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**CHIJ KATONG CONVENT  
MID-YEAR EXAMINATION 2016  
SECONDARY 4 EXPRESS**

**MATHEMATICS  
PAPER 1**

**4048/1**

Duration: 2 hours

Classes: 403, 404, 405, 406

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**READ THESE INSTRUCTIONS FIRST**

Write your name, class and registration 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 staples, paper clips, glue or correction fluid/tape.

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.

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  $\pi$ , use either your calculator value or 3.142, unless the question requires the answer in terms of  $\pi$ .

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

FOR EXAMINER'S USE	
Total marks	/80

### Mathematical Formulae

#### Compound interest

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

#### Mensuration

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

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

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

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

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

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

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

#### Trigonometry

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

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

#### Statistics

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

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

Name: \_\_\_\_\_ ( )

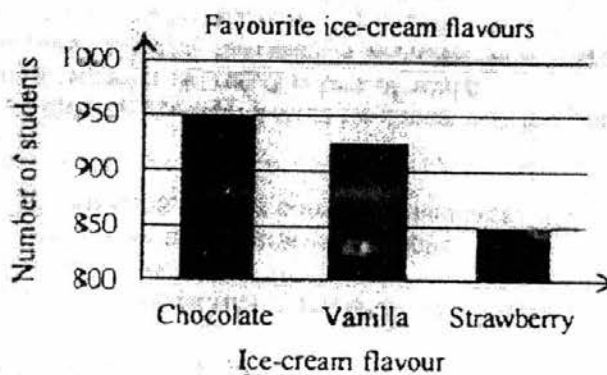
Class: \_\_\_\_\_

Answer all the questions.

- 1 Estimate the value of  $100 \times 0.45 + \frac{2.9^2 \times 1.74}{\sqrt{0.2498}}$ , giving your answer to 1 significant figure.

Answer ..... [2]

- 2 The graph below shows the survey results of students in a school on their choice of three ice-cream flavours. Mavis claims that the chocolate flavour is two times more popular than the strawberry flavour ice-cream. Explain why she is wrong and how the graph should be presented.

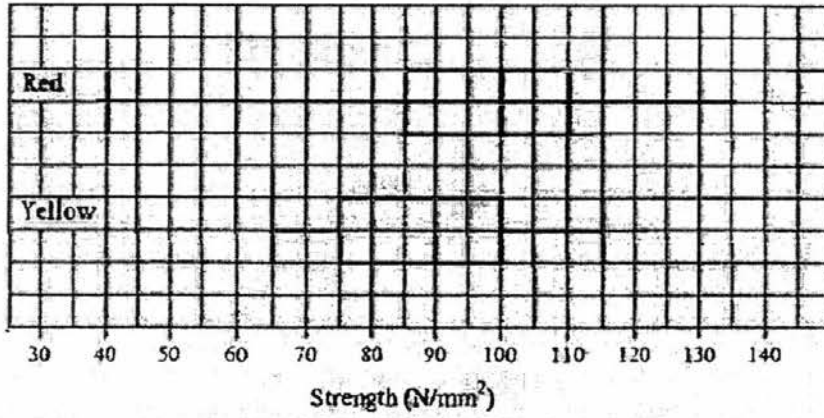


Answer: ..... [2]

- 3 When  $(a - b)$  is subtracted from  $(3a - 4b)$  the result is  $4b$ . Find the ratio of  $a : b$ .

Answer  $a : b = \dots$  [2]

- 4 A builder can choose between two types of bricks that are red or yellow. The box and whisker plots below illustrate the results of tests on the strength of the bricks in  $N/mm^2$ .



Give a reason why the builder might prefer to use the

- (a) the red bricks,

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

- (b) the yellow bricks.

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

- 5 Donald changed 10000 USD to Japanese Yen in Jan 2016 at a rate of 1 USD = 118.94412 ¥. In March 2016, he changed the yen back to USD at a rate of 1 USD = 111.74412 ¥.

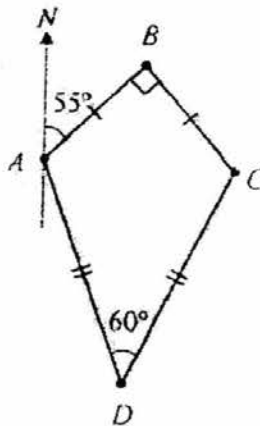
What is the increase / decrease in the amount of USD that he received?  
 Give your answer correct to 2 decimal places.

Answer USD ..... [3]

Name: \_\_\_\_\_ ( )

Class: \_\_\_\_\_

6 The diagram shows four points  $A$ ,  $B$ ,  $C$ , and  $D$  on a field.



Given that  $\angle B = 90^\circ$ ,  $\angle D = 60^\circ$  and  $B$  is on a bearing of  $055^\circ$  from  $A$ ,

(a) find the bearing of  $D$  from  $A$ .

Answer (a) .....  $^\circ$  [2]

(b) find the ratio of  $\frac{AB}{AD}$ .

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

7 Two tankers contain 825 litres and 675 litres of kerosene oil respectively.

(a) Find the maximum capacity of a container which can measure the kerosene oil of both the tankers when used an exact number of times.

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

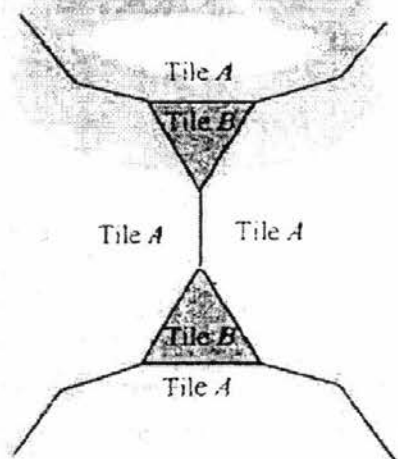
(b) Find the number of refills needed to fill the second tanker.

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

- 8 Express as a single fraction  $\frac{3x}{2y^2} \div \frac{x^{-2}}{y^2} - \frac{x^1}{5y}$ , giving your answer in positive indices.

Answer ..... [3]

- 9 The diagram shows part of a pattern made from tiles. The pattern is made from type *A* tiles and type *B* tiles, both of which are regular polygons.



Find the number of sides that tile *A* has.

Answer ..... sides [3]

Name: \_\_\_\_\_ ( )

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- 10 In quadrilateral  $ABCD$ ,  $BC = 3.2$  cm and  $\angle BAC = 22^\circ$ .

The point  $D$  is such that  $AD = AB$  and  $D$  lies on the perpendicular bisector of  $AB$ .

Given that  $\angle B$  is obtuse, complete the construction of quadrilateral  $ABCD$  in the space below.

$AB$  has already been drawn.

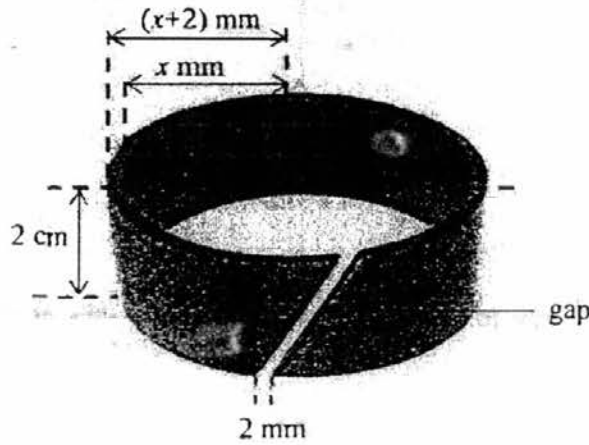
[3]



- 11 (a) Find the volume of a cylinder with radius  $x$  mm and height 2 cm in  $\text{mm}^3$ .  
Give your answer in terms of  $\pi$ .

Answer (a).....  $\text{mm}^3$  [1]

- (b) The diagram shows a metal ring cylinder used in an engine with a gap for expansion.  
The radii of the inner and the outer cylinders are  $x$  mm and  $(x+2)$  mm respectively.  
The height of the cylinder is 2 cm.  
The gap is in the shape of a parallelogram of base 2 mm.



Express in the simplest form, the volume of the ring cylinder in  $\text{mm}^3$ , in terms of  $x$  and  $\pi$ .

Answer (b).....  $\text{mm}^3$  [2]

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- 12 Mini invested \$50 000 in a time deposit which pays  $x$  % compound interest per annum. She received \$ 52531.25 in total after two years. Find the value of  $x$ .

*Answer*  $x = \dots\dots\dots$  [3]

- 13 The scale of a map is 1 : 250000.

(a) Calculate the distance, in cm, on the map for an actual distance of 62 km.

*Answer (a)*  $\dots\dots\dots$  cm [1]

(b) Calculate, in  $\text{km}^2$ , the area of a park represented by  $28 \text{ cm}^2$  on the map.

*Answer (b)*  $\dots\dots\dots$   $\text{km}^2$  [2]

14 It is given that

$$\mathcal{E} = \{x : x \text{ is an integer and } 0 < x \leq 10\}.$$

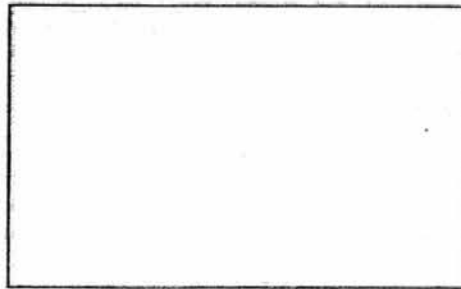
$$A = \{x : x^3 \leq 130\},$$

$$B = \{x : x \text{ is a factor of } 16\}.$$

- (a) Draw a Venn diagram to show the relationship of  $A$  and  $B$ , marking the elements in each region clearly. [2]

Answer (a)

$\mathcal{E}$



- (b) List the elements of  $(A \cup B)$ .

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

15 The cash price of a set of sofa is \$4000.  
Bruno bought the set on hire purchase with a deposit of 10% of the cash price, followed by 18 monthly instalments of \$228.80.

- (a) How much did Bruno pay in total for the sofa?

Answer (a) \$..... [2]

- (b) Calculate the extra cost of buying the sofa on hire purchase

Answer (b) \$..... [1]

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- 16 The volumes of two similar silver cones are  $270 \text{ cm}^3$  and  $640 \text{ cm}^3$  respectively. The height of the smaller cone is 30 cm.
- (a) The smaller cone costs \$2295. Assuming that the prices are according to the volumes, find the price difference between the larger and the smaller cone.

Answer (a) \$ ..... [1]

- (b) The radius of the base of the smaller cone is  $k$  cm. Find in terms of  $k$ , the radius of the base of the larger cone.

Answer (b) ..... cm [2]

- 17 Justin cycled at  $14.4 \text{ km/h}$  and passed by six equally spaced lamp posts in 1 minute.

- (a) Find the distance between adjacent lamp posts, in m.

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

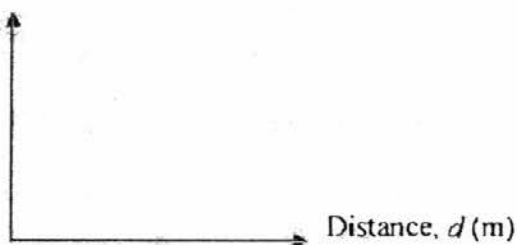
- (b) Find the total time taken if he passed by 18 lamp posts altogether. Give your answer in minutes and seconds.

