii) Eric's daily commute to work and back home consists of 20% expressway driving and 80% city driving. Represent these percentages in a 2×1 matrix $\mathbf{C}$.

Hence evaluate the matrix $\mathbf{Z} = \mathbf{FC}$. [2]

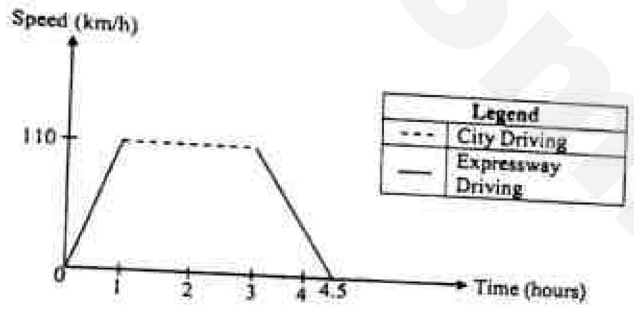
(iii) State what the elements of $\mathbf{Z}$ represent. [1]

(iv) Eric will enable the eco-mode whenever he drives.

Eric's car is able to hold 40 litres of fuel.

Calculate the maximum distance the car can travel before requiring a refuel, assuming that he only uses his car to commute to work and back home. [1]

4 (b) Eric is driving to Kuala Lumpur (KL). The speed time graph of his journey is illustrated below.



Eric took 4.5 hours to complete his journey from Singapore to KL.

He used Sport-Mode throughout this journey.

Assuming that his car's petrol tank was full before the journey, can Eric reach KL without refuelling his car? Show your workings clearly. [4]

5. Ash decided to hike up a hill on his quest for Pokemons.

The path up the hill is 16 km long.

He hiked up along this path at an average speed of x km/h.

(a) Write an expression, in terms of x, for the number of hours he took to reach the summit of the hill. [1]

(b) He decided to explore a different path down the hill.

The length of the path down the hill is 22 km.

His average speed walking down the hill was 3 km/h faster than his average speed going up the hill.

It took Ash 1.5 hours less to come down than to go up the hill.

Write down an equation in x, and show that it simplifies to $x^2+7x-32=0$. [4]

(c) Solve the equation $x^2+7x-32=0$. [2]

(d) Calculate the total time Ash took to hike up and down the hill. [2]

6. **Answer the whole of this question on a sheet of graph paper.**

The variables x and y are connected by the equation

$$y=x^2(5-x)-5.$$

Some corresponding values of x and y are given in the table below.

x	-2	-1	0	1	2	3	3.5	4	4.5	5
y	23	q	-5	-1	7	13	13.4	11	5.1	-5

(a) Find the value of q. [1]

(b) Using a scale of 2 cm to represent 1 unit, draw a horizontal axis for $-2 \le x \le 5$.

Using a scale of 1 cm to represent 2 units, draw a vertical axis for $-8 \le y \le 26$.

On your axes, plot the points given in the table and join them with a smooth curve. [3]

(c) For $-2 \le x \le 5$, find the range of values of p for which $x^2(5-x)-5=p$ has exactly three solutions. [2]

(d) By drawing a tangent, find the gradient of the curve at $(4.5,\ 5.1)$. [2]

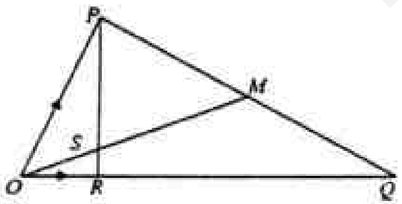
(e) By drawing a suitable straight line, solve $-x^3+5x^2-6x-11=0$. [3]

7. OPQ is a triangle.

$\overrightarrow{OP} = \mathbf{p}$ and $\overrightarrow{OR} = \mathbf{r}$.

M is the midpoint of PQ.

$OR : RQ = 1 : 4$ and $\overrightarrow{RS} = \frac{1}{6}\overrightarrow{RP}$.



(a) Express, as simply as possible, in terms of p and/or r,

(i) $\overrightarrow{OQ}$, [1]

(ii) $\overrightarrow{RS}$. [1]

(b) Find the position vector of M in terms of p and/or r. [2]

(c) (i) Show that $\overrightarrow{OM} = k\overrightarrow{OS}$, where k is a constant. [1]

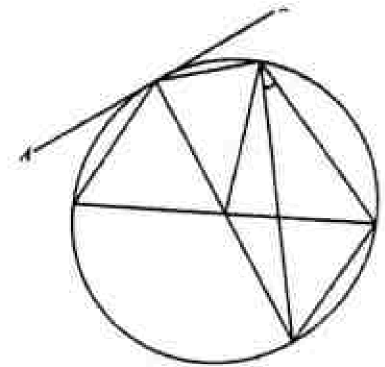
(ii) What can be deduced about the points O, S, M? [1]

(d) Find the value of

(i) $\dfrac{\text{Area of } \Delta ORS}{\text{Area of } \Delta ORP}$, [1]

(ii) $\dfrac{\text{Area of } \Delta ORS}{\text{Area of } \Delta OPQ}$. [2]

8. (a)



Line AC is a tangent to the circle at point B.

BG and HE are diameters of the circle.

Points H, B, D, E and G are on the circumference of the circle.

Angle $EDG = 29°$ and angle $OFD = 76°$.

(i) Find

(a) angle OHB, [2]

(b) angle CBD. [3]

(ii) Given that the radius of the circle is 6 cm, calculate the length of minor arc DE. [3]

(b)

The diagram shows a right angle triangle OBC and a sector of a circle OAC.

$OC = 9$ cm and the arc length $AC = 4$ cm.

Calculate

(i) angle AOC in radians, [1]

(ii) the area of the shaded region. [3]

9. The marks distribution of a mathematics test of a class of 20 students is shown in the stem-and-leaf diagram.

Boys		Girls
8 7 6	0	9
9 4 1	1	2 8 8
8 3	2	3 6 6
5 1	3	1 1 6

Key (Boys): 2 | 1 means 12

Key(Girls): 1 | 2 means 12

(a) State the median marks for the girls in the class. [1]

(b) Calculate the

(i) mean marks of the test for the boys, [1]

(ii) standard deviation of the test for the boys. [1]

(c) The statistical results for the girls in the class are summarized below.

Mean	23
Standard Deviation	8.26

A student commented that "*Girls did better than boys as the standard deviation for girls is lower than that of boys*".

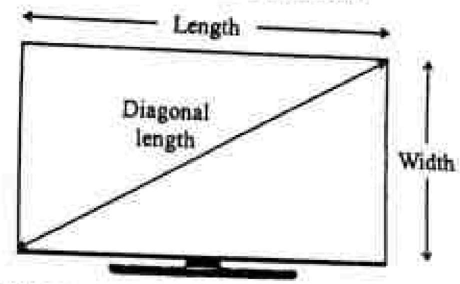
Do you agree or disagree with the student's statement. Please explain your answer. [2]

(d) The passing mark for this particular test is 18.

(i) A student was selected at random from the class. Find the probability that the student selected passed the mathematical test. [1]

(ii) Two students were selected at random. Find the probability that at least one student passed the test. [2]

10. Jonathan intends to buy a television for his new house. The television will be placed in his living room. Jonathan went to a local electronics store and the salesperson gave Jonathan a brief introduction about the things he should take note of when buying a television.
Firstly, Jonathan should take note of the aspect ratio of a television. A typical high definition television comes with an aspect ratio of 16:9 for better viewing experience. Aspect ratio is the ratio of the length of the screen to the width of the screen.

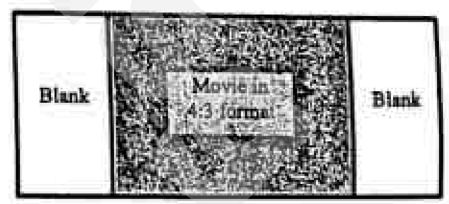


(a) Jonathan's living room can accommodate a television with a maximum length of 2 metres. If he buys a television with an aspect ratio of 16:9, find the maximum width of the television. [1]

(b) Next, Jonathan should note that television screen size refers to the diagonal length of the screen, measured in inches.

Calculate the maximum screen size that his living room can accommodate. Correct your answer to the nearest inches. (1 inch = 0.0254 m) [2]

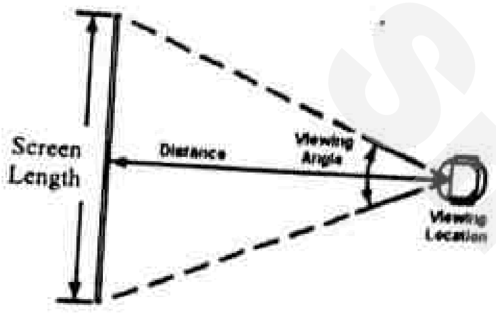
(c) Jonathan has a movie which he wishes to play. The movie has an aspect ratio of 4:3. If the movie uses the full width of a television screen with aspect ratio 16:9 (as illustrated in the diagram below), calculate the percentage of the television screen that is not used.



[2]

(d) Lastly, Jonathan has to consider the viewing angle. The optimal viewing angle at eye level is between 30° and 45°.

An illustration of the viewing angle is shown below.



Top view

Screen size (inch)	Screen length (m)	Screen width (m)
40	0.89	0.50
55		
65	1.32	0.74

Table 1

Jonathan's sofa will be located 2.4 metres away from his television.

Jonathan has shortlisted three 16:9 aspect ratio televisions of varying screen sizes.

Copy and complete the table above in the writing paper provided.

Using the information in the table, suggest which television Jonathan should buy. Support your answer with mathematical reasoning. [5]

End of Paper

2016 EM Prelim S4Exp/5NA P2 (100 marks): One Page Answer

Qn	Answer Scheme
1(ai)	$\therefore P = 2.18S + 3.20$
1(aii)	$x = 0.978km$
1(b)	\$22871.25
2(a)	$4m^{3}n^{\frac{1}{3}}$
2(b)	$\frac{3(x+3)}{2(x+1)}$
2(c)	$x \geq -9\frac{1}{2}$
2(d)	$x = 4\frac{1}{2}$ or -2
3(a)	$AD = 53.239 \approx 53.2km$
3(b)	201°
3(c)	$BC = 102.349$ $BC \approx 102$ km
3(d)	9279.013 ≈ 9280 km²
3(e)	$x = 3805.746$ $x \approx 3810$ m
4(ai)	$F = \begin{pmatrix} 25 & 14 \\ 15 & 9 \end{pmatrix}$
4(aii)	$Z = \begin{pmatrix} 16.2 \\ 10.2 \end{pmatrix}$
4(aiii)	Fuel consumption for the eco-mode and sport-mode respectively with a travel pattern of 20% expressway and 80% city.

Setter: Mr. Tan K.B.

