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Name: _____

Register Number: _____

Class: _____

Clementi Town Secondary School
Preliminary Examination 2015
Secondary 4 Express / 5 Normal Academic



MATHEMATICS
Paper 1

4016/01
2 September 2015
2 hours

Candidates answer on the Question Paper.

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READ THESE INSTRUCTIONS FIRST

Do not open the booklets until you are told to do so.

Write your name, register number and class on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

Answer **all** questions.

If working is needed for any question it must be shown with the answer.

Omission of essential working will result in loss of marks.

The use of an approved scientific calculator is expected, where appropriate.

If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures.

Give answers in degrees to one decimal place.

For π , use either your calculator value or 3.142, unless the question requires the answer in terms of π .

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

The total number of marks for this paper is 80.

For Examiner's Use
80

This question paper consists of 17 printed pages, including this cover page.

131

[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

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

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

For
Examiner's
UseFor
Examiner's
Use

- 3 The line $6x + 3y = 18$ crosses the x -axis at C .

(a) Find the coordinates of point C .

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

(b) Find the gradient of the line.

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

- 4 The ratio of Ahmad's expenditure to Bala's expenditure is $4 : 9$ and the ratio of Charlie's expenditure to Bala's expenditure is $5 : 3$.
The difference between Ahmad's and Charlie's expenditure is \$55.
Calculate the amount of Bala's expenditure.

Answer \$ $\dots\dots\dots$ [2]

- 5 (a) Given that $8^{3d-1} = 1$, find d .

Answer (a) $d = \dots\dots\dots$ [1]

(b) Given that $\frac{1}{2^x} = 4$, find x .

Answer (b) $x = \dots\dots\dots$ [1]

For
Examiner's
Use

- 6 The surface of a spherical solid of radius 5 m is to be painted and each tin of paint can paint an area of $6\pi\text{m}^2$.

How many tins of paint are to be bought to paint the spherical solid?

For
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Use

Answer [3]

- 7 (a) Express 2016 as a product of its prime factors.

Answer (a) [1]

- (b) Given that $\frac{2016}{k}$ is a perfect square, find the smallest possible integer value of k .

Answer (b) $k =$ [2]

[Turn over

For
Examiner's
UseFor
Examiner's
Use

- 8 A cyclist cycles at an average speed of 28 km/h for 45 minutes.
After resting for 25 minutes, he continues to cycle for another 12 km in 30 minutes.

Calculate the average speed of the cyclist in km/h for the entire journey.

Answer km/ h [3]

- 9 (a) Solve the inequality $x + 6 < 13 \leq 5x - 2$.

Answer (a) [2]

- (b) Hence, write down the largest possible prime value of x that satisfies
 $x + 6 < 13 \leq 5x - 2$.

Answer (b) $x =$ [1]

For
Examiner's
Use

For
Examiner's
Use

- 10 (a) Express $x^2 - 6x - 16$ in the form of $(x - a)^2 - b$.

Answer (a) [1]

- (b) Hence, write down the minimum value of $y = x^2 - 6x - 16$.

Answer (b) [1]

- (c) Write down the equation of the line of symmetry of the graph of $y = x^2 - 6x - 16$.

Answer (c) [1]

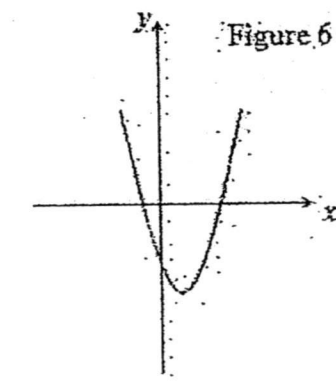
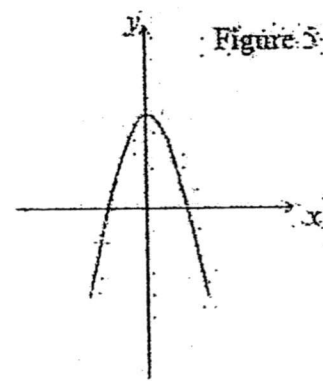
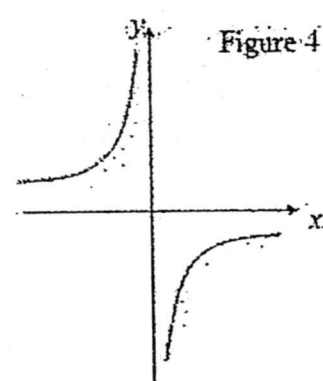
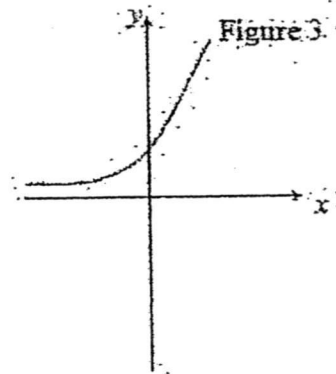
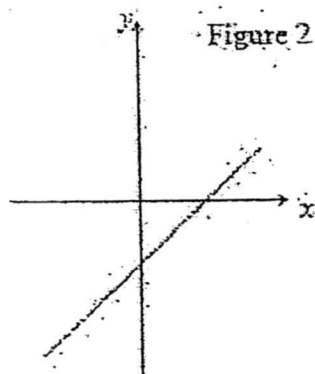
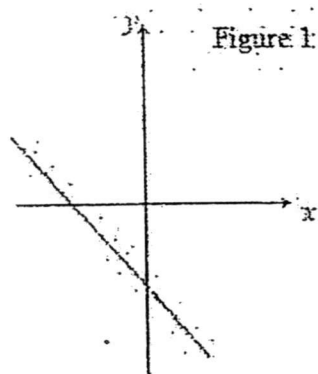
- 11 Ali's height is 150 cm.
Brian's height is 110% of Chandra's height.
Brian's height is 96 % of Ali's height.

What is Chandra's height in metres?

Answer m [3]

For
Examiner's
Use

12

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Use

Which of the graphs shown above could be the graph of

(a) $y = -\frac{1}{x}$

Answer (a) Figure [1]

(b) $y + x = -2$

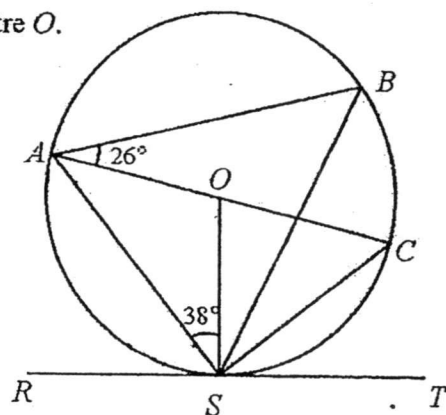
Answer (b) Figure [1]

(c) $y = 1 - x^2$

Answer (c) Figure [1]

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- 13 In the diagram, AOC is the diameter of the circle, centre O .
 RST is the tangent at S .
 $\angle ASO = 38^\circ$ and $\angle BAC = 26^\circ$.



- (a) Find $\angle ASR$.

Answer (a) $\angle ASR = \dots\dots\dots^\circ$ [1]

- (b) Find $\angle ACS$.

Answer (b) $\angle ACS = \dots\dots\dots^\circ$ [1]

- (c) Find $\angle BSC$.

Answer (c) $\angle BSC = \dots\dots\dots^\circ$ [1]

- 14 $\mathcal{E} = \{ \text{integers } x: 2 < x \leq 10 \}$
 $P = \{ \text{prime numbers} \}$
 $Q = \{ \text{factors of } 12 \}$

- (a) List the elements in Q .

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

- (b) List the elements in $(P \cup Q)'$.

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

- (c) Find $n(P \cap Q')$.

Answer (c) $\dots\dots\dots$ [1]

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- 15 A hawker sells green tea and jasmine tea, each available in small, medium and large cups.

The matrices show the number of cups sold during lunch and the price of one cup of each size.

	Small	Medium	Large		Price
Green Tea	4	8	2	Small	1.20
Jasmine Tea	1	5	0	Medium	1.50
				Large	1.80

(a) Find $\begin{pmatrix} 4 & 8 & 2 \\ 1 & 5 & 0 \end{pmatrix} \begin{pmatrix} 1.2 \\ 1.5 \\ 1.8 \end{pmatrix}$.

Answer (a) [2]

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

Answer (b) [1]

16 (a) Simplify $\frac{4x+6}{2xy+3y}$.

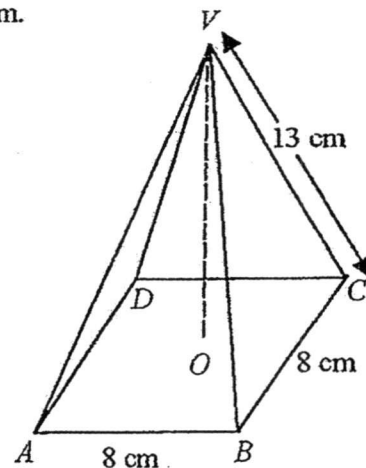
Answer (a) [1]

(b) Express as a single fraction in its simplest form $\frac{4}{a+3b} - \frac{a-21b}{a^2-9b^2}$.

Answer (b) [2]

For
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- 17 $ABCDV$ is a right pyramid with a square base of side 8 cm.
 VO is vertical and $VC = 13$ cm.



For
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Use

- (a) Find the length of OC .

Answer (a) $OC = \dots\dots\dots$ cm [1]

- (b) Find the vertical height VO .

Answer (b) $VO = \dots\dots\dots$ cm [1]

- (c) Calculate the volume of the pyramid.

Answer (c) $\dots\dots\dots$ cm³ [1]

For
Examiner's
UseFor
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- 18 (a) Factorise completely $8ab + 1 - 4a - 2b$.

Answer (a) [2]

- (b) Factorise $3x^2 - 15x + 18$.

Answer (b) [2]

- 19 It is given that x is inversely proportional to the square root of y .

When $x = 6$, $y = 4$.

- (a) Find the equation relating x and y .

Answer (a) [2]

- (b) Hence, find the value of x when $y = 256$.

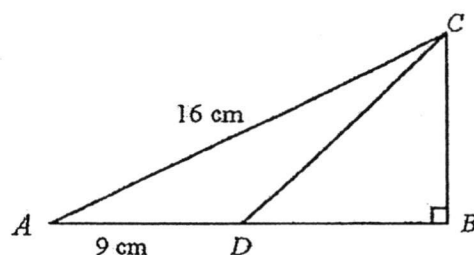
Answer (b) $x =$ [1]

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- 20 In the diagram, ADB is a straight line, $\angle ABC = 90^\circ$, $AC = 16$ cm, $AD = 9$ cm and area of $\triangle ADC = 36$ cm².

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Use



- (a) Prove that $\angle CAD = 30^\circ$.

Answer (a)

[2]

- (b) Find the shortest distance between point D and the line AC .

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

- (c) Find the length of CD .

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

- (d) Find $\sin \angle ADC$.

Answer (d)..... [2]

[Turn over]

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- 21 (a) Convert 2015 picoseconds to seconds, giving your answer in standard form.

Answer (a) seconds [1]

- (b) In the Singapore Budget 2015, the Ministry of Education was allocated \$10.9 billion from the total budget of \$67 820 000 000.

- (i) How much was allocated to the other ministries?
Give your answer in billion.

