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EDEXCEL INTERNATIONAL GCSE MATHS: QUESTIONS BY TOPIC

Graphs (A4)

International GCSE Mathematics A (4MA1) · Higher tier

104 questions · 412 marks · Mark schemes included

Past papers June 2018 - June 2025 · 4 sub-topics

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HOW TO USE THIS BOOKLET

Questions are grouped by sub-topic and run from the lowest to the highest mark tariff, then oldest paper first.
Click any row below to jump straight to that sub-topic or question.
On every question page, click ANSWER in the top-right corner to jump to its mark scheme; < QUESTION brings you back.
A gold bar in the left margin marks exactly where the question sits on the original page.
Diagrams, graphs, grids and tables are printed exactly as they appear in the original papers.
Each question is filed under its main topic; longer questions may also test skills from other topics.

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QUESTIONS

104 questions · 412 marks · 4 sub-topics

SUB-TOPIC A4a

COORDINATES & STRAIGHT-LINE GRAPHS

Sub-topic A4a · 42 questions · 175 marks · lowest tariff first

6 Point A has coordinates $(-3, 11)$
Point B has coordinates $(47, b)$
The midpoint of AB has coordinates $(a, -19)$

Find the value of a and the value of b.

$a =$ .....

$b =$ .....

(Total for Question 6 is 2 marks)

7 Pedro drove from Toulouse to Montpellier in 2 hours 42 minutes.
He drove at an average speed of 90 km/hour.

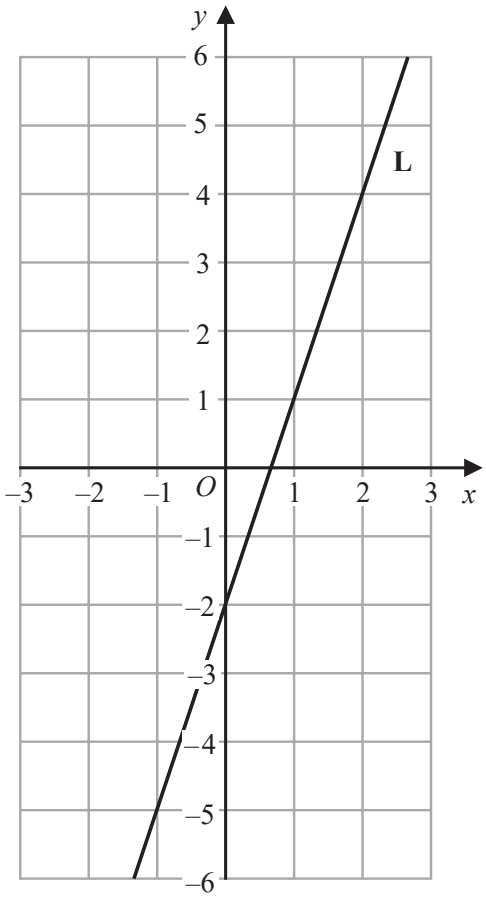
Janine drove from Toulouse to Montpellier along the same route as Pedro.
The journey took her 3 hours.

Work out Janine's average speed for the journey.

..... km/hour

(Total for Question 7 is 4 marks)

6 The line **L** is shown on the grid.



Find an equation for **L**.

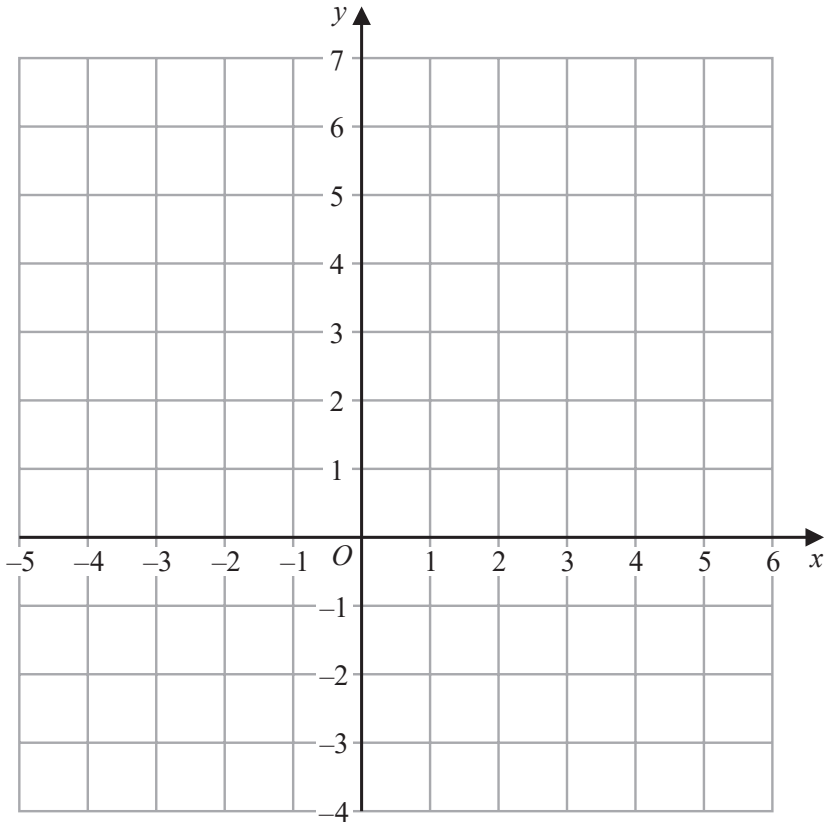
.....

(Total for Question 6 is 2 marks)

11 Show, by shading on the grid, the region that satisfies all three of the inequalities

$$x \leqslant 4 \qquad \text{and} \qquad y \geqslant -2 \qquad \text{and} \qquad y \leqslant x$$

Label the region **R**.



(Total for Question 11 is 3 marks)

12 Find the gradient of the straight line with equation $5x + 2y = 7$

.....

(Total for Question 12 is 2 marks)

8 The mean number of goals scored by a hockey team in 8 matches is 6
The team plays 2 more matches and scores k goals in each match.
The mean number of goals scored by the hockey team in the 10 matches is 7

Work out the value of k

$k =$ .....

(Total for Question 8 is 3 marks)

9 A straight line passes through the points with coordinates (0, –3) and (2, 0)

Find an equation of the line.

.....

(Total for Question 9 is 2 marks)

18 The straight line **P** has equation $5y + 2x = 7$

Find the gradient of a straight line that is perpendicular to **P**

.....

(Total for Question 18 is 2 marks)

19 $G = \dfrac{c}{2f - 3h}$

$c = 8$ correct to the nearest whole number
$f = 6.62$ correct to 2 decimal places
$h = 1.2$ correct to 1 decimal place

Work out the lower bound for the value of G
Give your answer correct to 3 decimal places.
Show your working clearly.

