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Geylang Methodist School (Secondary) Preliminary Examination 2014

Candidate
Name

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Class

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Index
Number

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MATHEMATICS

4016/01

Paper 1

4 Express
5 Normal (Academic)
Hope 4-1

Candidates answer on the Question Paper.

2 hours

Setter: Mr Ho Ming Da

6 August 2014

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name in the spaces at the top of this page.

Write in dark blue or black pen.

You may use a pencil for any diagram or graph.

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 the 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 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 .

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

80

This document consists of 18 printed pages including the cover page.

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 Factorise completely
- (a) $xy - 2xa - 3y + 6a$,
- (b) $6x^2 - 8x - 30$.

Answer (a) [2]

(b) [2]

- 2 Michael bought a mobile phone in April.
In May, he decided to sell away the phone for \$250, and he made a loss of 20% of his cost.
Find the cost price.

Answer \$ [2]

For
Examiner's
UseFor
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3 The first four terms of a sequence are 2, -3 , -8 and -13 .

(a) Write down the 8th term of the sequence.

Answer (a) [1]

(b) Find an expression, in terms of n , for the n th term of the sequence.

Answer (b) [1]

(c) One of the terms in this sequence is -493 .

Find the value of n for this term.

Answer (c) $n =$ [1]

- 4 (a) Simplify $30(x^3y^2)^{\frac{2}{3}} \div 5x^{-6}y$.

Answer (a) [1]

- (b) Given that $\frac{x^5 \times y^0}{\sqrt{x}} = x^k$, find k .

Answer (b) $k =$ [1]

- 5 The population of Singapore in 2010 is approximately 5.08×10^6 .
The population of Singapore in 2014 is approximately 5.41×10^6 .

- (a) How many more people are there in Singapore in 2014 than in 2010?
Leave your answer in standard form.

Answer (a) [1]

- (b) Calculate the percentage increase in the population of Singapore.

Answer (b)% [1]

6 $\xi = \{x \text{ is an integer: } 1 \leq x \leq 15\}$

$A = \{\text{prime numbers}\}$

$B = \{\text{multiples of 3}\}$

(a) List the elements in $(A \cup B)'$.

Answer (a) [1]

(b) Find $n(A' \cap B')$.

Answer (b) [1]

7 (a) Solve the inequalities $-3 \leq \frac{1}{2}(5x + 3) < 2x + 4$.

Answer (a) [2]

(b) Hence, state the smallest rational value of x .

Answer (b) [1]

- 8 Written as the product of its prime factors,

$$126 = 2 \times 3^2 \times 7.$$

- (a) Express 60 as the product of its prime factors.

Answer (a) [1]

- (b) Hence write down the Lowest Common Multiple of 126 and 60, giving your answer as the product of its prime factors.

Answer (b) [1]

- (c) Find the greatest integer that will divide both 126 and 60 exactly.

Answer (c) [1]

- (d) Find the smallest possible integer k such that $126k$ is a square number.

Answer (d) [1]

- 9 (a) Simplify $3(2p + 3q) - 4(p - 5q)$.

Answer (a) [1]

- (b) One solution of $3x^2 + kx - 2 = 0$ is $x = 2$.
Find

- (i) the value of k ,

Answer (b)(i) $k =$ [1]

- (ii) the other solution of the equation.

Answer (b)(ii) $x =$ [1]

- 10 (a) Solve $(x - 2)^2 = 5x - 16$.

Answer (a) $x =$ or [2]

- (b) Write as a single fraction in its simplest form $\frac{5x}{x^2 - 1} - \frac{2}{x - 1}$.

Answer (b) [2]

11 The line $4x - 3y = 10$ crosses the x -axis at P and the y -axis at Q .

(a) Find the coordinates of P and Q .

Answer (a) P (.....,.....) [1]

Q (.....,.....) [1]

(b) Calculate the length of the line joining P to Q .

Answer (b) units [2]

(c) The line $4x - 3y = 10$ passes through the point $(4p, p^2 - 1)$.
Find the possible values of p .

Answer (c) $p =$ or [2]

- 12 (a) The interior angle of a regular polygon is five times the exterior angle of the same polygon. Calculate the number of sides that the polygon has.

Answer (a) [1]

- (b) Find the value of each exterior angle of a regular decagon.

Answer (b)° [1]

- 13 A bag contains six identical balls numbered 1, 2, 3, 4, 5 and 6. Two balls are drawn at random, one after the other from the bag **without replacement**.

- (a) Complete the possibility diagram to show the outcome of the draw. An example has been given below. [1]

6						
5						
4						
3						
2						
1		(1,2)				
	1	2	3	4	5	6

- (b) Find, as a fraction in its simplest form, the probability that

- (i) the sum of the numbers drawn is 8.
(ii) at least one of the numbers drawn is a multiple of 2.

Answer (b)(i) [1]

(b)(ii) [1]

- 14 The cost of painting the surface area of one small sphere is $\frac{9}{16}$ of the cost of painting the surface area of one large sphere.

(a) The larger sphere has a diameter of 24 cm. Calculate the diameter of the smaller sphere.

Answer (a) cm [2]

(b) The larger sphere has a volume of 128 cm^3 .
Find the volume of the smaller sphere.

Answer (b) cm^3 [1]

- 15 In the recent World Cup 2014, Brazil and Mexico both belonged to the same Group A. The matrices show the number of games they had played and the points gained for a win, draw or loss.

	Win	Draw	Lose	Points
Brazil	4	2	0	Win 3
Mexico	1	3	2	Draw 1
				Lose 0

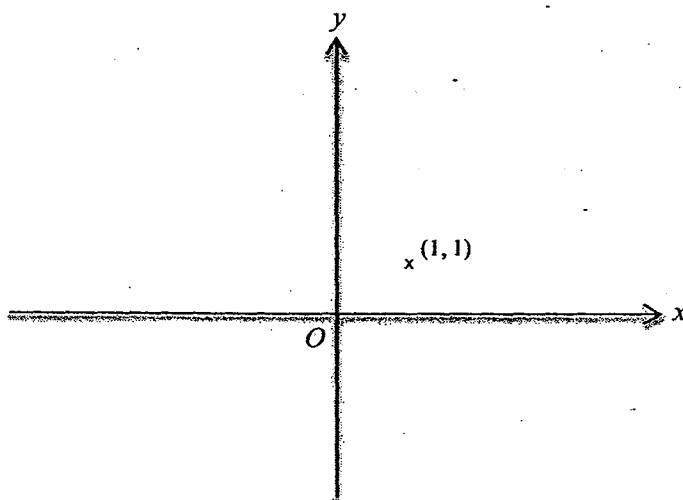
(a) Find 4 2 0 3
 1 3 2 1
 1 3 2 0

Answer (a) [2]

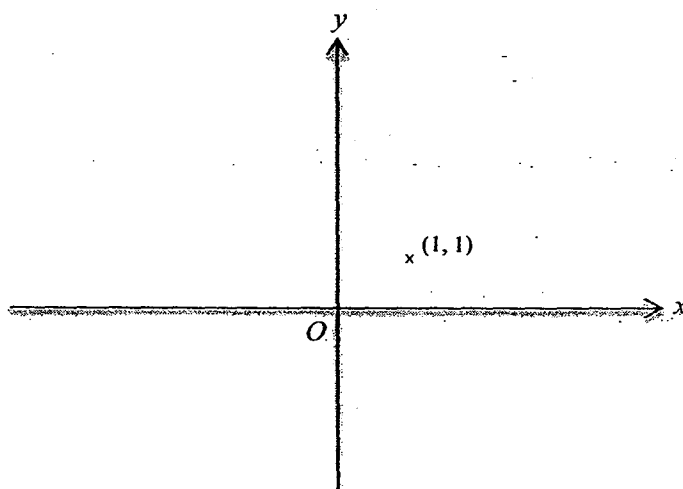
(b) Explain what your answer to (a) represents.