Answer (b)(i) \$ billion [2]

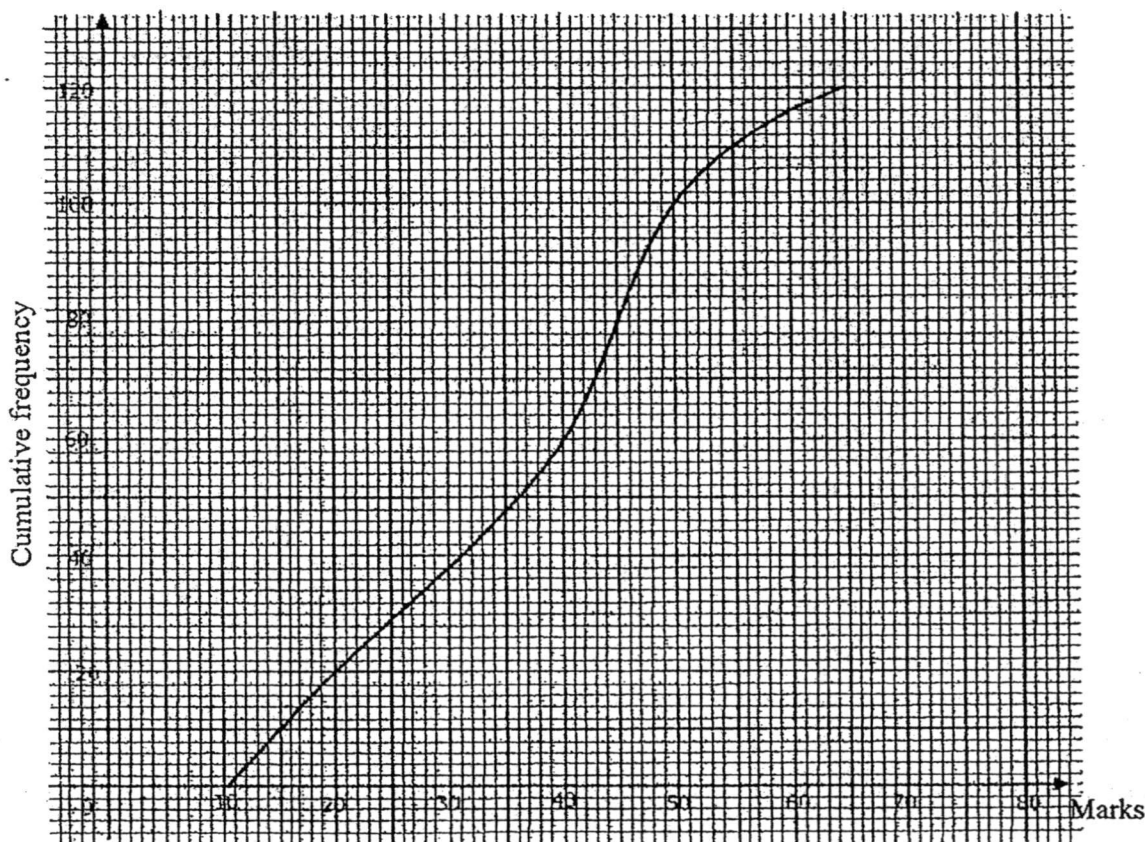
- (ii) Calculate the percentage of the total budget allocated to the Ministry of Education.

Answer (b)(ii) % [2]

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- 22 The cumulative frequency curve below illustrates the marks obtained, out of 70, by 120 students in test A. The passing mark is 35.



- (a) Use the graph to find

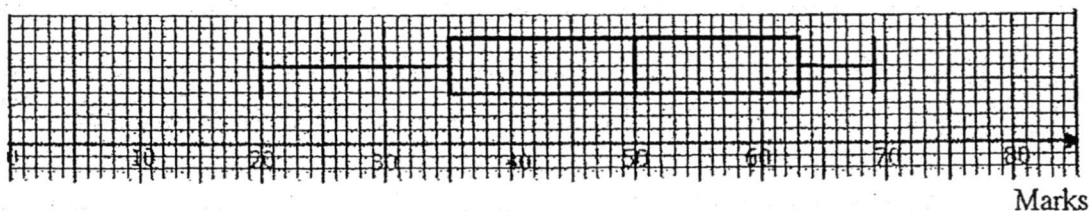
(i) the median mark,

Answer (a)(i) [1]

(ii) the interquartile range.

Answer (a)(ii) [1]

- (b) The box-and-whisker plot represents the marks, out of 70, obtained by the same group of 120 students in test B two weeks later.



Find the interquartile range.

Answer (b) [1]

[Turn over

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- (c) In which exam did the students perform better? Justify your answer.

Answer (c)

 [2]

- 23 The numerator of a fraction is x and its denominator is y when expressed in its simplest form.

The sum of the numerator and the denominator of the fraction is 21.

When 5 is added to the numerator, the fraction becomes 1.

- (a) Write down two simultaneous equations, in terms of x and y , to represent this information.

Answer (a)
 [2]

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

Answer (b) $x =$
 $y =$ [2]

- (c) Hence, state the reciprocal of the original fraction.

Answer (c) [1]

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- 24 The diagram shows the speed-time graph of a particle over a period of 15 seconds. The particle uniformly decelerated from 10 m/s to v m/s in 5 seconds. It then maintains at this speed for the next 5 seconds and accelerates uniformly at 2 m/s^2 for another 5 seconds. The distance travelled in the first 5 seconds is 35 m.

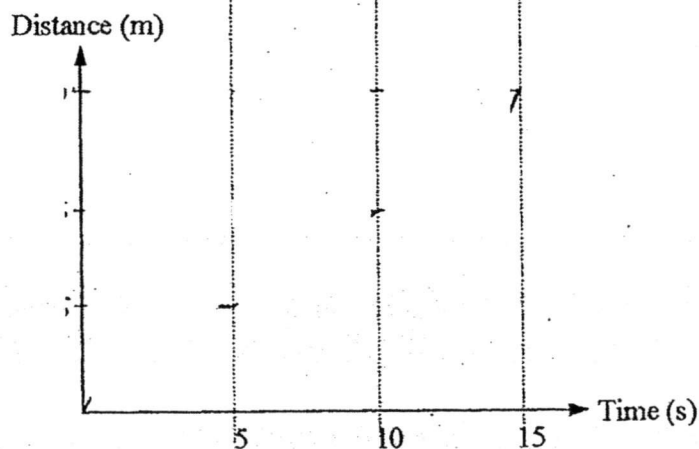
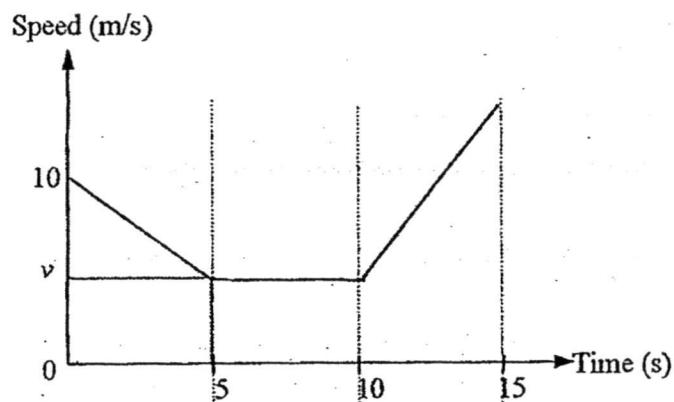
- (a) Find the value of v .

Answer (a) $v = \dots\dots\dots$ [1]

- (b) Find the speed of the particle after 15 seconds.

Answer (b) $\dots\dots\dots \text{ m/s}$ [1]

- (c) Complete the corresponding distance-time graph. [3]



~ END OF PAPER ~

Name: _____

Register Number: _____

Class: _____

Clementi Town Secondary School
Preliminary Examination 2015
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MATHEMATICS
Paper 1

Marking Scheme

4016/01
2 September 2015
2 hours

Candidates answer on the Question Paper.

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For Examiner's Use
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139

[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

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

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

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Answer **all** the questions.

- 1 (a) Simplify $7(a-15) - 8(a-15)$.

15 - a B1

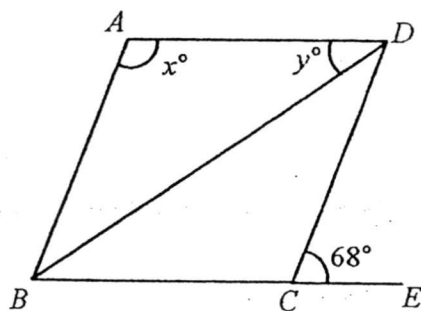
Answer (a) [1]

- (b) Solve $(3b+1)(b-2)=0$.

$-\frac{1}{3}$ 2 B1

Answer (b) $b =$ or [1]

- 2 The diagram shows a sketch of a rhombus.



- (a) Find x .

112 B1

Answer (a) $x =$ [1]

- (b) Find y .

34 B1

Answer (b) $y =$ [1]

140

[Turn over]

For
Examiner's
UseFor
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Use

- 3 The line $6x + 3y = 18$ crosses the x -axis at C .

(a) Find the coordinates of point C .

B1

3 0

Answer (a) $C(.....,)$ [1]

(b) Find the gradient of the line.

B1

-2

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

- 4 The ratio of Ahmad's expenditure to Bala's expenditure is $4 : 9$ and the ratio of Charlie's expenditure to Bala's expenditure is $5 : 3$.
The difference between Ahmad's and Charlie's expenditure is \$55.
Calculate the amount of Bala's expenditure.

A	:	B	C	
4	:	9		
		3	:	5
		9	:	15

M1

11 U ---- \$55
1 U ---- \$5
9 U ---- \$45

A1

Answer \$ [2]

- 5 (a) Given that $8^{3d-1} = 1$, find d .

B1

$\frac{1}{3}$

Answer (a) $d =$ [1]

(b) Given that $\frac{1}{2^x} = 4$, find x .

B1

-2

Answer (b) $x =$ [1]

For
Examiner's
Use

For
Examiner's
Use

- 6 The surface of a spherical solid of radius 5 m is to be painted and each tin of paint can paint an area of $6\pi \text{ m}^2$.

How many tins of paint are to be bought to paint the spherical solid?

$$\begin{aligned}\text{Surface area of sphere} &= 4\pi(5)^2 \\ &= 100\pi\end{aligned}\quad \text{M1}$$

$$\frac{100\pi}{6\pi} = 16.66667 \quad \text{M1}$$

$$\text{No of tins} = 17 \quad \text{A1}$$

Answer [3]

- 7 (a) Express 2016 as a product of its prime factors.

$$\begin{aligned} & 2^5 \times 3^2 \times 7 \quad \text{B1} \\ \text{Answer (a)} & \dots\dots\dots [1] \end{aligned}$$

- (b) Given that $\frac{2016}{k}$ is a perfect square, find the smallest possible integer value of k .

$$\frac{2^5 \times 3^2 \times 7}{k} = \frac{(2 \times 2 \times 3) \times (2 \times 2 \times 3) \times 2 \times 7}{k} \quad \text{M1}$$

$$k = 14 \quad \text{A1}$$

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

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[Turn over]

For
Examiner's
UseFor
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Use

- 8 A cyclist cycles at an average speed of 28 km/h for 45 minutes.
After resting for 25 minutes, he continues to cycle for another 12 km in 30 minutes.

Calculate the average speed of the cyclist in km/h for the entire journey.

$$\begin{aligned}\text{Total time taken} &= 45 + 30 + 25 && \text{M1} \\ &= 100 \text{ mins} = 1\frac{2}{3} \text{ h}\end{aligned}$$

$$\begin{aligned}\text{Total Distance travelled} &= 12 + 28 \times \frac{3}{4} && \text{M1} \\ &= 33 \text{ km}\end{aligned}$$

$$\begin{aligned}\text{Average speed} &= 33 / 1\frac{2}{3} \\ &= 19.8 \text{ km/h} && \text{A1}\end{aligned}$$

Answer km/h [3]

- 9 (a) Solve the inequality $x + 6 < 13 \leq 5x - 2$.

$$\begin{aligned}x + 6 &< 13 \leq 5x - 2 \\ x + 6 &< 13 && \text{or} && 13 \leq 5x - 2 \\ x &< 7 && && 3 \leq x && \text{M1} \\ 3 &\leq x < 7 && \text{A1}\end{aligned}$$

Answer (a) [2]

- (b) Hence, write down the largest possible prime value of x that satisfies $x + 6 < 13 \leq 5x - 2$.