.....

(Total for Question 19 is 3 marks)

9 In a sale, normal prices are reduced by 15%

The sale price of a dishwasher is 612 Swiss francs.

Work out the normal price of the dishwasher.

..... Swiss francs

(Total for Question 9 is 3 marks)

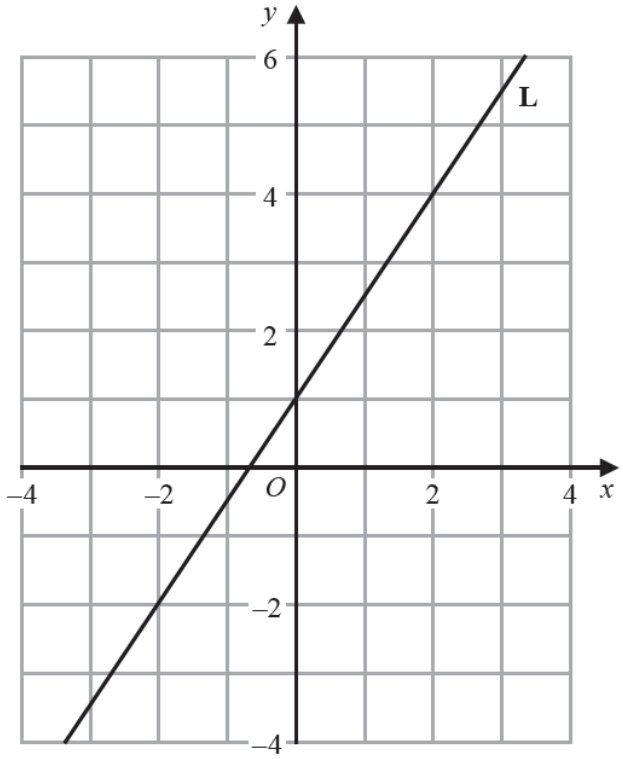
10 A straight line, **L**, is parallel to the line with equation $y = 2 - 5x$
The line **L** passes through the point (0, 6)

Find an equation of the line **L**

.....

(Total for Question 10 is 2 marks)

10 The line **L** is drawn on the grid.



Find an equation for **L**.

(Total for Question 10 is 3 marks)

11 The straight line $\mathbf{L}_1$ has equation $x + 2y = 4$
The straight line $\mathbf{L}_2$ passes through the points $(-1, -7)$ and $(7, 9)$

Michael says that the lines $\mathbf{L}_1$ and $\mathbf{L}_2$ are perpendicular.

Is Michael correct?
You must show clearly how you get your answer.

(Total for Question 11 is 3 marks)

10 Henri buys a yacht for 150 000 euros.

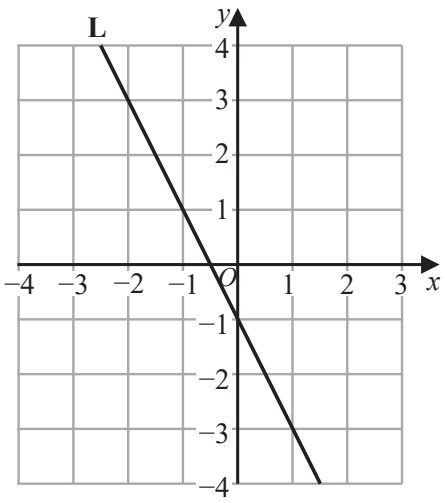
The yacht depreciates in value by 18% each year.

Work out the value of the yacht at the end of 3 years.
Give your answer correct to the nearest euro.

..... euros

(Total for Question 10 is 3 marks)

11 Line **L** is drawn on the grid.

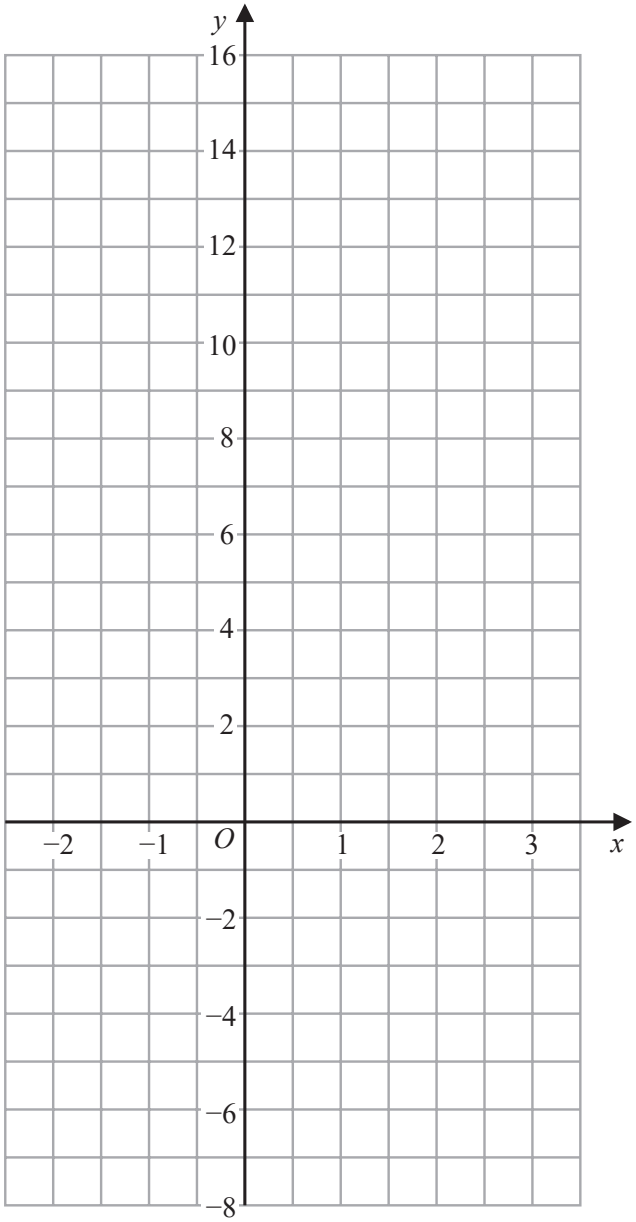


Find an equation for **L**.

.....

(Total for Question 11 is 3 marks)

3 On the grid, draw the graph of $y = 7 - 4x$ for values of x from -2 to 3



(Total for Question 3 is 3 marks)

13 Point A has coordinates (5, 8)
Point B has coordinates (9, –4)

(a) Work out the gradient of AB.

.....

(2)

The straight line **L** has equation $y = -4x + 5$

(b) Write down the gradient of a straight line that is perpendicular to **L**.

.....