4(aiv)	$16.2 \times 40 = 648$ km
4(b)	$\therefore$ Fuel consumption for sport-mode $= 11.31$ km/l $\therefore \frac{357.5}{11.31} \approx 33.2l$ There is no need for a refuel as his car has a capacity for 40 litres. He is able to complete his journey on a single full tank.
5(a)	$\frac{16}{x}$
5(b)	Shown
5(c)	$x = 3.15$ or -10.2
5(d)	8.6566 $\approx 8.66 hrs$
6	Refer to graph paper
7(ai)	$\overrightarrow{OQ} = 5r$
7(aii)	$\overrightarrow{RS} = -\frac{1}{6}r + \frac{1}{6}\rho$
7(b)	$\overrightarrow{OM} = \frac{1}{2}(\rho + 5r)$
7(ci)	$\overrightarrow{OM} = 3(\rho + 5r)$ (shown)
7(cii)	The points are collinear.
7(di)	$\frac{1}{6}$
7(dii)	$\frac{1}{30}$
8(ai)	$\angle OHB = 61^\circ$
8(aii)	$\angle CBD = 18^\circ$
8(aiii)	Arc Length $= 9.01$ cm

8(bi)	$\theta = \frac{4}{9}$ rad
8(bii)	Shaded Area $= 1.287 \approx 1.29$ cm^2
9(a)	Median $= 24.5$
9(bi)	Mean $= 18.2$
9(bii)	$\sigma = 10.0678 \approx 10.1$
9(c)	I disagree with the statement. This is because standard deviation measures the consistency of the results rather than then the performances of the girls and boys respectively. The student can use the median instead.
9(di)	$\frac{13}{20}$
9(dii)	$\frac{169}{190}$
10(a)	$x = 1.125$m
10(b)	$y = 90.34 \approx 90$ inches
10(c)	% Wastage $= 25\%$
10(d)	To complete the table: Length $= 1.22$m Width $= 0.68$m Jonathan should choose the 65 inches television as the viewing angle falls inside the optimal range.

Answer all the questions.

1 (a) Calculate $\frac{12.603+\sqrt[3]{8-5\times(-6.1)}}{2^3}$.

Write down the first five digits on your calculator display.

Answer (a) .... [1]

(b) Write your answer to part (a) correct to 3 significant figures.

Answer (b) .... [1]

2 Arrange the following in order of size, largest first.

$\frac{33}{41}$, 0.803, $\sqrt{0.64}$, $0.52^{\frac{1}{3}}$

Answer ...., ..., ..., ... [2]
largest smallest

3 Factorise fully $\frac{4}{5}x^3-\frac{1}{5}xy^2$.

Answer .... [2]

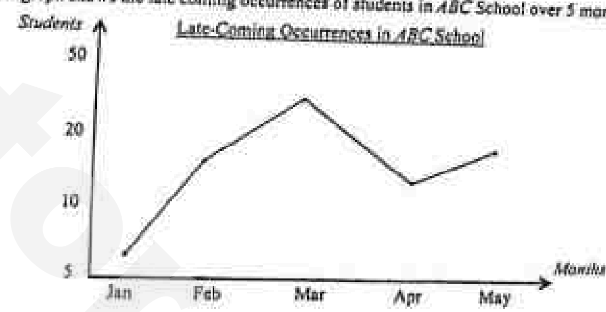
4 (a) Simplify $\left(\frac{y^{18}}{125}\right)^{-\frac{1}{3}}$.

Answer (a) .... [1]

(b) Given that $729^{\frac{1}{3}}\times 9=3^k$, find the value of k.

Answer (b) k = ... [1]

5 The line graph shows the late coming occurrences of students in *ABC* School over 5 months.



Write down two statistical misrepresentations of this line graph.

Answer

1 ....

2 .... [2]

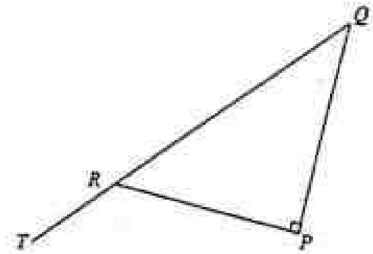
6 April, Bella and Chad shared a sum of money between them in the ratio 3 : 5 : 9.
If Chad gives Bella \$30, both of them will have an equal share.
What was the total sum of money that was shared amongst the three?

Answer \$ .... [2]

7 Simplify $4(x^2+3xy)-(2x-y)^2$.

Answer .... [2]

8 PQR is a right-angled triangle.
QRT is a straight line. $PR = 12$ cm and $QR = 19$ cm.



Find the values of the following, giving your answer to 2 decimal places where necessary.

(a) $\tan \angle PQR$

Answer (a) $\tan \angle PQR =$ .... [2]

(b) $\cos \angle TRP$

Answer (b) $\cos \angle TRP =$ .... [1]

9 (a) Express 660 as the product of its prime factors.

Answer (a) $660 =$ .... [1]

(b) The lowest common multiple of 6, 12 and k is 660.
Given that $k < 150$, find two possible values of k.

Answer (b) $k =$ .... or .... [2]

10 (a) ξ = {integers $x : 1 \le x < 18$}
A = {prime numbers}
B = {divisible by 3}

(i) List the elements in A'.

Answer (a) A' = {...} [1]

(ii) Find $n(A \cup B)$.

Answer (b) $n(A \cup B)$ = ... [1]

(b) Given that P = {girls who play the guitar} and Q = {girls who play the drums}, describe what $P \cap Q = \{\}$ means.

Answer (b) .... [1]

11 Melissa jogs at a speed of 9 km/h.
One evening she jogged around her neighbourhood for 1 hour 20 minutes.

(a) Given that the scale of the map of the neighbourhood is 1 : 25000, find, in cm, the map distance that she covered.

Answer (a) .... cm [2]

(b) A reservoir located in her neighbourhood occupies a total area of 1.68 cm^2 on the map. What is the actual area, in m^2, of the reservoir?

Answer (b) .... m^2 [2]

12 (a) Express $x^2 - 5x - 3$ in the form $(x - a)^2 + b$.

Answer (a) .... [2]

(b) Hence solve $x^2 - 5x - 3 = 0$, giving your answers correct to two decimal places.

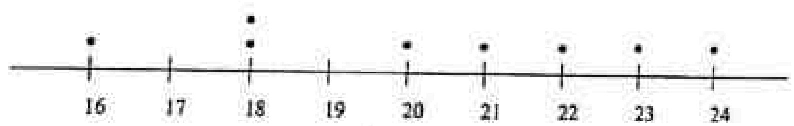
Answer (b) x = ... or .... [2]

13 The table below shows the ages of 16 students who work part-time at a book shop.

20	21	16	18
22	17	19	24
23	22	17	22
24	19	19	18

(a) Complete the dot diagram to show the distribution of the ages of the employees.

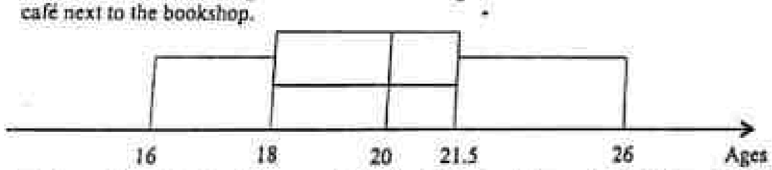
Answer (a) [1]



(b) Find the median of the distribution of the ages.

Answer (b) Median = ... years [1]

(c) The box-and-whisker diagram below shows the ages of another 16 students who work at a café next to the bookshop.



Explain, with statistical evidence, whether the following statement is TRUE or FALSE.
"The ages of the 4 youngest students who work at the café are closer together than the ages of the 4 youngest students who work at the bookshop."

Answer (c) [2]

The statement is .... because ....

....

14 (a) The line l has equation $4x + 2y + 7 = 0$.

(i) Find the gradient of line l.

Answer (a)(i) gradient = ... [1]

(ii) Find the coordinates of the point where l cuts the y-axis.

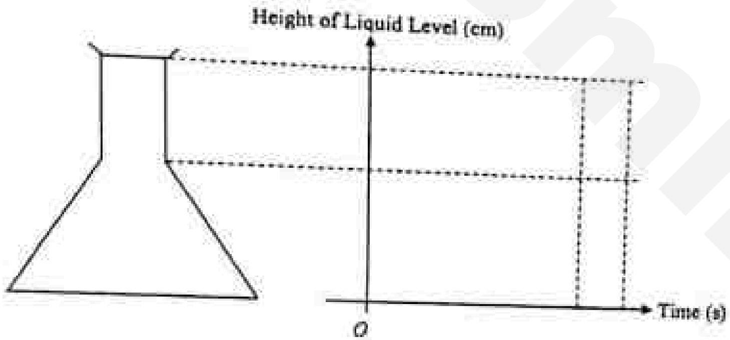
Answer (a)(ii) (.........., ...) [1]

(b) Another line k is parallel to $y = \frac{1}{2}x + 5$ and it passes through the point (8, 3).
Find the equation of line k.

Answer (b) .... [2]

15 (a) Mrs Ong pours water into a conical flask at a constant rate.
She stops once the flask is filled to the brim as shown in the diagram below.
Sketch a graph to show how the height of the water level changes with time.

Answer (a) [2]



(b) Electric power, P, in watt (W) is proportional to the square of the current, I, in amps (A).
If $P = 0.8$ W when $I = 0.02$ A, find an equation for P in terms of I.

Answer (b) .... [2]

16 Given that $A = \begin{pmatrix} 7 & 5 \\ -2 & 3 \end{pmatrix}$, find

(a) A^2,

Answer (a) $A^2 =$ .... [2]

(b) the value of x and of y if $3A - \begin{pmatrix} 15 & x \\ 2 & 0 \end{pmatrix} = \begin{pmatrix} 6 & 16 \\ y & 9 \end{pmatrix}$.

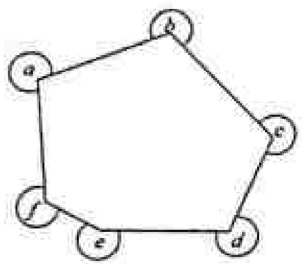
Answer (b) $x =$ .... [1]

$y =$ .... [1]

17 (a) Calculate the sum of the interior angles of a hexagon. Show your working clearly.

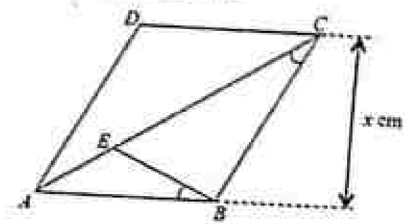
Answer (a) .... ° [2]

(b) The diagram below shows a hexagon. Calculate the value of $a+b+c+d+e+f$.



Answer (b) .... ° [2]

18 In the diagram, $ABCD$ is a parallelogram. E is the point on AC such that angle ACB = angle ABE. The vertical height of the parallelogram is x cm.



(a) Show that triangles ACB and ABE are similar.

Answer (a) ....

....

....

.... [1]

(b) Given that $AE = 4$ cm and $EC = 5$ cm, find the length of AB.

Answer (b) .... cm [2]

(c) Parallelogram $ABCD$ is the cross-sectional face of a right prism with height 12 cm. Find the volume of the prism if $x = 9$.

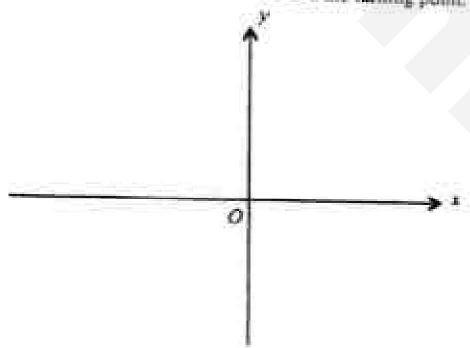
Answer (c) .... cm^3 [2]

19 **(a)** **(i)** Solve $-(x-1)(x+3)=0$.

Answer (a)(i) $x =$ .... or .... [1]

(ii) Sketch the graph of $y=-(x-1)(x+3)$.
Label clearly the intercepts with the axes and the turning point.