5 B1
Answer (b) $x =$ [1]

For
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Use

For
Examiner's
Use

- 10 (a) Express $x^2 - 6x - 16$ in the form of $(x - a)^2 - b$.

B1
 $(x - 3)^2 - 25$

Answer (a) [1]

- (b) Hence, write down the minimum value of $y = x^2 - 6x - 16$.

B1
 $y = -25$

Answer (b) [1]

- (c) Write down the equation of the line of symmetry of the graph of $y = x^2 - 6x - 16$.

B1
 $x = 3$

Answer (c) [1]

- 11 Ali's height is 150 cm.
Brian's height is 110% of Chandra's height.
Brian's height is 96 % of Ali's height.

What is Chandra's height in metres?

Brian's height = 0.96×150 M1
= 144 cm

Chandra's height = $\frac{100}{110} \times 144$ M1
 $\approx 1.31\text{m}$ (3s.f) A1

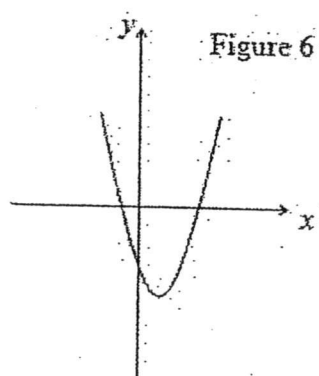
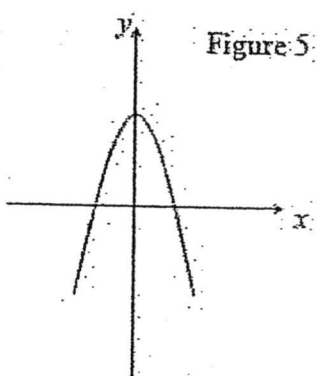
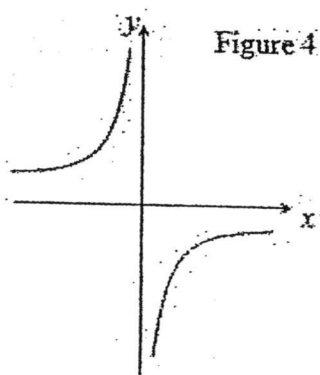
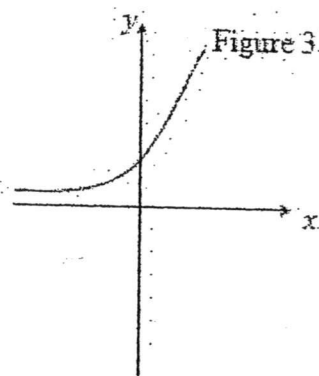
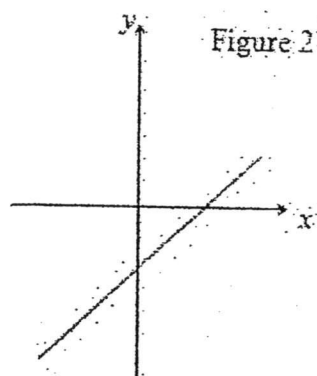
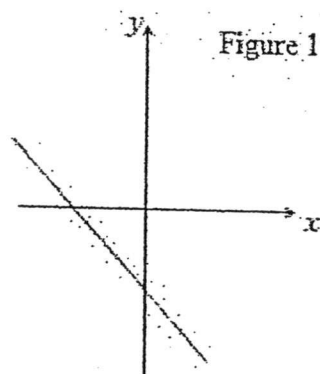
Answer m [3]

145

[Turn over

For
Examiner's
Use

12

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Examiner's
Use

Which of the graphs shown above could be the graph of

(a) $y = -\frac{1}{x}$,

B1

4

Answer (a) Figure [1]

(b) $y + x = -2$,

B1

1

Answer (b) Figure [1]

(c) $y = 1 - x^2$.

5

B1

Answer (c) Figure [1]

For
Examiner's
Use

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Use

13 In the diagram, AOC is the diameter of the circle, centre O .

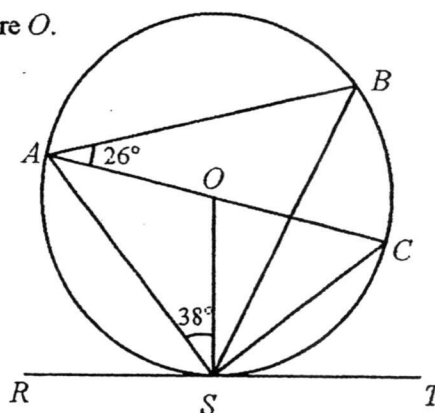
RST is the tangent at S .

$\angle ASO = 38^\circ$ and $\angle BAC = 26^\circ$.

(a) Find $\angle ASR$.

$$\begin{aligned}\angle ASR &= 90^\circ - 38^\circ \quad (\text{Tangent to circle}) \\ &= 52^\circ\end{aligned}$$

B1



Answer (a) $\angle ASR = \dots\dots\dots^\circ$ [1]

(b) Find $\angle ACS$.

$$\begin{aligned}\angle ACS &= \angle OSC \quad (\text{Base angle of isos. triangle}) \\ &= 90^\circ - 38^\circ \quad (\text{angle in a semi circle}) \\ &= 52^\circ\end{aligned}$$

B1

Answer (b) $\angle ACS = \dots\dots\dots^\circ$ [1]

(c) Find $\angle BSC$.

$$\begin{aligned}\angle BSC &= \angle BAC \quad (\text{Angle in same segment}) \\ &= 26^\circ\end{aligned}$$

B1

Answer (c) $\angle BSC = \dots\dots\dots^\circ$ [1]

14 $\mathcal{E} = \{\text{integers } x: 2 < x \leq 10\}$

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

$Q = \{\text{factors of } 12\}$

(a) List the elements in Q .

{3,4,6} B1

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

(b) List the elements in $(P \cup Q)'$.

{8,9,10} B1

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

(c) Find $n(P \cap Q)$.

2

B1

Answer (c) $\dots\dots\dots$ [1]

For
Examiner's
UseFor
Examiner's
Use

- 15 A hawker sells green tea and jasmine tea, each available in small, medium and large cups.
The matrices show the number of cups sold during lunch and the price of one cup of each size.

	Small	Medium	Large		Price
Green Tea	4	8	2	Small	1.20
Jasmine Tea	1	5	0	Medium	1.50
				Large	1.80

(a) Find $\begin{pmatrix} 4 & 8 & 2 \\ 1 & 5 & 0 \end{pmatrix} \begin{pmatrix} 1.2 \\ 1.5 \\ 1.8 \end{pmatrix} = \begin{pmatrix} 4 \times 1.2 + 8 \times 1.5 + 2 \times 1.8 \\ 1 \times 1.2 + 5 \times 1.5 + 0 \times 1.8 \end{pmatrix}$ M1

$$= \begin{pmatrix} 20.4 \\ 8.7 \end{pmatrix} \quad \text{A1}$$

Answer (a) [2]

- (b) Explain what your answer to (a) represents. B1

Answer (b) The elements in (a) represents the total amount earned by the drink stall for selling green tea and jasmine tea respectively. [1]

16 (a) Simplify $\frac{4x+6}{2xy+3y}$.

$$\frac{2}{y} \quad \text{B1}$$

Answer (a) [1]

- (b) Express as a single fraction in its simplest form $\frac{4}{a+3b} - \frac{a-21b}{a^2-9b^2}$.

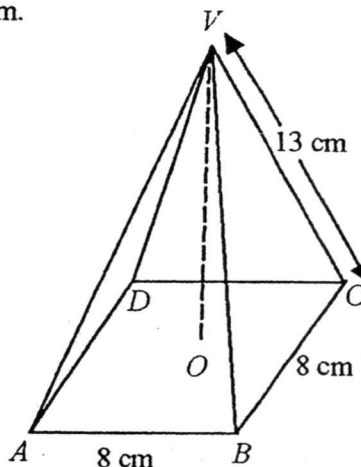
$$\begin{aligned} \frac{4}{a+3b} - \frac{a-21b}{a^2-9b^2} &= \frac{4(a-3b) - (a-21b)}{(a+3b)(a-3b)} \quad \text{M1} \\ &= \frac{3a+9b}{(a+3b)(a-3b)} \\ &= \frac{3}{a-3b} \quad \text{A1} \end{aligned}$$

Answer (b) [2]

For
Examiner's
Use

- 17 $ABCDV$ is a right pyramid with a square base of side 8 cm.
 VO is vertical and $VC = 13$ cm.

For
Examiner's
Use



- (a) Find the length of OC .

$$\begin{aligned} OC &= \frac{1}{2} AC \\ &= \frac{1}{2} \sqrt{8^2 + 8^2} \\ &\approx 5.66 \text{ cm (3 s.f.)} \end{aligned} \quad \text{B1}$$

Answer (a) $OC = \dots\dots\dots$ cm [1]

- (b) Find the vertical height VO .

$$\begin{aligned} VO &= \sqrt{13^2 - OC^2} \\ &= \sqrt{137} \\ &\approx 11.7 \text{ cm (3 s.f.)} \end{aligned} \quad \text{B1}$$

Answer (b) $VO = \dots\dots\dots$ cm [1]

- (c) Calculate the volume of the pyramid.

$$\begin{aligned} \text{Volume} &= \frac{1}{3} (8^2) \sqrt{137} \\ &\approx 250 \text{ cm}^3 \text{ (3 s.f.)} \end{aligned} \quad \text{B1}$$

Answer (c) $\dots\dots\dots$ cm³ [1]

1111

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Use

- 18 (a) Factorise completely
- $8ab + 1 - 4a - 2b$
- .

$$8ab + 1 - 4a - 2b = 4a(2b - 1) - (-1 + 2b) \quad \text{M1}$$

$$= (4a - 1)(2b - 1) \quad \text{A1}$$

Answer (a) [2]

- (b) Factorise
- $3x^2 - 15x + 18$
- .

$$3x^2 - 15x + 18 = 3(x^2 - 5x + 6) \quad \text{M1}$$

$$= 3(x - 3)(x - 2) \quad \text{A1}$$

Answer (b) [2]

- 19 It is given that
- x
- is inversely proportional to the square root of
- y
- .

When $x = 6$, $y = 4$.

- (a) Find the equation relating
- x
- and
- y
- .

$$x = \frac{k}{\sqrt{y}}, \text{ where } k \text{ is a constant} \quad \text{M1}$$

$$k = 12$$

$$x = \frac{12}{\sqrt{y}} \quad \text{A1}$$

Answer (a) [2]

- (b) Hence, find the value of
- x
- when
- $y = 256$
- .

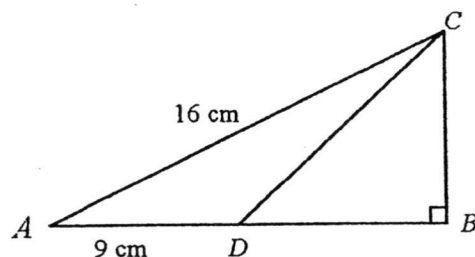
$$\frac{3}{4} \quad \text{B1}$$

Answer (b) $x =$ [1]

For
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For
Examiner's
Use

- 20 In the diagram, ADB is a straight line, $\angle ABC = 90^\circ$, $AC = 16$ cm, $AD = 9$ cm and area of $\triangle ADC = 36$ cm².



- (a) Prove that $\angle CAD = 30^\circ$.