(1)

(Total for Question 13 is 3 marks)

10 The straight line **L** has equation $2y + 7x = 10$

(a) Find the gradient of **L**

.....

(2)

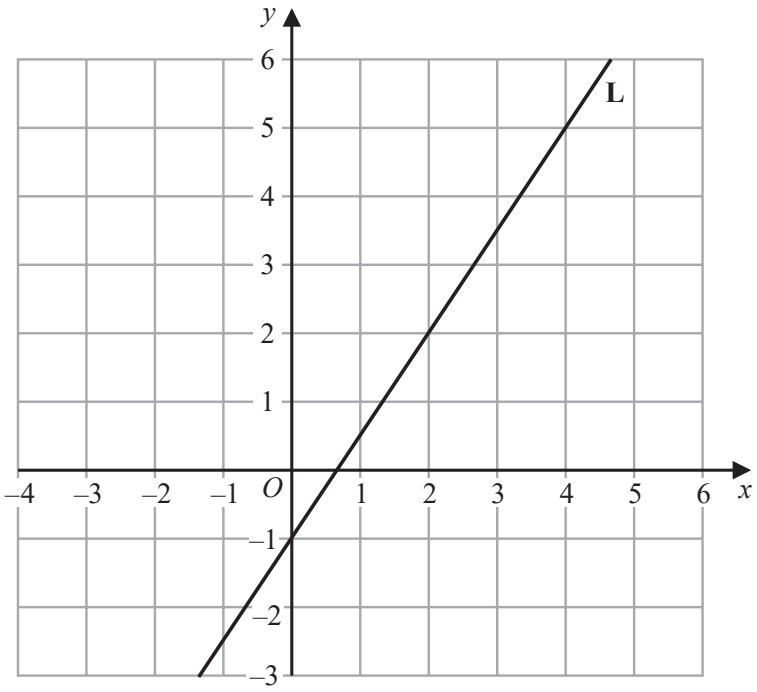
(b) Find the coordinates of the point where **L** crosses the y-axis.

(..... , ...)

(1)

(Total for Question 10 is 3 marks)

10 Line **L** is drawn on the grid.



Find an equation for **L**
Give your answer in the form $y = mx + c$

.....

(Total for Question 10 is 3 marks)

6 The points A and B are on a coordinate grid.

The coordinates of A are (6, 4)
The coordinates of B are (17, j) where j is a constant.

The midpoint of AB has coordinates (k, 15) where k is a constant.

Find the value of j and the value of k

$j =$ .....

$k =$ .....

(Total for Question 6 is 3 marks)

7 Solve the simultaneous equations

$$5x + 4y = -2$$
$$2x - y = 4.4$$

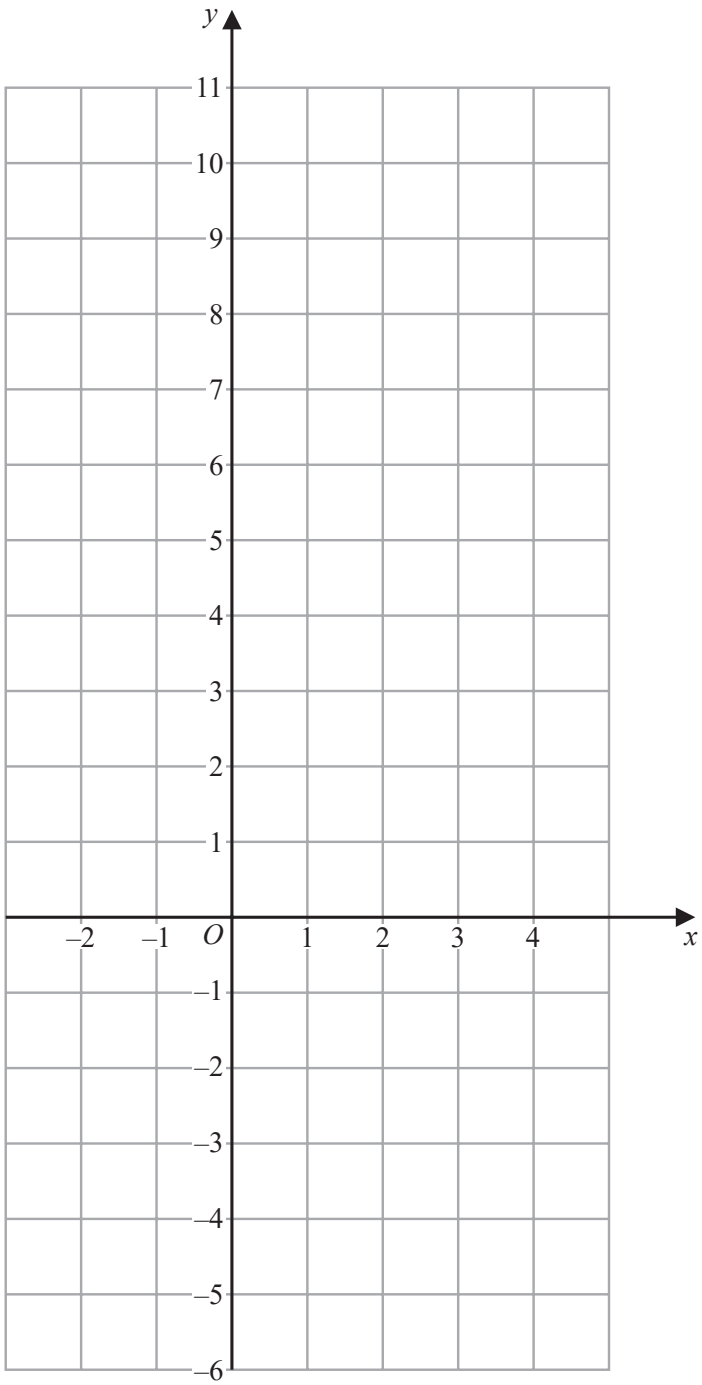
Show clear algebraic working.

$x =$ .....

$y =$ .....

(Total for Question 7 is 3 marks)

5 On the grid, draw the graph of $5x + 2y = 10$ for values of x from –2 to 4



(Total for Question 5 is 3 marks)

13 A is the point with coordinates (–5, 12)

B is the point with coordinates (19, –48)

Find an equation of the straight line that passes through the points A and B

.....