Answer (b) ..... s [2]

- 18 The electrostatic force between two selected objects,  $f$  Newton, is inversely proportional to the square of the distance between the two objects,  $d$  m.
- (a) Sketch a graph to illustrate the relationship between the force and distance between the two objects.

Answer (a)

Force,  $f$  (N)



[1]

- (b) The force between the objects is 17.5N when the distance apart is 0.2 m.  
Express  $f$  in terms of  $d$ .

Answer (b)  $f = \dots\dots\dots$  [2]

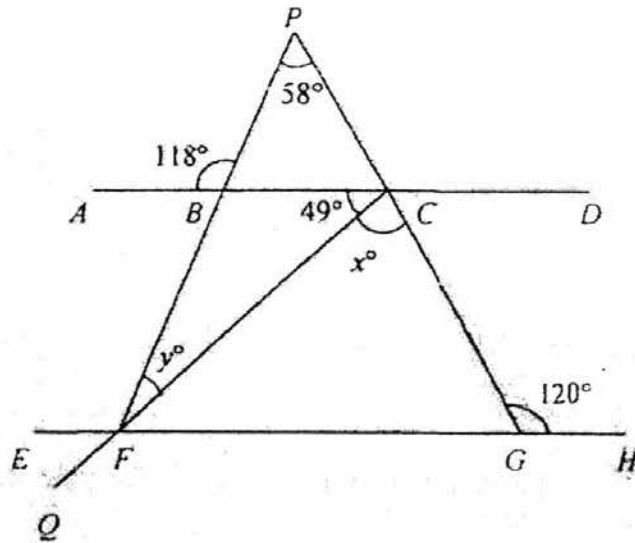
- (c) Find the distance when the force is 70 N.

Answer (c)  $d = \dots\dots\dots$  m [1]

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Class: \_\_\_\_\_

19 In the diagram,  $ABCD$  and  $EFGH$  are straight lines.



(a) Prove that  $AD \parallel EH$ .

Answer (a) .....

.....

.....

.....

.....

..... [2]

(b) Find the values of  $x$  and  $y$ .

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

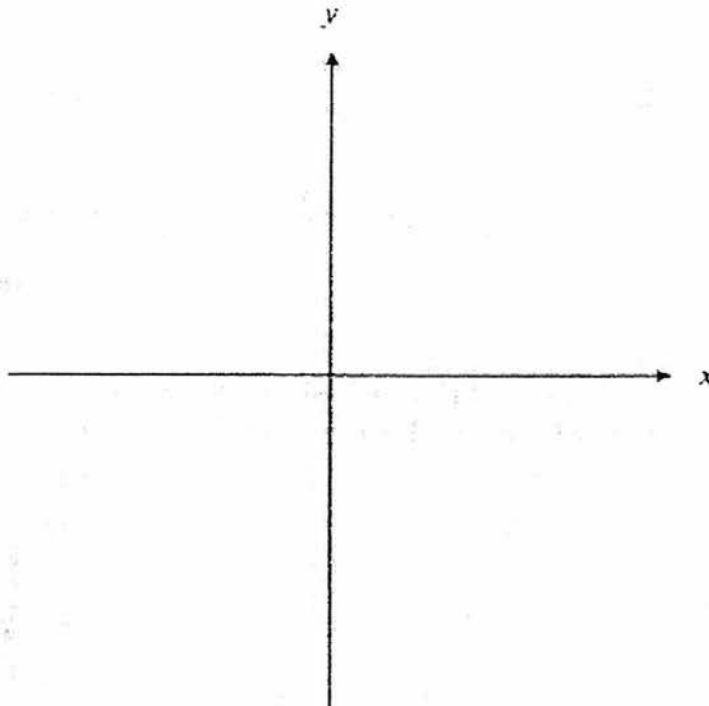
$y =$  ..... [1]

- 20 (a) Express  $x^2 - 4x + 5$  in the form of  $(x - p)^2 + q$ , where  $p$  and  $q$  are constants.

*Answer (a)* [2]

- (b) Hence, or otherwise, sketch the graph of  $y = 4x - x^2 - 5$  below. [2]

*Answer (b)*

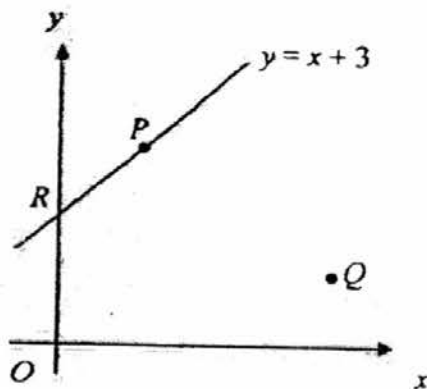


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- 21 In the diagram, the coordinates of the points  $P$  and  $Q$  are  $(a, b)$  and  $(5, 2)$  respectively.

The point  $P$  lies on the line  $y = x + 3$  which cuts the  $y$ -axis at  $R$ .



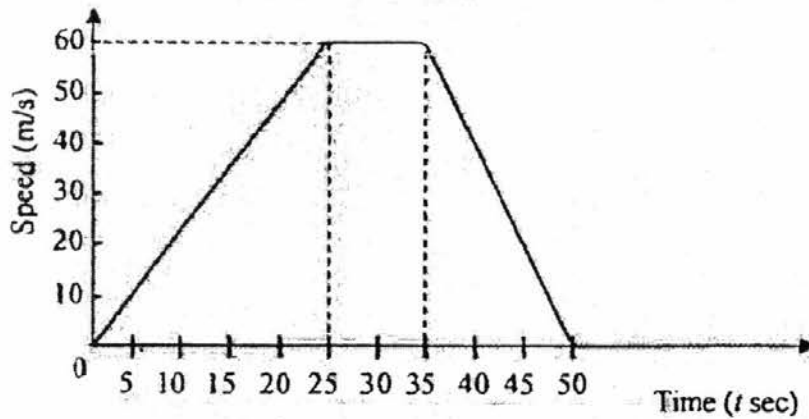
- (a) Find the length of  $QR$ .

Answer (a)  $QR = \dots\dots\dots$  units [1]

- (b) Given that the gradient of  $PQ$  is  $-\frac{1}{2}$ , find the coordinates of  $P$ .

Answer (b)  $P = (\dots\dots\dots)$  [4]

22 The diagram shows the speed-time graph of a car.



Answer (b) [1]

(a) Calculate

(i) the average speed of the car for the first 25 seconds,

Answer (a) (i)..... m/s [2]

(ii) the speed when  $t = 42$ .

Answer (a) (ii)..... m/s [2]

(b) A truck starts from rest and moves with a constant acceleration of  $1.5 \text{ m/s}^2$  for the first 40 seconds and decelerates constantly for the next 10 seconds until it comes to a stop.

Draw on the same graph, the motion of the truck.

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23 In a game, two dice are thrown together.

Die *A* has 2 red faces and 4 white faces.

Die *B* has 4 red faces and 2 blue faces.

(a) Draw a tree diagram to show the possible outcomes and probabilities below. [2]

*Answer (a)*

(b) Find the probability that just one die shows a red face on top.

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

(c) If both dice show red, the player wins a prize.  
 If one die shows red, the player throws the dice again and wins a prize if both dice show red.  
 Calculate the probability that the player wins a prize on either the first or second throw.

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

24 The number of 5m, 10m and 50m ropes in three camping stores are shown in the table below.

Stores	Length of ropes (m)		
	5	10	50
<i>A</i>	1	1	3
<i>B</i>	3	0	1
<i>C</i>	4	3	2

(a) Represent the table above in the form of a matrix *T*.

Answer (a)  $T =$  [1]

(b) Evaluate  $N = T \begin{pmatrix} 5 \\ 10 \\ 50 \end{pmatrix}$  and explain what the elements in *N* represent.

Answer (b)  $N =$

.....  
 ..... [2]

(c) All the stores ordered 200% more ropes for all types of ropes.  
 Using matrix multiplication, find the total number of each type of ropes that all the stores will have altogether after the order.

Answer (c) .....  
 ..... [2]

*End of Paper*

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**4048/1**

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The total number of marks for this paper

FOR EXAMINER'S USE	
Total marks	/80

### Mathematical Formulae

#### Compound interest

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

#### Mensuration

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

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

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

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

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

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

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

#### Trigonometry

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

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

#### Statistics

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

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

Name: \_\_\_\_\_ ( )

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Answer all the questions.

- 1 Estimate the value of  $100 \times 0.45 + \frac{2.9^2 \times 1.74}{\sqrt{0.2498}}$ , giving your answer to 1 significant figure.

[Solution]

$$100 \times 0.45 + \frac{2.9^2 \times 1.74}{\sqrt{0.2498}} \approx 45 + \frac{9 \times 2}{\sqrt{0.25}} \quad \text{M1 for estimation}$$

$$= 45 + \frac{18}{0.5}$$

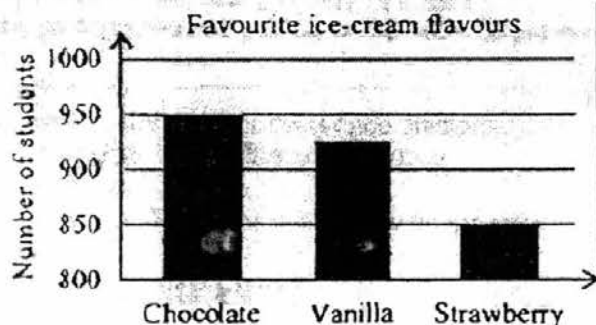
$$= 81$$

$$= 80 \text{ (1sf)} \quad \text{A1}$$

OR  $45 + \frac{9 \times 1.7}{0.5} = 75.6 = 80$

Answer ..... [2]

- 2 The graph below shows the survey results of students in a school on their choice of three ice-cream flavours. Mavis claims that the chocolate flavour is two times more popular than the strawberry flavour ice-cream. Explain why she is wrong and how the graph should be presented.



[Solution]  
950 is not  $3 \times 850 = 2550$  which is two times more than 850. B1

The vertical scale should start from zero B1

Answer: .....

.....

..... [2]

- 3 When  $(a - b)$  is subtracted from  $(3a - 4b)$  the result is  $4b$ . Find the ratio of  $a : b$ .

[Solution]

$$3a - 4b - (a - b) = 4b$$

$$3a - 4b - a + b = 4b$$

$$2a = 7b$$

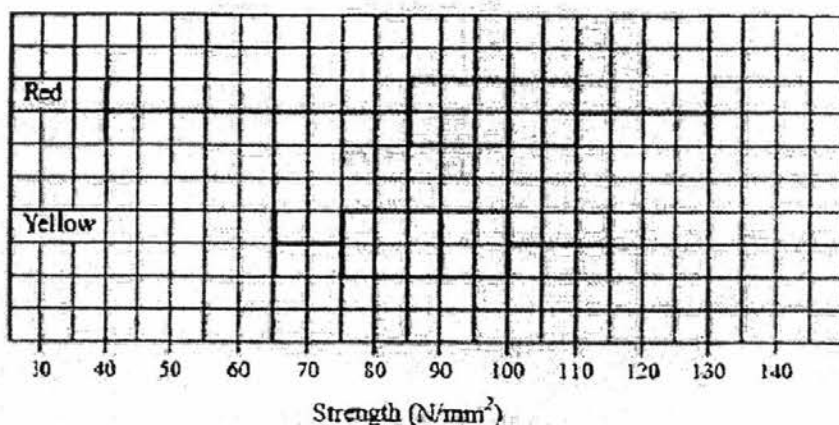
$$a : b = 7 : 2$$

M1 for formulation

A1

Answer  $a : b =$  ..... [2]

- 4 A builder can choose between two types of bricks that are red or yellow. The box and whisker plots below illustrate the results of tests on the strength of the bricks in  $N/mm^2$ .