Answer (a)

$$\begin{aligned} \frac{1}{2} \times 9 \times 16 \times \sin \angle CAD &= 36 && \text{M1} \\ \sin \angle CAD &= 0.5 \\ \angle CAD &= 30^\circ && \text{(Proved) A1} \end{aligned}$$

[2]

- (b) Find the shortest distance between point D and the line AC .

$$\begin{aligned} \frac{1}{2} \times 16 \times \text{shortest distance} &= 36 \\ \text{shortest distance} &= 36 \div 8 = 4.5 \text{ cm} \end{aligned}$$

B1

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

- (c) Find the length of CD .

$$\begin{aligned} CD &= \sqrt{9^2 + 16^2 - 2 \times 9 \times 16 \times \cos 30^\circ} && \text{M1} \\ &\approx 9.36 \text{ cm (3 s.f)} && \text{A1} \end{aligned}$$

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

- (d) Find $\sin \angle ADC$.

$$\begin{aligned} BC &= \frac{36 \times 2}{9} && \text{M1} \\ &= 8 \end{aligned}$$

$$\begin{aligned} \sin \angle ADC &= \sin \angle BDC \\ \sin \angle ADC &= \frac{BC}{CD} \\ \sin \angle ADC &\approx 0.855 \text{ (3 s.f)} && \text{A1} \end{aligned}$$

Answer (d)..... [2]

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- 21 (a) Convert 2015 picoseconds to seconds, giving your answer in standard form.

$$2.015 \times 10^{-9} \quad \text{B1}$$

Answer (a) seconds [1]

- (b) In the Singapore Budget 2015, the Ministry of Education was allocated \$10.9 billion from the total budget of \$67 820 000 000.

- (i) How much was allocated to the other ministries?
Give your answer in billion.

$$\begin{aligned} 6.782 \times 10^{10} - 10.9 \times 10^9 & \quad \text{M1} \\ = 5.692 \times 10^{10} \end{aligned}$$

$$56.92 \quad \text{A1}$$

Answer (b)(i) \$ billion [2]

- (ii) Calculate the percentage of the total budget allocated to the Ministry of Education.

$$\frac{10.9 \times 10^9}{6.782 \times 10^{10}} \times 100\% \quad \text{M1}$$

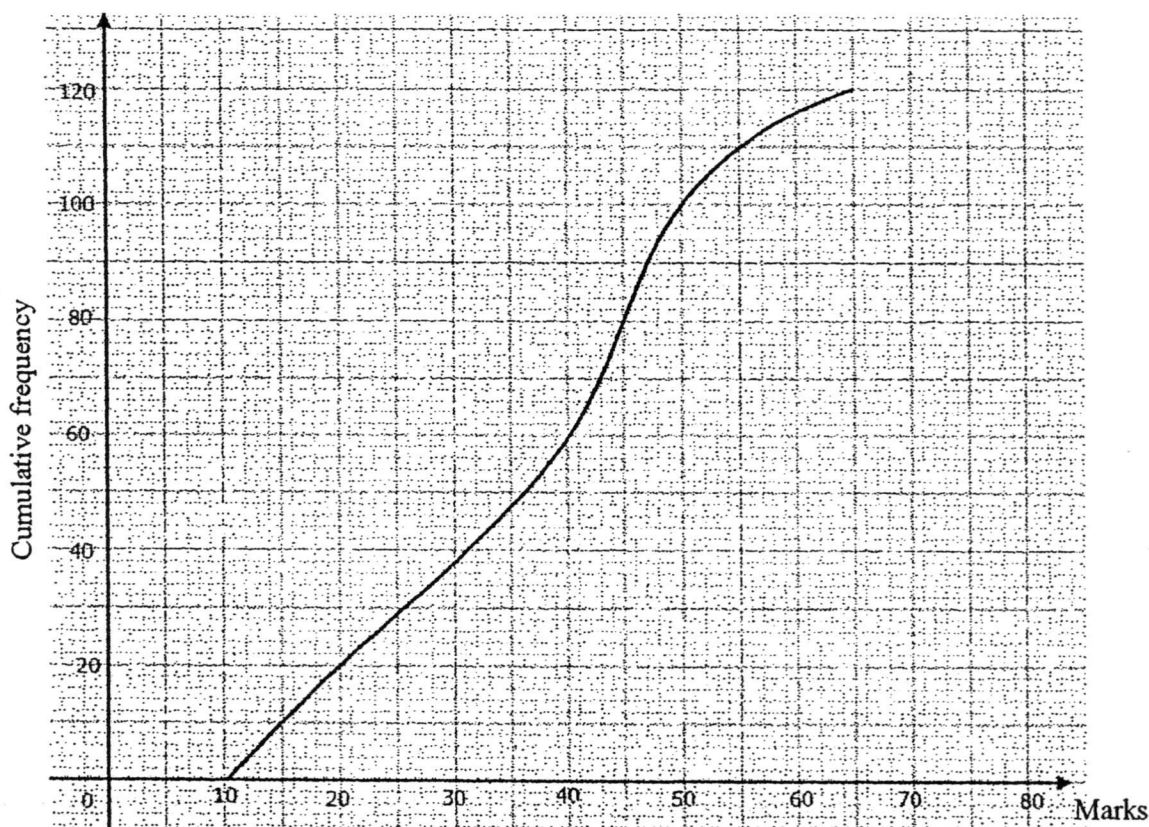
$$= 16.1\% \quad \text{A1}$$

Answer (b)(ii) % [2]

For
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- 22 The cumulative frequency curve below illustrates the marks obtained, out of 70, by 120 students in test A. The passing mark is 35.

For
Examiner's
Use



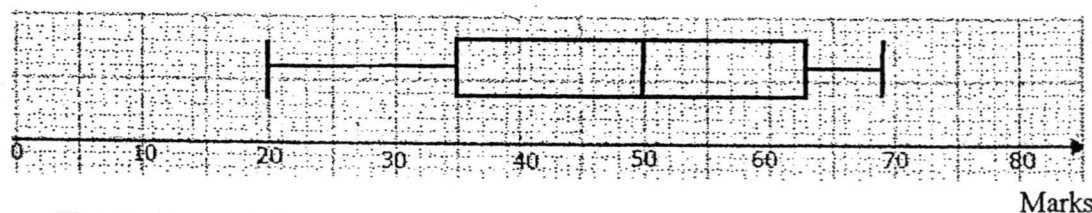
- (a) Use the graph to find
(i) the median mark,

40 B1
Answer (a)(i) [1]

- (ii) the interquartile range.,

Accept Ans:
21 to 22 B1
Answer (a)(ii) [1]

- (b) The box-and-whisker plot represents the marks, out of 70, obtained by the same group of 120 students in test B two weeks later.



Find the interquartile range.

28 B1
Answer (b) [1]
146

[Turn over

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Examiner's
Use

- (c) In which exam did the students perform better? Justify your answer.

Answer (c) Test B has a higher mean mark than that of Test A, hence the students

perform better for Test B.

[2]

- 23 The numerator of a fraction is x and its denominator is y when expressed in its simplest form.

The sum of the numerator and the denominator of the fraction is 21.

When 5 is added to the numerator, the fraction becomes 1.

- (a) Write down two simultaneous equations, in terms of x and y , to represent this information.

$$\frac{x+5}{y} = 1 \quad \text{B1}$$

Answer (a)

$$x + y = 21 \quad \text{B1}$$

[2]

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

$$\text{Answer (b) } x = \frac{8}{13} \quad \text{B1}$$

$$y = \frac{13}{8} \quad \text{B1} \quad [2]$$

- (c) Hence, state the reciprocal of the original fraction.

$$\frac{13}{8} \quad \text{B1}$$

Answer (c) [1]

For
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Use

For
Examiner's
Use

- 24 The diagram shows the speed-time graph of a particle over a period of 15 seconds. The particle uniformly decelerated from 10 m/s to v m/s in 5 seconds. It then maintains at this speed for the next 5 seconds and accelerates uniformly at 2 m/s^2 for another 5 seconds. The distance travelled in the first 5 seconds is 35 m.

- (a) Find the value of v .

4 B1

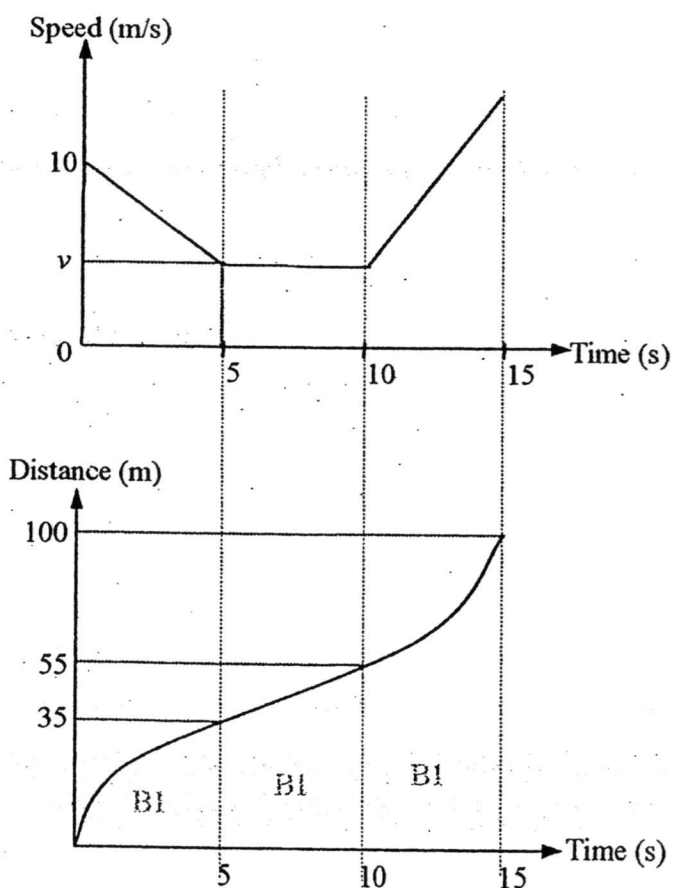
Answer (a) $v = \dots\dots\dots$ [1]

- (b) Find the speed of the particle after 15 seconds.

14 B1

Answer (b) $\dots\dots\dots$ m/s [1]

- (c) Complete the corresponding distance-time graph. [3]



~ END OF PAPER ~

Name : _____

Register Number : _____

Class : _____

Clementi Town Secondary School
Preliminary Examination 2015
Secondary 4 Express / 5 Normal Academic



Mathematics

Paper 2

4016/2

14 September 2015
2 hours 30 minutes

Additional Materials provided: Answer Paper (7 sheets)
Graph paper (1 sheet)

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READ THESE INSTRUCTIONS FIRST

Do not open the booklets until you are told to do so.

Write your name, register number and class on all the work you hand in.

Write in dark blue or black pen on both sides of the answer paper.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.

If working is needed for any question it must be shown with the answer.

Omission of essential working will result in loss of marks.

Calculators should be used where appropriate.

If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures.

Give answers in degrees to one decimal place.

For π , use either your calculator value or 3.142, unless the question requires the answer in terms of π .

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

The total 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

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

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

Answer **all** the questions.

1 (a) Solve $(2x+1)^2 = 25$. [2]

(b) Simplify $\frac{x+2y}{4} + \frac{2x^2-8y^2}{8}$. [2]

(c) It is given that $z = \sqrt{\frac{x}{3x-y}}$.

(i) Find z when $x = 3$ and $y = 1.5$. [1]

(ii) Express x in terms of y and z . [2]

(d) Express $2 - \frac{4f-g}{f+2g}$ as a single fraction in its simplest form. [2]

-
- 2 (a) Lenny bought a brand new car at a selling price of \$109 000.
He paid 40% of the selling price in cash and took a 5-year loan for the rest of the amount.
If the bank charges 2.8% of simple interest per annum for the loan, calculate

(i) the total interest payable, [2]

(ii) the amount Lenny has to pay per month for the loan. [2]

- (b) Lenny's new car uses fuel at an average rate of 9.5 litres per 100 km driven.
In an average year, Lenny drives 15 000 km.
The retail price of fuel is \$2.25 per litre and Lenny has a loyalty card that gives him 10% discount off the retail price.
Assuming the price of fuel remains the same, work out the amount Lenny would expect to spend on fuel in one year, correct to the nearest dollar. [2]

- (c) The original value of the car is its selling price of \$109 000.
For each of the first five years, the value of the car decreases by 13% of its value at the start of every year.
After three years, Lenny decides to sell the car.
Calculate the overall percentage reduction in the value of the car compared with its original value, giving your answer to 2 decimal places. [3]

3



Diagram I

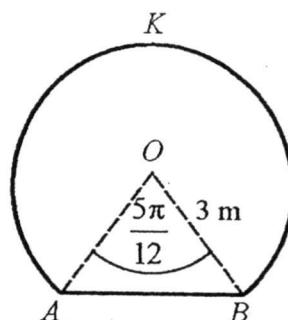


Diagram II

A 20-metre long tunnel can be found along a hiking trail, as shown in Diagram I. The cross-section of this tunnel is a segment AKB of a circle centre O and radius 3 m, as shown in Diagram II.