Answer (b) [1]

- 16 (a) Sketch the graph of $y = 5^x$.



- (b) Sketch the graph of $y = -x^3$.



Answer (a) Answer on the graph provided [1]

(b) Answer on the graph provided [1]

- 17 (a) Express $x^2 - 10x + 15$ in the form $(x - p)^2 + q$.

Answer (a) [1]

- Answer (b)* [1]

- Answer (c)* [1]

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- 19 The force, F Newtons (N), between any two particles in the universe is inversely proportional to the square of the distance, r metres (m), between them.

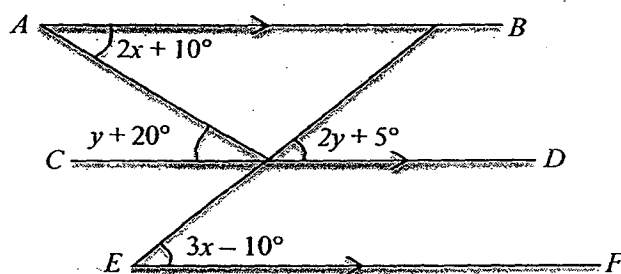
- (a) It is known that $F = 100\text{N}$ for a particular value of r .
Find the value of F when this value of r is doubled.

Answer (a) N [2]

- (b) $F = 50\text{N}$ when $r = 5\text{m}$.
Find the value of F when $r = 10\text{m}$.

Answer (b) N [2]

- 20 In the diagram, AB is parallel to CD and EF .



- (a) Using the information shown in the diagram above, write down two simultaneous equations, in terms of x and y .

Answer (a)

[2]

- 20 (b) Solve the simultaneous equations to find the value of x and the value of y .

Answer (b) $x = \dots\dots\dots$, $y = \dots\dots\dots$ [2]

- 21 On a map, 5 cm represents an actual distance of 800 m.

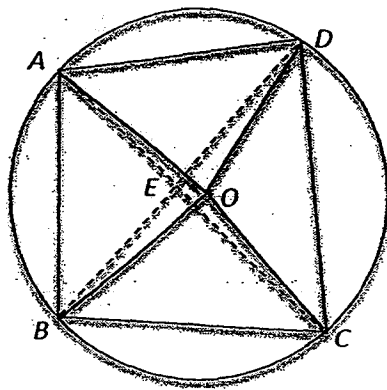
- (a) Calculate the distance, in centimetres, on the map which represents an actual distance of 1000 m.

Answer (a) $\dots\dots\dots$ cm [2]

- (b) Find the actual area, in square kilometres, which is represented by an area of 50 cm^2 on the map.

Answer (b) $\dots\dots\dots$ km^2 [2]

- 22 A, B, C and D are points on the circumference of the circle. The centre of the circle is at O . The diagonals AC and BD intersect at E , and $AD = BC$.



- (a) Name a triangle that is congruent to triangle BOC , giving a reason for your answer.

Answer (a)

.....

.....

..... [2]

- (b) Given that $\angle BOC = 2x^\circ$ and $\angle ECB = (x + 5)^\circ$, find an expression, in terms of x , for

(i) $\angle BDC$,

(ii) $\angle BDA$.

Answer (b)(i) $^\circ$ [1]

(b)(ii) $^\circ$ [1]

- (c) Given that $\angle ABC = 95^\circ$, use your answers to part (b) to find x .

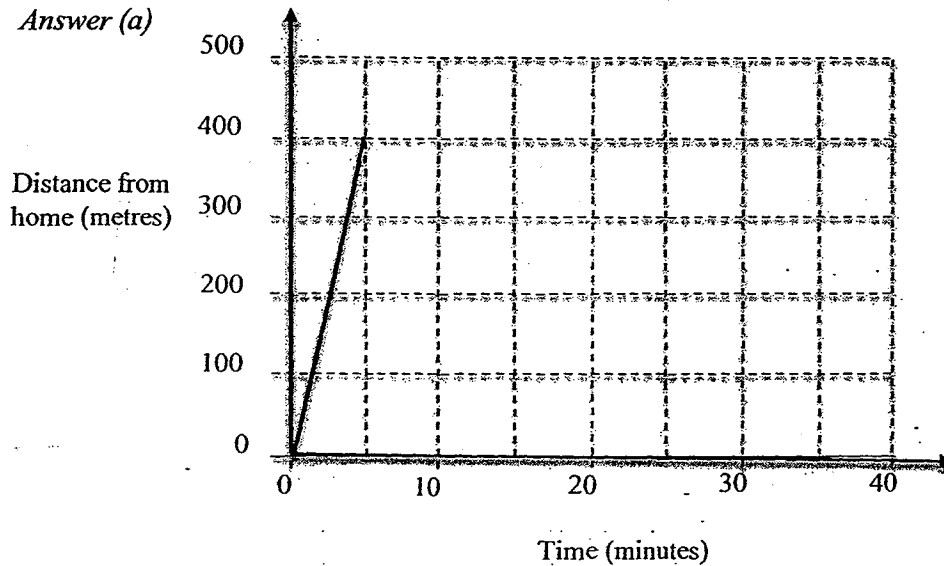
Answer (c) $x =$ [1]

- 23 Peter runs at a constant speed from his home to the bank 400m away. He spends 25 minutes at the bank and then walks back home at a constant speed. He is away from home for 40 minutes. The first part of his journey is shown on the distance-time graph below.

(a) On the grid, complete the graph for Peter's journey.

[1]

Answer (a)



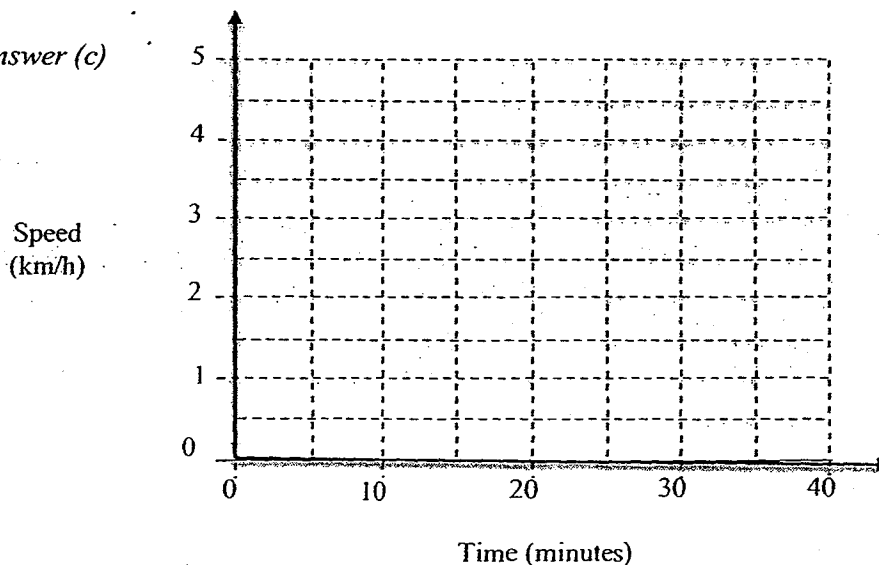
- (b) Calculate Peter's speed as he runs to the bank.
Give your answer in kilometres per hour.