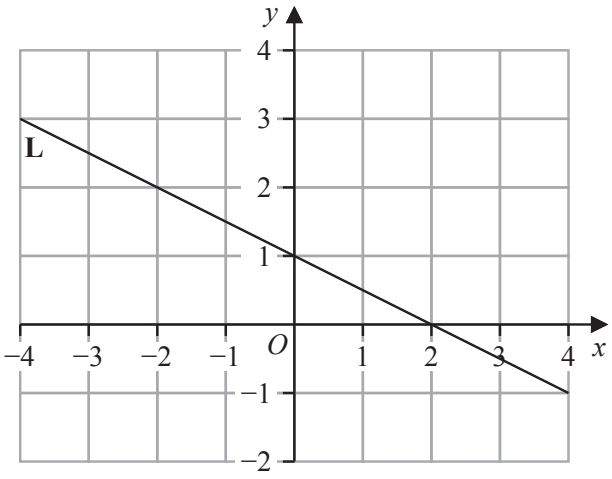
(Total for Question 13 is 3 marks)

14 Factorise fully $50g^2 - 18$

.....

(Total for Question 14 is 3 marks)

9 Line **L** is drawn on the grid.



Find an equation for **L**
Give your answer in the form $y = mx + c$

.....

(Total for Question 9 is 3 marks)

10 Here are the numbers of goals scored by a hockey team in its 11 games this season.

0 1 2 2 3 4 4 6 7 9 11

Work out the interquartile range of the numbers of goals.

.....

(Total for Question 10 is 2 marks)

13 The straight line $\mathbf{L}_1$ has equation $y = 6 - 2x$
The straight line $\mathbf{L}_2$ is perpendicular to $\mathbf{L}_1$ and passes through the point (4, 7)

Find the coordinates of the point where the line $\mathbf{L}_2$ crosses the x-axis.

(..... , ...)

(Total for Question 13 is 4 marks)

14 $128 = 4^{2x} \times 2^x$

Work out the value of x.

$x =$ .....

(Total for Question 14 is 3 marks)

21 Line **L** has equation $4y - 6x = 33$
Line **M** goes through the point A (5, 6) and the point B (−4, k)

L is perpendicular to **M**.

Work out the value of k.

(Total for Question 21 is 4 marks)

15 The straight line $\mathbf{L}_1$ has equation $2y = 6x - 5$

The straight line $\mathbf{L}_2$ is perpendicular to $\mathbf{L}_1$ and passes through the point $(9, -1)$

Find an equation for $\mathbf{L}_2$
Give your answer in the form $ay + bx = c$

.....

(Total for Question 15 is 4 marks)

Answer all TWENTY TWO questions.

Write your answers in the spaces provided.

You must write down all the stages in your working.

1 The point A has coordinates $(5, -4)$
The point B has coordinates $(13, 1)$

(a) Work out the coordinates of the midpoint of AB.

(..... , ...)

(2)

Line **L** has equation $y = 2 - 3x$

(b) Write down the gradient of line **L**.

.....

(1)

Line **L** has equation $y = 2 - 3x$

(c) Does the point with coordinates $(100, -302)$ lie on line **L**?
You must give a reason for your answer.

.....

.....

.....

(1)

(Total for Question 1 is 4 marks)

22 $ABCD$ is a rhombus.

The diagonals, AC and BD, intersect at the point M.
The coordinates of M are $(6, -11)$

The points A and C both lie on the line with equation $2y + 7x = 20$

Find the exact coordinates of the point where the line through B and D intersects the y-axis.

(..... , ...)

(Total for Question 22 is 4 marks)

17 The straight line **L** passes through the points (4, −1) and (6, 4)

The straight line **M** is perpendicular to **L** and intersects the *y*-axis at the point (0, 8)

Find the coordinates of the point where **M** intersects the *x*-axis.

(..... , ...)

(Total for Question 17 is 4 marks)

21 $ABCD$ is a square.

The point A has coordinates $(-5, 2)$
The point B has coordinates $(3, 5)$

Find an equation of the line that passes through B and C
Give your answer in the form $ax + by + c = 0$ where a, b and c are integers.

.....

(Total for Question 21 is 4 marks)

18 The straight line **L** is perpendicular to the straight line with equation $2x + y = 9$ and passes through the point with coordinates (8, 11)

Find an equation for **L**
Give your answer in the form $y = mx + c$

.....

(Total for Question 18 is 4 marks)

20 ABC is an isosceles triangle such that

$AB = AC$
A has coordinates (4, 37)
B and C lie on the line with equation $3y = 2x + 12$

Find an equation of the line of symmetry of triangle ABC.
Give your answer in the form $px + qy = r$ where p, q and r are integers.
Show clear algebraic working.

.....

(Total for Question 20 is 5 marks)

TOTAL FOR PAPER IS 100 MARKS

23 $ABCD$ is a kite with $AB = AD$ and $CB = CD$.

B is the point with coordinates (10, 19)
D is the point with coordinates (2, 7)

Find an equation of the line AC.
Give your answer in the form $py + qx = r$ where p, q and r are integers.

.....

(Total for Question 23 is 5 marks)

One of the customers is selected at random.

Given that this customer had spent more than 30 minutes in the supermarket,

(b) find the probability that this customer spent more than 36 minutes in the supermarket.

.....

(2)

(Total for Question 18 is 5 marks)

19 (a) Write down an equation of a line that is parallel to the line with equation $y = 7 - 4x$

.....

(1)

The line **L** passes through the points with coordinates (–3, 1) and (2, –2)

(b) Find an equation of the line that is perpendicular to **L** and passes through the point with coordinates (–6, 4)
Give your answer in the form $ax + by + c = 0$ where a, b and c are integers.

.....

(4)

(Total for Question 19 is 5 marks)

24 $\mathbf{L}_1$ and $\mathbf{L}_2$ are two straight lines.
The origin of the coordinate axes is O.

$\mathbf{L}_1$ has equation $5x + 10y = 8$
$\mathbf{L}_2$ is perpendicular to $\mathbf{L}_1$ and passes through the point with coordinates (8, 6)

$\mathbf{L}_2$ crosses the x-axis at the point A.
$\mathbf{L}_2$ intersects the straight line with equation $x = -3$ at the point B.

Find the area of triangle AOB.
Show your working clearly.

.....

(Total for Question 24 is 5 marks)

22 ABC is an isosceles triangle with $AB = AC$.

B is the point with coordinates $(-1, 5)$
C is the point with coordinates $(2, 10)$
M is the midpoint of BC.

Find an equation of the line through the points A and M.
Give your answer in the form $py + qx = r$ where p, q and r are integers.

.....

(Total for Question 22 is 5 marks)

TOTAL FOR PAPER IS 100 MARKS

22 ABC is a triangle in which angle $ABC = 90°$

p and q are integers such that

the coordinates of A are $(p, 10)$
the coordinates of B are $(-1, -5)$
the coordinates of C are $(8, q)$

Given that the gradient of AC is $-\frac{6}{7}$

work out the value of p and the value of q

$p =$ .....

$q =$ .....