Answer (aii) [2]

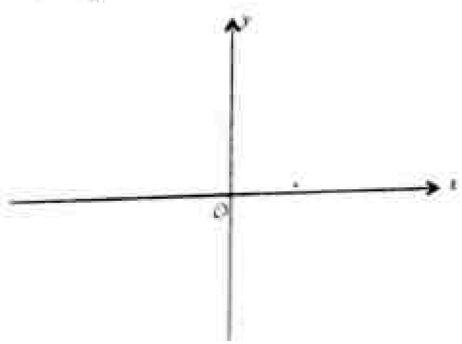


(iii) State the equation of the line of symmetry of $y=-(x-1)(x+3)$.

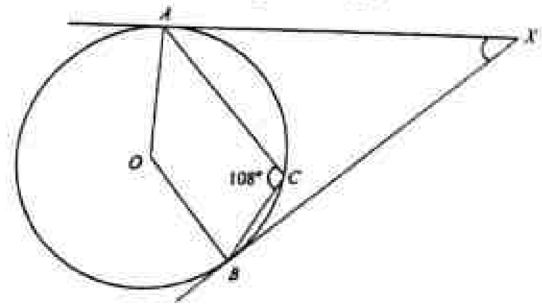
Answer (a)(iii) .... [1]

(b) Sketch the graph of $y=-\frac{2}{x}$.

Answer (b) [1]



20 **(a)** In the diagram, A, B and C are points on the circumference of the circle with centre O. AX and BX are tangents to the circle. Angle $ACB = 108°$.



(i) Find reflex angle AOB. Give a reason for your answer.

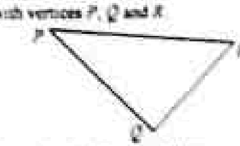
Answer (a)(i) Reflex angle $AOB =$ .... ° because ....

.... [2]

(ii) Find angle AXB.

Answer (a)(ii) .... ° [2]

(b) The diagram, not drawn to scale, shows a triangle with vertices P, Q and R.
$PQ = 15$ cm, $QR = 8$ cm and $PR = 17$ cm.



Explain why P, Q and R lie on the circumference of a circle with diameter 17 cm.

Answer (b) ....

.... [3]

21 The first four terms in a sequence of numbers, $T_1, T_2, T_3, T_4, \ldots$, are given below.

$T_1 = 3\left(\frac{4}{3}\right) - 1 = 3$

$T_2 = 3\left(\frac{4}{3}\right)^2 - 3 = \frac{7}{3}$

$T_3 = 3\left(\frac{4}{3}\right)^3 - 5 = \frac{19}{9}$

$T_4 = 3\left(\frac{4}{3}\right)^4 - 7 = \frac{67}{27}$

(a) Write down an expression for T_5 and show that $T_5 = \frac{295}{81}$.

Answer (a)

[1]

(b) Write down an expression for T_7 and evaluate it.

Answer (b)

[1]

(c) Find an expression, in terms of n, for the nth term, T_n, of the sequence.

Answer (c) T_n = ... [2]

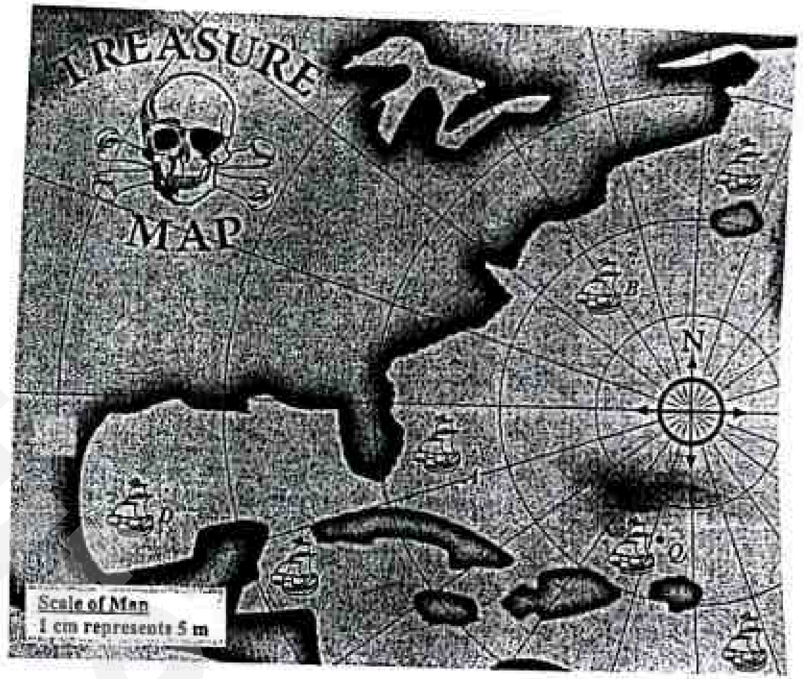
(d) Alvin claims that the value of the kth term, T_k, has a denominator of 1458.
Explain why Alvin is incorrect.

Answer (d) ....

....

.... [1]

22 You are out at sea in your sail boat Q searching for a precious treasure.
You have to determine the location of the treasure quickly so that you can get hold of it before the other treasure hunters.



(a) Boat A and boat B are closest to the buried treasure.
The treasure lies on a point that is equidistant from boat A and boat B.
Construct the line that the treasure is lying on. [1]

(b) The treasure is located on a bearing of 30° from boat D.
Mark the location of the treasure with a cross 'X'. [1]

(c) You discover the treasure box and a note tells you that more treasure can be found within 10 m from 'X'.
Draw and shade the area where additional treasure may be found. [1]

22 (continued from previous page)

(d) In the treasure box that you discovered at point X, you found US\$ 12 000.
The current exchange rate is S\$ 1 = US\$ 0.75.
How much Singapore Dollars will you receive?

Answer (d) S\$ .... [1]

(e) You decide to save the Singapore Dollars that you received, from **(d)**, in a bank for 5 years.
The following shows the savings plan from two different banks.
Determine which bank you should choose to deposit your money in if you aim to receive as much money as possible at the end of 5 years.
Support your answer with numerical evidence.

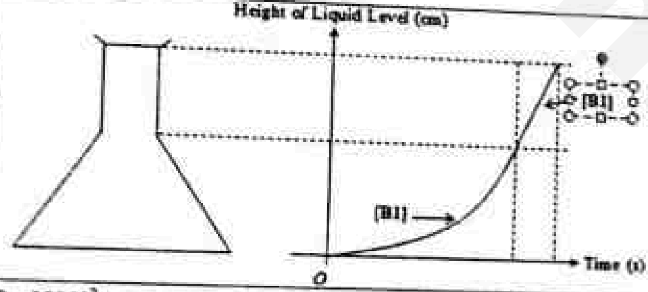
Bank Flourish	Bank Prosper
Plan: Simple Interest	Plan: Compound Interest
0.8% per annum	0.9% per annum
No bank fee	Bank fee to be deducted from account after 5 years = S\$ 88

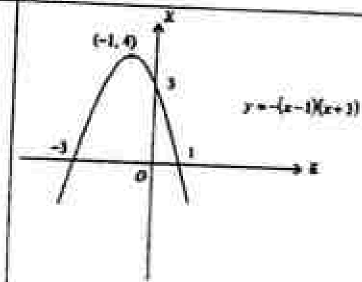
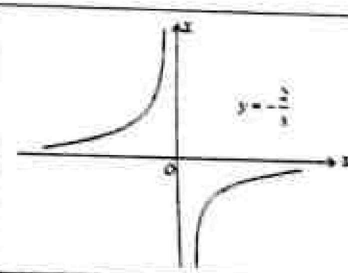
Answer (e) I will choose Bank .... because ....
....
.... [3]

End of Paper

2016 Sec 4 Prelims Mathematics P1 (Answer Key)

Question	Solution
1(a)	1.9974
1(b)	2.00
2	$0.52^{\frac{1}{7}}$, $\frac{33}{41}$, 0.803, $\sqrt{0.64}$
3	$\frac{1}{5}x(2x+y)(2x-y)$
4(a)	$\frac{5}{y^4}$
4(b)	$k=4$
5	• It is not clear whether the vertical axis represents the number of students or the percentage of the students. • The intervals between the values on the vertical axis are not equal. • The vertical axis is truncated and does not start from zero.
6	\$255
7	$16xy-y^2$
8(a)	$\tan\angle PQR = 0.81$ (2 dp)
8(b)	$\cos\angle TRP = -\frac{12}{19}$
9(a)	$660 = 2^2\times 3\times 5\times 11$
9(b)	55, 110
10(a)(i)	$A' = \{1, 4, 6, 8, 9, 10, 12, 14, 15, 16\}$
10(a)(ii)	$n(A\cup B) = 11$
10(b)	$P\cap Q = \{\}$ means that none of the girls play both the guitar and the drums.
11(a)	48 cm
11(b)	105000 m^2
12(a)	$\left(x-\frac{5}{2}\right)^2-\frac{37}{4}$ or $(x-2.5)^2-9.25$
12(b)	$x=\sqrt{\frac{37}{4}}+\frac{5}{2}$ or $x=-\sqrt{\frac{37}{4}}+\frac{5}{2}$ $=5.54$ (2 dp) $=-0.54$ (2 dp)
13(a)	
13(b)	Median = 0.5 (19 + 20) = 19.5
13(c)	Lower quartile of ages (book shop) = 18 years Lower quartile of ages (café) = 18 years

Question	Solution
	The statement is <u>not true</u> because the lower quartiles are the same therefore <u>the ages of the 4 youngest students are equally close</u> for both the café and the book shop.
14(a)(i)	Gradient = -2
14(a)(ii)	$\left(0,-\frac{7}{2}\right)$ or $\left(0,-3\frac{1}{2}\right)$ or $(0,-3.5)$
14(b)	equation of line k is $y=\frac{1}{2}x-1$.
15a	
15(b)	$P=2000l^2$
16(a)	$\begin{pmatrix} 39 & 50 \\ -20 & -1 \end{pmatrix}$
16(b)	$x=-1,\ y=-8$
17(a)	720°
17(b)	1440°
18(a)	$\angle ACB=\angle ABE$ (given) $\angle BAC=\angle EAB$ (common angle) Triangles ACB and ABE are similar.
18(b)	$AB=6$ cm
18(c)	648 cm^3
19(a)(i)	$x=1$ or -3

Question	Solution
19aii	
19(a)(iii)	x = -1
19(b)	
20(a)(i)	Reflex angle AOB = 216° because <u>angle at centre is twice angle at the circumference</u>
20(a)(ii)	$\angle AXB=36°$
21(a)	$T_5=3\left(\frac{4}{3}\right)^5-9=\frac{295}{81}$
21(b)	$T_7=3\left(\frac{4}{3}\right)^7-13=\frac{6907}{729}$
21(c)	$T_n=3\left(\frac{4}{3}\right)^n-(2n-1)$ or $T_n=3\left(\frac{4}{3}\right)^n-2n+1$
21(d)	Alvin is incorrect because the denominator are all <u>powers of 3</u>, but1458 is not a power of 3.

Question	Solution
22	
22(d)	S$ 16 000
22(e)	I will choose Bank Prosper because there is a greater amount of interest received/ the savings yield higher returns/ I will receive more money from Bank Flourish.

Answer all the questions.