Give a reason why the builder might prefer to use the

- (a) the red bricks,

Answer

- (a) ..... [Solution]  
 (a) The median strength of the red bricks is higher than the median of the yellow bricks B1 [1]

- (b) the yellow bricks.

- Answer [Solution]  
 (b) The median strength of the yellow brick is  $10N/m^2$  lower but the strength is more consistent as the range is  $40N/m^2$  less than the range of red bricks (90)  
 OR : The median strength of the yellow brick is  $10N/m^2$  lower but the minimum strength is  $25 N/m^2$  higher than that of the red bricks B1 ]

- 5 Donald changed 10000 USD to Japanese Yen in Jan 2016 at a rate of 1 USD = 118.94412 ¥. In March 2016, he changed the yen back to USD at a rate of 1 USD = 111.74412 ¥.

What is the increase / decrease in the amount of USD that he received?  
 Give your answer correct to 2 decimal places.

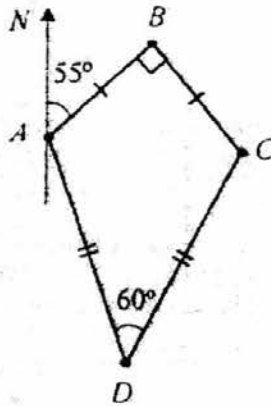
- [Solution]  
 $10000 \times 118.94412 = 1189441.2 \text{ ¥}$  M1 convert USD to ¥  
 $\frac{1189441.2}{111.74412} = \text{USD } 10644.32919$  M1 convert ¥ to USD  
 Increase =  $10644.32919 - 10000 = \text{USD } 644.33$  A1

Answer USD ..... [3]

Name: \_\_\_\_\_ ( )

Class: \_\_\_\_\_

- 6 The diagram shows four points  $A$ ,  $B$ ,  $C$ , and  $D$  on a field.



Given that  $\angle B = 90^\circ$ ,  $\angle D = 60^\circ$  and  $B$  is on a bearing of  $055^\circ$  from  $A$ ,

- (a) find the bearing of  $D$  from  $A$ .

[Solution]

$$\angle BAD = \frac{360 - 90 - 60}{2} = 105^\circ \text{ (} \angle \text{ sum of trapezium) M1}$$

$$\text{Bearing} = 105 + 55 = 160^\circ$$

A1

Answer (a) .....  $^\circ$  [2]

- (b) find the ratio of  $\frac{AB}{AD}$ .

[Solution] In  $\triangle ABD$ ,  $\frac{AB}{\sin ADB} = \frac{AD}{\sin ABD}$

$$\frac{AB}{AD} = \frac{\sin ADB}{\sin ABD} = \frac{\sin 30}{\sin 45} = 0.707 \text{ (3 sf)}$$

B1

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

- 7 Two tankers contain 825 litres and 675 litres of kerosene oil respectively.

- (a) Find the maximum capacity of a container which can measure the kerosene oil of both the tankers when used an exact number of times.

[Solution]

$$825 = 3 \times 5 \times 5 \times 11$$

$$675 = 3 \times 3 \times 3 \times 5 \times 5$$

$$\text{Maximum capacity} = 3 \times 5 \times 5 = 75 \text{ litres}$$

M1 for prime factorisation

A1

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

- (b) Find the number of refills needed to fill the second tanker.

[Solution]  $\frac{675}{75} = 9$  refills

B1

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

- 8 Express as a single fraction  $\frac{3x}{2y^3} \div \frac{x^{-2}}{y^2} - \frac{x^3}{5y}$ , giving your answer in positive indices.

[Solution]

$$\frac{3x}{2y^3} \div \frac{x^{-2}}{y^2} - \frac{x^3}{5y} = \frac{3x}{2y^3} \times \frac{y^2 x^2}{1} - \frac{x^3}{5y}$$

M1 for negative to positive index

$$= \frac{3x^3}{2y} - \frac{x^3}{5y}$$

$$= \frac{15x^3 - 2x^3}{10y}$$

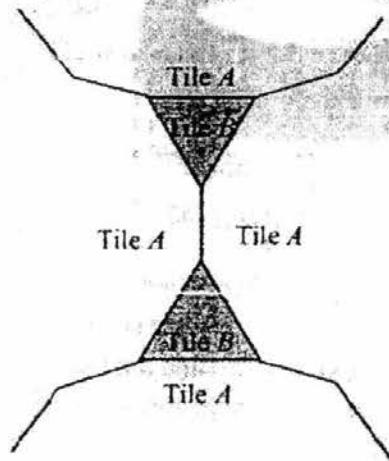
M1 for single fraction

$$= \frac{13x^3}{10y}$$

A1

Answer ..... [3]

- 9 The diagram shows part of a pattern made from tiles. The pattern is made from type *A* tiles and type *B* tiles, both of which are regular polygons.



Find the number of sides that tile *A* has.

[Solution]

$$\text{Interior angle of } A = \frac{360-300}{2} = 150$$

M1 for int angle of *A*

$$\text{Ext angle of } A = 180 - 150 = 30 \text{ or } \frac{(n-2)180}{n} = 150$$

M1 for ext angle or equating int angle

$$\text{Number of sides} = \frac{360}{30} = 12$$

A1

Answer ..... sides [3]

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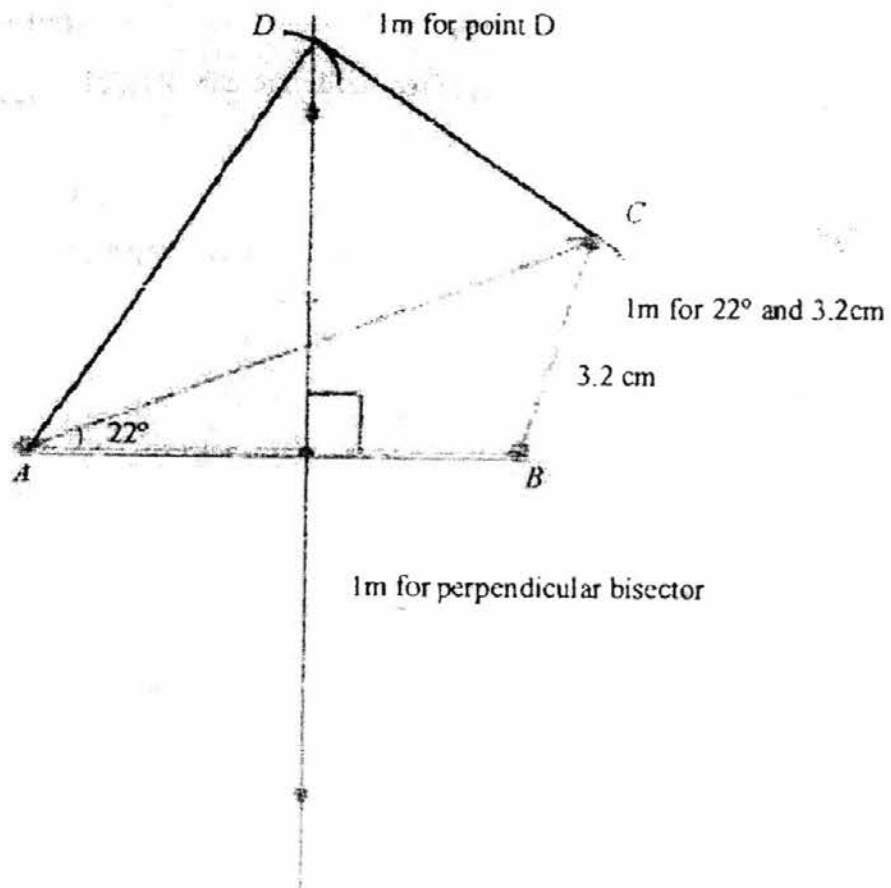
10 In quadrilateral  $ABCD$ ,  $BC = 3.2$  cm and  $\angle BAC = 22^\circ$ .

The point  $D$  is such that  $AD = AB$  and  $D$  lies on the perpendicular bisector of  $AB$ .

Given that  $\angle B$  is obtuse, complete the construction of quadrilateral  $ABCD$  in the space below.

$AB$  has already been drawn.

[3]



- 11 (a) Find the volume of a cylinder with radius  $x$  mm and height 2 cm in  $\text{mm}^3$ .  
Give your answer in terms of  $\pi$ .

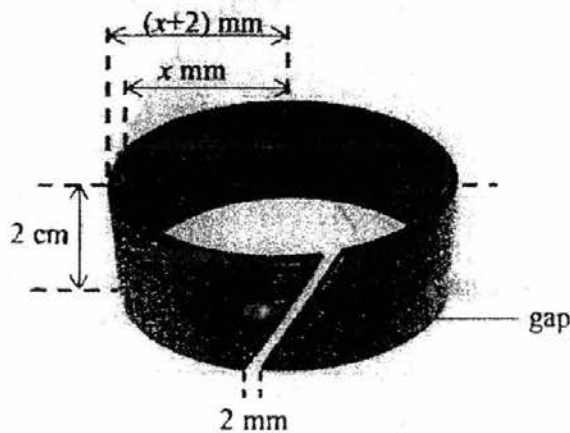
[Solution]

$$\pi(x)^2(20) = 20\pi x^2 \text{ mm}^3$$

B1

Answer (a) .....  $\text{mm}^3$  [1]

- (b) The diagram shows a metal ring cylinder used in an engine with a gap for expansion. The radii of the inner and the outer cylinders are  $x$  mm and  $(x+2)$  mm respectively. The height of the cylinder is 2 cm. The gap is in the shape of a parallelogram of base 2 mm.



Express in the simplest form, the volume of the ring cylinder in  $\text{mm}^3$ , in terms of  $x$  and  $\pi$ .

[Solution]

$$\begin{aligned} \text{Vol} &= \pi(x+2)^2(20) - \pi(x)^2(20) - 2(20)(2) && \text{M1 for formulating} \\ &= 20\pi[(x+2)^2 - (x)^2] - 80 \\ &= 20\pi[x^2 + 4x + 4 - x^2] - 80 \\ &= 80(\pi x + \pi - 1) \text{ mm}^3 && \text{A1} \end{aligned}$$

Answer (b) .....  $\text{mm}^3$  [2]

Name: \_\_\_\_\_ ( )

Class: \_\_\_\_\_

- 12 Mini invested \$50 000 in a time deposit which pays  $x\%$  compound interest per annum. She received \$ 52531.25 in total after two years. Find the value of  $x$ .

[Solution]

$$50000\left(1 + \frac{x}{100}\right)^2 = 52531.25$$

M1 for applying formula

$$\left(1 + \frac{x}{100}\right)^2 = \sqrt{\frac{52531.25}{50000}}$$

M1 for evaluating  $\left(1 + \frac{x}{100}\right)^2$

$$1 + \frac{x}{100} = 1.025$$

$$x = 2.5$$

A1

Answer  $x =$  ..... [3]

- 13 The scale of a map is 1 : 250000.

- (a) Calculate the distance, in cm, on the map for an actual distance of 62 km.

[Solution]

1cm rep 2.5 km

$$\text{Dist on map} = \frac{62}{2.5} = 24.8 \text{ cm}$$

B1

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

- (b) Calculate, in  $\text{km}^2$ , the area of a park represented by  $28 \text{ cm}^2$  on the map.