(Total for Question 22 is 5 marks)

Turn over for Question 23

25 $PQRS$ is a square.

PR is a diagonal of the square.

P is the point with coordinates (4, 7)
R is the point with coordinates (8, –5)

Find an equation of the straight line that passes through the points Q and S
Give your answer in the form $ay = bx + c$ where a, b and c are integers.

.....

(Total for Question 25 is 5 marks)

TOTAL FOR PAPER IS 100 MARKS

22 Triangle HJK is isosceles with $HJ = HK$ and $JK = \sqrt{80}$

H is the point with coordinates $(-4, 1)$
J is the point with coordinates $(j, 15)$ where $j < 0$
K is the point with coordinates $(6, k)$

M is the midpoint of JK.
The gradient of HM is 2

Find the value of j and the value of k.

$j =$ .....

$k =$ .....

(Total for Question 22 is 6 marks)

TOTAL FOR PAPER IS 100 MARKS

23 P and Q are two points.

The coordinates of P are $(-1, 6)$

The coordinates of Q are $(5, -4)$

Find an equation of the perpendicular bisector of PQ.
Give your answer in the form $ax + by + c = 0$ where a, b and c are integers.

.....

(Total for Question 23 is 6 marks)

23 $ABCD$ is a kite.

$AB = AD$ and $CB = CD$

The point B has coordinates $(k, 1)$ where k is a negative constant.
The point D has coordinates $(8, 7)$

The straight line **L** passes through the points B and D

The straight line **L** is parallel to the line with equation $5y - 3x = 6$

Find an equation of AC
Give your answer in the form $px + qy = r$ where p, q and r are integers.
Show your working clearly.

.....

(Total for Question 23 is 6 marks)

Turn over for Question 24

25 *ABCD* is a trapezium with *AB* parallel to *DC*

A is the point with coordinates (–4, 6)
B is the point with coordinates (2, 3)
D is the point with coordinates (–1, 8)

The trapezium has one line of symmetry.
The line of symmetry intersects *CD* at the point *E*

Work out the coordinates of the point *E*

(..... , ...)

(Total for Question 25 is 6 marks)

Turn over for Question 26

24 $ABCD$ is a kite with $AB = AD$ and $CB = CD$

A is the point with coordinates $(-2, 10)$

B is the point with coordinates $\left(-\frac{27}{5}, 4\right)$

C is the point with coordinates $(4, -5)$

Work out the coordinates of D

(..... , ...)

(Total for Question 24 is 6 marks)

Turn over for Question 25

25 The straight line with equation $y - 2x = 7$ is the perpendicular bisector of the line AB where A is the point with coordinates $(j, 7)$ and B is the point with coordinates $(6, k)$

Find the coordinates of the midpoint of the line AB
Show clear algebraic working.

(..... , ...)

(Total for Question 25 is 6 marks)

Turn over for Question 26

24 PQ is a straight line drawn on a square grid, with a scale of 1 cm for 1 unit on each axis.

P has coordinates $(-5, a)$ and Q has coordinates $(7, 3a)$ where $a > 0$

The length of PQ is $4\sqrt{10}$ cm

Find an equation of the perpendicular bisector of PQ
Give your answer in the form $y = mx + c$ where m and c are integers.

.....

(Total for Question 24 is 6 marks)

18 A rectangle $ABCD$ is to be drawn on a centimetre grid such that

A has coordinates $(-4, -2)$
B has coordinates $(1, 10)$
C has coordinates $(19, a)$
D has coordinates (b, c)

(a) Work out the value of a, the value of b and the value of c.

$a =$ .....

$b =$ .....

$c =$ .....

(4)

(b) Calculate the perimeter, in centimetres, of rectangle *ABCD*.

..... cm

(3)

(Total for Question 18 is 7 marks)

20 The straight line **L** passes through point A (– 6, 2) and point B (5, 3)
The straight line **M** is perpendicular to **L** and passes through the midpoint of A and B.
The line **M** intersects the line $x = -1$ at point C.

Calculate the area of triangle ABC.

.....

(Total for Question 20 is 7 marks)

TOTAL FOR PAPER IS 100 MARKS

22 $ABCD$ is a kite, with diagonals AC and BD, drawn on a centimetre square grid, with a scale of 1 cm for 1 unit on each axis.

A is the point with coordinates $(-3, 4)$

The diagonals of the kite intersect at the point M with coordinates $(0, 2)$

Given that $AB = AD = 6.5$ cm and the x coordinate of B is positive,

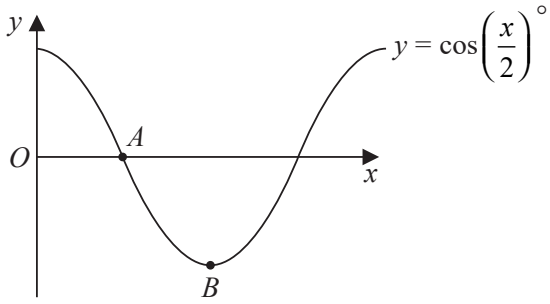
find the coordinates of the points B and D.

(..... , ...)

(..... , ...)

(Total for Question 22 is 7 marks)

23 The diagram shows a sketch of the graph of $y = \cos\left(\frac{x}{2}\right)^\circ$



(i) Find the coordinates of the point A

(..... , ...)

(1)

(ii) Find the coordinates of the point B

(..... , ...)

(1)

(Total for Question 23 is 2 marks)

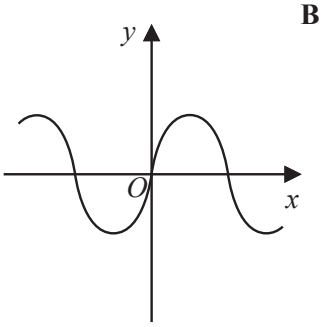
SUB-TOPIC A4b

QUADRATIC & OTHER GRAPHS

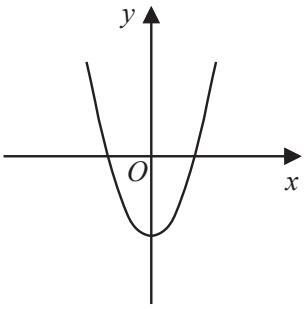
Sub-topic A4b · 24 questions · 98 marks · lowest tariff first