1 A path along Pasir Ris Park is 12 km long.

(a) Darryl walks at an average speed of x km/h. Write down an expression, in terms of x, for the number of hours he takes to walk the entire path. [1]

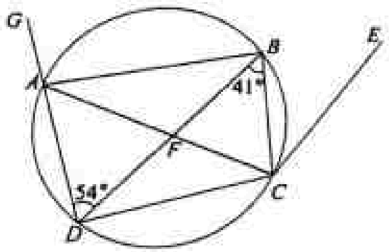
(b) Oliver walks at an average speed of $(x+0.5)$ km/h. Write down an expression, in terms of x, for the number of hours he takes to walk the entire path. [1]

(c) Darryl takes 10 minutes longer than Oliver to walk the entire path. Write down an equation in x, and show that it simplifies to $2x^2+x-72=0$. [2]

(d) Solve the equation $2x^2+x-72=0$, giving the solutions correct to 3 **decimal places.** [3]

(e) Oliver and Darryl took part in a 30 km relay walkathon, where each of them walked half the distance at the average speed stated in (a) and (b). Find the total time taken by them to complete the walkathon. [2]

2 In the diagram, AC is a diameter of the circle $ABCD$. AC and BD cut at F. DAG is a straight line. Angle $ADB = 54°$ and angle $DBC = 41°$.



(a) Calculate, stating your reasons clearly,

(i) $\angle BCF$, [1]

(ii) $\angle BFC$, [1]

(iii) $\angle BAC$, [1]

(iv) $\angle BAG$. [2]

(b) It is given that BD is parallel to CE. Lily says that CE is a tangent to the circle at point C. Explain, with calculations, why Lily is not correct. [1]

[Turn Over

3 (a) The number of hours of sleep per night of a group of girls is recorded in the table shown below.

Number of hours	4	5	6	7	8	9
Frequency	5	6	7	2	x	6

(i) Given that the median is 6, find the largest possible value of x. [1]

(ii) With the value of x found in (i), calculate

(a) the mean number of hours of sleep, [1]

(b) the standard deviation. [1]

(iii) The number of hours of sleep per night of a group of boys is summarised below.

Mean	5.75
Standard Deviation	2.31

Make two comparisons between the number of hours of sleep per night by the two groups, using your answer found in (ii). [2]

(b) A basket contains identical Easter eggs which are painted either blue or red in colour. There are 8 blue eggs and 3 red eggs.
An egg is picked out at random and not replaced.
A second egg is picked out at random and not replaced.

(i) Find, as a fraction in its simplest form, the probability that

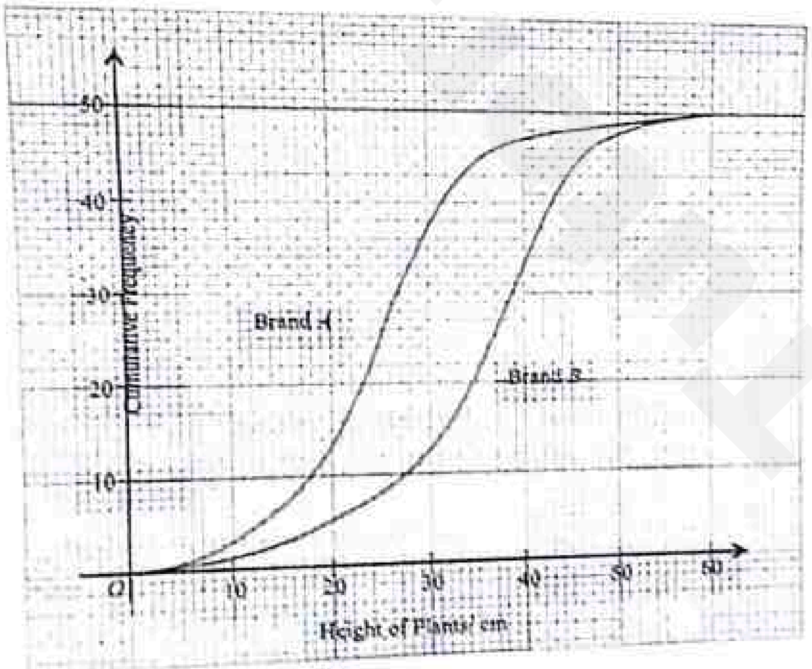
(a) the first egg taken is red, [1]

(b) the second egg is blue, given that the first egg is blue, [1]

(c) one egg is red and the other is blue. [2]

(ii) Some green eggs are added to the basket and two eggs are picked out at random. Given that the probability that no green eggs are picked is $\frac{11}{21}$, calculate the number of green eggs added. [3]

4 The diagram below is the cumulative frequency curve for the heights, in cm, of two batches of plants each of which was given Brand A and Brand B fertilizer respectively.



(a) Use the graph for Brand A to estimate

(i) the median. [1]

(ii) the interquartile range. [2]

(iii) the number of plants whose heights are more than 36 cm. [1]

(b) A plant is measured to be 24 cm tall with Brand A fertilizer. Use the two graphs to estimate this plant's height if it had been given Brand B fertilizer. [1]

(c) State, with a reason, which you think is the better fertilizer. [1]

[Turn Over

5 (a) A is the point $(3, -2)$, B is the point $(9, 6)$.

(i) Write down the column vector $\overrightarrow{AB}$. [1]

(ii) Calculate the value of $|\overrightarrow{AB}|$. [2]

(iii) D is a point such that $\overrightarrow{AD} = 5\overrightarrow{BA}$. Find the coordinates of D. [2]

(b) The table below shows the number of tubs of ice-cream of three flavours, sold at three shops.

	Vanilla	Chocolate	Strawberry
Moo	5	3	2
Cool	11	5	6
Icez	8	5	4

The cost price of a tub of Vanilla, Chocolate and Strawberry ice-cream is \$20, \$18 and \$15 respectively.

The cost is represented by the matrix $B = \begin{pmatrix} 20 \\ 18 \\ 15 \end{pmatrix}$.

(i) Write down a 3×3 matrix A that represents the data in the table above. [1]

(ii) Given that $P = AB$, evaluate P. [1]

(iii) Explain what the elements in P represent. [1]

Moo makes a profit of 10%, Cool makes a profit of 15% and Icez makes a profit of 20%.

(iv) Write down a matrix C given that the product CP gives the profit that each shop earns. [1]

(v) Evaluate the matrix CP. [1]

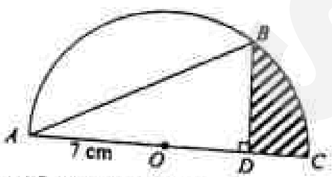
6 (a) Solve the inequality $\frac{x-1}{5} \geq \frac{3-x}{2}$. [2]

(b) Express as a single fraction in its simplest form

$$\frac{3}{2x-1} + \frac{1}{1-3x} + \frac{1}{6x^2-5x+1}$$ [4]

(c) Given that $xy^2 + x^2 - 1 = x^2y^2 + 3y^2 - 3xy^2$, express y in terms of x. [4]

7 In the diagram, $OABC$ is a semi-circle, with centre O and radius 7 cm. The length of the arc BC is 5.24 cm.



B is a point on the arc AC. The perpendicular from B to AC meets AC at D.

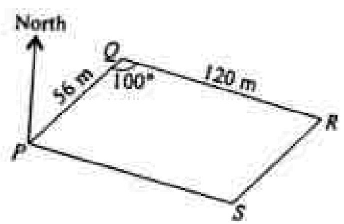
(i) Find angle BOC in radians, giving your answer correct to 3 significant figures. [2]

(ii) Find the length of BD. [2]

(iii) Show that the length OD is approximately 5.13 cm. [1]

(iv) Find the area of the shaded region. [2]

8 The diagram shows P, Q, R and S, the four corners of a horizontal field $PQRS$. $PQRS$ is a parallelogram. The corner Q is 56 metres from P on a bearing of 034°, angle PQR is 100° and R is 120 metres from Q.



(a) Calculate

(i) the bearing of R from Q, [2]

(ii) the length PR, [2]

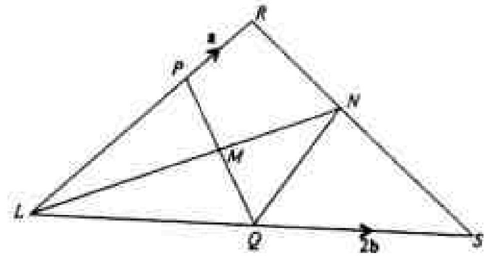
(iii) the area of the field $PQRS$, [2]

(iv) angle QPR. [2]

(b) An eagle was hovering at a height of 35 metres above the field. It spots its prey on the ground at an angle of depression of 58°. Calculate the distance that the eagle must fly to catch its prey. [2]

[Turn Over

9 In the triangle LRS, the point P on LR is such that $RL = 3RP$. Q is the midpoint of LS and M is the midpoint of PQ. LM produced meets RS at N and $5LM = 7MN$. $\overrightarrow{PR} = \mathbf{a}$ and $\overrightarrow{QS} = 2\mathbf{b}$.



(a) Express each of the following, as simply as possible, in terms of $\mathbf{a}$ and /or $\mathbf{b}$,

(i) $\overrightarrow{PQ}$, [1]

(ii) $\overrightarrow{RS}$, [1]

(iii) $\overrightarrow{LM}$. [2]

(b) Show that $\overrightarrow{RN} = \frac{1}{7}(-9\mathbf{a} + 12\mathbf{b})$. [1]

(c) Calculate the value of

(a) $\frac{RN}{NS}$, [1]

(b) $\frac{\text{area of } \Delta LNQ}{\text{area of } \Delta QNS}$, [1]

(c) $\frac{\text{area of } \Delta RLM}{\text{area of } \Delta NLS}$. [2]

10 **Answer the whole of this question on a sheet of graph paper.**

The variables x and y are connected by the equation $y = \frac{x^2}{4} + \frac{1}{x} - 3$.

The table below shows some values of x and the corresponding values of y, correct to 1 decimal place.

x	0.2	1	2	3	4	5	6.5	8
y	2.0	−1.8	k	−0.4	1.3	3.5	7.7	13.1

(a) Find the value of k. [1]

(b) Using a scale of 2 cm to 1 unit, draw a horizontal x-axis for $0.2 \le x \le 8$.
Using a scale of 1 cm to 1 unit, draw a vertical y-axis for $-2 \le y \le 14$.
On your axes, plot the points given in the table and join them with a smooth curve. [3]

(c) Use your graph to solve the equation $\frac{x^2}{4} + \frac{1}{x} = 3$. [2]

(d) By drawing a tangent, find the gradient of the curve at the point (5, 3.5). [2]

(e) By drawing a suitable straight line on your graph, solve
$x^3 - 4x^2 - 16x + 4 = 0$. [3]

[Turn Over

11

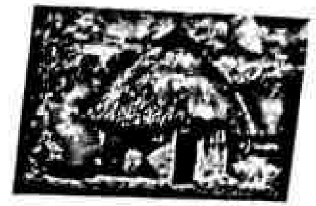


Diagram I

In the question, the hut can be modelled as a *cylinder* with a *cone* on top, as shown in Diagram I. The roof is the curved surface of a cone and is supported by a central vertical pole.

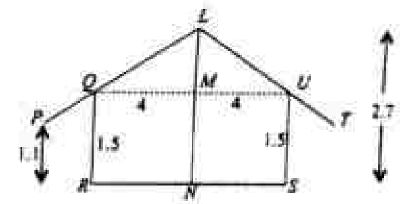


Diagram II

Diagram II shows a vertical cross-section of the hut. QU and RS are horizontal. Both P and T are 1.1 m vertically above the ground level. $LN = 2.7$ m, $QM = MU = 4$ m and $QR = US = 1.5$ m.