[Solution]

$$1\text{cm}^2 : 6.25\text{km}^2$$

M1 for area scale

$$28\text{cm}^2 \text{ reps } 6.25 \times 28 = 175\text{km}^2$$

A1

Answer (b) .....  $\text{km}^2$  [2]

14 It is given that

$$\mathcal{E} = \{x : x \text{ is an integer and } 0 < x \leq 10\},$$

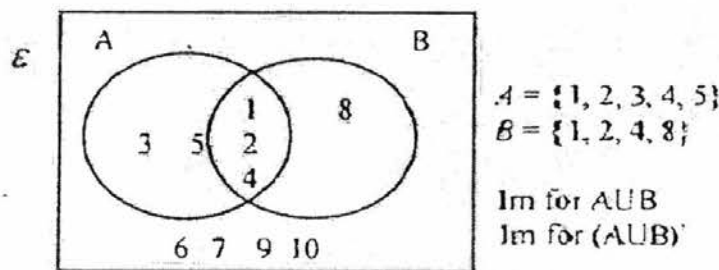
$$A = \{x : x^2 \leq 130\},$$

$$B = \{x : x \text{ is a factor of } 16\}.$$

- (a) Draw a Venn diagram to show the relationship of  $A$  and  $B$ , marking the elements in each region clearly. [2]

Answer (a)

[Solution]



- (b) List the elements of  $(A \cup B)$ .

[Solution] {6, 7, 9, 10} B1

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

15 The cash price of a set of sofa is \$4000.

Bruno bought the set on hire purchase with a deposit of 10% of the cash price, followed by 18 monthly instalments of \$228.80.

- (a) How much did Bruno pay in total for the sofa?

[Solution]

$$\text{Deposit} = \frac{1}{10} \times 4000 = \$400 \quad \text{M1 for 10\% of } \$4000$$

$$\begin{aligned} \text{Total instalment} &= 18 \times 228.80 \\ &= \$4118.40 \end{aligned}$$

$$\begin{aligned} \text{Total amount} &= 400 + 4118.40 \\ &= \$4518.40 \quad \text{A1} \end{aligned}$$

Answer (a) \$..... [2]

- (b) Calculate the extra cost of buying the sofa on hire purchase.

[Solution]  $4518.40 - 4000 = 518.40$  B1

Answer (b) \$..... [1]

Name: \_\_\_\_\_ ( )

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- 16 The volumes of two similar silver cones are  $270 \text{ cm}^3$  and  $640 \text{ cm}^3$  respectively. The height of the smaller cone is 30 cm.

- (a) The smaller cone costs \$2295. Assuming that the prices are according to the volumes, find the price difference between the larger and the smaller cone.

[Solution]

$$\text{Price of the larger cone} = \frac{640}{270} \times 2295 = \$5440$$

$$\text{Difference} = 5440 - 2295 = \$3145$$

B1

Answer (a) \$ ..... [1]

- (b) The radius of the base of the smaller cone is  $k$  cm. Find in terms of  $k$ , the radius of the base of the larger cone.

[Solution]

$$\frac{270}{640} = \left(\frac{k}{r}\right)^3$$

M1 apply ratio

$$\frac{3}{4} = \frac{k}{r}$$

$$\text{Radius of the larger cone} = \frac{4k}{3} \text{ cm.}$$

A1

Answer (b) ..... cm [2]

- 17 Justin cycled at 14.4 km/h and passed by six equally spaced lamp posts in 1 minute.

- (a) Find the distance between adjacent lamp posts, in m.

[Solution]

$$14.4 \text{ km/h} = 14.4 \times \frac{1000}{60} = 240 \text{ m/min}$$

M1 unit conversion

$$\text{Distance between 2 lamp posts} = \frac{240}{5} = 48 \text{ m}$$

A1

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

- (b) Find the total time taken if he passed by 18 lamp posts altogether. Give your answer in minutes and seconds.

[Solution]

$$\text{Distance between 18 lamp posts} = 17 \times 48 = 816 \text{ s}$$

M1

$$\text{Time taken} = \frac{816}{240} = 3.4 \text{ min} = 3 \text{ min } 24 \text{ s}$$

A1

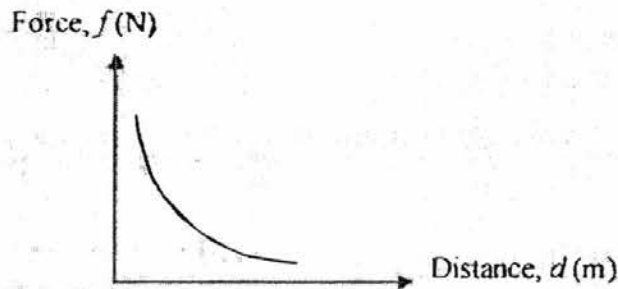
Answer (b) ..... s [2]

18 The electrostatic force between two selected objects,  $f$  Newton, is inversely proportional to the square of the distance between the two objects,  $d$  m.

(a) Sketch a graph to illustrate the relationship between the force and distance between the two objects.

Answer (a)

[Solution]



[1]

(b) The force between the objects is 17.5N when the distance apart is 0.2 m. Express  $f$  in terms of  $d$ .

[Solution]

$$17.5 = \frac{k}{0.2^2}$$

$$k = 0.7$$

$$f = \frac{0.7}{d^2} = \frac{7}{10d^2}$$

M1 for equation and substitution

A1

Answer (b)  $f = \dots\dots\dots$  [2]

(c) Find the distance when the force is 70 N.

[Solution]

$$70 = \frac{0.7}{d^2}$$

$$d = 0.1$$

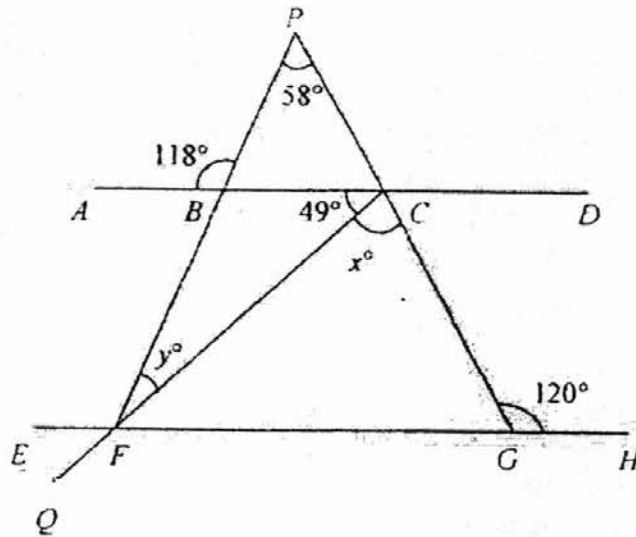
B1

Answer (c)  $d = \dots\dots\dots$  m [1]

Name: \_\_\_\_\_ ( )

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19 In the diagram,  $ABCD$  and  $EFGH$  are straight lines.



(a) Prove that  $AD \parallel EH$ .

Answer (a) .....

(a)  $\angle ACP = 118 - 58$  (ext angle of tri)  
 $= 60^\circ$  B1  
 $\angle ACG = 180 - 60$  (adj angles on a straight line)  
 $= 120^\circ$   
 Hence,  $\angle ACG = \angle AGH$  B1  
 Hence,  $AD \parallel EH$  (alternate angles)

[2]

(b) Find the values of  $x$  and  $y$ .

$\angle ACG = x + 49 = 120$  (alt.  $\angle$ s,  $AD \parallel EH$ )  
 $x = 71$  B1  
 $\angle FBC = 118^\circ$  (vert. opp.  $\angle$ s)  
 $y = 180 - 118 - 49$  ( $\angle$  sum of  $\triangle FBC$ )  
 $= 13$  B1

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

$y =$  ..... [1]

- 20 (a) Express  $x^2 - 4x + 5$  in the form of  $(x - p)^2 + q$ , where  $p$  and  $q$  are constants.

[Solution]

(a)  $x^2 - 4x + 5 = x^2 - 4x + (-2)^2 - (-2)^2 + 5$  M1    OR  $x^2 - 4x + 5 = (x - 2)^2 - 2^2 + 5$   
 $= (x - 2)^2 + 1$  A1

Answer (a) [2]

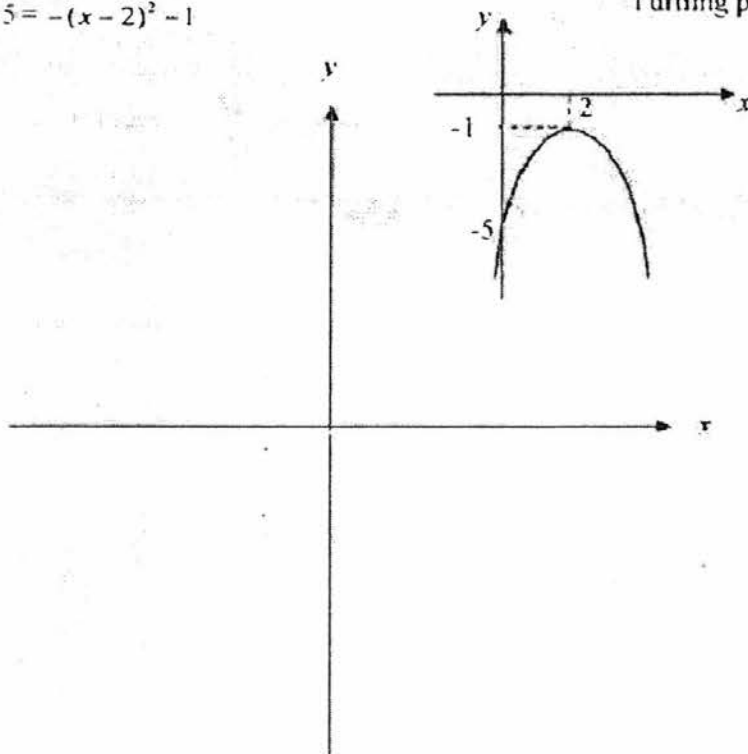
- (b) Hence, or otherwise, sketch the graph of  $y = 4x - x^2 - 5$  below. [2]

Answer (b)

[Solution]

Shape - 1m  
 Turning pt & y-int - 1m

$4x - x^2 - 5 = -(x - 2)^2 - 1$

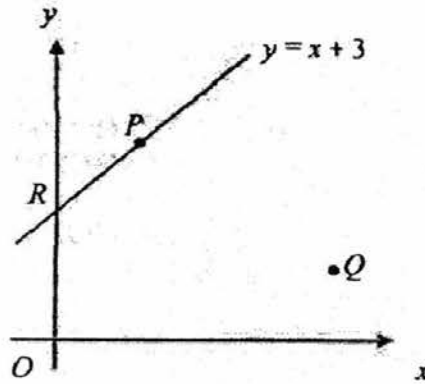


Name: \_\_\_\_\_ ( )

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21 In the diagram, the coordinates of the points  $P$  and  $Q$  are  $(a, b)$  and  $(5, 2)$  respectively.

The point  $P$  lies on the line  $y = x + 3$  which cuts the  $y$ -axis at  $R$ .



(a) Find the length of  $QR$ .

[Solution]  $R = (0, 3), Q(5, 2)$   
 $\sqrt{(5-0)^2 + (2-3)^2} = 5.10$  (3 sf) B1

Answer (a)  $QR = \dots\dots\dots$  units [1]

(b) Given that the gradient of  $PQ$  is  $-\frac{1}{2}$ , find the coordinates of  $P$ .