Answer (b) km/h [2]

- (c) On the grid below, draw the speed-time graph for the whole of Peter's journey.

[2]

Answer (c)



- 24 (a) Construct a triangle XYZ where $XY = 8\text{cm}$, and $YZ = 10\text{cm}$.
 XZ has already been drawn.
 Answer (a), (b) and (c)

[1]

X ————— Z

(b) Construct

- (i) the perpendicular bisector of XZ , [1]
 (ii) the bisector of angle YXZ . [1]

- (c) Mark clearly a possible point where it is inside the triangle, equidistant from X and Z ,
 and is nearer to YX than ZX .
 Label this point A . [1]

END OF PAPER



Geylang Methodist School (Secondary) Preliminary Examination 2014

200

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The total number of marks for this paper is 80.

For Examiner's Use

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

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

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

Answer all the questions.

For
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Use

For
Examiner's
Use

1 Factorise completely

(a) $xy - 2xa - 3y + 6a$,

(b) $6x^2 - 8x - 30$.

1(a) $xy - 2xa - 3y + 6a$

$= x(y - 2a) - 3(y - 2a)$ [M1]

$= (x - 3)(y - 2a)$ [A1]

1(b) $6x^2 - 8x - 30$

$= 2(3x^2 - 4x - 15)$ [M1]

$= 2(3x + 5)(x - 3)$ [A1]

Answer (a) [2]

(b) [2]

2 Michael bought a mobile phone in April.

In May, he decided to sell away the phone for \$250, and he made a loss of 20% of his cost.

Find the cost price.

Cost price $= \frac{250}{80} \times 100$ [M1]

$= \$312.50$ (to 2 d.p) [A1]

Answer \$ [2]

For
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- 3 The first four terms of a sequence are 2, -3, -8 and -13.

(a) Write down the 8th term of the sequence.

2, -3, -8, -13, -18, -23, -28, -33

8th term = -33 [A1]

Answer (a) [1]

(b) Find an expression, in terms of n , for the n th term of the sequence.

n th term =

$$2 + (n - 1)(-5)$$

$$= 2 - 5n + 5$$

$$= 7 - 5n \text{ [A1]}$$

Answer (b) [1]

(c) One term in the sequence is -493.

Find the value of n for this term.

$$7 - 5n = -493$$

$$-5n = -493 - 7$$

$$n = 100 \text{ [A1]}$$

Answer (c) $n =$ [1]

4 (a) Simplify $30(x^3y^2)^{\frac{2}{3}} \div 5x^{-6}y$.

$$\begin{aligned} & 30(x^3y^2)^{\frac{2}{3}} \div 5x^{-6}y \\ &= 30(x^2y^{\frac{4}{3}}) \div 5x^{-6}y \\ &= 6x^{2-(-6)}y^{\frac{4}{3}-1} \\ &= 6x^8y^{\frac{1}{3}} \text{ [A1]} \end{aligned}$$

Answer (a) [1]

(b) Given that $\frac{x^5y^0}{\sqrt{x}} = x^k$, find k .

$$\begin{aligned} \frac{x^5 \times y^0}{\sqrt{x}} &= x^k \\ \frac{x^5 \times 1}{\sqrt{x}} &= x^k \\ x^{5-\frac{1}{2}} &= x^k \end{aligned}$$

$$k = 4.5 \text{ [A1]}$$

Answer (b) $k =$ [1]

5 The population of Singapore in 2010 is approximately 5.08×10^6 .
The population of Singapore in 2014 is approximately 5.41×10^6 .

(a) How many more people are there in Singapore in 2014 than in 2010?
Leave your answer in standard form.

$$\begin{aligned} & 5.41 \times 10^6 - 5.08 \times 10^6 \\ &= (5.41 - 5.08) \times 10^6 \\ &= 0.33 \times 10^6 \\ &= 3.3 \times 10^5 \text{ [A1]} \end{aligned}$$

Answer (a) [1]

(b) Calculate the percentage increase in the population of Singapore.

$$\begin{aligned} & \frac{3.3 \times 10^5}{5.08 \times 10^6} \times 100 \\ &= 6.50 \% \text{ or } 6\frac{63}{127} \% \text{ [A1]} \end{aligned}$$

Answer (b)% [1]

6 $\xi = \{x \text{ is an integer: } 1 \leq x \leq 15\}$

$A = \{\text{prime numbers}\}$

$B = \{\text{multiples of 3}\}$

(a) List the elements in $(A \cup B)'$.

$A = \{\text{prime numbers}\} = \{2, 3, 5, 7, 11, 13\}$

$B = \{\text{multiples of 3}\} = \{3, 6, 9, 12, 15\}$

$A \cup B = \{2, 3, 5, 6, 7, 9, 11, 12, 13, 15\}$

$(A \cup B)' = \{1, 4, 8, 10, 14\}$ [A1]

Answer (a) [1]

(b) Find $n(A' \cap B')$.

$A' = \{1, 4, 6, 8, 9, 10, 12, 14, 15\}$

$B' = \{1, 2, 4, 5, 7, 8, 10, 11, 13, 14\}$

$A' \cap B' = \{1, 4, 8, 10, 14\}$

$n(A' \cap B') = 5$

Answer (b) [1]

7 (a) Solve the inequalities $-3 \leq \frac{1}{2}(5x + 3) < 2x + 4$.

$-3 \leq \frac{1}{2}(5x + 3) \text{ and } \frac{1}{2}(5x + 3) < 2x + 4$

$-6 \leq 5x + 3 \quad 5x + 3 < 4x + 8$

$-6 - 3 \leq 5x \quad 5x - 4x < 8 - 3$

$-9 \leq 5x \quad x < 5$

$x \geq -1.8$

$x \geq -1.8 \text{ and } x < 5$ [M1]

$-1.8 \leq x < 5$ [A1]

Answer (a) [2]

(b) Hence, state the smallest rational number value of x .

Smallest rational number value = -1.8 [A1]

Answer (b) [1]

For
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Use

8 Written as the product of its prime factors,

$$126 = 2 \times 3^2 \times 7.$$

(a) Express 60 as the product of its prime factors.

$$60 = 2^2 \times 3 \times 5 \text{ [A1]}$$

Answer (a) [1]

(b) Hence, write down the Lowest Common Multiple of 126 and 60, giving your answer as the product of its prime factors.

$$\text{LCM} = 2^2 \times 3^2 \times 5 \times 7 \text{ [A1]}$$

Answer (b) [1]

(c) Find the greatest integer that will divide both 126 and 60 exactly.

$$\text{HCF} = 2 \times 3 = 6 \text{ [A1]}$$

Answer (c) [1]

(d) Find the smallest possible integer k such that $126k$ is a square number.

$$k = 2 \times 7 = 14 \text{ [AI]}$$

Answer (d) [1]

9 (a) Simplify $3(2p + 3q) - 4(p - 5q)$.

$$\begin{aligned} & 3(2p + 3q) - 4(p - 5q) \\ &= 6p + 9q - 4p + 20q \\ &= 2p + 29q \quad [\text{A1}] \end{aligned}$$

Answer (a) [1]

(b) One solution of $3x^2 + kx - 2 = 0$ is $x = 2$.
Find

(i) the value of k ,

$$\begin{aligned} & 3(2)^2 + k(2) - 2 = 0 \\ & 12 + 2k - 2 = 0 \\ & 10 + 2k = 0 \\ & 2k = -10 \\ & k = -5 \quad [\text{A1}] \end{aligned}$$

Answer (b)(i) $k =$ [1]

(ii) the other solution of the equation.