(a) Calculate

(i) the volume of the interior of the hut, [3]

(ii) the surface area of the roof. [4]

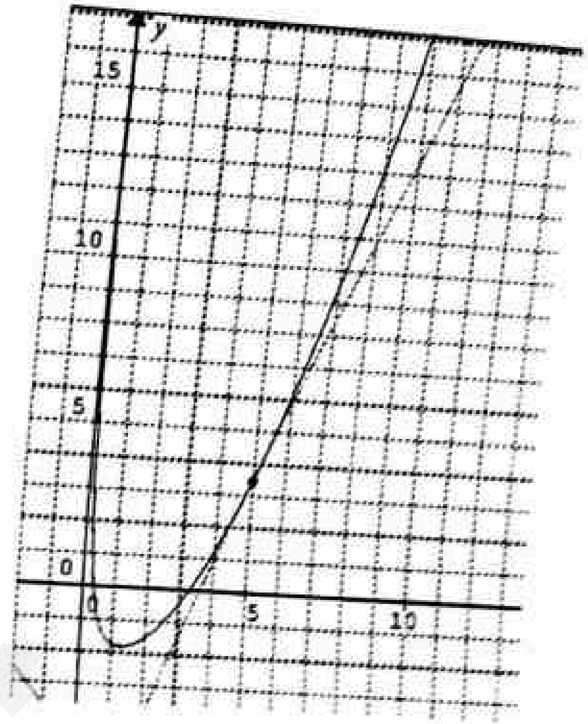
(b) At noon, the sun is directly above the hut. The shadow of the overhanging section of the roof on the ground is a circular ring around the hut. At this time of the day, a minimum shadow of 50 m² is needed to keep the family cool. The central vertical pole LN can be adjusted in height to change the area of the shadow formed by the roof. Explain why it is not possible to provide the family with the required 50 m² of shadow. [3]

END OF PAPER

2016 Secondary 4 Prelims Mathematics Paper 2 (Answer Key)

1a	$\frac{12}{x}$
1b	$\frac{24}{2x+1}$
1d	$x = 5.755$ or -6.255
1e	5.00 hours (3sf)
2ai	$\angle BCF = 54°$ ($\angle$s in the same segment)
2aii	$\angle BFC = 85°$ ($\angle$ sum of Δ)
2aiii	$\angle BAC = 36°$ ($\angle$ in semi-circle)
2aiv	$\angle BAG = 103°$ (ext $\angle$ of cyclic quad)
2b	$\angle BCE = 41°$ (alt $\angle$s) $\angle ACE = 54° + 41° = 95°$ AC is not perpendicular to CE, hence CE is not tangent to the circle at C. (tan $\perp$ rad)
3ai	9
3aiia	6.63 h
3aiib	1.73 h
3aiii	The girls sleep longer hours with a higher mean number of hours. The girls are also more consistent with a smaller standard deviation
3bia	$\frac{3}{11}$
3bib	$\frac{7}{10}$
3bic	$\frac{24}{55}$
3bii	4 green eggs added.
4ai	25 cm
4aii	10 cm (accept 30.5 – 19.5 = 11)
4aiii	5
4b	35.5 cm (accept 36 cm)
4c	Brand B fertilizer is better has it has a higher median. Plants grow taller with Brand B.
5ai	$\begin{pmatrix} 6 \\ 8 \end{pmatrix}$
5aii	10 units
5aiii	$D(-27, -42)$
5bi	$\begin{pmatrix} 5 & 3 & 2 \\ 11 & 8 & 6 \\ 8 & 5 & 4 \end{pmatrix}$
5bii	$\begin{pmatrix} 184 \\ 454 \\ 310 \end{pmatrix}$
5biii	The total cost price incurred by each shop.
5biv	$\begin{pmatrix} 0.1 & 0 & 0 \\ 0 & 0.15 & 0 \\ 0 & 0 & 0.2 \end{pmatrix}$
5bv	$\begin{pmatrix} 18.4 \\ 68.1 \\ 62 \end{pmatrix}$
6a	$x \geq 2\frac{3}{7}$
6b	$\frac{3}{2x-1} - \frac{1}{3x-1} + \frac{1}{(3x-1)(2x-1)}$ $= \frac{3(3x-1)-(2x-1)+1}{(3x-1)(2x-1)}$ $= \frac{9x-3-2x+1+1}{(3x-1)(2x-1)}$ $= \frac{7x-1}{(3x-1)(2x-1)}$
6c	$y = \pm\sqrt{\frac{x+1}{x-3}}$
7i	$\angle BOC = 0.749$ rad (3sf)
7ii	$BD = 4.76$ cm (3sf)
7iii	$OD = 5.13$ cm (3sf)
7iv	Area of shaded region $= 6.12$ sq cm (3sf)
8ai	Bearing of R from Q $= 114°$
8aii	$PR = 141$ m (3sf)
8aiii	Area of field $PQRS$ $= 6620$ sq m (3sf)
8aiv	$\angle QPR = 57.0°$ (1dp)
8b	41.3 m (3sf)

9ai	$-2\mathbf{a}+2\mathbf{b}$
9aii	$-3\mathbf{a}+4\mathbf{b}$
9aiii	$\overrightarrow{LM}$ $=\mathbf{a}+\mathbf{b}$
9ci	$\frac{3}{4}$
9cii	1
9ciii	$\frac{\Delta RLM}{\Delta NLS}=\frac{7}{16}$
10a	-1.5
10b	See attached graph
10c	$x = 3.25$ (accept 3.2 – 3.3) or 0.4 (accept 0.3 – 0.5)
10d	Draws tangent at $x = 5$ and estimates (change in y)/(change in x) 2.3 – 2.6
10e	Add $y = x + 1$ $x = 0.25$ or 6.35
11ai	Volume of hut = 95.5 m^3 (3sf)
11aii	93.3 m^2 (3sf)
11b	It is not possible to have a shadow of 50 m^2 at noon.



1

Answer all the questions.

1 (a) Calculate $\dfrac{12+\sqrt[3]{27-3\times3\times(-2)}}{1.3^2}$.

Write down the first five digits on your calculator display.

Answer (a) .... [1]

(b) Write your answer to part (a) correct to 2 decimal places.

Answer (b) .... [1]

2 The first four term of a sequence are

12 19 26 33.

(a) Write down the next two terms of the sequence.

Answer (a) .... [1]

(b) Write down an expression, in terms of n, for the nth term of the sequence.

Answer (b) .... [1]

2

3 Two numbers have HCF = 100 and LCM = 3000. Find the smaller of the two numbers if both numbers are more than 100.

Answer .... [2]

4

	Singapore	Kuala Lumpur	London
Population	54×10^5	1.70×10^6	8.67×10^6
Area (km²)	7.19×10^2	2.43×10^2	1.57×10^3

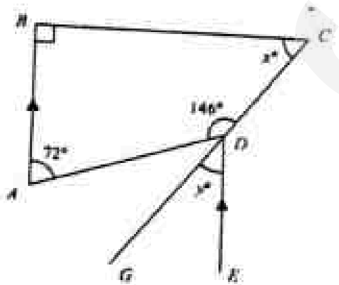
(a) How many more people live in London than in Singapore?
Give your answer in standard form.

Answer (a) .... [1]

(b) Calculate the average number of people per square kilometer in Kuala Lumpur, correct your answer to the nearest thousand.

Answer (b) .... [1]

5 $ABCD$ is a quadrilateral. CDG is a straight line and AB is parallel to ED. $\angle CBA = 90°$, $\angle BAD = 72°$ and $\angle ADC = 146°$, calculate the value of



(a) x,

Answer (a) $x =$ .... [1]

(b) y.

Answer (b) $y =$ .... [1]

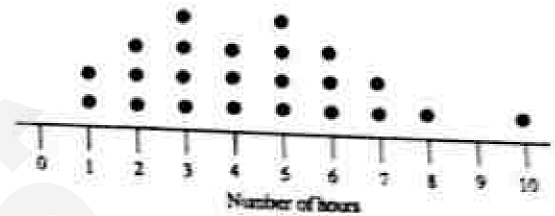
Find the smallest prime number which satisfies $\frac{2x-8}{3} < \frac{1+2x}{2} - 4$.

Answer .... [2]

7 Given that y is proportional to the square of x. x is increased by 50%. Find the percentage increase in y.

Answer .... [2]

8



A survey was conducted for a week to find out the number of hours that students spent on using their mobile phone apps on weekdays. The data collected was displayed on a dot diagram.
Find

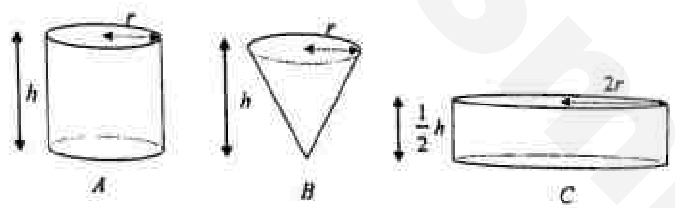
(a) the range,

Answer (a) .... hours [1]

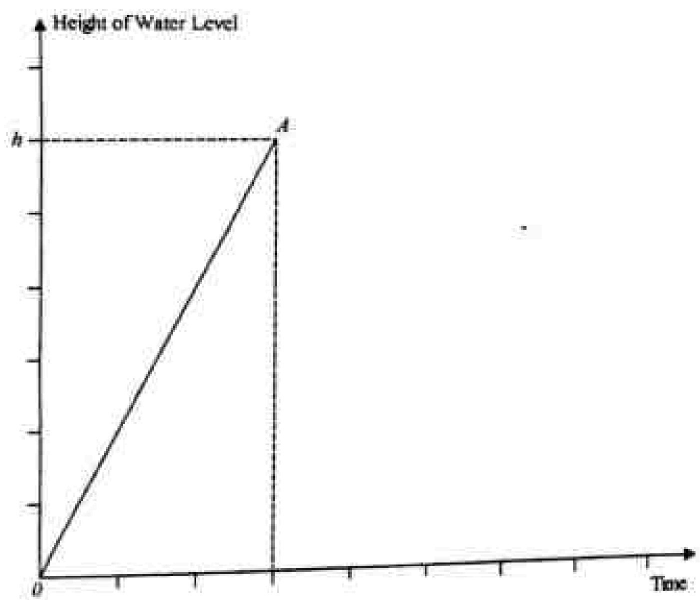
(b) the median number of hours.

Answer (b) .... hours [1]

9 The diagram shows three containers A, B and C. Water is poured into the three containers at a constant rate until they are completely filled.



In the given axes, OA represents how the height of the water level changes against time for container A.
Draw the graphs to show how the height of the water level changes over time for containers B and C.



Answer [2]

10 On a map, the area of a lake is $0.25\ cm^2$. The actual area of the lake is $4\ km^2$.

(a) Express the scale of the map in the form $1 : n$.

0.25 = 4
1 =

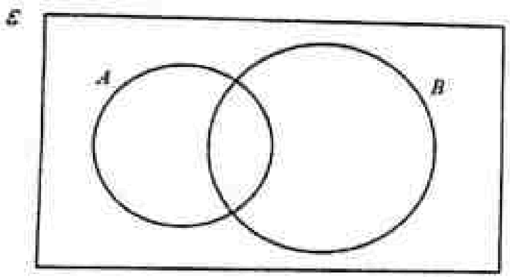
Answer (a) 1 : ………………………… [1]

(b) The distance between two towns A and B is 10 cm on the map. Find the distance between A and B on another map with a scale of 1 : 250 000.

Answer (b) …………………………cm[2]

11 $\xi = \{\text{integers } x : 1 \le x \le 16\}$
$A = \{\text{integers that are perfect squares}\}$
$B = \{\text{integers divisible by 2}\}$

(i) On the Venn Diagram shown below, shade the set $A' \cup B$.