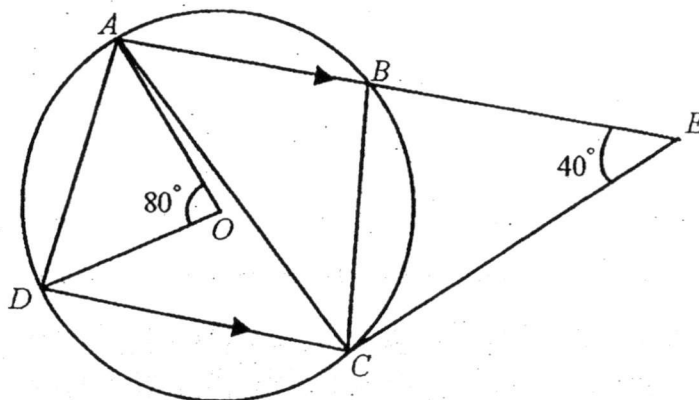
It is given that angle $AOB = \frac{5\pi}{12}$.

(a) Calculate

- (i) the length of AB , [2]
- (ii) the perimeter of the segment AKB , [2]
- (iii) the area of the segment AKB . [3]

- (b) During a construction project, the tunnel is to be permanently sealed off by filling it with cement.
Work out the total cost of cement required to completely fill the tunnel, assuming that the cost of cement is \$30 per cubic metre. [2]

4

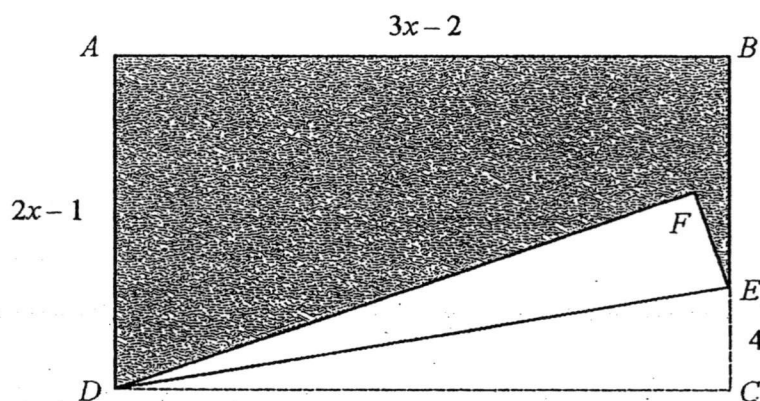


- (a) In the diagram above, $ABCD$ is a cyclic quadrilateral in a circle with centre O . ABE is a straight line which is parallel to DC .
Given that angle $AEC = 40^\circ$ and angle $AOD = 80^\circ$, find

- (i) angle DAO , [1]
- (ii) angle ACD . [1]

- (b) Given further that angle $ODC = 30^\circ$, find angle OAC . [1]
- (c) By showing your working and stating all the reasons clearly,
- (i) prove that triangle ACE is isosceles, [2]
- (ii) show that triangle BCE and triangle DAC are similar. [2]
- (d) A point, F , is on the same side of AD as O , such that angle AFD is 30° .
- Determine whether the point F lies on the circumference of the circle, inside the circle, or outside the circle.
Give a reason for your answer. [2]

5



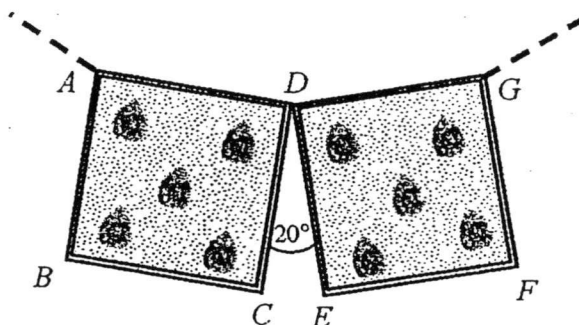
A rectangular piece of paper $ABCD$ is folded along the line ED such that C is moved to F .
The length of AB is $(3x - 2)$ cm, AD is $(2x - 1)$ cm and EC is 4 cm.

- (a) Write down an expression, in terms of x , for
- (i) area of rectangle $ABCD$, [1]
- (ii) area of the triangle DEF . [1]
- (b) Given that the area of the shaded region $ABEFD$ is 184 cm^2 , form an equation in x and show that it reduces to $6x^2 - 19x - 174 = 0$. [2]
- (c) Solve the equation $6x^2 - 19x - 174 = 0$, giving the answers correct to three decimal places. [3]
- (d) Find the perimeter of the folded piece of paper. [2]

150

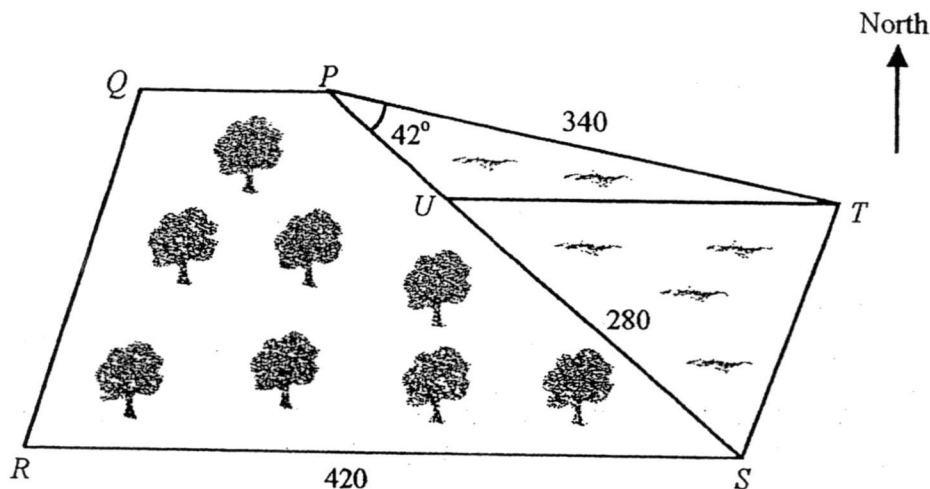
[Turn over]

6



- (a) The diagram above shows part of the design of a necklace.
 AD and DG are sides of a regular polygon.
 $ABCD$ and $DEFG$ are squares, while angle $CDE = 20^\circ$.
- (i) Find the total number of sides of this regular polygon. [3]
- (ii) Calculate angle AGF . [2]
- (b) The first five terms in a sequence of numbers, $T_1, T_2, T_3, T_4, T_5, \dots$ are given by $-9, -4, 1, 6, 11, \dots$
- (i) Find T_6 and T_7 . [1]
- (ii) Is it possible for the terms beyond T_5 to be negative?
 Explain your answer. [1]
- (iii) Find an expression, in terms of n , for T_n . [2]
- (iv) Evaluate T_{150} . [1]
-

7



The diagram shows a large garden, $PQRS$, which overlooks a triangular pond, PST . A bridge is built across the pond from U to T , where U is a point on PS and T is due east of U . Angle $TPU = 42^\circ$ and the bearing of P from T is 290° . $PT = 340$ m, $SU = 280$ m and $RS = 420$ m.

- (a) Calculate
 - (i) angle PTU , [1]
 - (ii) the bearing of S from P . [2]
- (b) After a stroll in the garden, Joe stops at U .
Suppose the entrance to the garden is at P , how far is Joe away from the entrance? [2]
- (c) Calculate the area of the triangular pond, PST . [2]
- (d) During a renovation of the garden, the original bridge is replaced by a new bridge that would join PS to T by the shortest distance.
Calculate the length of this new bridge. [2]
- (e) When the pond appears on an accurate map, $PT = 17$ mm.
Find the area of the pond on this map in square millimetres. [2]

- 8 (a) P is the point $(2, 1)$.

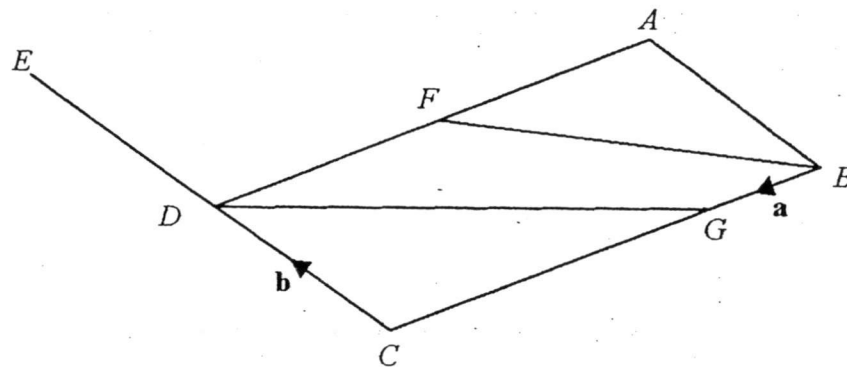
The position vector of Q is $\begin{pmatrix} -3 \\ 6 \end{pmatrix}$.

- (i) Write down the column vector $\overrightarrow{PQ}$. [1]

- (ii) Find the exact value of $|\overrightarrow{PQ}|$. [2]

- (iii) Find the position vector of R , such that $\overrightarrow{QR} = 3\overrightarrow{QP}$. [1]

(b)



$ABCD$ is a parallelogram and E lies on CD produced such that $CD = DE$.
 F is the midpoint of AD and G is a point on BC such that $BG : GC = 1 : 3$.
 Given $\overrightarrow{BG} = \mathbf{a}$ and $\overrightarrow{CD} = \mathbf{b}$,

- (i) express, as simply as possible, in terms of $\mathbf{a}$ and/or $\mathbf{b}$,

(a) $\overrightarrow{DF}$, [1]

(b) $\overrightarrow{BF}$, [1]

(c) $\overrightarrow{BE}$. [1]

- (ii) Make two statements about B , F and E . [2]

- (iii) Find the numerical value of

(a) $\frac{\text{area of triangle } AFB}{\text{area of triangle } DCG}$, [1]

(b) $\frac{\text{area of triangle } AFB}{\text{area of quadrilateral } FBGD}$. [1]

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

The table below shows the number of residents (n) in Town S after t years.

The variables t and n are connected by the equation $n = 60(2^t) + 150$.

Year (t)	0	1	2	3	4	5	6	7
Number of residents (n)	210	270	390	630	1110	2070	k	7830

- (a) Find the value of k . [1]
- (b) Using a scale of 2 cm to represent 1 year, draw a horizontal axis for $0 \leq t \leq 7$.
Using a scale of 2 cm to represent 1000 residents, draw a vertical axis for $0 \leq n \leq 8000$.

On your axes, plot the points given in the table and join them with a smooth curve. [3]
- (c) Use your graph to estimate the number of years it took for the population of the town to reach 1000. [1]
- (d) (i) By drawing a tangent, find the gradient of the curve at (5, 2070). [2]
(ii) What does this gradient represent? [1]
- (e) The number of residents in another town, Town M is given by the equation $n = 7000 - 600t$ for $0 \leq t \leq 7$.
(i) On the same axes, draw a graph to represent the number of residents in Town M . [2]
(ii) Find the value of t when the two towns have the same number of residents. [1]

- 10 (a) A goodie bag contains 5 chocolates and 3 candy bars.
Ann takes an item randomly from the goodie bag and eats it.
Ben then takes an item randomly from the goodie bag.
- (i) Draw a tree diagram to show the probabilities of the possible outcomes. [2]
- Find, as a fraction in its simplest form, the probability that
- (ii) both of them take a candy bar, [1]
- (iii) Ben takes a chocolate, [1]
- (iv) one of the items taken is a chocolate. [1]

- (b) Twenty students took part in a Mathematics quiz which has a maximum of 10 marks.
Their marks are shown in the frequency table below.