[Solution]

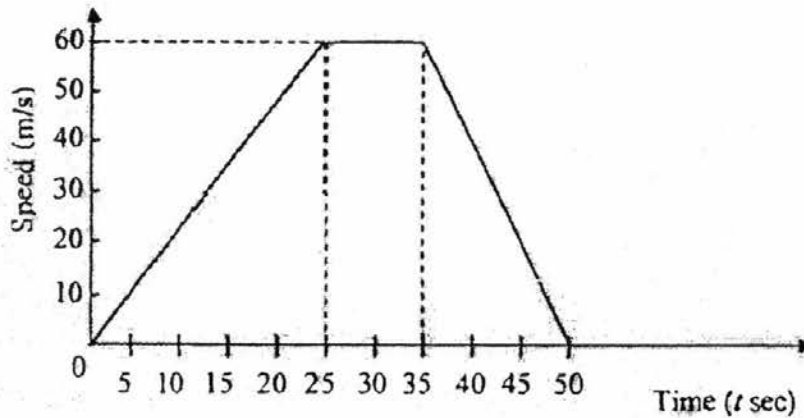
Eqn of  $PQ$ :  $\frac{y-2}{x-5} = \frac{1}{2}$  M1 for finding eqn  
 $x + 2y = 9 \dots\dots(1)$

$P$  lies on  $y = x + 3$ ;  $x + 2(x + 3) = 9$  B1  
 Solving,  $a = x = 1, b = y = 4$  A2 (1m for each),  $\sqrt$  eqn (1)

$P = (1, 4)$

Answer (b)  $P = ( \dots, \dots )$  [4]

22 The diagram shows the speed-time graph of a car.



Answer (b) [1]

(a) Calculate

(i) the average speed of the car for the first 25 seconds,

[Solution]

Dist. travelled =  $\frac{1}{2} \times 25 \times 60 = 750$  m      M1 find distance using area under graph

Ave speed =  $\frac{750}{25} = 30$  m/s      A1

Answer (a) (i) ..... m/s [2]

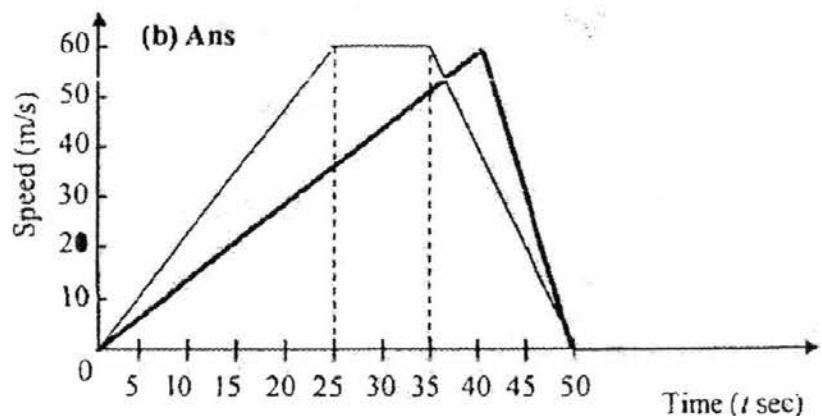
(ii) the speed when  $t = 42$ .

[Solution]

Using gradient or acc'n

$\frac{60 \text{ m/s}}{15 \text{ s}}$       M1

$s = \frac{60 \times 8}{15} = 32$  m/s      A1



Answer (a)(ii) ..... m/s [2]

(b) A truck starts from rest and moves with a constant acceleration of  $1.5 \text{ m/s}^2$  for the first 40 seconds and decelerates constantly for the next 10 seconds until it comes to a stop. Draw on the same graph, the motion of the truck.

Name: \_\_\_\_\_ ( )

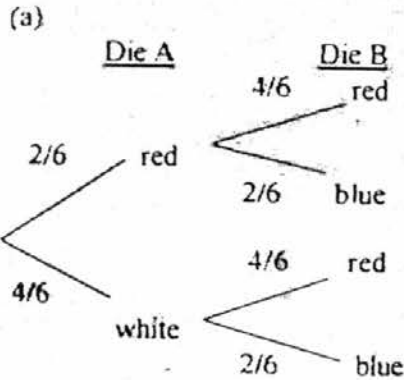
Class: \_\_\_\_\_

23 In a game, two dice are thrown together.

Die A has 2 red faces and 4 white faces.

Die B has 4 red faces and 2 blue faces.

(a) Draw a tree diagram to show the possible outcomes and probabilities below. [2]



1m for die A and probabilities  
1m for die B and probabilities

(b) Find the probability that just one die shows a red face on top.

[Solution]

$$\frac{2}{6} \times \frac{2}{6} + \frac{4}{6} \times \frac{4}{6} = \frac{5}{9}$$

B1

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

(c) If both dice show red, the player wins a prize.

If one die shows red, the player throws the dice again and wins a prize if both dice show red. Calculate the probability that the player wins a prize on either the first or second throw.

[Solution]

$$\frac{2}{6} \times \frac{4}{6} + \frac{5}{9} \times \frac{2}{6} \times \frac{4}{6}$$

$$= \frac{28}{81}$$

M1

A1

Answer (c) ..... [2]

24 The number of 5m, 10m and 50m ropes in three camping stores are shown in the table below.

Stores	Length of ropes (m)		
	5	10	50
A	1	1	3
B	3	0	1
C	4	3	2

(a) Represent the table above in the form of a matrix  $T$ .

[Solution]  $\begin{pmatrix} 1 & 1 & 3 \\ 3 & 0 & 1 \\ 4 & 3 & 2 \end{pmatrix}$  B1 Answer (a)  $T =$  [1]

(b) Evaluate  $N = T \begin{pmatrix} 5 \\ 10 \\ 50 \end{pmatrix}$  and explain what the elements in  $N$  represent.

[Solution]  $N = T \begin{pmatrix} 5 \\ 10 \\ 50 \end{pmatrix} = \begin{pmatrix} 1 & 1 & 3 \\ 3 & 0 & 1 \\ 4 & 3 & 2 \end{pmatrix} \begin{pmatrix} 5 \\ 10 \\ 50 \end{pmatrix} = \begin{pmatrix} 165 \\ 65 \\ 150 \end{pmatrix}$  B1

The elements rep. the total length of all the ropes that store A, B and C has respectively.

Answer (b)  $N =$

[2]

(c) All the stores ordered 200% more ropes for all types of ropes.

Using matrix multiplication, find the total number of each type of ropes that all the stores will have altogether after the order.

[Solution]  $(3 \ 3 \ 3)T = (3 \ 3 \ 3) \begin{pmatrix} 1 & 1 & 3 \\ 3 & 0 & 1 \\ 4 & 3 & 2 \end{pmatrix}$  M1

$= (24 \ 12 \ 18)$

The total number of the 5m, 10m and 50m ropes of all stores will be 24, 12 and 18 ropes respectively. A1

Answer (c) .....

[2]

End of Paper

Name \_\_\_\_\_ ( . )

Class: \_\_\_\_\_



**CHIJ KATONG CONVENT  
MID-YEAR EXAMINATION 2016  
SECONDARY 4 EXPRESS**

**MATHEMATICS  
PAPER 2**

**4048/1**

Duration: 2 hours 30 minutes

Classes: 403, 404, 405, 406

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**READ THESE INSTRUCTIONS FIRST**

Write your name, class and registration 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/tape.

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.

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  $\pi$ , use either your calculator value or 3.142, unless the question requires the answer in terms of  $\pi$ .

At the end of the examination, fasten all your work securely together. Hand in Section A and Section B separately.

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**

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

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

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

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

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

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

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

**Trigonometry**

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

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

**Statistics**

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

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

## Section A

Answer **all** the questions.

- 1 (a) Solve the inequality  $\frac{1-2y}{5} \geq \frac{-y+1}{3}$  [2]
- (b) It is given that  $v = \sqrt{u^2 + 2as}$
- (i) Find  $v$  when  $u = 5$ ,  $a = 9.8$  and  $s = 10$ . [1]
- (ii) Express  $s$  in terms of  $v$ ,  $u$  and  $a$ . [2]
- (c) Simplify  $\frac{4-9x^2}{(3x-1)(3x-2)}$ . [2]
- (d) Solve the equation  $\frac{1}{x-1} - \frac{2}{x+2} = \frac{1}{2}$  where  $x \neq 1$  and  $x \neq 4$ . [3]

- 2 The table shows the water sales by the Public Utilities Board, in million cubic metres (1 000 000 m<sup>3</sup>), in Singapore in 2014.




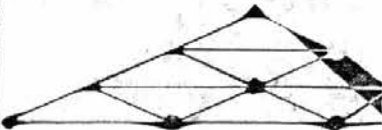
NEWater	Industrial Water	Total
117	27.6	650.9

- (a) Express the total annual water sale into cubic metres (m<sup>3</sup>) in standard form. Give your answer correct to 3 significant figures. [2]
- (b) Calculate the percentage of the total water sales that was in the form of NEWater. [2]
- (c) The population in Singapore in 2014 was 5.469 million.  
Calculate the average amount of water consumed per person in 2014. Give your answer to the nearest cubic metre (m<sup>3</sup>). [2]
- (d) Given that the percentage increase in NEWater sales from 2008 to 2014 is 77.3%, find the amount of NEWater sold in 2008. [2]
- (e) The cost of NEWater and Industrial Water is \$1.22 per m<sup>3</sup> and \$0.65 per m<sup>3</sup> respectively.  
Calculate the total revenue collected by the Public Utilities Board through the sales of NEWater and Industrial Water in 2014. Give your answer in standard form correct to 3 significant figures. [2]

**Section B**

Answer **all** the questions in this section on a separate piece of writing paper.

3 Study the number pattern in the table below and answer the questions that follow.

Figure, $n$	Diagram	Number of small isosceles triangles, $I$	Number of dots, $D$
1		$I_1 = 0$	$D_1 = 1$
2		$I_2 = 1$	$D_2 = 3$
3		$I_3 = 4$	$D_3 = 6$
4		$I_4 = 9$	$D_4 = 10$
5		$I_5 = a$	$D_5 = b$
...	...	...	...
$n$		$I_n$	$D_n$

- (a) Find the values of  $a$  and  $b$ . [2]
- (b) Express  $I_n$  in terms of  $n$ . [1]
- (c) Express  $D_n$  in terms of  $n$ . [1]
- (d) How many dots will there be in the 14<sup>th</sup> figure? [1]

4 Answer the whole question on a sheet of graph paper.

The variables  $x$  and  $y$  are connected by the equation

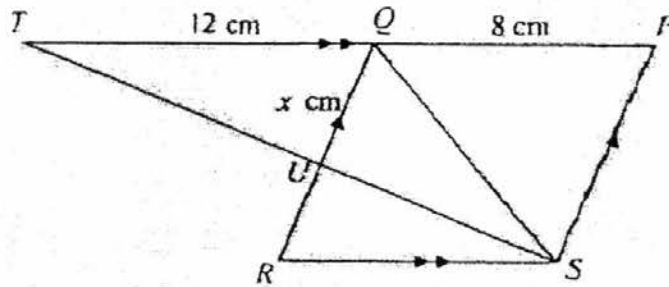
$$y = x^3 - 2x^2 - 5x.$$

Some corresponding values of  $x$  and  $y$  are given in the table below.