Answer [1]

(ii) Write down $n(A' \cap B')$.

Answer (ii)................................[1]

(iii) A number k is chosen from ε.
Find the probability that $k \in A \cup B$.

Answer (iii)................................[1]

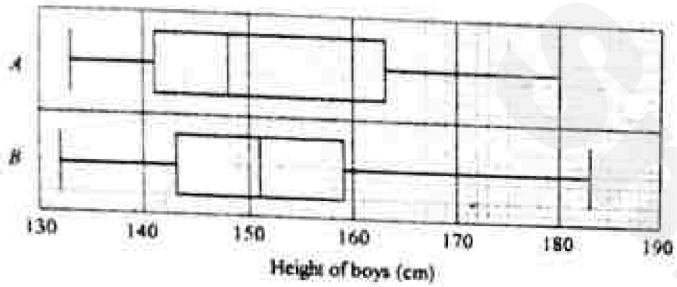
12 (a) Factorise completely $xy - 4y - 12 + 3x$.

Answer (a)................................[1]

(b) Factorise completely $(x^2-3)^2 + (x^2-3) - 2$.

Answer (b)................................[2]

13 The box plots show the distributions of the heights of a number of boys in two different schools, A and B.



(a) Find the interquartile range for school A.

Answer (a) ....cm[1]

(b) Here are two statements comparing the heights of boys in the two schools.

For each one, write whether you agree or disagree.
Give a reason for each answer, stating clearly which statistics you use to make your decision.

(i) On average, boys in school A are taller than boys in school B.

Answer ....because...

....[1]

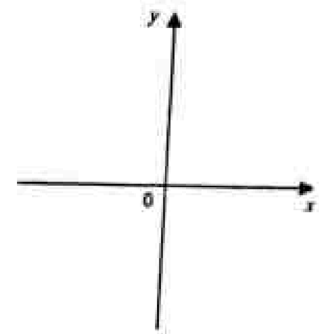
(ii) More boys are above the height of 160 centimetres in school B than in school A.

Answer ....because...

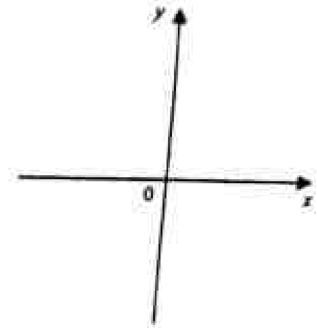
....[1]

14 (a) On the axes, sketch the following graphs, indicating the x and y intercepts if any.

(i) $y = 2^x$



(ii) $y = -\frac{1}{x^2}$



Answer [2]

(b) Hence explain why the equation $2^x + \frac{1}{x^2} = 0$ has no solutions.

Answer (b) ....

....

.... [1]

15 (a) By expressing $-x^2+3x+7$ in the form $-(x-a)^2+b$, state the equation of the line of symmetry of the graph $y=-x^2+3x+7$.

Answer .... [2]

(b) Hence solve the equation $-x^2+3x+7=\frac{1}{4}$.

Answer (b) $x =$ .... or .... [2]

16 (a) The value of Mr Lim's car is \$140 000. By the end of the each year, the value of the car decreases by 15% of its value at the start of the year. Find the value of the car at the end of 2 years.

Answer (a) \$.................................. [2]

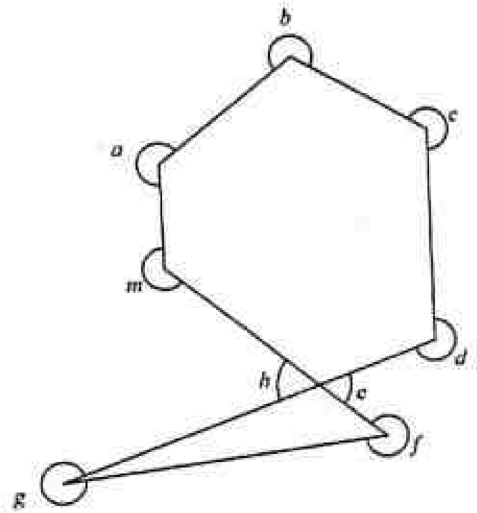
(b) A car is priced at \$200 000. It can be bought on hire purchase with a down payment of \$40 000, interest rate of 4.5% per annum over 7 years and equal monthly instalment. Find the monthly instalment, correct your answer to the nearest cents.

Answer (b) \$.................................. [2]

17 (a) Calculate the sum of the interior angles of a hexagon.

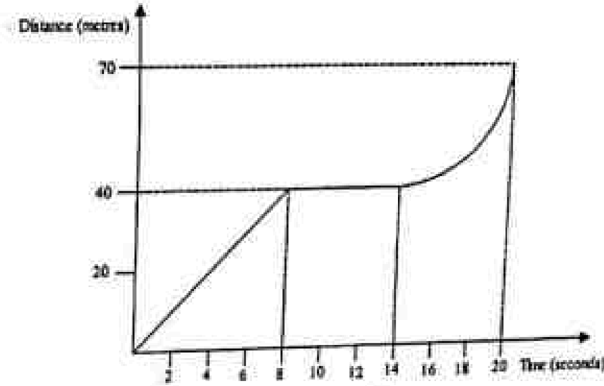
Answer (a) .... ° [2]

(b) Calculate the sum of the angles $a, b, c, d, e, f, g, h, m$.



Answer (b) .... ° [2]

18 The diagram shows the distance-time graph for the first 20 seconds of a man running on the track.



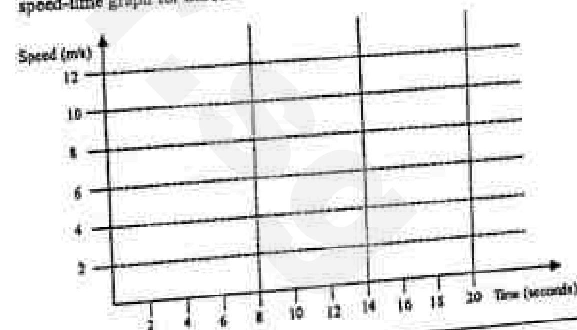
(a) Find the average speed for the first 10 seconds of the run.

Answer (a) .... m/s [1]

(b) Convert this speed into km/h.

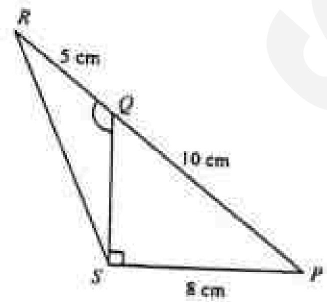
Answer (b) .... km/h [1]

(c) The man accelerates at 2 m/s^2 for the last 6 seconds. On the grid below, sketch the speed-time graph for the run.



[2]

19 In the triangle, $PQ = 10$ cm, $PS = 8$ cm and $QR = 5$ cm. Angle PSQ is a right angle and PQR is a straight line.



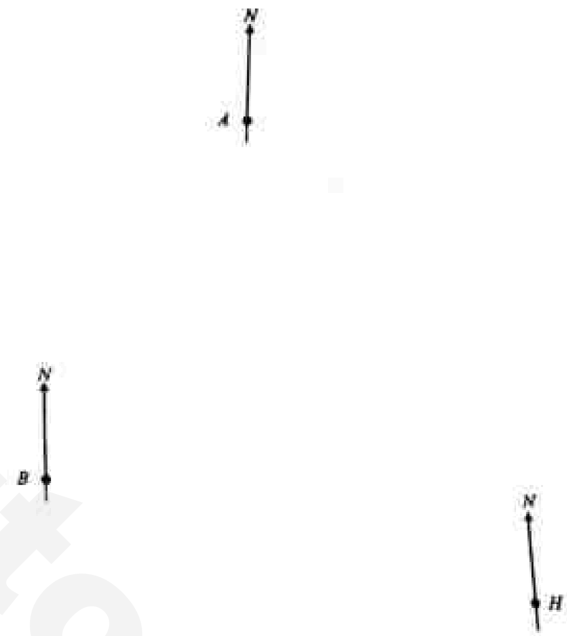
(a) Find the value of $\cos \angle RQS$.

Answer (a) $\cos \angle RQS$ = ... [2]

(b) Hence, calculate RS.

Answer (b) RS = ... cm [2]

20 The diagram below shows the position of a lighthouse H, a coastguard center A and a patrolling vessel B. The scale is 1 cm to 5 km.



(a) Construct the perpendicular bisector of AB. [1]

A ship S is on a bearing of 115° from A and 37.5 km from H.

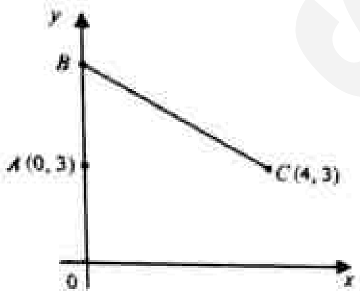
(b) Find and label the position of the ship S. [2]

(c) Explain if the ship is nearer to AB or BH.

Answer (c)...

.... [1]

21 In the diagram, A and B lie on the y-axis. The equation of BC is $4y+3x=24$ and A and C have coordinates $(0, 3)$ and $(4, 3)$ respectively.



(a) Find the equation of the line parallel to BC passing through A.

Answer (a) .... [1]

(b) State the coordinates of D such that $ABCD$ is a parallelogram.

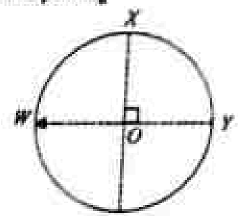
$D($, $)$

Answer (b) .... [1]

(c) Calculate the shortest distance between BC and AD.

Answer (c) .... units [2]

22 **(a)** The diagram shows a circular disc with a spinner fixed at centre O. An unbiased die is thrown. If 1 or 2 is thrown, the spinner is rotated 90° clockwise, otherwise it is rotated 90° anticlockwise. Given initially the spinner points to W, write down, as a fraction the probability that the spinner is pointing



(i) to position X after 1 throw,
(ii) to position Y after 2 throws.

Answer (a)(i) .... [1]

(a)(ii) .... [1]

(b) Three unbiased dice are thrown together. Find the probability that
(i) all the dice show different number,
(ii) at least two dice show the same number.

Answer (b)(i) .... [1]

(b)(ii) .... [1]

23 (a) Solve the simultaneous equations

$$\frac{3}{x}+\frac{2}{y}=5,$$
$$\frac{1}{x}+\frac{1}{y}=4.$$

Answer (a) $x =$ ...., $y =$ .... [3]

(b) Given that $x = 2$ is a solution of the equation $2x^2 - 5x + k = 0$, where k is a constant,
Find

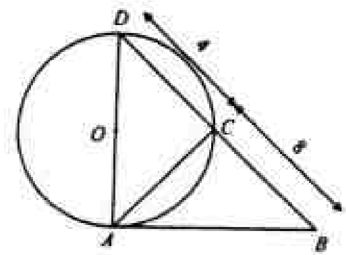
(i) the value of k,

Answer (i) $k =$ .... [1]

(ii) the other solution of the equation.

Answer (ii) $x =$ ....[1]

24 In the diagram, AD is the diameter of the circle with centre O, AB is a tangent to the circle at A and BCD is a straight line.



(a) State a reason why $\angle ACD$ is $90°$.

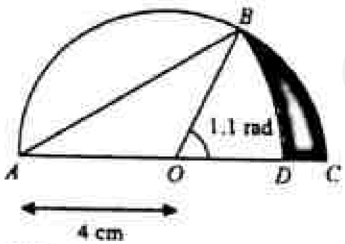
Answer (a)..