Mark	2	3	4	5	6	7	8	9	10
Frequency	1	1	0	2	5	3	1	4	3

- (i) Write down the median mark. [1]
- (ii) Calculate the mean mark. [1]
- (iii) What is the passing mark of the quiz if 40% of the students passed? [1]
- (iv) Calculate the standard deviation. [2]
- (v) The same group of students took part in a Science quiz with the same maximum mark.
The mean mark for the Science quiz was 7.5 and the standard deviation was 2.02.
Make two comparisons between the performances of the students in these two quizzes. [2]

Name : _____

Register Number : _____

Class : _____

Clementi Town Secondary School
Preliminary Examination 2015
Secondary 4 Express / 5 Normal Academic



Mathematics
Paper 2

MARKING SCHEME

4016/2

14 September 2015
2 hours 30 minutes

Additional Materials provided: Answer Paper (7 sheets)
Graph paper (1 sheet)

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READ THESE INSTRUCTIONS FIRST

Do not open the booklets until you are told to do so.

Write your name, register number and class on all the work you hand in.

Write in dark blue or black pen on both sides of the answer paper.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.

If working is needed for any question it must be shown with the answer.

Omission of essential working will result in loss of marks.

Calculators should be used where appropriate.

If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures.

Give answers in degrees to one decimal place.

For π , use either your calculator value or 3.142, unless the question requires the answer in terms of π .

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

The total 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

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

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

Answer **all** the questions.

1 (a) Solve $(2x+1)^2 = 25$. [2]

(b) Simplify $\frac{x+2y}{4} + \frac{2x^2-8y^2}{8}$. [2]

(c) It is given that $z = \sqrt{\frac{x}{3x-y}}$.
(i) Find z when $x = 3$ and $y = 1.5$. [1]
(ii) Express x in terms of y and z . [2]

(d) Express $2 - \frac{4f-g}{f+2g}$ as a single fraction in its simplest form. [2]

1 (a) $(2x+1) = \pm\sqrt{25}$
 $x = \frac{5-1}{2}$ or $\frac{-5-1}{2}$
 $x = 2$ or -3 [B2 – 1 mark for each correct answer]

1 (b) $\frac{x+2y}{4} + \frac{2(x-2y)(x+2y)}{8}$ [M1 – factorise]
 $= \frac{x+2y}{4} \times \frac{2(x-2y)(x+2y)}{2(x-2y)(x+2y)}$
 $= \frac{1}{x-2y}$ [A1]

1 (c) (i) $z \approx 0.632$ [B1]
(ii) $z^2 = \frac{x}{3x-y}$
 $3z^2x - z^2y = x$
 $3z^2x - x = z^2y$ [M1 – grouping like terms]
 $x(3z^2 - 1) = z^2y$
 $x = \frac{z^2y}{3z^2 - 1}$ [A1]

1 (d) $\frac{2f+4g-(4f-g)}{f+2g}$ [M1 – combine as a single fraction]
 $= \frac{5g-2f}{f+2g}$ [A1]

- 2 (a) Lenny bought a brand new car at a selling price of \$109 000.
He paid 40% of the selling price in cash and took a 5-year loan for the rest of the amount.
If the bank charges 2.8% of simple interest per annum for the loan, calculate
- (i) the total interest payable, [2]
(ii) the amount Lenny has to pay per month for the loan. [2]
- (b) Lenny's new car uses fuel at an average rate of 9.5 litres per 100 km driven.
In an average year, Lenny drives 15 000 km.
The retail price of fuel is \$2.25 per litre and Lenny has a loyalty card that gives him 10% discount off the retail price.
Assuming the price of fuel remains the same, work out the amount Lenny would expect to spend on fuel in one year, correct to the nearest dollar. [2]
- (c) The original value of the car is its selling price of \$109 000.
For each of the first five years, the value of the car decreases by 13% of its value at the start of every year.
After three years, Lenny decides to sell the car.
Calculate the overall percentage reduction in the value of the car compared with its original value, giving your answer to 2 decimal places. [3]

- 2 (a) (i) $\text{Interest} = \$ \frac{(0.6 \times 109\,000) \times 2.8 \times 5}{100}$ [M1 – simple interest]
 $= \$9\,156$ [A1]
- (ii) $\text{Monthly payment} = \$ \frac{(0.6 \times 109\,000) + 9\,156}{5 \times 12}$ [M1 – instalment]
 $= \$1\,242.60$ [A1]
- 2 (b) $\left. \begin{array}{l} \text{Amount of fuel required in a year} = 9.5 \times 150 = 1425 \text{ litres} \\ \text{Price of 1 litre of fuel after discount} = \$2.025 \end{array} \right\} \text{ [M1 – either one]}$
 $\text{Amount of money spent on fuel in a year} = \$2\,885.625 \approx \$2\,886$ [A1]
- 2 (c) $109\,000 \times (0.87)^3 = 71\,776.827$ [M1 – depreciation]
 $\frac{109\,000 - 71\,776.827}{109\,000} \times 100\%$ [M1 – find % change]
 $\approx 34.15\% \text{ (to 2 d.p.)}$ [A1]

3

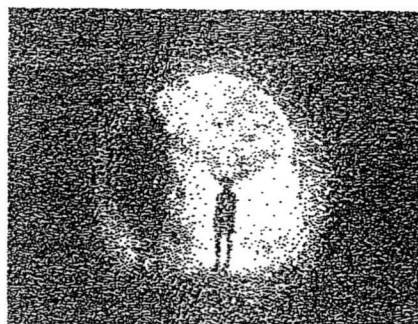


Diagram I

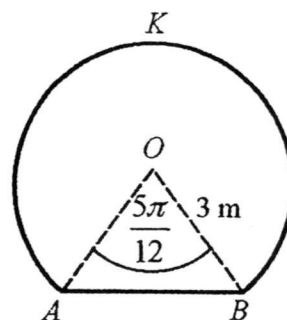


Diagram II

A 20-metre long tunnel can be found along a hiking trail, as shown in Diagram I. The cross-section of this tunnel is a segment AKB of a circle centre O and radius 3 m, as shown in Diagram II.

It is given that angle $AOB = \frac{5\pi}{12}$.

(a) Calculate

(i) the length of AB , [2]

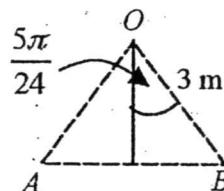
(ii) the perimeter of the segment AKB , [2]

(iii) the area of the segment AKB . [3]

(b) During a construction project, the tunnel is to be permanently sealed off by filling it with cement.

Work out the total cost of cement required to completely fill the tunnel, assuming that the cost of cement is \$30 per cubic metre. [2]

3 (a) (i) $AB = 2\left(3\sin\frac{5\pi}{24}\right)$ [M1 – use trigo ratio]
 $\approx 3.65 \text{ m (3 s.f.)}$ [A1]



OR by cosine rule

3 (a) (ii) Perimeter $= 3\left(2\pi - \frac{5\pi}{12}\right) + AB$ [M1 – find arc length]
 $\approx 18.6 \text{ m (3 s.f.)}$ [A1]

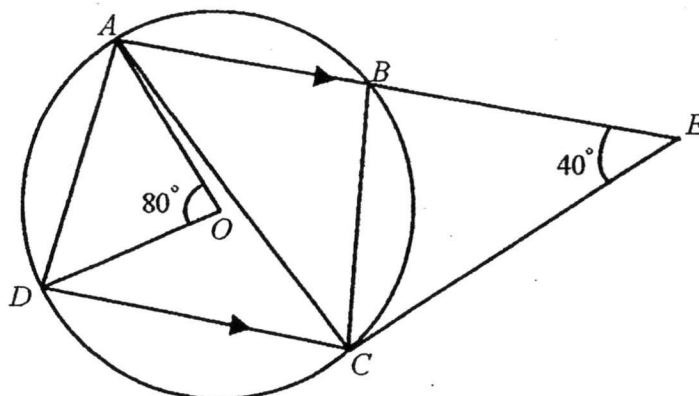
3 (a) (iii) Area of minor segment $= \frac{1}{2}(3)^2\left(\frac{5\pi}{12} - \sin\frac{5\pi}{12}\right)$ [M1]
 $\approx 1.54382 \text{ m}^2$

Area of major segment $AKB = \pi(3)^2 - 1.54382$ [M1]
 $\approx 26.7305 \text{ m}^2$
 $\approx 26.7 \text{ m}^2 \text{ (3 s.f.)}$ [A1]

3 (b) Volume of tunnel $= 26.7305 \times 20 = 534.61 \text{ m}^3$ [M1] 155

Total cost of cement $= 30 \times 534.61 \approx \$16000 \text{ (3 s.f.) or } \16038.30 [A1]

4



- (a) In the diagram above, $ABCD$ is a cyclic quadrilateral in a circle with centre O . ABE is a straight line which is parallel to DC .

Given that angle $AEC = 40^\circ$ and angle $AOD = 80^\circ$, find

- (i) angle DAO , [1]
 - (ii) angle ACD . [1]
- (b) Given further that angle $ODC = 30^\circ$, find angle OAC . [1]
- (c) By showing your working and stating all the reasons clearly,
- (i) prove that triangle ACE is isosceles, [2]
 - (ii) show that triangle BCE and triangle DAC are similar. [2]

- (d) A point, F , is on the same side of AD as O , such that angle AFD is 30° .

Determine whether the point F lies on the circumference of the circle, inside the circle, or outside the circle.

Give a reason for your answer. [2]

- 4 (a) (i) $\angle DAO = \frac{180^\circ - 80^\circ}{2} = 50^\circ$ (isos. triangle) [A1 – with reason]
- 4 (a) (ii) $\angle ACD = \frac{1}{2}(80^\circ) = 40^\circ$ ($\angle$ at centre = 2 $\angle$ at circumf) [A1 – with reason]
- 4 (b) $\angle OAC = 180^\circ - 50^\circ - 50^\circ - 40^\circ - 30^\circ = 10^\circ$ (sum of $\angle$ s in a triangle) [A1 – with reason]
- 4 (c) (i) $\angle EAC = \angle ACD = 40^\circ$ (from (a)(ii); alt. $\angle$ s, $AE \parallel DC$)
Hence $\angle EAC = 40^\circ$ [M1]
Since $\angle EAC = \angle AEC$
Hence, triangle ACE is isosceles. [A1]
- 4 (c) (ii) $\left. \begin{array}{l} \angle CBE = \angle ADC \text{ (ext } \angle \text{ of cyclic quad)} \\ \angle BEC = \angle DCA = 40^\circ \text{ (from (a))} \end{array} \right\}$ [A1 – with reason]

By AA similarity test, triangle BCE and triangle DAC are similar. [A1]

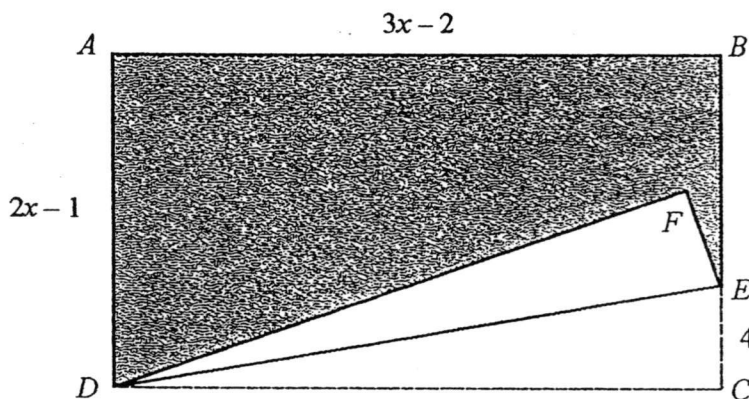
- 4 (d) F lies outside the circle. [B1]

If F lies on the circumference, $\angle AFD = 40^\circ$.