$x$	-2	-1	-0.5	0	1	2	3	3.5	4
$y$	$p$	2	1.9	0	-6	-10	-6	0.9	12

- (a) Find the value of  $p$ . [1]
- (b) Using a scale of 2 cm to represent 1 unit, draw a horizontal  $x$ -axis for  $-2 \leq x \leq 5$ .  
Using a scale of 2 cm to represent 5 units, draw a vertical  $y$ -axis for  $-20 \leq y \leq 20$ .  
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 number of solution(s) to  $x^3 - 2x^2 - 5x = -3$ . [2]
- (d) By drawing a tangent, find the gradient of the curve at (3.5, 0.9). [2]
- (e) (i) On the same axes, draw the line  $y = -5x - 5$ . [2]
- (ii) Write down the coordinates of the point where the line intersects the curve. [1]

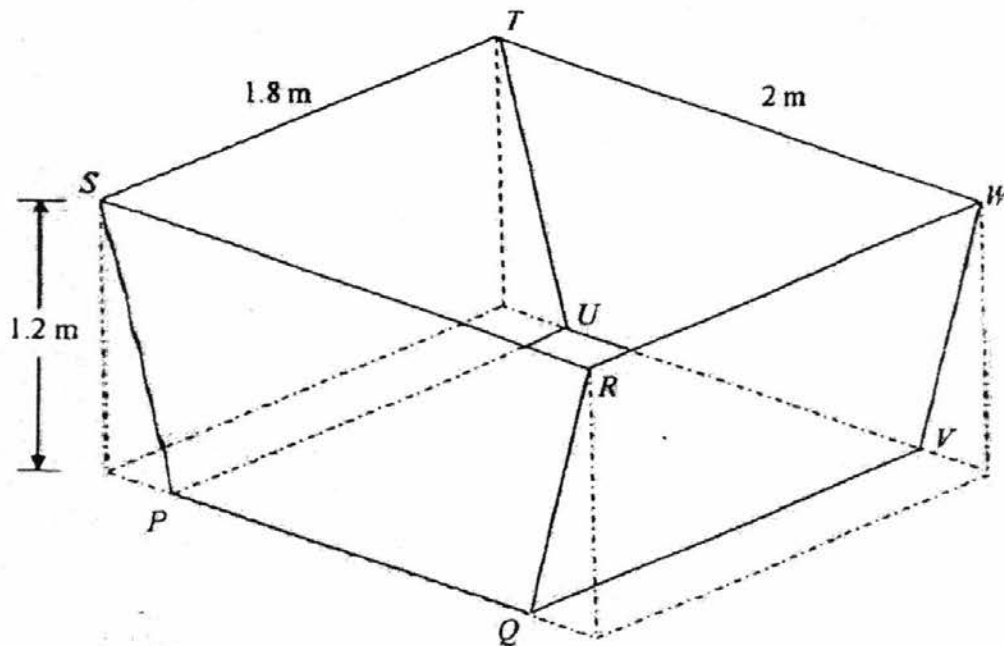
5



The diagram shows a rhombus  $PQRS$  with  $PQ$  produced to  $T$ .  
 $U$  is the intersection of  $ST$  and  $QR$ .  
 $QP = 8\text{ cm}$  and  $QU = x\text{ cm}$ .

- (a) Name a pair of congruent triangles. [1]
- (b) (i) Show that triangles  $UQT$  and  $URS$  are similar. [2]
- (ii) Find the value of  $x$ . [2]
- (c) Given that the area of  $\Delta URS = 11.09\text{ cm}^2$ , find the area of
  - (i) triangle  $TUQ$ , [2]
  - (ii) trapezium  $UQPS$ . [3]

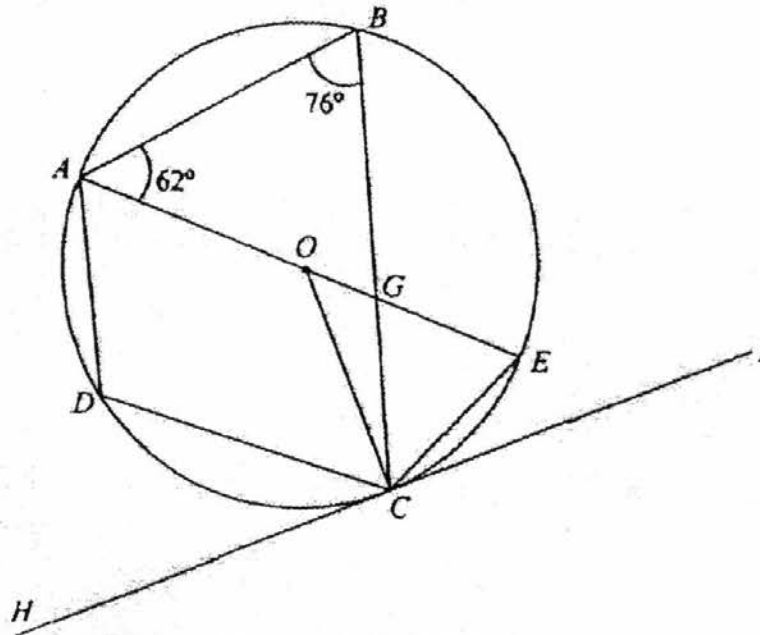
6



The diagram shows an open top container made of 5 metal sheets. The base,  $PQYU$  and sides,  $QRWV$  and  $PSTU$  are rectangular sheets. The other vertical sides,  $PQRS$  and  $UYWT$  are trapeziums and  $\tan \angle RSP = \tan \angle SRQ = 4.8$ .  $ST = 1.8$  m,  $TW = 2$  m, and the height of the container is 1.2 m.

- (a) Find the length  $PQ$ . [2]
- (b) Calculate the cross sectional area  $PQRS$ . [2]
- (c) Find the total surface area of the exterior of the open top container. [4]
- (d) The container is completely filled with paint. Given that  $1 \text{ m}^3$  of paint has a mass of 825 kg, determine the mass of the paint in the container. [3]

7 (a)

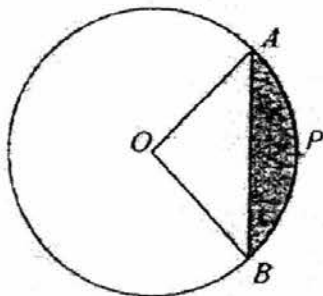


The diagram shows a circle  $ABECD$ , centre  $O$ .  
 $HI$  is a tangent to the circle at  $C$ .  
 $BC$  intersects  $AE$  at  $G$ .  
 Angle  $ABC = 76^\circ$  and angle  $OAB = 62^\circ$ .

Find, giving reasons for each answer,

- (i) angle  $BCE$ , [1]
- (ii) angle  $ADC$ , [1]
- (iii) angle  $COE$ , [2]
- (iv) angle  $BCO$ , [2]
- (v) angle  $GCI$ . [1]

(b)



The diagram shows the cross section of a piece of lens, segment  $APB$ . It is a segment of a circle with centre  $O$  and radius  $7$  mm.

Given that angle  $OAB$  is  $\frac{3}{14}\pi$  radians, calculate

- (i) angle  $AOB$  in radians. [1]
- (ii) the area of the cross section of the piece of lens,  $APB$ . [2]

8 Daniel is planning an expedition.

He investigates three possible routes: route *A*, route *B* and route *C*.

- (a) If Daniel travels on route *A*, which is 300 km long, he expects to cover  $x$  km per day.

If Daniel travels on route *B*, which is the same distance as route *A*, he would only expect to cover  $(x - 5)$  km per day.

And if Daniel travels on route *C*, which is 100 km longer than route *A*, he would expect to cover  $(x + 5)$  km per day.

Write down an expression, in terms of  $x$ , for the number of days that he expects to take on

- (i) route *A*, [1]  
(ii) route *B*, [1]  
(iii) route *C*, [1]

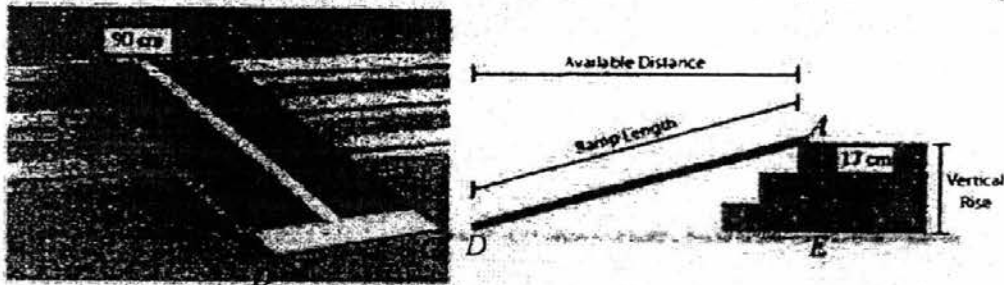
- (b) Daniel estimates that route *C* will take 20 days less than route *B*.

Write down an equation in  $x$  to represent this information, and show that it reduces to  $x^2 + 5x - 450 = 0$  [3]

- (c) Solve the equation  $x^2 + 5x - 450 = 0$ , giving your solutions correct to 2 decimal places. [2]

- (d) Calculate Daniel's average speed, in km/h for the whole journey, if he expects to take route *A* to reach his destination and route *C* on his return journey. [3]

9



There is a vertical three step staircase on horizontal ground at the entrance to a building.

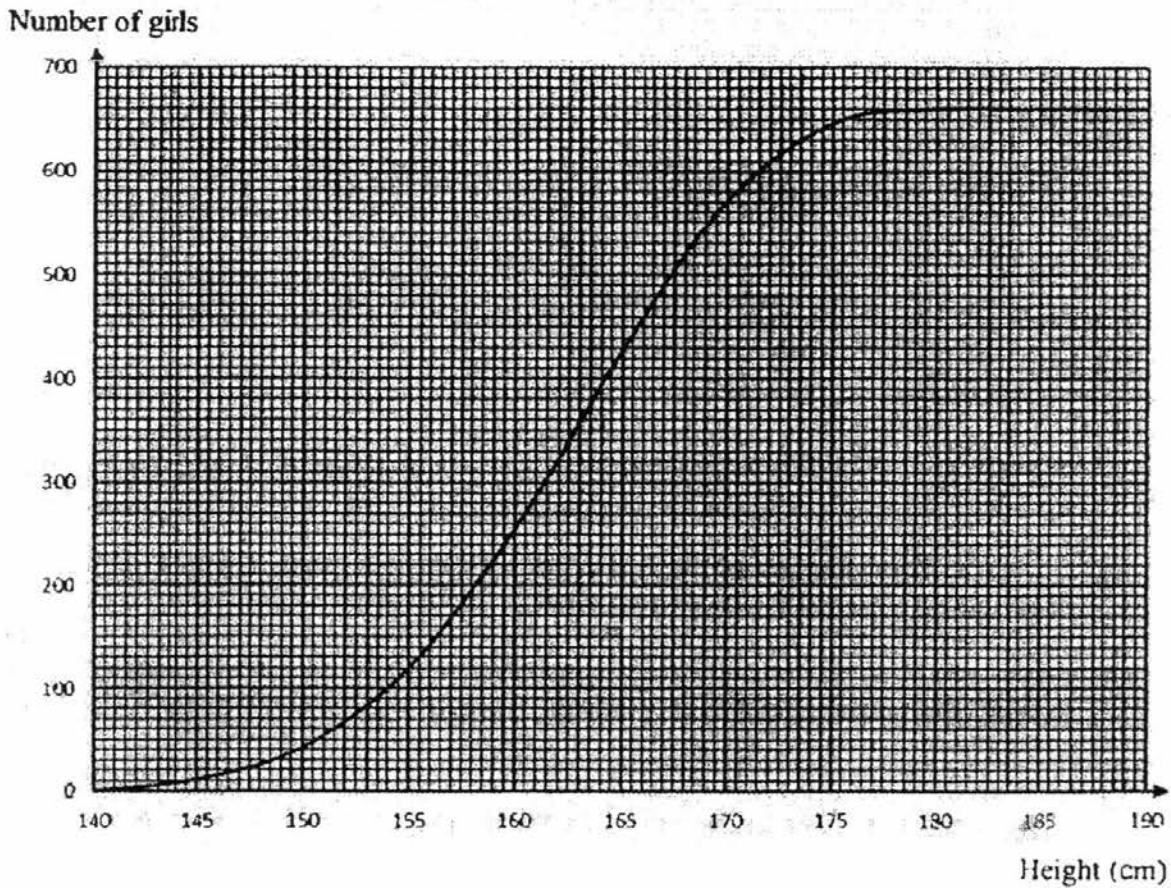
The height of each step is 17 cm.