.... [1]

(b) Given that $BC = 8$ cm, $CD = 4$ cm and $AC = h$ cm. Find the length of AD.

Answer (b) ....cm[4]

25 $ABCDO$ is a semi-circle with diameter AC, centre O and radius of 4 cm. ABD is a sector with centre A. Given that $\angle BOD = 1.1$ rad, find



(a) the length of arc BD,
(b) perimeter of shaded region.

Answer (a) BD = ...cm [3]
(b) ....cm[2]

Answer all the questions.

1 (a) 9.2052

(b) 9.21

2 (a) 40, 47

(b) $7n+5$

3 The smaller number is 300 or 200.

4 (a) 3.27×10^4

(b) 7000

5 (a) $x^\circ = 52^\circ$
(b) $y^\circ = 38^\circ$

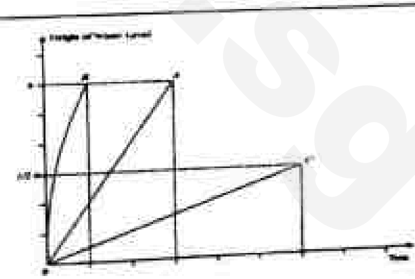
6 Smallest prime number is 3.

7 125%

8 (a) $10-1=9$ hours

(b) median = 4 hours

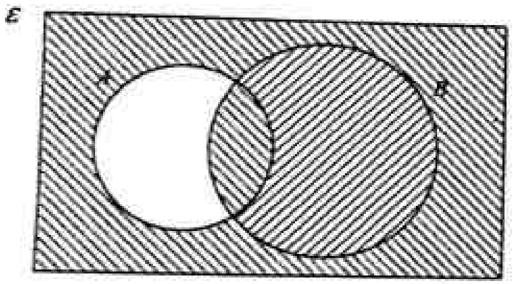
9



10 (a) 1 : 400 000

(b) 40 km : 16 cm

11 (i)



Answer [1]

(ii) $n(A' \cap B') = 6$

(iii) probability $= \frac{10}{16} = \frac{5}{8}$

12 (a) $(y+3)(x-4)$

(b) $(x+1)(x-1)(x+2)(x-2)$

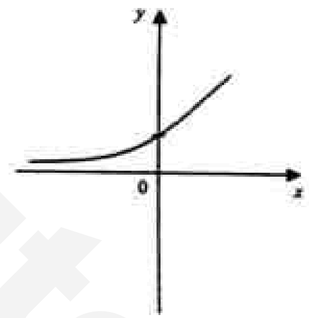
13 (a) $163 - 141 = 22$

(b) (i) I disagree because the mean height of boys in school A is less than the mean height of boys in school B.

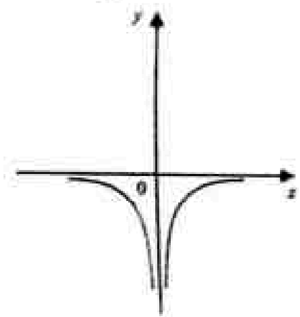
(ii) I disagree because boys in school A has a higher upper quartile. More than 25% of boys in school A has a height above 1.60 m but less than 25% of the boys in school B has a height above 1.60 m.

14 (a) On the axes given, sketch the following graphs, indicating the x and y intercepts if any.

(i) $y = 2^x$



(ii) $y = -\frac{1}{x^2}$



Answer [2]

(b) Hence explain why the equation $2^x + \frac{1}{x^2} = 0$ has no solutions.

$2^x = -\frac{1}{x^2}$

Answer *(b)* Since both graphs do not intersect each other, the equation has no solutions. [1]

15 (a) $x = 1.5$

(b) $x = 4.5$ or $x = -1.5$

16 (a) \$101 150

(b) \$2504.76

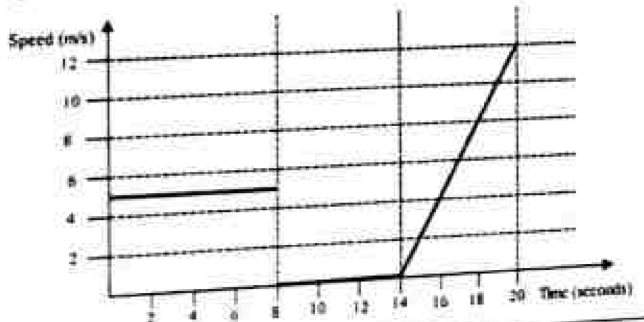
17 (a) 720°

(b) 1980°

18 (a) average speed $= \frac{40}{10} = 4$ m/s

(b) 14.4 km/h

(c) The man accelerates at 2 m/s^2 for the last 6 seconds. On the grid below, sketch the speed-time graph for the run.



[2]

19 (a) $-\frac{3}{5}$

(b) 9.85 cm

20 (c) Ship S is nearer to BH because it is between the angle bisector and the line BH.

21 (a) Equation of line is $y = -\frac{3}{4}x + 3$.

(b) Coordinates of D is $(4, 0)$.

(c) 2.4 units

22 (a) (i) P(spinner at X after 1 throw) $= \frac{2}{6} = \frac{1}{3}$

(ii) P(spinner at Y after 2 throws) $= \frac{5}{9}$

(b) (i) P(all the dice show different number) $= \frac{5}{9}$

(ii) P(at least two dice show the same number) $= \frac{4}{9}$

23 (a) $x = -\frac{1}{3}$, $y = \frac{1}{7}$

(b) (i) $k = 2$

(ii) $x = \frac{1}{2}$

24 (a) $\angle ACD = 90°$ because it is the angle in a semi-circle

(b) $AD = 6.93$ cm

25 (a) 3.75 cm

(b) 9.33 cm

Answer **all** the questions.

1 A shop sells two flavours of ice cream, Cherry and Durian. Each flavour is sold in cups of three different sizes, small, medium and large at \$2.50, \$3.20 and \$4.50 respectively. The sales in two successive days are given in the table below.

	Saturday			Sunday		
Size	Small	Medium	Large	Small	Medium	Large
Number of cups of Cherry sold	12	17	8	14	12	10
Number of cups of Durian sold	18	15	11	13	21	16

The information for Saturday's sale can be represented by the matrix, $\mathbf{M}=\begin{pmatrix}12 & 17 & 8\\ 18 & 15 & 11\end{pmatrix}$ and the cost of each flavour for each size can be represented by the matrix $\mathbf{C}=\begin{pmatrix}2.5\\ 3.2\\ 4.5\end{pmatrix}$. The information for the Sunday's sale can be represented by the matrix **N**.

(a) Write down the matrix **N** and calculate $\mathbf{P}=\mathbf{M}+\mathbf{N}$. [2]
(b) Describe what the elements of **P** represent. [1]
(c) Calculate $\mathbf{Q}=\mathbf{PC}$. [2]
(d) Describe what the elements of $\frac{1}{2}\mathbf{Q}$ represent. [1]
(e) Write down the matrix **S** such that the elements of **SPC** represent the total amount received from the sales of the ice cream. [1]

2 (i) Isaac typed 20 pages of a research journal at an average speed of x pages per hour. Write down an expression, in terms of x, for the number of hours he took to type 20 pages. [1]

(ii) Lucas typed at an average speed that was 2 pages per hour faster than Isaac's typing speed. Write down an expression, in terms of x, for the number of hours Lucas took to type 20 pages. [1]

(iii) Given that the difference between the two timings were 24 minutes, write down an expression, in terms of x and show that it simplifies to $x^2+2x-100=0$. [3]

(iv) Solve the equation $x^2+2x-100=0$, giving your solutions correct to one decimal place. [3]

(v) Hence, find the time taken by Lucas to type 20 pages. Give your answer in hours and minutes, correct to the nearest minutes. [1]

3 (a) Simplify $\left(\frac{3x^2}{4y}\right)^{-2}+\frac{y^4}{9x^3}$. [2]

(b) Simplify $\frac{2x-x^2}{x^2-5x+6}$. [2]

(c) Make r the subject of the formula $\frac{p}{2q}=\left(\frac{r}{3s-1}\right)^2$. [2]

(d) Solve the equation $\frac{7}{(x-2)^2}-\frac{2}{2-x}=\frac{2}{3}$. [4]

4 (a) Adam exchanged 5000 Singapore Dollars (SGD) into British Pounds (GBP) at the bank. The bank's exchange rates are given below.

Singapore Dollars (SGD) to 1 unit of British Pounds (GBP)	Buying	Selling
	2.44	2.50

(i) Find the amount of British Pounds that Adam received. [1]

(ii) He then invested the British Pounds in a bank for three years which paid an interest of 4% compounded half-yearly. Find out the amount of money Adam received, in British Pounds, correct to two decimal places, at the end of three years. [2]

(iii) Adam exchanged the British pounds back to Singapore Dollars at a new exchange rate of 2.10 (SGD) to 1 (GBP). Find the amount in Singapore Dollars that Adam received, correct to the nearest cent. Hence calculate his percentage loss at the end of his investment. [3]

(b) In a club, each member present shakes hands just once with every other member.

(i) Suppose there are only 2 members present. How many handshakes are involved? [1]

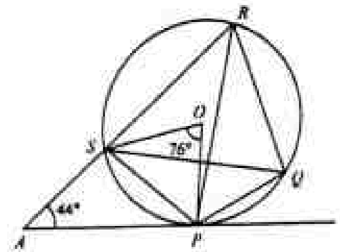
(ii) Copy and complete the following table. [1]

Number of members in the club	Number of handshakes
1	
2	
3	
4	
5	

(iii) How many handshakes will be involved if there are n number of members? [1]

(iv) Explain, with a reason, if it is possible to have 204 handshakes. [1]

5 In the diagram, O is the centre of the circle $PQRS$ and $\angle POS = 76°$. AP is a tangent to the circle at P. RS is produced to A such that $\angle PAS = 44°$.



(a) Calculate, stating your reasons clearly,

(i) $\angle PRS$, [1]

(ii) $\angle SQP$, [1]

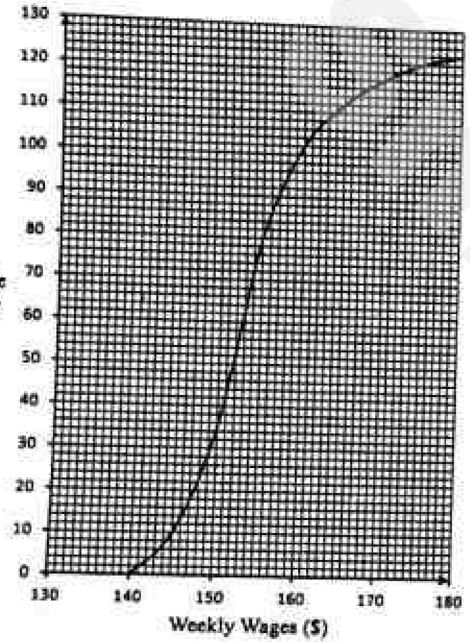
(iii) $\angle SPA$, [1]

(iv) $\angle PQR$, [2]

(v) $\angle RPO$. [3]

(b) Given that the radius of the circle is 6 cm, calculate the length of chord PR. [2]

6 The cumulative frequency curve below shows the weekly wages of 124 workers in a company.



(a) Copy and complete the grouped frequency table of the weekly wages of the workers. [2]

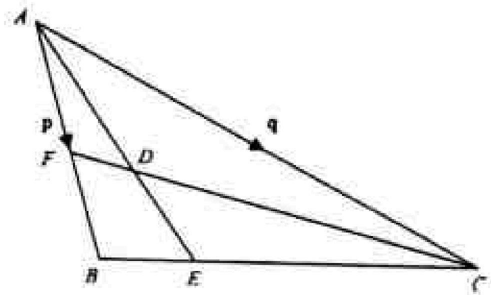
Weekly wage ($)	$130 < x \le 140$	$140 < x \le 150$	$150 < x \le 160$	$160 < x \le 170$	$170 < x \le 180$
Number of workers	0		68		6

(b) Using your grouped frequency table, calculate an estimate of the
(i) mean weekly wages of the workers, [1]
(ii) standard deviation. [2]

(c) Two workers are chosen at random in the company, one after another.
Find as a fraction in its simplest form, the probability that
(i) both workers earn a weekly wage of at most $150, [2]
(ii) one worker earns more than $170 but another earns at most $160. [2]

(d) Another company of 124 workers have the same median weekly wages but a smaller interquartile range. Describe how the cumulative frequency curve will differ from the given curve. [1]

7 In the diagram, F is the midpoint of AB. E is the point on BC such that $4BE = BC$. $\overrightarrow{AB} = \mathbf{p}$ and $\overrightarrow{AC} = \mathbf{q}$.