$$\begin{aligned} & 3x^2 - 5x - 2 = 0 \\ & (3x+1)(x-2) = 0 \\ & x = -\frac{1}{3} \text{ or } 2 \end{aligned}$$

$$x = -\frac{1}{3} \quad [\text{A1}]$$

Answer (b)(ii) $x =$ [1]

10 (a) Solve $(x-2)^2 = 5x - 16$.

$$\begin{aligned} & x^2 - 4x + 4 = 5x - 16 \quad [\text{M1}] \\ & x^2 - 4x - 5x + 4 + 16 = 0 \\ & x^2 - 9x + 20 = 0 \\ & (x-4)(x-5) = 0 \\ & x = 4 \text{ or } x = 5 \quad [\text{A1}] \end{aligned}$$

Answer (a) $x =$ or [2]

(b) Write as a single fraction in its simplest form $\frac{5x}{x^2-1} - \frac{2}{x-1}$.

$$\begin{aligned} & \frac{5x}{x^2-1} - \frac{2}{x-1} \\ &= \frac{5x}{(x-1)(x+1)} - \frac{2}{x-1} \quad [\text{M1}] \\ &= \frac{5x}{(x-1)(x+1)} - \frac{2(x+1)}{(x-1)(x+1)} \\ &= \frac{5x-2x-2}{(x-1)(x+1)} = \frac{3x-2}{(x-1)(x+1)} \quad [\text{A1}] \end{aligned}$$

Answer (b) [2]

11 The line $4x - 3y = 10$ crosses the x -axis at P and the y -axis at Q .

(a) Find the coordinates of P and Q .

When $x = 0$, $4(0) - 3y = 10$

$$-3y = 10$$

$$y = -3\frac{1}{3}$$

$$Q(0, -3\frac{1}{3}) \text{ [A1]}$$

When $y = 0$, $4x - 3(0) = 10$

$$4x = 10$$

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

$$P(2\frac{1}{2}, 0) \text{ [A1]}$$

Answer (a) $P(\dots\dots\dots, \dots\dots\dots)$ [1]

$Q(\dots\dots\dots, \dots\dots\dots)$ [1]

(b) Calculate the length of the line joining P to Q .

$$\text{Length} = \sqrt{(0 - 2\frac{1}{2})^2 + (-3\frac{1}{3} - 0)^2} \text{ [M1]}$$

$$= 4.17 \text{ [A1]}$$

Answer (b) $\dots\dots\dots$ units [2]

(c) The line $4x - 3y = 10$ passes through the point $(4p, p^2 - 1)$.
Find the possible values of p .

$$4(4p) - 3(p^2 - 1) = 10$$

$$16p - 3p^2 + 3 - 10 = 0$$

$$-3p^2 + 16p - 7 = 0 \text{ [M1]}$$

$$p = \frac{-16 \pm \sqrt{16^2 - 4(-3)(-7)}}{2(-3)}$$

$$= 0.481 \text{ or } 4.85 \text{ (to 3 s.f.) [A1]}$$

Answer (c) $p = \dots\dots\dots$ or $\dots\dots\dots$ [2]

- 12 (a) The interior angle of a regular polygon is five times the exterior angle of the same polygon. Calculate the number of sides that the polygon has.

$$180^\circ \div 6 = 30^\circ$$

$$360^\circ \div 30^\circ = 12 \text{ sides [A1]}$$

Answer (a) [1]

- (b) Find the exterior angle of a regular decagon.

Decagon has 10 sides.

$$360^\circ \div 10 = 36^\circ \text{ [A1]}$$

Answer (b)° [1]

- 13 A bag contains six identical balls numbered 1, 2, 3, 4, 5 and 6. Two balls are drawn at random, one after the other from the bag **without replacement**.

- (a) Complete the possibility diagram to show the outcome of the draw. [1]

6	(6,1)	(6,2)	(6,3)	(6,4)	(6,5)	
5	(5,1)	(5,2)	(5,3)	(5,4)		(5,6)
4	(4,1)	(4,2)	(4,3)		(4,5)	(4,6)
3	(3,1)	(3,2)		(3,4)	(3,5)	(3,6)
2	(2,1)		(2,3)	(2,4)	(2,5)	(2,6)
1		(1,2)	(1,3)	(1,4)	(1,5)	(1,6)
	1	2	3	4	5	6

- (b) Find, as a fraction of its simplest form, the probability that

- (i) the sum of the numbers drawn is 8.
(ii) at least one of the numbers drawn is a multiple of 2.

(i) Probability = $\frac{4}{30} = \frac{2}{15}$ [A1]

(i) Probability = $\frac{24}{30} = \frac{4}{5}$ [A1]

Answer (b)(i) [1]

(b)(ii) [1]

- 14 The cost of painting the surface area of one small sphere is $\frac{9}{16}$ of the cost of painting the surface area of one large sphere.

(a) The larger sphere has a diameter of 24 cm. Calculate the diameter of the smaller sphere.

$$\sqrt{\frac{9}{16}} = \frac{d}{24} \quad [\text{M1}]$$

$$\frac{3}{4} = \frac{d}{24}$$

$$d = 18 \text{ cm} \quad [\text{A1}]$$

Answer (a) cm [2]

(b) The larger sphere has a volume of 128 cm^3 .
Find the volume of the smaller sphere.

$$\left(\frac{3}{4}\right)^3 = \frac{V}{128}$$

$$V = 54 \text{ cm}^3 \quad [\text{A1}]$$

Answer (b) cm^3 [1]

- 15 In the recent World Cup 2014, Brazil and Mexico both belonged to the same Group A. The matrices show the number of games they had played and the points gained for a win, draw or loss.

	Win	Draw	Lose	Points
Brazil	$\begin{bmatrix} 4 \\ 2 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 2 \\ 2 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 0 \\ 1 \\ 2 \end{bmatrix}$	$\begin{bmatrix} 3 \\ 1 \\ 0 \end{bmatrix}$
Mexico	$\begin{bmatrix} 1 \\ 3 \\ 2 \end{bmatrix}$	$\begin{bmatrix} 3 \\ 2 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 2 \\ 0 \\ 0 \end{bmatrix}$	$\begin{bmatrix} 3 \\ 1 \\ 0 \end{bmatrix}$

(a) Find $\begin{bmatrix} 4 & 2 & 0 \\ 2 & 2 & 1 \\ 1 & 3 & 0 \end{bmatrix} \begin{bmatrix} 3 \\ 1 \\ 0 \end{bmatrix}$

$$\begin{bmatrix} 4 & 2 & 0 \\ 2 & 2 & 1 \\ 1 & 3 & 0 \end{bmatrix} \begin{bmatrix} 3 \\ 1 \\ 0 \end{bmatrix} = \begin{pmatrix} 12 + 2 + 0 \\ 6 + 2 + 0 \\ 3 + 0 + 0 \end{pmatrix} \quad [\text{M1}]$$

$$= \begin{pmatrix} 14 \\ 8 \\ 3 \end{pmatrix} \quad [\text{A1}]$$

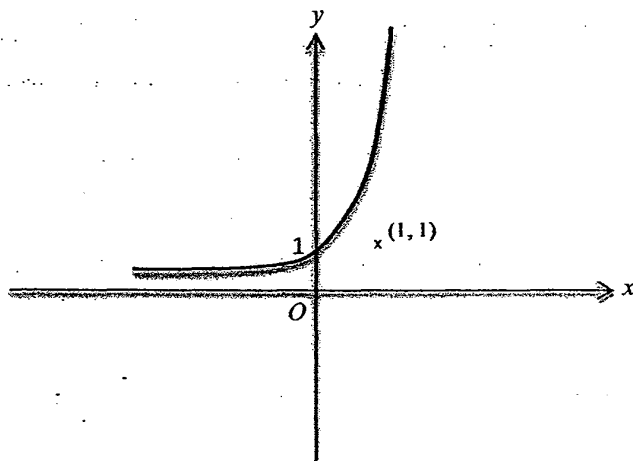
Answer (a) [2]

(b) Explain what your answer to (a) represents.