16 Here are six graphs.

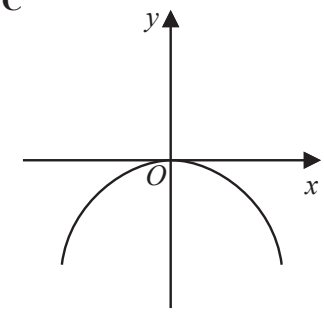
A



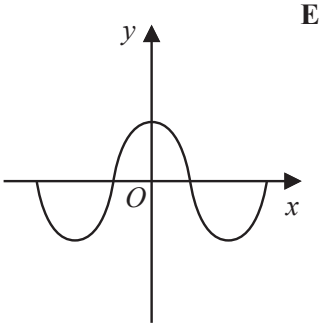
B



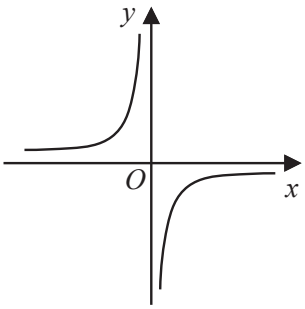
C



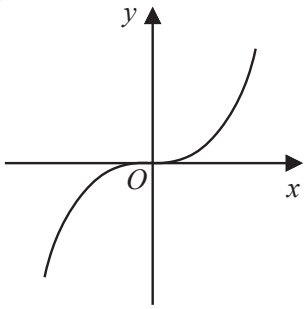
D



E



F



Write down the letter of the graph that could have the equation

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

.....

(1)

(ii) $y = \sin x°$

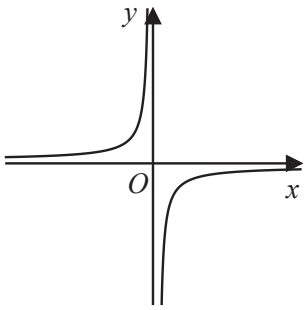
.....

(1)

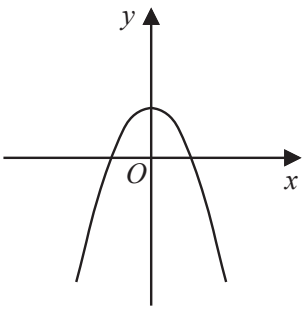
(Total for Question 16 is 2 marks)

14 Here are five graphs.

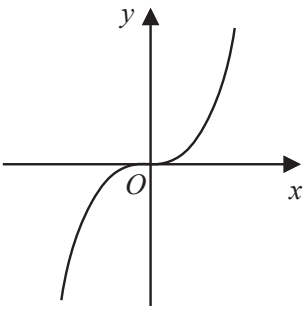
A



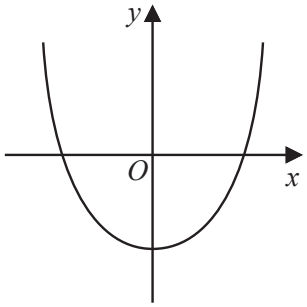
B



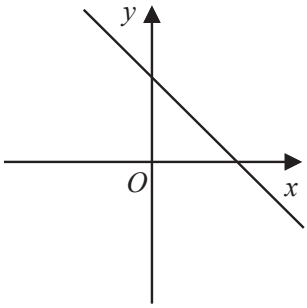
C



D



E



(a) Write down the letter of the graph that could have the equation $y = 5 - x^2$

.....

(1)

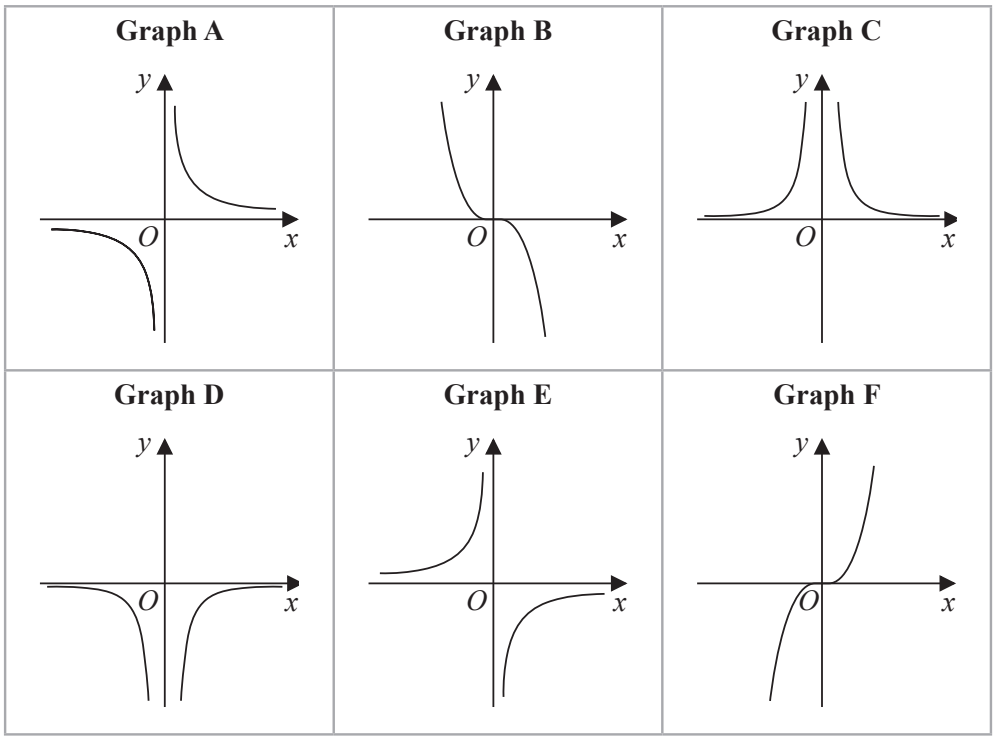
(b) Write down the letter of the graph that could have the equation $y = 2x^3$

.....

(1)

(Total for Question 14 is 2 marks)

15 Here are six graphs.



Complete the table below with the letter of the graph that could represent each given equation.

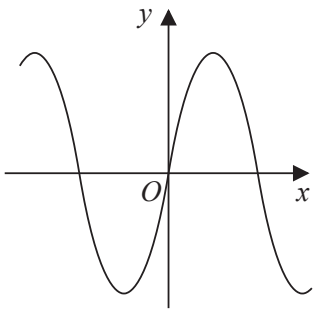
Write your answers on the dotted lines.

Equation	Graph
$y = \frac{2}{x^2}$	.....
$y = -\frac{1}{2}x^3$	.....
$y = -\frac{5}{x}$	.....