(a) Express as simply as possible, in terms of **p** and/or **q**,
(i) $\overrightarrow{BC}$, [1]
(ii) $\overrightarrow{EC}$, [1]
(iii) $\overrightarrow{AE}$, [1]
(iv) $\overrightarrow{FC}$. [1]

(b) It is given that $\overrightarrow{CD} = h\overrightarrow{CF}$. Express the vector $\overrightarrow{AD}$ as simply as possible, in terms of h, **p** and **q**. [1]

(c) It is given that $\overrightarrow{AD} = k\overrightarrow{AE}$, find the value of h and of k. [3]

(d) Find the numerical value of
(i) $\dfrac{\text{Area of } \Delta AFD}{\text{Area of } \Delta AFC}$, [1]
(ii) $\dfrac{\text{Area of } \Delta CDE}{\text{Area of } \Delta ADF}$. [2]

8 **Answer the whole of this question on a sheet of graph paper.**
The variables x and y are connected by the equation

$$y = x - \frac{x^2}{2} - \frac{x^3}{5}.$$

Some corresponding values of x and y are given in the following table.

x	−4	−3	−2	−1	0	0.5	1	2	3
y	0.8	−2.1	−2.4	−1.3	0	0.35	0.3	p	−6.9

(a) Calculate the value of p. [1]

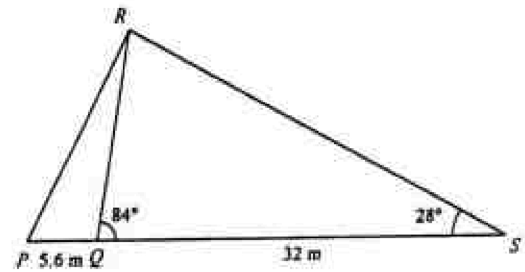
(b) Using a scale of 2 cm to represent 1 unit, draw a horizontal x-axis for $-4 \le x \le 3$.
Using a scale of 2 cm to represent 1 unit, draw a vertical y-axis for $-7 \le y \le 1$.
On your axes, plot the points given in the table and join them with a smooth curve. [3]

(c) Use your graph to find the three solutions of the equation $x - \frac{x^2}{2} - \frac{x^3}{5} = 0$. [2]

(d) By drawing a tangent, find the gradient of the curve at $x = 1.5$. [2]

(e) By drawing a suitable straight line on your graph, solve $3x - \frac{x^2}{2} - \frac{x^3}{5} + 4 = 0$. [3]

9 PQ is the width of a rugby goal post at one end of a rugby pitch. S is position of the corner flag. P, Q and S lie on a straight line with $PQ = 5.6$ m and $QS = 32$ m. A player is spotted at R, such that $\angle RQS = 84°$ and $\angle RSQ = 28°$.



(a) Calculate
(i) the distance RS, [2]
(ii) the distance RP, [3]
(iii) $\angle PRQ$. [2]

(b) A flying drone capturing the gameplay is hovering at a height of 15 m directly above S. Find the angle of elevation of the drone from the player R. [2]

(c) The player at R wishes to run to line QS in the fastest time. Calculate the distance that the player should run. [2]

10

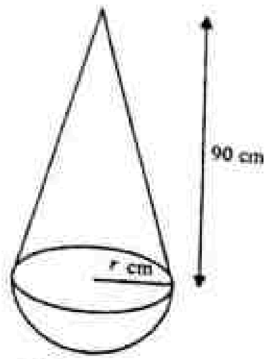


Figure A

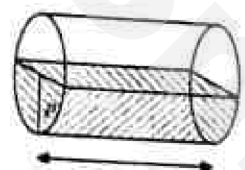


Figure B

(a) Figure A shows a hollow container which is made up of a hemispherical bowl of radius r cm and a right circular cone of radius r cm and height 90 cm. The capacity of the right circular cone is 4 times that of the hemispherical bowl.

(i) Find the value of r. [2]

(ii) Find the total exterior surface area of the container. [3]

(iii) The container is completely filled with water. Calculate the volume of the water in the container. [2]

(b) Figure B shows a cylindrical container which is resting on a horizontal surface. The cylinder has radius p cm and length 28 cm.

(i) If all the water from container in Figure A is poured into the container in Figure B, it will fill up to exactly half of the capacity of cylinder in Figure B. Calculate the value of p. [2]

(ii) Find the total surface area of the container in Figure B which is in contact with water. [2]

1

Answer *all* the questions.

1 (a) $\begin{pmatrix} 26 & 29 & 18 \\ 31 & 36 & 27 \end{pmatrix}$

(b) Total number of small, medium and large cups of cherry and durian ice-cream sold on Saturday and Sunday.

(c) $\begin{pmatrix} 238.8 \\ 314.2 \end{pmatrix}$

(d) The average amount received from selling both cherry and durian ice-cream on Saturday and Sunday.

(e) $S = \begin{pmatrix} 1 & 1 \end{pmatrix}$

2 (i) $\frac{20}{x}$ hours

(ii) $\frac{20}{x+2}$ hours

(iii) $\frac{20}{x} - \frac{20}{x+2} = \frac{24}{60}$

(iv) $x = 9.0$ or $x = -11.0$

(v) Time taken $= \frac{20}{9.04+2} =$ 1 hour 49 minutes

3 (a) $\frac{16}{xy^7}$

(b) $\frac{x}{3-x}$

(c) $r = \pm(3s-1)\sqrt{\frac{p}{2q}}$

(d) $x = -0.0707$ or $x = 7.07$

4 (a)(i) Adam recieved $= 5000 \div 2.50 = 2000$ GBP

(a)(ii) Adam received $= 2252.32$ GBP

(a)(iii) 5.40%

(b)(i) 1 handshake

(b)(ii)

Number of members in the club	Number of handshakes
1	0
2	1

3	3
4	6
5	10

(b)(iii) $\frac{n(n-1)}{2}$

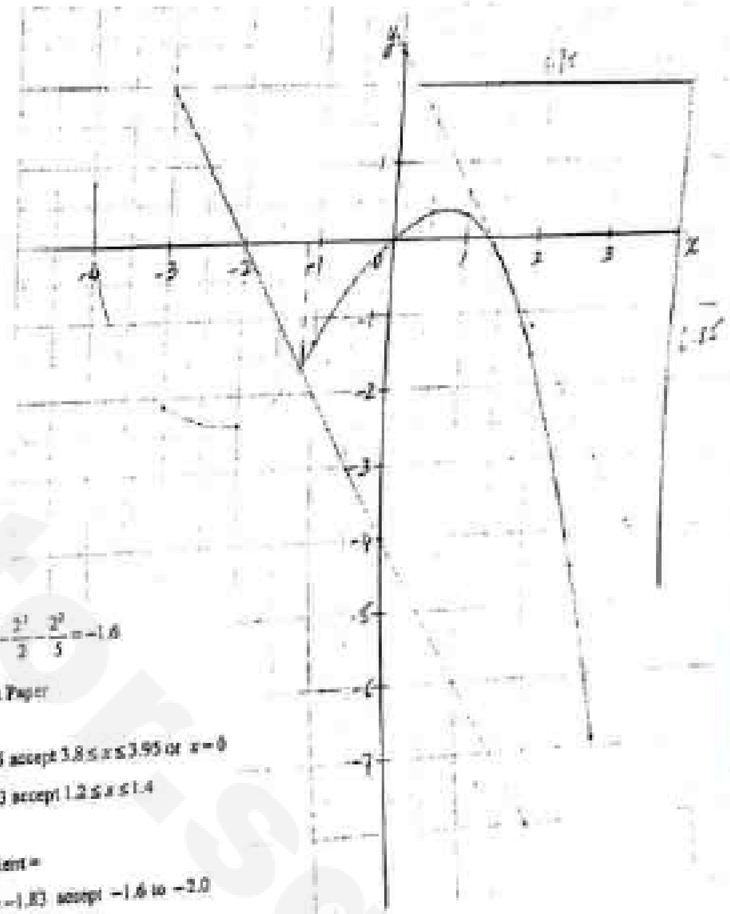
(b)(iv)
Since $n=-19.7$ or $n=20.7$ is not a whole number, it is not possible to have 204 handshakes.

5 (a)(i) $\angle PRS=38°$
(a)(ii) $\angle SQP=\angle PRS=38°$
(a)(iii) $\angle SPA=\angle SQP=38°$
(a)(iv) $\angle PQR=98°$
(a)(v) $8°$
(b) $PR=11.9$ cm

6 (a) $p=34$ or 35, $q=16$
(b)(i) Mean = \$154.51
b(ii) SD = \$7.71
(c)(i) P(Both workers earned at most \$150) = $\frac{595}{7626}$
(c)(ii) P(One worker earned more \$170 but the other at most \$160) = $\frac{102}{1271}$
(d) The cumulative curve will be steeper.

7 (a)(i) $\mathbf{q}-\mathbf{p}$
(a)(ii) $\frac{3}{4}(\mathbf{q}-\mathbf{p})$
(a)(iii) $\frac{3}{4}\mathbf{p}+\frac{1}{4}\mathbf{q}$
(a)(iv) $\mathbf{q}-\frac{1}{2}\mathbf{p}$
(b) $\frac{1}{2}h\mathbf{p}-(h-1)\mathbf{q}$
(c) $k=\frac{4}{7}$, $h=\frac{6}{7}$
(d)(i) $\frac{1}{6}$ (d)(ii) $\frac{9}{2}$

8



(a) $p=2-\frac{2^3}{2}-\frac{2^2}{5}=-1.6$
(b) Graph Paper
(c)
$x=-3.95$ accept $3.8\le x\le 3.95$ or $x=0$
or $x=1.3$ accept $1.2\le x\le 1.4$
(d) Gradient =
$-\frac{6.85}{3.75}=-1.83$ accept -1.6 to -2.0
(e) Draw line $y=-2x-4$
$x=-1.15$ accept $-1.1\le x\le -1.25$

9

(a)(i) 34.3 m (ii) 17.7 m (iii) 18.4°
(b) 23.6°
(c) 16.1 m

10

(a)(i) 11.25
(a)(ii) 4000 cm^2
(a)(iii) 14910 cm^3
(b)(i) 18.4
(b)(ii) 2684 cm^2