A rectangular ramp  $ABCD$  in the shape of a flat plane of negligible thickness is to be installed.

The gradient of the ramp is such that the ratio of vertical rise : available distance is 1:13.

- (a) Calculate the angle of depression of point  $D$  of the ramp from point  $A$ , the top of the staircase in degrees. [2]
- (b) Calculate the length of the ramp  $AD$ , in metres. [3]
- (c) Given that the width of the ramp  $AB$  is 90 cm, find
  - (i) the length  $BE$ , in metres, and [2]
  - (ii)  $\angle BCE$  in radians. [4]

- 10 (a) The heights of 660 girls are distributed as shown in the cumulative frequency graph below.



Use the curve to estimate the

- (i) the median of the distribution, [1]
- (ii) the value of the height above which the heights of the tallest 20% of the girls lie, [1]
- (iii) the number of girls whose height,  $x$  cm, fall within the range of  $155 \text{ cm} < x \leq 160 \text{ cm}$ . [2]

- 10 (b) The table below summarizes the heights of 660 boys.

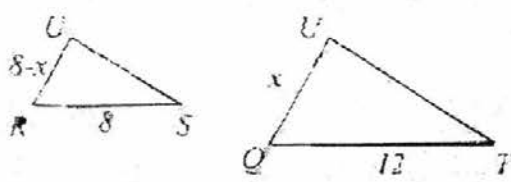
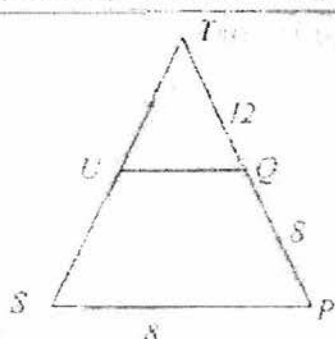
Height ( $x$ cm)	Frequency
$140 < x \leq 145$	0
$145 < x \leq 150$	2
$150 < x \leq 155$	20
$155 < x \leq 160$	47
$160 < x \leq 165$	67
$165 < x \leq 170$	182
$170 < x \leq 175$	210
$175 < x \leq 180$	80
$180 < x \leq 185$	40
$185 < x \leq 190$	12

- (i) What percentage of the boys are taller than 175 cm? [1]
- Calculate an estimate of
- (ii) the mean height of the boys, [2]
- (iii) the standard deviation of the height of the boys. [2]
- (c) The mean height of the 660 girls in (a) is 161.8 cm and the standard deviation is 7.44 cm.
- Make two comparisons between the heights of the boys in (b) and the girls in (a). [2]

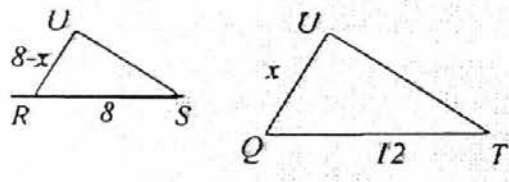
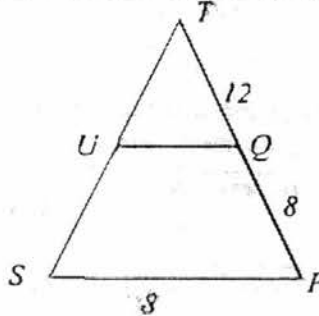
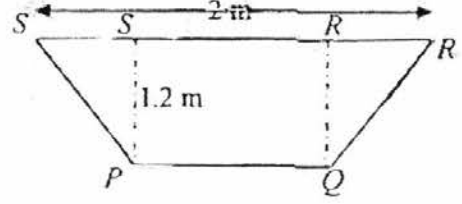
*End of Paper*

Answer Key		
1a	$\frac{1-2y}{5} \geq \frac{-y+1}{3}$ $3(1-2y) \geq 5(-y+1)$ $3-6y \geq -5y+5$ $-2 \geq y,$ $y \leq -2$	<p>1 mark</p> <p>1 mark</p>
1bi	$v = \sqrt{u^2 + 2as} = \sqrt{5^2 + 2(9.8)(10)}$ $= \sqrt{221} = 14.866 \approx 14.9 \text{ (3 s.f.)}$	1 mark
1bii	$v = \sqrt{u^2 + 2as}$ $v^2 = u^2 + 2as$ $s = \frac{v^2 - u^2}{2a}$	<p>1 mark</p> <p>1 mark</p>
1c	$\frac{4-9x^2}{(3x-1)(3x-2)}$ $= \frac{(2-3x)(2+3x)}{(3x-1)(3x-2)}$ $= \frac{-(3x-2)(2+3x)}{(3x-1)(3x-2)}$ $= \frac{2+3x}{1-3x}$	<p>1 mark</p> <p>1 mark</p>
1d	$\frac{1}{x-1} - \frac{2}{x+2} = \frac{1}{2}$ $\frac{1(x+2) - 2(x-1)}{(x-1)(x+2)} = \frac{1}{2}$ $\frac{x+2-2x+2}{(x-1)(x+2)} = \frac{1}{2}$ $\frac{4-x}{(x-1)(x+2)} = \frac{1}{2}$ $8-2x = x^2+x-2$ $x^2+3x-10=0$ $(x+5)(x-2)=0$ $x = -5 \text{ or } x = 2$	<p>1 mark</p> <p>1 mark</p>
2a	$650.9 \text{ million m}^3 = 650.9 \times 1,000,000$ $= 650,900,000$ $= 6.509 \times 10^8$ $\approx 6.51 \times 10^8 \text{ m}^3$	<p>1 mark</p> <p>1 mark</p>
2b	$\text{Percentage} = \frac{117}{650.9} \times 100\%$ $= 17.975 \approx 18.0\%$	<p>1 mark</p> <p>1 mark</p>
2c	$\text{Average per person} = \frac{650.9 \text{ million}}{5.469 \text{ million}}$ $= 119.016 \approx 119 \text{ m}^3.$	<p>1 mark</p> <p>1 mark</p>

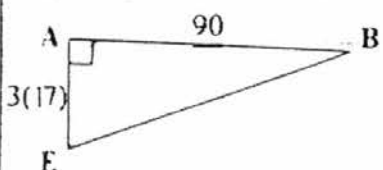
2d	$77.3 = \frac{117 - x}{x} \times 100$ , $77.3x = 11700 - 100x$ $x = 65.98 \approx 66.0\%$	1 mark 1 mark						
2c	Total revenue = $117 \times 10^6 \times 1.22 + 27.6 \times 10^6 \times 0.65$ $= \$1.6068 \times 10^8 \approx \$1.61 \times 10^8$	1 mark 1 mark						
3a	$a = 16$ & $b = 15$	1 mark each						
3b	$I_n = (n-1)^2$	1 mark						
3c	$D_n = \frac{n(n-1)}{2} + n = \frac{n(n+1)}{2}$	1 mark						
3d	When $n = 14$ , $D_{14} = 105$	1 mark						
4a	$p = (-2)^3 - 2(-2)^2 - 5(-2)$ $p = -6$	1 mark						
4b	1 mark for full labelled axis as specified in question 1 mark for correct plotting of points 1 mark for smooth curve	1 mark 1 mark 1 mark						
4c	When $y = -3$ , 1 mark for horizontal line on the graph  Number of solutions = Number of intersections = 3 Theoretical answers, $x = -1.7734$ , $x = -0.52$ , $x = 3.2534$	1 mark 1 mark						
4d	1 mark for drawing of tangent at $x = 3.5$ (Sample Answer) Gradient of tangent = $\frac{17.5 - (-15)}{4.5 - 2.5} = 16$ Theoretical answer $\frac{dy}{dx} = 17.75$ , Acceptable range $15.0875 \leq m(\pm 15\%) \leq 20.4125$	1 mark 1 mark						
4ei	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px;">x</td> <td style="padding: 2px;">-1</td> <td style="padding: 2px;">0</td> </tr> <tr> <td style="padding: 2px;">Y = -5x-5</td> <td style="padding: 2px;">0</td> <td style="padding: 2px;">-5</td> </tr> </table>	x	-1	0	Y = -5x-5	0	-5	1 mark for correct coordinates for line 1 mark for drawing of line
x	-1	0						
Y = -5x-5	0	-5						
4eii	Theoretical answer: $x = -1.2419$ , $y = 1.2095$ Acceptable range (1 small square around theoretical) $-1.35 \leq x \leq -1.15$ $0.75 \leq y \leq 1.75$	1 mark in coordinate						

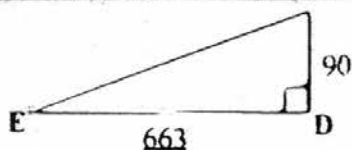
		form
5a	Congruent triangles: Triangle RQS and Triangle PQS Or Triangle RQS and PSQ	1 mark
5bi	$\angle URS = \angle UQT$ (alternate angles) $\angle USR = \angle UTQ$ (alternate angles) $\angle RUS = \angle QUT$ (vertically opposite angles) triangles $UQT$ and $URS$ are similar to each other (3 pairs of corresponding angles are equal)	(any 2) 1 mark 1 mark
5bii	 $\frac{8-x}{x} = \frac{8}{12}$ $96 - 12x = 8x$ $96 = 20x$ $x = 4.8$	1 mark 1 mark
5ci	$\frac{(RS)^2}{(QT)^2} = \frac{8^2}{12^2} = \frac{11.09}{24.9525}$ $Area\ TUQ = 24.9525 \approx 25.0\ cm^2$	1 mark 1 mark
5cii	 $\frac{(TQ)^2}{(TP)^2} = \frac{12^2}{20^2} = \frac{24.9525}{69.3125} = \frac{Area\ TUQ}{Area\ TSP}$ $Area\ TSP = 69.3125$ $Area\ UQPS = 69.3125 - 24.9525 = 44.36 \approx 44.4\ cm^2$	1 mark 1 mark 1 mark
3a	$p = (-2)^4 - 2(-2)^3 - 5(-2)$ $p = -6$	1 mark