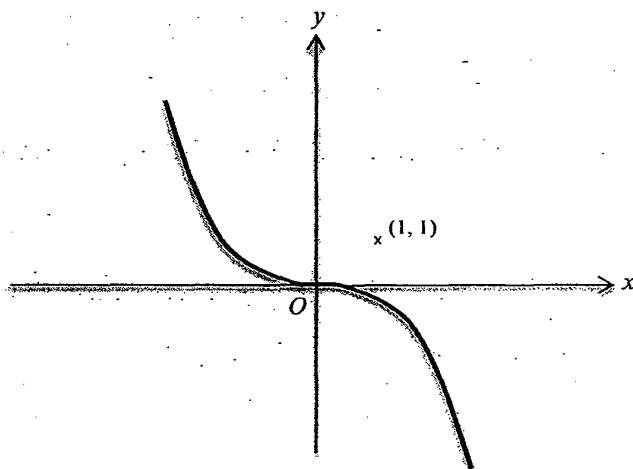
Answer (b) Brazil gained 14 points and Mexico gained 6 points.

[1]

- 16 (a) Sketch the graph of $y = 5^x$.



- (b) Sketch the graph of $y = -x^3$.



Answer (a) Answer on the graph provided [1]

(b) Answer on the graph provided [1]

- 17 (a) Express $x^2 - 10x + 15$ in the form $(x-p)^2 + q$.

$$\begin{aligned} x^2 - 10x + 15 &= x^2 - 10x + \left(\frac{-10}{2}\right)^2 + 15 - \left(\frac{-10}{2}\right)^2 \\ &= (x-5)^2 - 10 \quad [\text{A1}] \end{aligned}$$

Answer (a) [1]

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- 17 (b) Hence write down the minimum value of $x^2 - 10x + 15$.

Minimum value = -10 [A1]

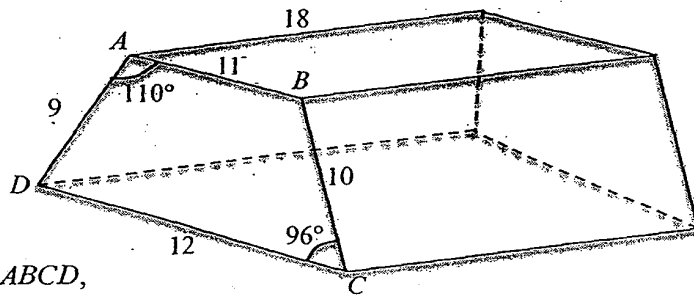
Answer (b) [1]

- (c) Write down the equation of the line of symmetry of the graph of $y = x^2 - 10x + 15$.

Equation of the line of symmetry: $x = 5$ [A1]

Answer (c) [1]

- 18 The diagram shows a prism where, $AB = 11\text{cm}$, $BC = 10\text{cm}$, $CD = 12\text{cm}$, $AD = 9\text{cm}$, angle $DAB = 110^\circ$, angle $BCD = 96^\circ$ and the length of the prism is 18cm .



Calculate

- (a) the area of the cross section $ABCD$,
(b) the volume of the prism.,

$$\begin{aligned} \text{(a) Area of trapezium} &= \frac{1}{2}(9)(11)\sin 110^\circ + \frac{1}{2}(12)(10)\sin 96^\circ \text{ [A1]} \\ &= 106.186... \\ &= 106 \text{ cm}^2 \text{ [A1]} \end{aligned}$$

$$\text{(b) Volume of trapezium} = (106.186...) \times 18 = 1911.3498.... = 1910 \text{ cm}^3 \text{ [A1]}$$

Answer (a) cm^2 [2]

(b) cm^3 [1]

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- 19 The force, F Newtons (N), between any two particles in the universe is inversely proportional to the square of the distance, r metres (m), between them.

- (a) It is known that $F = 100\text{N}$ for a particular value of r .
Find the value of F when this value of r is doubled.

$$F = \frac{k}{r^2}$$

$$100 = \frac{k}{r^2}$$

$$k = 100r^2$$

$$F = \frac{100r^2}{(2r)^2} \quad [\text{M1}]$$

$$= \frac{100r^2}{4r^2} = 25 \text{ N} \quad [\text{A1}]$$

Answer (a) N [2]

- (b) $F = 50\text{N}$ when $r = 5$.
Find the value of F when $r = 10$ m.

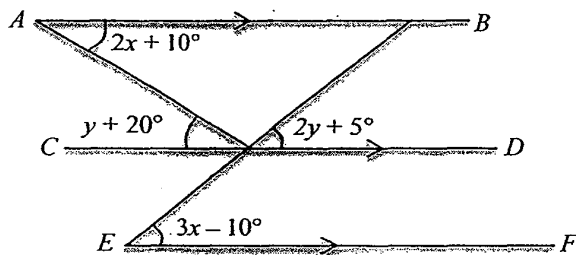
$$50 = \frac{k}{5^2}$$

$$k = 1250 \quad [\text{M1}]$$

$$\text{Therefore, } F = \frac{1250}{r^2} = \frac{1250}{10^2} = 12.5 \text{ N} \quad [\text{A1}]$$

Answer (b) N [2]

- 20 In the diagram, AB is parallel to CD and EF .



- (a) Using the information shown in the diagram above, write down two simultaneous equations, in terms of x and y .

$$2x + 10^\circ = y + 20^\circ \quad \text{or} \quad 180 = 180 - (2y + 5) - (y + 20) - (2x + 10)$$

$$2x - y = 20^\circ - 10^\circ \quad 5x - 3y = 25 \quad [\text{A1}]$$

$$2x - y = 10 \quad [\text{A1}]$$

$$3x - 10^\circ = 2y + 5^\circ$$

$$3x - 2y = 10^\circ + 5^\circ$$

$$3x - 2y = 15 \quad [\text{A1}]$$

Answer (a)

[2]

20 (b) Solve the simultaneous equations to find the value of x and the value of y .

$$2x - y = 10 \quad \text{---(1)}$$

$$(1) \times 2: 4x - 2y = 20 \quad \text{---(2)}$$

$$3x - 2y = 15 \quad \text{---(3)}$$

$$(2) - (3): 4x - 2y - (3x - 2y) = 20 - 15$$

$$4x - 2y - 3x + 2y = 5$$

$$x = 5 \text{ [A1]}$$

$$\text{Sub } x = 5 \text{ into } 2x - y = 10 \quad \text{---(1)}$$

$$2(5) - y = 10$$

$$y = 0 \text{ [A1]}$$

Answer (b) $x = \dots\dots\dots$, $y = \dots\dots\dots$ [2]

21 On a map, 5 cm represents an actual distance of 800 m.

(a) Calculate the distance, in centimetres, on the map which represents an actual distance of 1000 m.

$$\frac{5}{800} \times 1000 \quad \text{[M1]}$$

$$= 6.25 \text{ cm} \quad \text{[A1]}$$

Answer (a) $\dots\dots\dots$ cm [2]

(b) Find the actual area, in square kilometres, which is represented by an area of 50 cm^2 on the map.