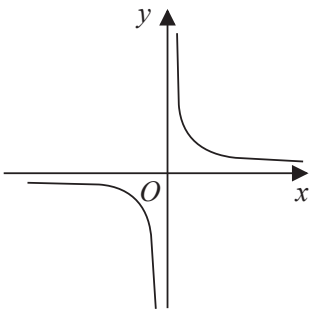
(Total for Question 15 is 3 marks)

16 Here are nine graphs.

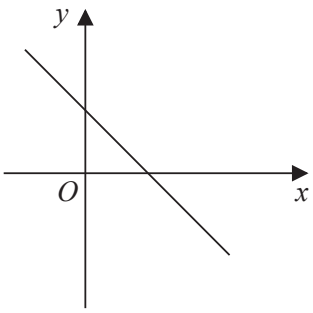
Graph A



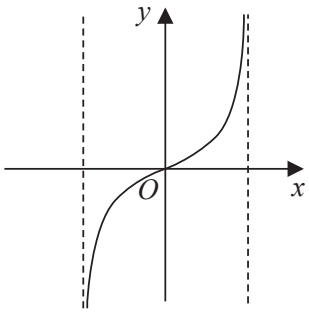
Graph B



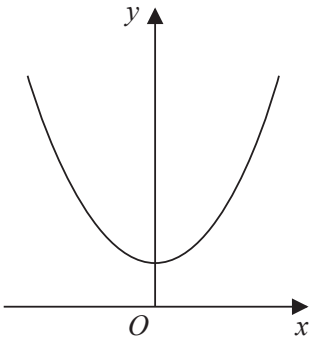
Graph C



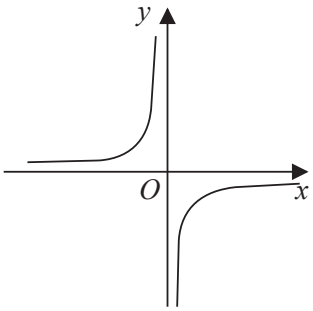
Graph D



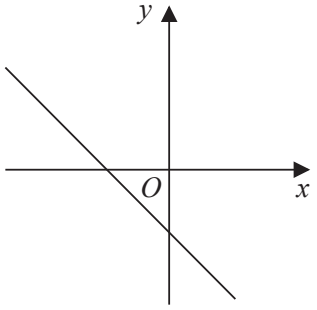
Graph E



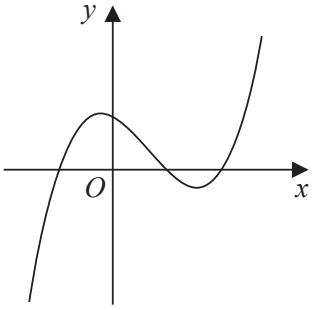
Graph F



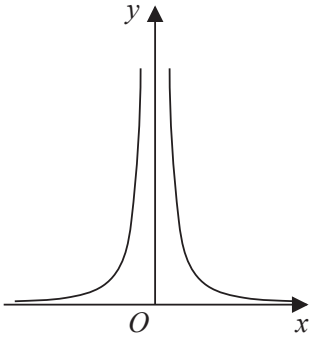
Graph G



Graph H



Graph I



Complete the table below with the letter of the graph that could represent each given equation.
Write each answer on the dotted line.

Equation	Graph
$y = -2x + 3$	.....
$y = -\frac{1}{x}$	.....
$y = \tan x°$	.....
$y = (x + 1)(x - 1)(x - 2)$	.....

(Total for Question 16 is 3 marks)

17 Use algebra to show that $0.3\dot{4}\dot{5} = \frac{19}{55}$

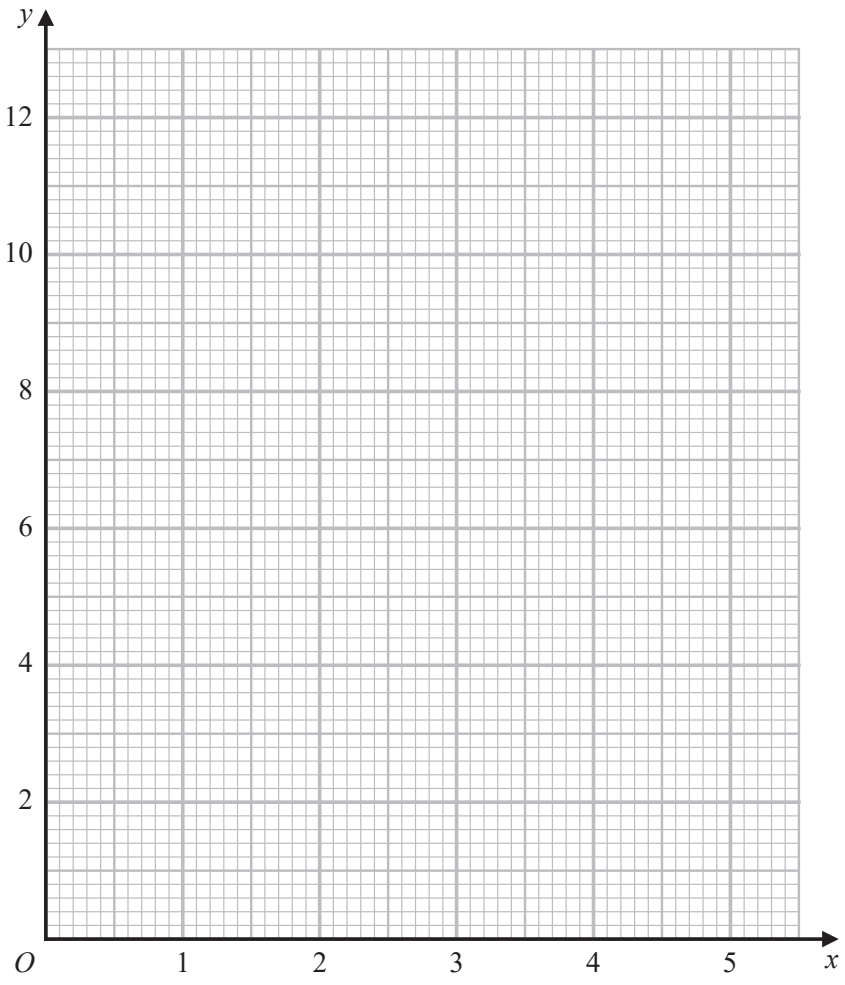
(Total for Question 17 is 2 marks)

14 (a) Complete the table of values for $y = \frac{2}{x}\left(5 - \frac{1}{x}\right)$

x	0.5	1	2	3	4	5
y		8		3.1	2.4	1.9

(1)