If F lies inside the circle, $40^\circ < \angle AFD < 80^\circ$. ($\angle$ at centre = $2 \angle$ at circumf)

Hence F must lie outside the circle [A1 – with reason]

5



A rectangular piece of paper $ABCD$ is folded along the line ED such that C is moved to F .

The length of AB is $(3x - 2)$ cm, AD is $(2x - 1)$ cm and EC is 4 cm.

- (a) Write down an expression, in terms of x , for
 (i) area of rectangle $ABCD$, [1]
 (ii) area of the triangle DEF . [1]
- (b) Given that the area of the shaded region $ABEFD$ is 184 cm^2 , form an equation in x and show that it reduces to $6x^2 - 19x - 174 = 0$. [2]
- (c) Solve the equation $6x^2 - 19x - 174 = 0$, giving the answers correct to three decimal places. [3]
- (d) Find the perimeter of the folded piece of paper. [2]

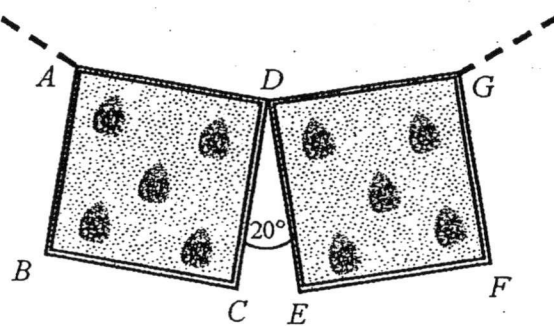
5 (a) (i) $(3x - 2)(2x - 1) = 6x^2 - 7x + 2$ [B1]

5 (a) (ii) $\frac{1}{2}(4)(3x - 2) = 6x - 4$ [B1]

5 (b) $6x^2 - 7x + 2 - 2(6x - 4) = 184$ [M1]
 $6x^2 - 19x - 174 = 0$ [A1]

- 5 (c) $x = \frac{-(-19) \pm \sqrt{(-19)^2 - (4)(6)(-174)}}{(2)(6)}$ [M1 – quadratic formula]
 $x = 7.196$ or -4.030 [A2 – 1 mark for each correct answer]
- 5 (d) $DC = 3x - 2 = 19.588$
 $DE = \sqrt{19.588^2 + 4^2} = 19.992$ cm [M1 – find DE by Pythagoras Theorem]
 Perimeter $= 3x - 2 + 2x - 1 + 2x - 5 + 19.992$
 $= 7x + 11.992$
 ≈ 62.4 cm [A1]

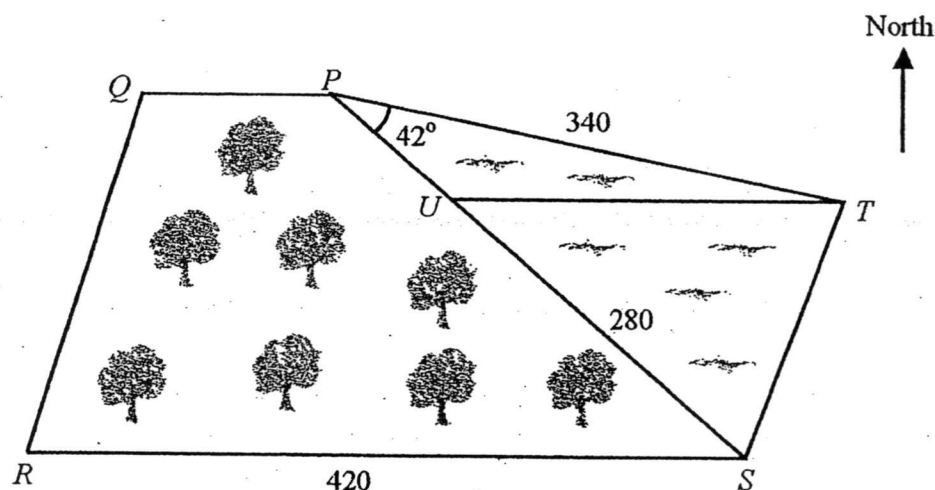
6



- (a) The diagram above shows part of the design of a necklace.
 AD and DG are sides of a regular polygon.
 $ABCD$ and $DEFG$ are squares, while angle $CDE = 20^\circ$.
- (i) Find the total number of sides of this regular polygon. [3]
- (ii) Calculate angle AGF . [2]
- 6 (b) The first five terms in a sequence of numbers, $T_1, T_2, T_3, T_4, T_5, \dots$ are given by $-9, -4, 1, 6, 11, \dots$
- (i) Find T_6 and T_7 . [1]
- (ii) Is it possible for the terms beyond T_5 to be negative? Explain your answer. [1]
- (iii) Find an expression, in terms of n , for T_n . [2]
- (iv) Evaluate T_{150} . [1]
- 6 (a) (i) Interior angle of polygon ($\angle ADG$) $= 360^\circ - 90^\circ - 90^\circ - 20^\circ$
 $= 160^\circ$ [M1 – angles at a point]
 $\therefore$ Exterior angle $= 180^\circ - 160^\circ = 20^\circ$
 No. of sides $= \frac{360}{20}$ [M1 – int or ext $\angle$ of polygon method]
 $= 18$ [A1]

- 6 (a) (ii) $\angle AGD = \frac{180^\circ - 160^\circ}{2} = 10^\circ$ [M1 – isos Δ]
 $\angle AGF = 10^\circ + 90^\circ = 100^\circ$ [A1]
- 6 (b) (i) $T_6 = 16, T_7 = 21$ [B1]
- 6 (b) (ii) No. Every term in this sequence is larger than the previous by 5. Since the terms after 2nd term is positive, any of the terms after the 5th term can never be negative. [B1]
- 6 (b) (iii) $\left. \begin{array}{l} T_n = -9, -4, 1, 6, 11, \dots \\ T_n + 14 = 5, 10, 15, 20, 25, \dots \\ T_n + 14 = 5n \end{array} \right\}$ [M1 – recognise the pattern]
 $T_n = 5n - 14$ [A1]
- 6 (b) (iv) $T_{150} = 5(150) - 14 = 736$ [B1]

7



The diagram shows a large garden, $PQRS$, which overlooks a triangular pond, PST .
 A bridge is built across the pond from U to T , where U is a point on PS and T is due east of U .
 Angle $TPU = 42^\circ$ and the bearing of P from T is 290° .
 $PT = 340$ m, $SU = 280$ m and $RS = 420$ m.

- (a) Calculate
- (i) angle PTU , [1]
- (ii) the bearing of S from P . [2]
- (b) After a stroll in the garden, Joe stops at U .
 Suppose the entrance to the garden is at P , how far is Joe away from the entrance? [2]

- (c) Calculate the area of the triangular pond, PST . [2]
- (d) During a renovation of the garden, the original bridge is replaced by a new bridge that would join PS to T by the shortest distance. Calculate the length of this new bridge. [2]
- (e) When the pond appears on an accurate map, $PT = 17$ mm. Find the area of the pond on this map in square millimetres. [2]

7 (a)(i) $\angle PTU = 290^\circ - 270^\circ = 20^\circ$ [B1]

7 (a)(ii) $\angle BTP = 360^\circ - 290^\circ = 70^\circ$

$$\angle APT = 180^\circ - 70^\circ = 110^\circ$$

$$\text{Bearing of } S \text{ from } P = 110^\circ + 42^\circ = 152^\circ$$
 [A1]

7 (b) $\angle PUT = 180^\circ - 42^\circ - 20^\circ = 118^\circ$

$$\frac{PU}{\sin 20^\circ} = \frac{340}{\sin 118^\circ}$$
 [M1– sine rule]

$$PU = \frac{340}{\sin 118^\circ} \times \sin 20^\circ$$

$$= 131.703$$

$$= 132 \text{ m (3 s.f.)}$$
 [A1]

7 (c) Area of the pond $= \frac{1}{2}(340)(280 + 131.703)\sin 42^\circ$ [M1 – $\frac{1}{2}ab \sin c^\circ$]
 $= 46832.12$
 $= 46800 \text{ m}^2 \text{ (3 s.f.)}$ [A1]

7 (d) Let x be the shortest distance from PS to T .

$$\text{Area of the pond} = 46832.12 \text{ m}^2$$

$$\frac{1}{2}(x)(280 + 131.703) = 46832.12$$
 [M1– area of triangle]

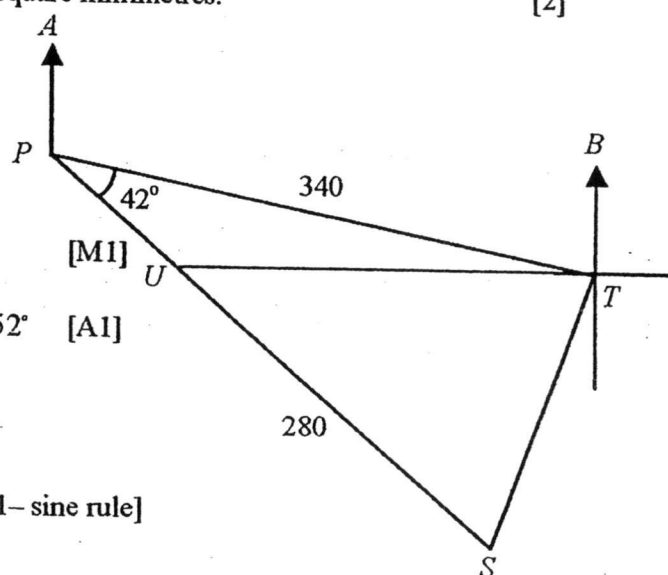
$$x = 227.504 \approx 228 \text{ m (3 s.f.)}$$
 [A1]

7 (e) Ratio of length $= 340 \text{ m} : 17 \text{ mm} = 20 \text{ m} : 1 \text{ mm}$

$$\text{Ratio of area} = 400 \text{ m}^2 : 1 \text{ mm}^2$$

[M1– area of similar figures]

$$\text{Area of pond on the map} = \frac{46832.12}{400} \approx 117 \text{ mm}^2$$
 [A1]



- 8 (a) P is the point $(2, 1)$.

The position vector of Q is $\begin{pmatrix} -3 \\ 6 \end{pmatrix}$.