$$5 \text{ cm} : 800 \text{ m}$$

$$= 5 \text{ cm} : 0.8 \text{ km}$$

$$= 1 \text{ cm} : 0.16 \text{ km}$$

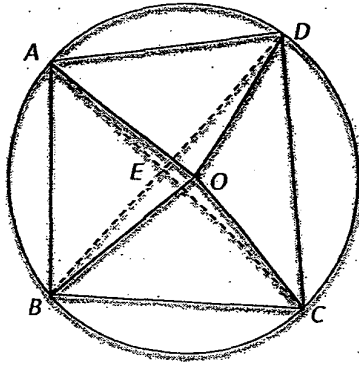
$$= 1 \text{ cm}^2 : 0.0256 \text{ km}^2 \quad \text{[M1]}$$

$$= 50 \text{ cm}^2 : 0.0256 \times 50 \text{ km}^2$$

$$= 50 \text{ cm}^2 : 1.28 \text{ km}^2 \quad \text{[A1]}$$

Answer (b) $\dots\dots\dots$ km^2 [2]

- 22 A, B, C and D are points on the circumference. The centre of the circle is at O . The diagonals AC and BD intersect at E , and $AD = BC$.



- (a) Name a triangle that is congruent to triangle BOC , giving a reason for your answer.

Answer (a) Triangle AOD or DOA . [A1]

$BO = AO$ (radius), $DO = CO$ (radius), $AD = BC$ (given).

All three sides of both triangles have the same lengths. [A1]

[2]

- (b) Given that $\angle BOC = 2x^\circ$ and $\angle ECB = (x + 5)^\circ$, find an expression, in terms of x , for

(i) $\angle BDC$,

(ii) $\angle BDA$.

(i) $\angle BDC = x^\circ$ (angle at centre = twice angle at circumference) [A1]

(ii) $\angle BDA = (x + 5)^\circ$ (angles in the same segment) [A1]

Answer (b)(i) $^\circ$ [1]

(b)(ii) $^\circ$ [1]

- (c) Given that $\angle ABC = 95^\circ$, use your answers to part (b) to find x .

$$95^\circ + (x + 5)^\circ + x^\circ = 180^\circ$$

$$100 + 2x = 180$$

$$x = 40 \text{ [A1]}$$

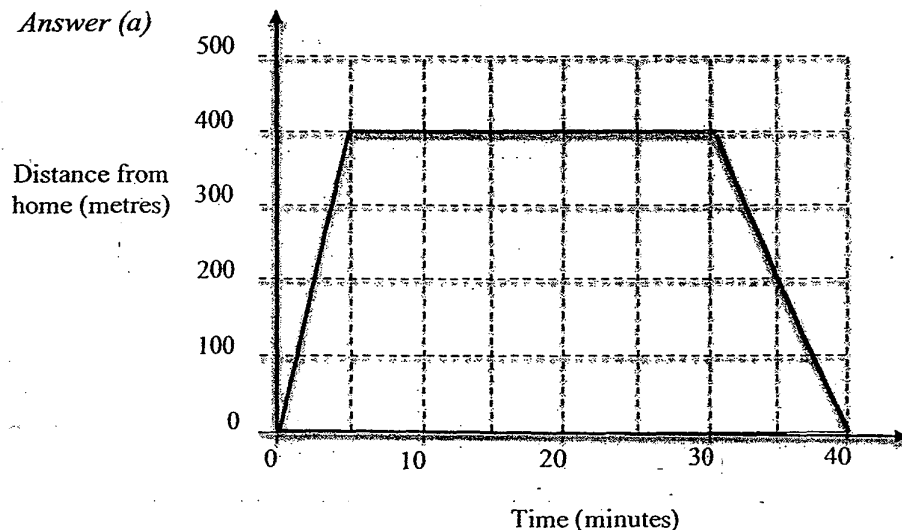
Answer (c) $x =$ [1]

- 23 Peter runs at a constant speed from his home to the bank 400 m away. He spends 25 minutes at the bank and then walks back home at a constant speed. He is away from home for 40 minutes. The first part of his journey is shown on the distance-time graph below.

(a) On the grid, complete the graph for Peter's journey.

[1]

Answer (a)



- (b) Calculate Peter's speed as he runs to the bank.
Give your answer in kilometres per hour.

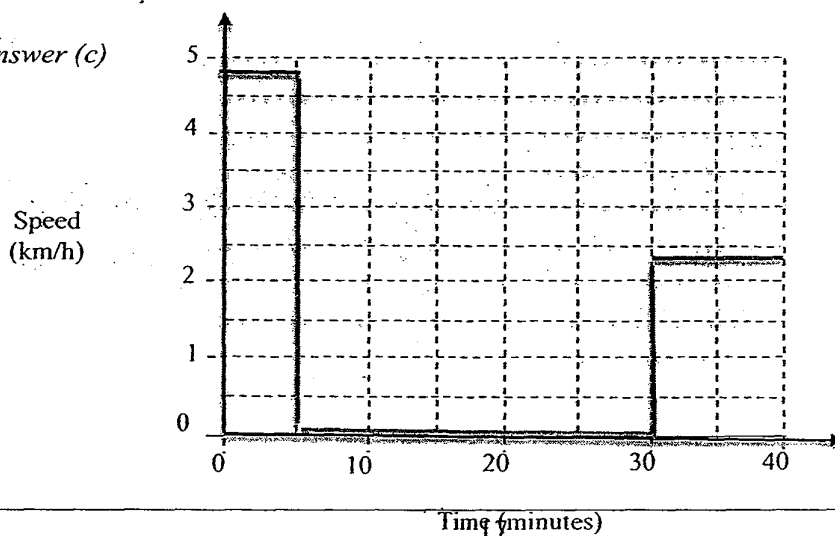
$$\frac{400 \text{ metres}}{5 \text{ mins}} = \frac{0.4 \text{ km}}{\frac{5}{60} \text{ h}} \quad [\text{M1}]$$
$$= 4.8 \text{ km/h} \quad [\text{A1}]$$

Answer (b) km/h [2]

- (c) On the grid below, draw the speed-time graph for the whole of Peter's journey.

[2]

Answer (c)



[Turn Over]

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- 24 (a) Construct triangle XYZ where $XY = 8\text{cm}$, $YZ = 10\text{cm}$.
 XZ has already been drawn.
 Answer (a), (b) and (c)

[1]

X  Z

Type equation here.

- (b) Construct
- (i) the perpendicular bisector of XZ . [1]
 - (ii) the bisector of angle YXZ . [1]
- (c) Mark clearly a possible point where it is inside the triangle, equidistant from X and Z , and is nearer to YX than ZX .
 Label this point A . [1]

END OF PAPER



Geylang Methodist School (Secondary) Preliminary Examination 2014

MATHEMATICS

4016/02

Paper 2

Sec 4 Express

Hope 4-1

Sec 5 Normal Academic

Additional Materials: Answer Paper
Graph paper (1 sheet)

2 hours 30 minutes

Setter : Mr Wong Han Ming

7 August 2014

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name in the spaces at the top of the answer papers.

Write in dark blue or black pen.

You may use a pencil for any diagram or graph.

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 the 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 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 .

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.

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100

This document consists of 10 printed pages.

[Turn over

Mathematical Formulae

Compound interest

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

Mensuration

$$\text{Curved Surface Area of a cone} = \pi r l$$

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

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

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

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

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

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

Trigonometry

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

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

Statistics

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

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

Answer all the questions.