3b	1 mark for full labelled axis as specified in question 1 mark for correct plotting of points 1 mark for smooth curve	1 mark 1 mark 1 mark						
3c	When $y = -3$ , 1 mark for horizontal line on the graph  Number of solutions = Number of intersections = 3 Theoretical answers, $x = -1.7734, x = -0.52, x = 3.2534$	1 mark   1 mark						
3d	1 mark for drawing of tangent at $x = 3.5$ (Sample Answer)  $\text{Gradient of tangent} = \frac{17.5 - (-15)}{4.5 - 2.5} = 16$  Theoretical answer $\frac{dy}{dx} = 17.75$ , Acceptable range $15.0875 \leq m(\pm 15\%) \leq 20.4125$	1 mark     1 mark						
3ei	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="padding: 2px;">x</td> <td style="padding: 2px;">-1</td> <td style="padding: 2px;">0</td> </tr> <tr> <td style="padding: 2px;"><math>Y = -5x - 5</math></td> <td style="padding: 2px;">0</td> <td style="padding: 2px;">-5</td> </tr> </table>	x	-1	0	$Y = -5x - 5$	0	-5	1 mark for correct coordinates for line  1 mark for drawing of line
x	-1	0						
$Y = -5x - 5$	0	-5						
3eii	Theoretical answer: $x = -1.2419, y = 1.2095$ Acceptable range (1 small square around theoretical): $-1.35 \leq x \leq -1.15$ $0.75 \leq y \leq 1.75$	1 mark in coordinate form						
4a	Congruent triangles: Triangle RQS and Triangle PQS Or Triangle RQS and PSQ	1 mark						

4bi	$\angle URS = \angle UQT$ (alternate angles) $\angle USR = \angle UTQ$ (alternate angles) $\angle RUS = \angle QUT$ (vertically opposite angles) triangles $UQT$ and $URS$ are similar to each other (3 pairs of corresponding angles are equal)	(any 2) 1 mark 1 mark
4bii	 $\frac{8-x}{x} = \frac{8}{12}$ $96 - 12x = 8x$ $96 = 20x$ $x = 4.8$	1 mark  1 mark
4ci	$\frac{(RS)^2}{(QT)^2} = \frac{8^2}{12^2} = \frac{11.09}{\text{area}TUQ}$ $\text{Area}TUQ = 24.9525 \approx 25.0 \text{ cm}^2$	1 mark  1 mark
4cii	 $\frac{(TQ)^2}{(TP)^2} = \frac{12^2}{20^2} = \frac{\text{Area}TUQ}{\text{Area}TSP} = \frac{\text{Area}TUQ}{\text{Area}TSP}$ $\text{Area}TSP = 69.3125$ $\text{Area}UQPS = 69.3125 - 24.9525 = 44.36 \approx 44.4 \text{ cm}^2$	1 mark  1 mark 1 mark
5a	$a = 16 \text{ \& } b = 15$	1 mark & 1 mark
5b	$I_n = (n-1)^2$	1 mark
5c	$D_n = \frac{n(n-1)}{2} + n = \frac{n(n+1)}{2}$	1 mark
5d	When $n = 14$ , $D_{14} = 105$	1 mark
6a	 $\tan RSP = \tan SRQ = 4.8$ $\tan RSP = \frac{1.2}{SS'} = 4.8 \text{ and } \tan SRQ = \frac{1.2}{RR'} = 4.8$ $SS' = 0.25 = RR'$	1 mark

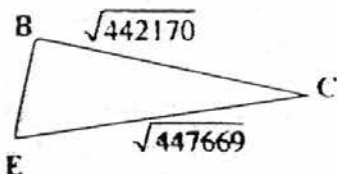
	$PQ = 2 - 0.25 - 0.25 = 1.5 \text{ m}$	1 mark
6b	Cross sectional area = $\frac{1}{2}(1.5 + 2)(1.2)$ $= 2.1 \text{ m}^2$	1 mark 1 mark
6c	$SP = \sqrt{0.25^2 + 1.2^2}$ $SP = 1.2257$ Total surface area = $2(2.1) + 2(1.8)(1.2257) + (1.8)(1.5)$ $= 11.3125 \approx 11.3 \text{ m}^2$	1 mark 1 mark 1 mark 1 mark
6d	Volume of container = $2.1 \times 1.8$ $= 3.78 \text{ m}^3$ Mass = $Density \times Volume = 825 \times 3.78$ $= 3118.5 \text{ kg}$	1 mark 1 mark 1 mark
7ai	$\angle BCE = \angle BAE = 62^\circ$ (angles in the same segment)	1 mark
7aii	$\angle ADC = 180 - 76 = 104^\circ$ (cyclic quadrilateral's opposite angles add up to $180^\circ$ ) (angles in opposite segment are supplementary)	1 mark
7aiii	$\angle AOC = 76 \times 2 = 152^\circ$ (angle at the center theorem) $\angle COE = 180 - 152 = 28^\circ$ (sum of angles on a straight line)	1 mark 1 mark
7aiv	$\triangle OCE$ is an isosceles triangle $\angle OCE = \frac{180 - 28}{2} = 76^\circ$ $\angle BCO = 76 - 62 = 14^\circ$	1 mark 1 mark
7av	$\angle GCI = 90 - \frac{180 - 28}{2} + 62 = 76^\circ$ (tangent is perpendicular to radius)	1 mark
7bi	$\angle AOB = \pi - 2\left(\frac{3\pi}{14}\right) = \frac{4}{7}\pi$ or $1.79519 \approx 1.80$ radians	1 mark
7bii	Area of the cross section of the lens $= \frac{1}{2}(7) \left[ \frac{4\pi}{7} - \sin\left(\frac{4\pi}{7}\right) \right]$ $= 20.096 \approx 20.1 \text{ mm}^2$	1 mark 1 mark
8ai	$\frac{800}{x}$ days	1 mark
8aii	$\frac{800}{x-5}$ days	1 mark
8aiii	$\frac{900}{x+5}$ days	1 mark
8b	$\frac{900}{x+5} + 20 = \frac{800}{x-5}$ $900(x-5) + 20(x+5)(x-5) = 800(x+5)$ $900x - 4500 + 20x^2 - 500 = 800x + 4000$ $20x^2 + 100x - 9000 = 0$ $x^2 + 5x - 450 = 0$	1 mark 1 mark 1 mark
8c	$x^2 + 5x - 450 = 0$	

	$x = \frac{- (5) \pm \sqrt{(5)^2 - 4(1)(-450)}}{2(1)}$ $x = \frac{- 5 \pm \sqrt{1825}}{2}$ $x = 18.860 \text{ or } - 23.860$ $x = 18.86 \text{ or } x = -23.86$	<p>1 mark</p> <p>1 mark</p>
8d	<p>Average speed = <math>\frac{\text{total distance}}{\text{total time}}</math></p> $= \frac{800 + 900}{\frac{800}{18.860} \times 24 + \frac{900}{18.860 + 5} \times 24}$ $= \frac{1700 \text{ km}}{1923.308 \text{ hours}} = 0.88389 \approx 0.884 \text{ km/h}$	<p>1 mark for total distance and 1 mark for total time</p> <p>1 mark</p>
9a	<p>Angle of depression = <math>\tan^{-1} \frac{1}{13}</math></p> $= 4.3987^\circ \approx 4.4^\circ$	<p>1 mark</p> <p>1 mark</p>
9b	<p><math>\tan \hat{A}DE = \frac{\text{vertical rise}}{\text{available distance}} = \frac{1}{13}</math></p> $\hat{A}DE = 4.3987^\circ$ <p><math>\sin \hat{A}CE = \frac{\text{vertical rise}}{\text{ramp length}} = \frac{3(17)}{\text{ramp length}}</math></p> <p>Ramp length = 664.958 cm = 6.65 m</p> <p>OR</p> $\frac{\text{Vertical rise}}{\text{Available distance}} = \frac{1}{13}$ $\frac{3(17)}{EC} = \frac{1}{13}$ $EC = 663 \text{ cm} = 6.63 \text{ m}$ <p>Ramp length = <math>\sqrt{663^2 + \{3(17)\}^2} = \sqrt{442170}</math></p> $= 664.958 \text{ cm} = 6.65 \text{ m}$	<p>1 mark</p> <p>1 mark</p> <p>1 mark</p> <p>1 mark</p> <p>1 mark</p> <p>1 mark</p>
9ci	 <p><math>BE = \sqrt{90^2 + 51^2} = \sqrt{10701}</math></p> $= 103.4456 \approx 103 \text{ cm} = 1.03 \text{ m}$	<p>1 mark</p> <p>1 mark</p>
9cii		



$$EC = \sqrt{663^2 + 90^2}$$

$$EC = \sqrt{447669} = 669.080$$



$$BE^2 = BC^2 + EC^2 - 2(BC)(EC)\cos BCE$$

$$10701 = 442170 + 447669 - 2(\sqrt{442170})(\sqrt{447669})\cos BCE$$

$$\cos BCE = \frac{442170 + 447669 - 10701}{2\sqrt{442170}\sqrt{447669}}$$

$$\cos BCE = 0.987993$$

$$\alpha = 0.155119$$

$$\hat{BCE} = 0.155119 \approx 0.155 \text{ rad}$$

1 mark

1 mark

1 mark

1 mark

10ai 50% of 660 = 330 girls  
162 ≤ Median ≤ 163

1 mark

10aii 80% of 660 = 528  
168 ≤ The tallest 20% has height ≤ 169

1 mark

10aiii The number of girls =  
= 260 - 120 or = 255 - 120 or = 250 - 120  
130 ≤ number ≤ 140

1 mark

10bi % of boys =  $\frac{80 + 40 + 12}{660} \times 100 = 20\%$

1 mark

10bii

Height (x cm)	Mid value (cm)	Frequency (Boys)	Frequency (girls)
140 < x ≤ 145	142.5	0	11
145 < x ≤ 150	147.5	2	31
150 < x ≤ 155	152.5	20	78
155 < x ≤ 160	157.5	47	134
160 < x ≤ 165	162.5	67	173
165 < x ≤ 170	167.5	182	144
170 < x ≤ 175	172.5	210	75
175 < x ≤ 180	177.5	80	14
180 < x ≤ 185	182.5	40	0
185 < x ≤ 190	187.5	12	0
		$\sum f = 660$	$\sum f = 660$

$$\sum fx = 112095$$

$$\bar{x} = \frac{\sum fx}{\sum f} = \frac{112095}{660} = 169.841 \approx 170 \text{ cm}$$

1 mark

1 mark

<p>10biii</p>	$\sum fx^2 = 19073425$ $\sigma_x = \sqrt{\frac{\sum fx^2}{\sum f} - \left(\frac{\sum fx}{\sum f}\right)^2} = \sqrt{\frac{19073425}{660} - \left(\frac{112095}{660}\right)^2}$ $= 7.29344 \approx 7.29 \text{ cm}$	<p>1 mark</p> <p>1 mark</p>
<p>10c</p>	<p>The mean height of the 660 girls in (a) is 161.8 cm and the standard deviation is 7.44 cm.                  The estimated mean height of the 660 boys in (b) is 170 cm and the standard deviation is 7.30 cm.                  [Central tendency] The boys are generally taller than the girls as the mean height of the boys is higher than the mean height of the girls.                  OR                  20 % of the girls have a height above 1.68 m and 20 % of the boys have a height above 1.75 m                  Or                  [Spread] The variation/spread/deviation from the mean/etc in height among the boys and the girls is roughly about the same as they share roughly the same standard deviation.                  Or (elaborate on consistency) Or                  Range of the girls = 180 – 140                  Range of the boys = 190 – 145 .....etc</p>	<p>1 mark (any 1 for central tendency argument or quartile argument)</p> <hr/> <p>1 mark for spread argument</p>