- (i) Write down the column vector $\overrightarrow{PQ}$. [1]

- (ii) Find the exact value of $|\overrightarrow{PQ}|$. [2]

- (iii) Find the position vector of R , such that $\overrightarrow{QR} = 3\overrightarrow{QP}$. [1]

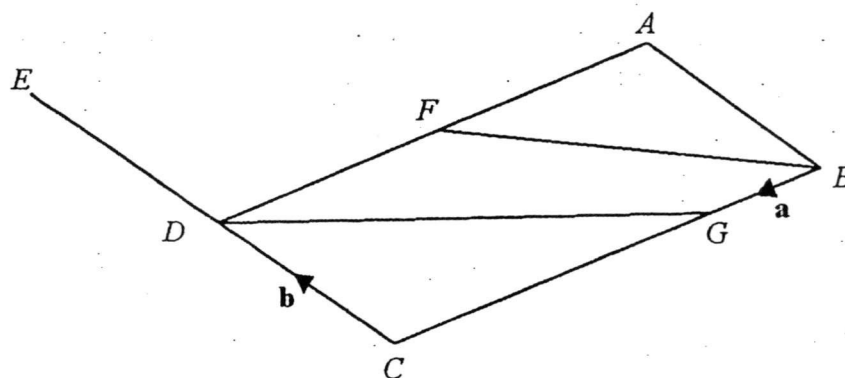
(a) (i) $\overrightarrow{OP} = \begin{pmatrix} 2 \\ 1 \end{pmatrix}$

$$\overrightarrow{PQ} = \overrightarrow{OQ} - \overrightarrow{OP} = \begin{pmatrix} -3 \\ 6 \end{pmatrix} - \begin{pmatrix} 2 \\ 1 \end{pmatrix} = \begin{pmatrix} -5 \\ 5 \end{pmatrix} \quad [\text{B1}]$$

(a) (ii) $|\overrightarrow{PQ}| = \sqrt{5^2 + 5^2} \quad [\text{M1}]$
 $= \sqrt{50} \text{ or } 5\sqrt{2} \text{ units} \quad [\text{A1}]$

(a) (iii) $\overrightarrow{QR} = 3\overrightarrow{QP}$
 $\overrightarrow{OR} - \overrightarrow{OQ} = 3(\overrightarrow{OP} - \overrightarrow{OQ})$
 $\overrightarrow{OR} = 3\overrightarrow{OP} - 2\overrightarrow{OQ} = 3\begin{pmatrix} 2 \\ 1 \end{pmatrix} - 2\begin{pmatrix} -3 \\ 6 \end{pmatrix} = \begin{pmatrix} 12 \\ -9 \end{pmatrix} \quad [\text{B1}]$

(b)



$ABCD$ is a parallelogram and E lies on CD produced such that $CD = DE$.
 F is the midpoint of AD and G is a point on BC such that $BG : GC = 1 : 3$.
 Given $\overrightarrow{BG} = \mathbf{a}$ and $\overrightarrow{CD} = \mathbf{b}$,

- (i) express, as simply as possible, in terms of $\mathbf{a}$ and/or $\mathbf{b}$,

(a) $\overrightarrow{DF}$, [1]

(b) $\overrightarrow{BF}$, [1]

(c) $\overrightarrow{BE}$. [1]

(ii) Make two statements about B , F and E . [2]

(iii) Find the numerical value of

(a) $\frac{\text{area of triangle } AFB}{\text{area of triangle } DCG}$ [1]

(b) $\frac{\text{area of triangle } AFB}{\text{area of quadrilateral } FBGD}$ [1]

(b) (i) (a) $\overrightarrow{DF} = -\overrightarrow{AF} = -\frac{1}{2}\overrightarrow{BC} = -\frac{1}{2}(4\mathbf{a}) = -2\mathbf{a}$ [B1]

(b) (i) (b) $\overrightarrow{BF} = \overrightarrow{BC} + \overrightarrow{CD} + \overrightarrow{DF} = 4\mathbf{a} + \mathbf{b} - 2\mathbf{a} = 2\mathbf{a} + \mathbf{b}$ [B1]

(b) (i) (c) $\overrightarrow{BE} = \overrightarrow{BC} + \overrightarrow{CE} = 4\mathbf{a} + 2\mathbf{b}$ [B1]

(b) (ii) $\therefore \overrightarrow{BE} = 2\overrightarrow{BF}$

(1) $BE = 2BF$ (2) B , F and E lie on the same straight line. [B2]

(b) (iii) (a) $\frac{\text{area of triangle } AFB}{\text{area of triangle } DCG} = \frac{2}{3}$ [B1]

(b) (iii) (b) $\frac{\text{area of triangle } AFB}{\text{area of parallelogram } ABCD} = \frac{1}{4} = \frac{2}{8}$
 $\frac{\text{area of triangle } AFB}{\text{area of triangle } DCG} = \frac{2}{3}$ (from (a))
 $\therefore \frac{\text{area of triangle } AFB}{\text{area of quadrilateral } FBGD} = \frac{2}{3}$ [B1]

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

The table below shows the number of residents (n) in Town S after t years.

The variables t and n are connected by the equation $n = 60(2^t) + 150$.

Year (t)	0	1	2	3	4	5	6	7
Number of residents (n)	210	270	390	630	1110	2070	k	7830

(a) Find the value of k . [1]

(b) Using a scale of 2 cm to represent 1 year, draw a horizontal axis for $0 \leq t \leq 7$.
Using a scale of 2 cm to represent 1000 residents, draw a vertical axis for $0 \leq n \leq 8000$.

On your axes, plot the points given in the table and join them with a smooth curve. [3]

(c) Use your graph to estimate the number of years it took for the population of the town to reach 1000. [1]

(d) (i) By drawing a tangent, find the gradient of the curve at (5, 2070). [2]

(ii) What does this gradient represent? [1]

(e) The number of residents in another town, Town M is given by the equation $n = 7000 - 600t$ for $0 \leq t \leq 7$.

(i) On the same axes, draw a graph to represent the number of residents in Town M . [2]

(ii) Find the value of t when the two towns have the same number of residents. [1]

9 (a) $k = 60(2^6) + 150 = 3990$
[B1]

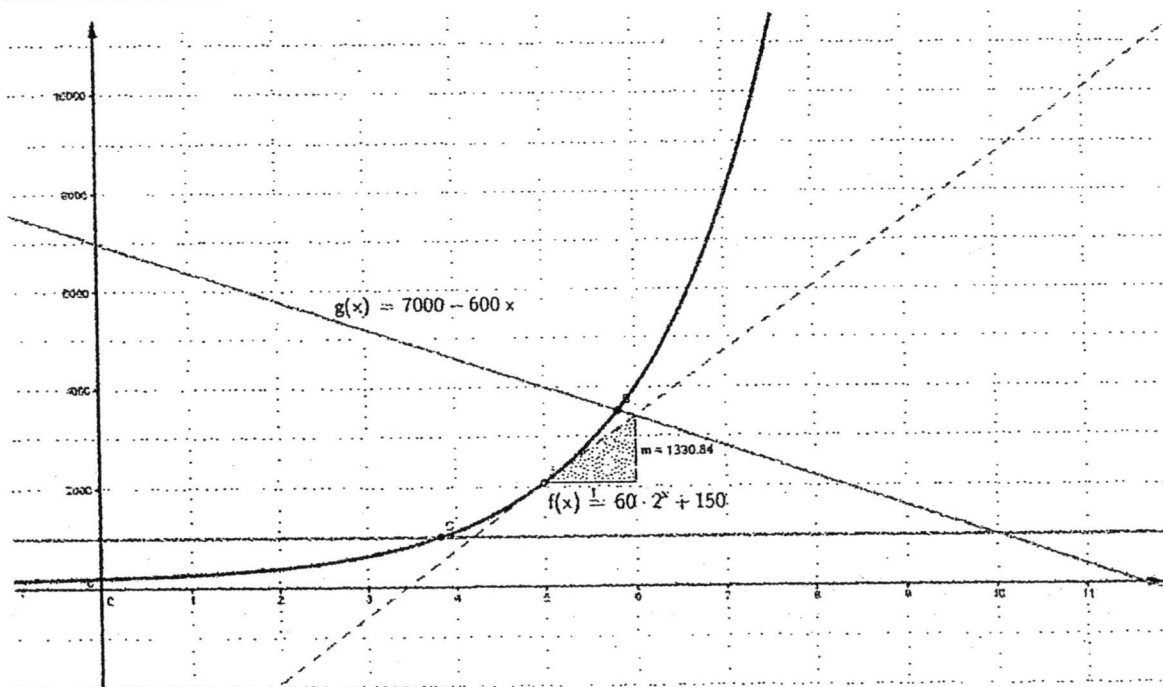
9 (b) Draw the axes with correct scale. [B1]
Plot all given points. [B1]
Draw a smooth curve through all plots. [B1]
(Refer to graph)

9 (c) $t = 3.8$ years (± 0.1) [B1]

9 (d) (i) Draw the tangent at $t = 5$. [M1]
Gradient = 1330 (± 100) [A1]
(ii) The gradient represents the rate at which the number of residents in the town is increasing at the instant when $t = 5$. [B1]

9 (e) (i) Plot at least 2 points from the given equation. [B1]
Draw a straight through all plots. [B1]
(Refer to graph)

9 (e) (ii) From the graph, $t = 5.8$ [B1]



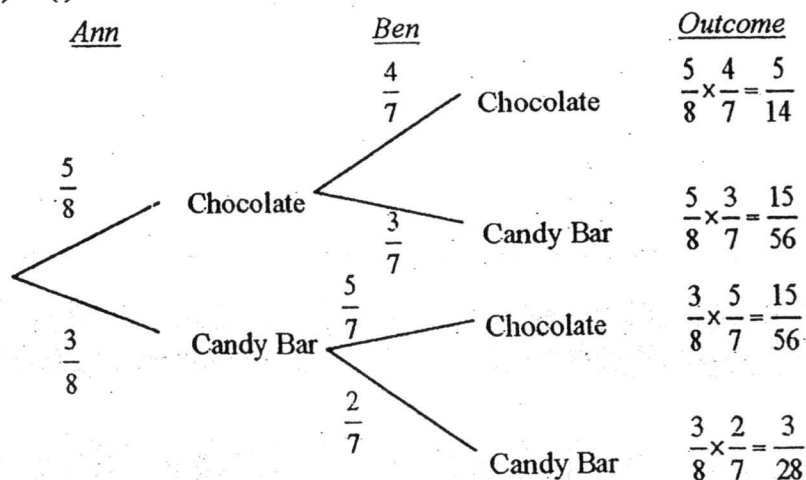
- 10 (a) A goodie bag contains 5 chocolates and 3 candy bars.
Ann takes an item randomly from the goodie bag and eats it.
Ben then takes an item randomly from the goodie bag.

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

Find, as a fraction in its simplest form, the probability that

- (ii) both of them take a candy bar, [1]
(iii) Ben takes a chocolate, [1]
(iv) one of the items taken is a chocolate. [1]

10 (a) (i)



[B2 for no errors, B1 for 1-2 errors, B0 for more than 2 errors]

10 (a) (ii) $\frac{3}{8} \times \frac{2}{7} = \frac{3}{28}$ [B1]

10 (a) (iii) $\frac{5}{8} \times \frac{4}{7} + \frac{3}{8} \times \frac{5}{7} = \frac{5}{8}$ [B1]

10 (a) (iv) $\frac{5}{8} \times \frac{3}{7} + \frac{3}{8} \times \frac{5}{7} = \frac{15}{28}$ [B1]

- 10 (b) Twenty students took part in a Mathematics quiz which has a maximum of 10 marks. Their marks are shown in the frequency table below.

Mark	2	3	4	5	6	7	8	9	10
Frequency	1	1	0	2	5	3	1	4	3

- (i) Write down the median mark. [1]
- (ii) Calculate the mean mark. [1]
- (iii) What is the passing mark of the quiz if 40% of the students passed? [1]
- (iv) Calculate the standard deviation. [2]
- (v) The same group of students took part in a Science quiz with the same maximum mark.
The mean mark for the Science quiz was 7.5 and the standard deviation was 2.02.
Make two comparisons between the performances of the students in these two quizzes. [2]

10 (b) (i) Median = 7 [B1]

10 (b) (ii) Mean = $\frac{2 \times 1 + 3 \times 1 + 5 \times 2 + 6 \times 5 + 7 \times 3 + 8 \times 1 + 9 \times 4 + 10 \times 3}{20} = 7$ [B1]

10 (b) (iii) Passing mark = 8 [B1]

10 (b) (iv) Standard deviation = $\sqrt{\frac{2^2 \times 1 + 3^2 \times 1 + 5^2 \times 2 + 6^2 \times 5 + 7^2 \times 3 + 8^2 \times 1 + 9^2 \times 4 + 10^2 \times 3}{20} - 7^2}$
= 2.21 (3 s.f.) [M1] [A1]

- 10 (b) (v) - The students generally performed **better** for the Science Quiz as the mean mark for the Science Quiz is higher than the mean mark for the Mathematics Quiz.
- The marks for the Science Quiz are more **consistent** than the marks for the Mathematics Quiz. [B2]

- End of Paper -