1 (a) Make z the subject of the equation $x = \sqrt{\frac{yz + xf}{z + f}}$. [3]

(b) (i) Factorise $12 - 27x^2$ completely. [2]

(ii) Hence, simplify $\frac{12 - 27x^2}{9x^2 - 60x + 36}$. [3]

(c) Express as a single fraction in its simplest form $\frac{2}{3y-4} - \frac{3}{y+9}$. [2]

2 (Note: USD = US dollars ; SGD = Singapore dollars)

(a) The cash price of a 90 inch television set is USD 11 000.

(i) Given that 1 USD = 1.26 SGD, find the cash price of the television set in SGD. [1]

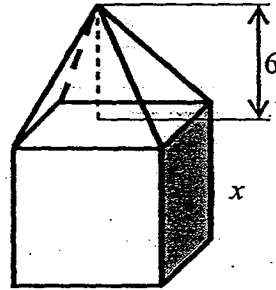
(ii) Alan buys the television set on hire purchase. He pays a deposit of 30% of the cash price in USD and the rest in monthly instalments over a period of 5 years at an interest rate of 4% per annum. Find the amount he pays for each instalment in USD. [4]

(b) In order to buy a sound speaker set, Alan takes a loan of USD 5 000 from a bank that charges a compound interest of 3% per annum, compounded annually. Find the interest he has to pay (in USD) if he intends to repay the loan in 4 years, correct to the nearest dollar. [2]

[Turn over 3

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

The following diagram shows a solid which is made up of a cube whose edge is x cm with a pyramid standing on one of the faces of the cube. The pyramid has a square base of side x cm and its vertical height is 6 cm.



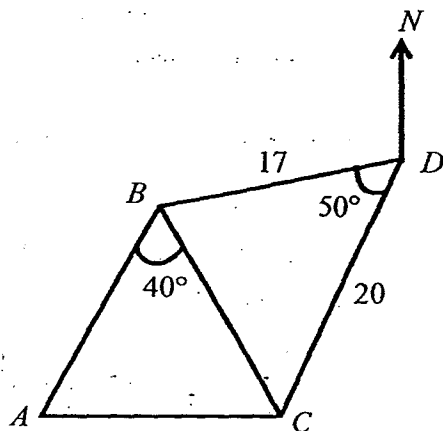
- (a) Show that the volume of the solid, V , is $x^3 + 2x^2$. [1]

- (b) The table below gives some values of x and the corresponding values of V that satisfies the equation $V = x^3 + 2x^2$.

x	0	1	2	3	4	5
V	0	3	16	p	96	175

- (i) Find the value of p . [1]
- (ii) Using a scale of 2 cm to represent 1 unit on the x -axis and a scale of 2 cm to represent 20 units on the V -axis, draw the graph of $V = x^3 + 2x^2$ for $0 \leq x \leq 5$. [3]
- (iii) Use your graph to estimate the volume of the solid when the pyramid has a base area of 12.25 cm^2 . [2]
- (iv) Use your graph to estimate the length of each side of the cube when the solid has a volume of 150 cm^3 . [1]
- (c) By drawing a tangent, find the gradient of the graph, $V = x^3 + 2x^2$, at the point where $x = 4$. [3]
- (d) Using your graph, solve the equation $x^3 + 2x^2 - 20 = 0$. [2]

- 4 In the diagram below, A, B, C and D are four points on the ground. $BD = 17$ m, $CD = 20$ m, $\angle BDC = 50^\circ$, $\angle ABC = 40^\circ$ and the bearing of C from D is 207° .



- (a) (i) Show that the length of BC is approximately 15.8715 m. [2]
 (ii) Find the bearing of C from B . [4]
- (b) A flagpole, 10 m in length is erected at point C .
 (i) Find the shortest distance of point C from AB . [2]
 (ii) Find the maximum angle of elevation of the top of the flagpole from a point on AB . [2]

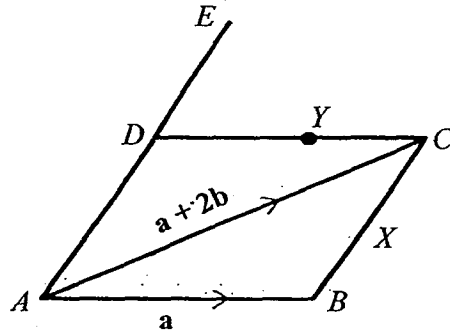
- 5 (a) Alice types at a rate of x words per minute. Write down the time (in minutes) required for Alice to type 200 words. [1]
- (b) Bess types at a rate of $(x - 4)$ words per minute. Write down the time (in minutes) required for Bess to type 200 words. [1]
- (c) Given that the difference in timing for both girls to finish typing 200 words is $4\frac{8}{23}$ minutes, form an equation in x and show that it reduces to
- $$x^2 - 4x - 184 = 0. \quad [3]$$
- (d) Solve the equation $x^2 - 4x - 184 = 0$, giving your answers to 4 decimal places. [3]
- (e) Hence, find the time (in minutes) Bess requires to type 500 words, giving your answer to the nearest minute. [2]

[Turn over 5

- 6 (a) Given that $\overrightarrow{OA} = \begin{pmatrix} 1 \\ 2 \end{pmatrix}$, $\overrightarrow{AB} = \begin{pmatrix} 4 \\ -3 \end{pmatrix}$, $\overrightarrow{OC} = \begin{pmatrix} 4 \\ 5 \end{pmatrix}$ and the x -coordinates of D is 10.

- (i) Find the vector $\overrightarrow{OB}$. [1]
 (ii) Given that CD is parallel to AB , find the coordinates of D . [2]

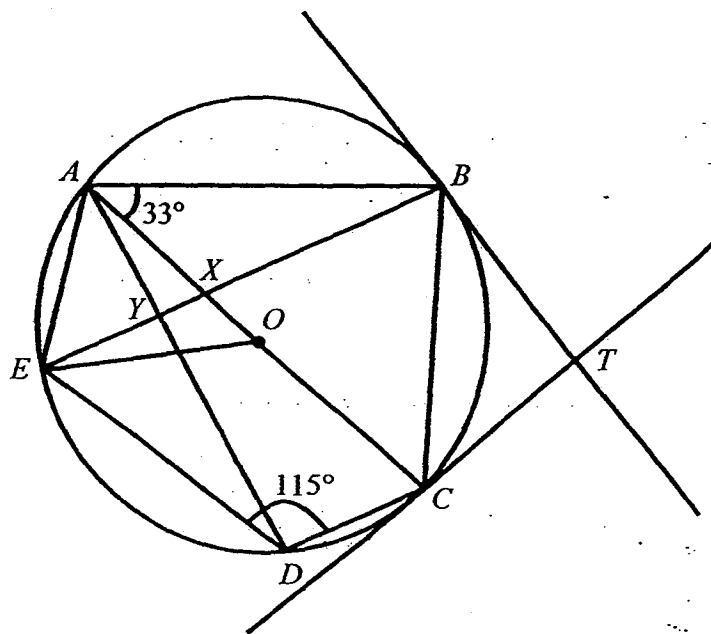
- (b) In the diagram (not drawn to scale), $ABCD$ is a parallelogram, X is the mid point of BC , $DY : DC$ is $4 : 7$ and $AD : DE$ is $3 : 2$. ADE is a straight line. $\overrightarrow{AB} = \mathbf{a}$ and $\overrightarrow{AC} = \mathbf{a} + 2\mathbf{b}$.



Find, in terms of $\mathbf{a}$ and/or $\mathbf{b}$,

- (i) $\overrightarrow{BC}$, [1]
 (ii) $\overrightarrow{AE}$, [1]
 (iii) $\overrightarrow{XY}$, [1]
 (iv) $\overrightarrow{XE}$. [2]

- From your answers in (b)(iii) and (b)(iv),
 (v) state two facts about X , Y and E . [2]



In the diagram, O is the centre of the circle. The points A, B, C, D and E lie on the circumference of the circle. The tangents of the circle at B and C intersect at point T . $\angle EDC = 115^\circ$ and $\angle BAC = 33^\circ$.

- (a) Prove that $\triangle ABY$ and $\triangle EDY$ are similar. [3]
- (b) Find, stating all the relevant reasons,
- (i) the obtuse angle, $\angle EOC$, [1]
 - (ii) $\angle EBC$, [1]
 - (iii) $\angle ABX$, [1]
 - (iv) $\angle BTC$. [2]
- (c) Another circle is drawn that passes through the points O, B, T and C . Explain why OT is the diameter of the new circle. [2]

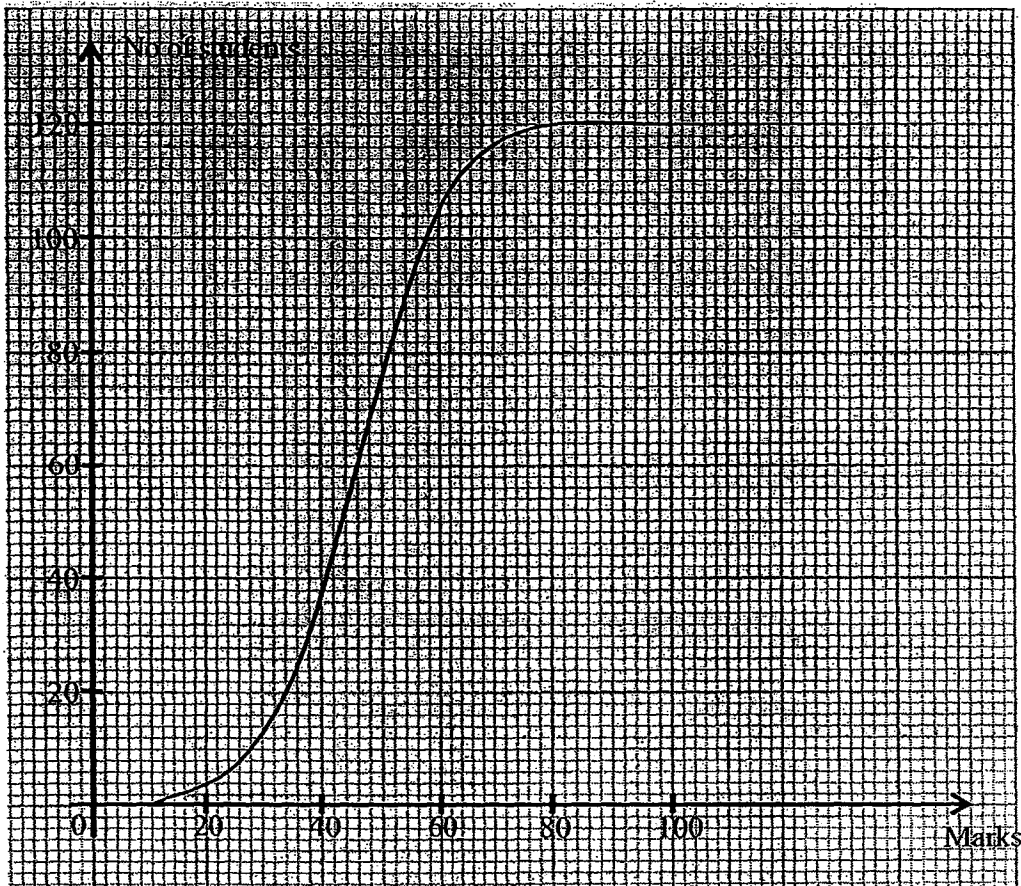
A diagram of a circular sector with center O , radius r , and angle θ . The sector is shaded black.

A conical cup (Figure 1) has a diameter of 6 cm. A cut is made along the dotted line, AO , and the cup is unfolded to form a sector as shown in Figure 2. If the volume of the cone in Figure 1 is $40\pi \text{ cm}^3$,

- (a) show that OA is $13\frac{2}{3}$ cm, [3]
- (b) show that θ is approximately 1.3792 radians, [2]
- (c) find the area of the sector in Figure 2, [2]
- (d) find the area of the shaded segment in Figure 2. [3]

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- 10 (a) The cumulative frequency graph represents the Mathematics results of 120 students.



From the graph,

- (i) find the median score, [1]
- (ii) find the interquartile range, [1]
- (iii) if the n th percentile of the students scored 40 marks and below, find the value of n , [2]
- (iv) if only 10% of the students achieved a distinction, calculate the minimum mark required to achieve a distinction. [2]

- (b) The children in two schools took a Science test. Information relating to the results is shown in the tables below.

School A

Marks (x)	$1 \leq x \leq 5$	$6 \leq x \leq 10$	$11 \leq x \leq 15$	$16 \leq x \leq 20$
Frequency	2	7	12	1

School B

Mean = 10.7
Standard Deviation = 4.6

- (i) For School A, calculate the mean and standard deviation. [2]
- (ii) Compare briefly, the results for the two schools. [2]

Answers

1(a)	$z = \frac{xf - x^2 f}{x^2 - y}$	6(a)(i)	$\overrightarrow{OB} = \begin{pmatrix} 5 \\ -1 \end{pmatrix}$
		6(a)(ii)	(10, 0.5)
1(b)(i)	$3(2 - 3x)(2 + 3x)$	6(b)(i)	$2b$
1(b)(ii)	$\frac{2+3x}{6-x}$ or equivalent	6(b)(ii)	$\frac{10}{3}b$
1(c)	$\frac{30-7y}{(3y-4)(y+9)}$	6(b)(iii)	$b - \frac{3}{7}a$
2(a)(i)	SGD 13860	6(b)(iv)	$\frac{7}{3}b - a$
2(a)(ii)	USD 154	6(b)(v)	$\overrightarrow{XE} = \frac{7}{3}\overrightarrow{XY}$ X, Y and E are collinear $XE = \frac{7}{3}XY$
2(b)	USD 628	7(a)	$3199.5\pi \text{ cm}^3$
3(b)(i)	45	7(b)	4590 cm^2
3(b)(iii)	67 cm^3	7(c)	74
3(b)(iv)	4.7 cm	8(a)	Use (AA) property
3(c)	64 ± 5	8(b)(i)	112.5°
3(d)	2.2 ± 0.1	8(b)(ii)	65°
4(a)(ii)	151.9°	8(b)(iii)	25°
4(b)(i)	10.2 m	8(b)(iv)	114°
4(b)(ii)	44.4°	8(c)	Since angle OCT = 90° (tangent is perpendicular to radius), and angle subtended by the diameter is also 90° , (angle in semicircle), OT must be the diameter.
5(a)	$\frac{200}{x}$	9(c)	129 cm^2
5(b)	$\frac{200}{x-4}$	9(d)	37.1 cm^2
5(d)	15.7113 ; -11.7113	10(a)(i)	46 marks
5(e)	43 minutes	10(a)(ii)	16 marks
		10(a)(iii)	30
		10(a)(iv)	62 marks
		10(b)(i)	Mean = 10.7 ; S.D. = 3.61
		10(b)(ii)	The mean is the same for both schools. This means that the two schools did equally well. The standard deviation is higher in School B. This means that the marks in School B is less consistent.