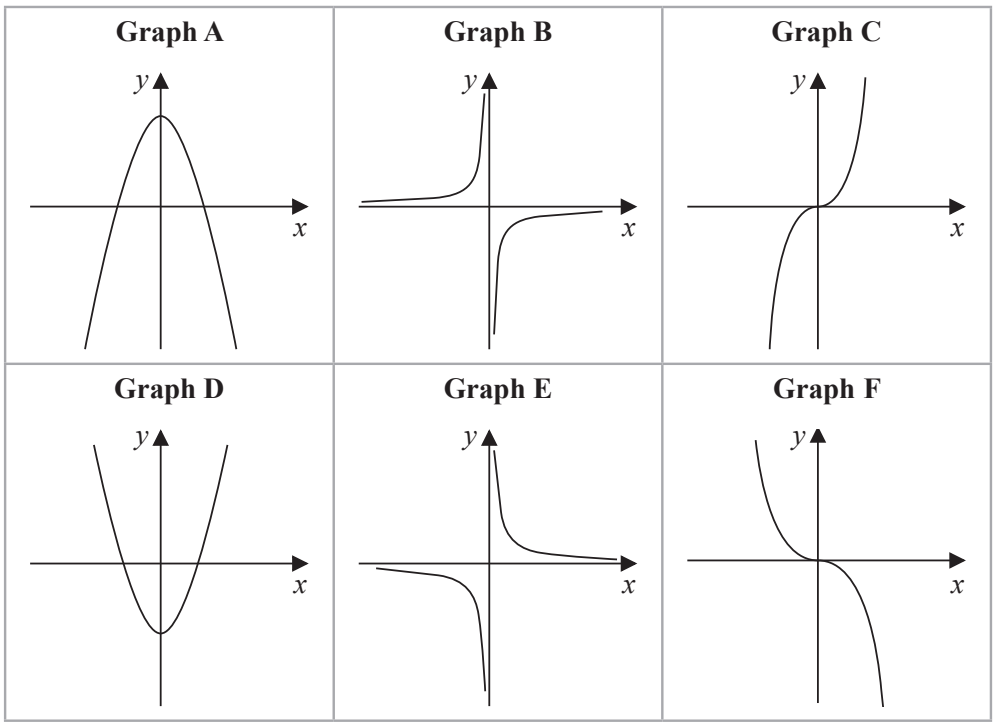
(b) On the grid, draw the graph of $y = \frac{2}{x}\left(5 - \frac{1}{x}\right)$ for $0.5 \leqslant x \leqslant 5$



(2)

(Total for Question 14 is 3 marks)

11 Here are six graphs.



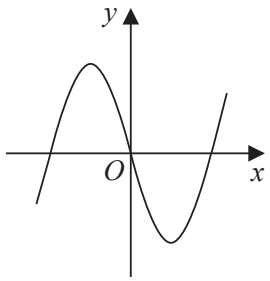
Complete the table below with the letter of the graph that could represent each given equation.
Write your answers on the dotted lines.

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

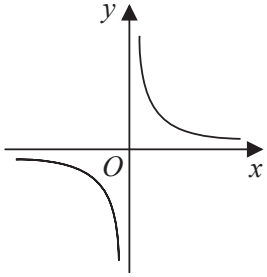
(Total for Question 11 is 3 marks)

18 Here are 6 graphs.

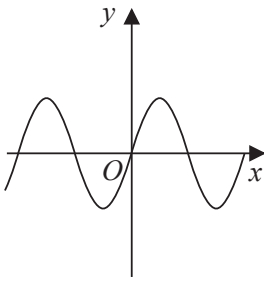
Graph A



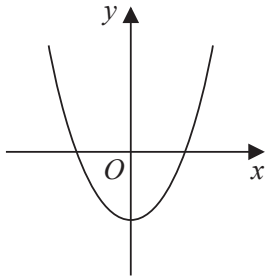
Graph B



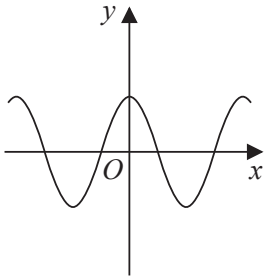
Graph C



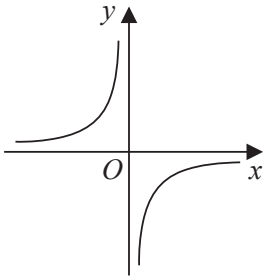
Graph D



Graph E



Graph F



Complete the table below with the letter of the graph that could represent each given equation.

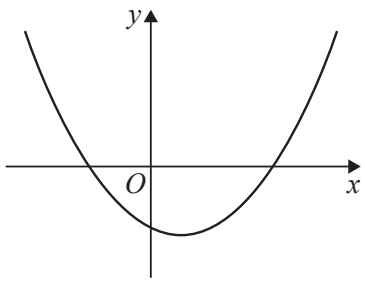
Write your answers on the dotted lines.

Equation	Graph
$y = \sin x$	.....
$y = -\frac{3}{x}$	.....
$y = 4x^3 - 5x$	.....

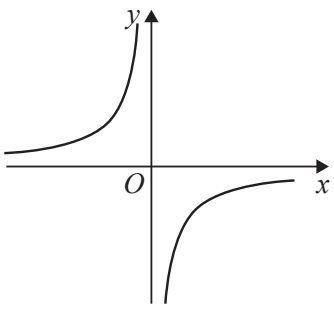
(Total for Question 18 is 3 marks)

12 Here are six graphs.

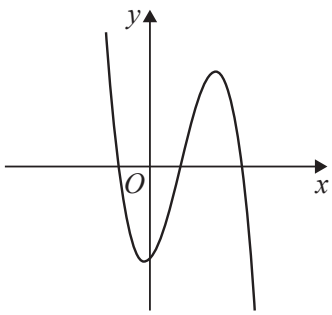
Graph **A**



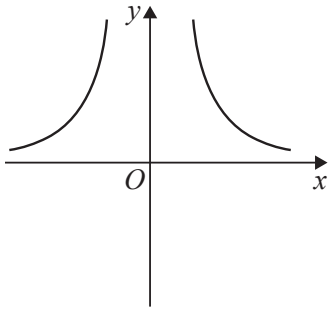
Graph **B**



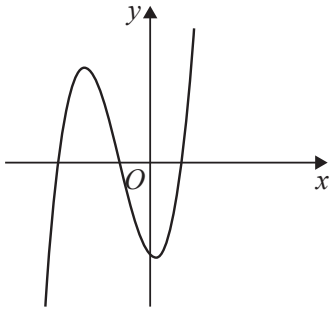
Graph **C**



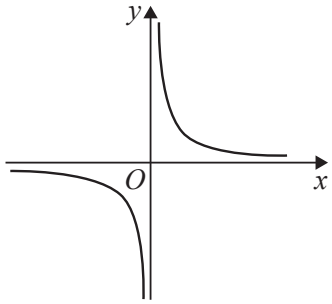
Graph **D**



Graph **E**



Graph **F**



Write down the letter of the graph of

(a) $y = \frac{10}{x^2}$

.....

(1)

(b) $y = x - 3 + 3x^2 - x^3$

.....

(1)

(c) $y = -\frac{3}{x}$

.....

(1)

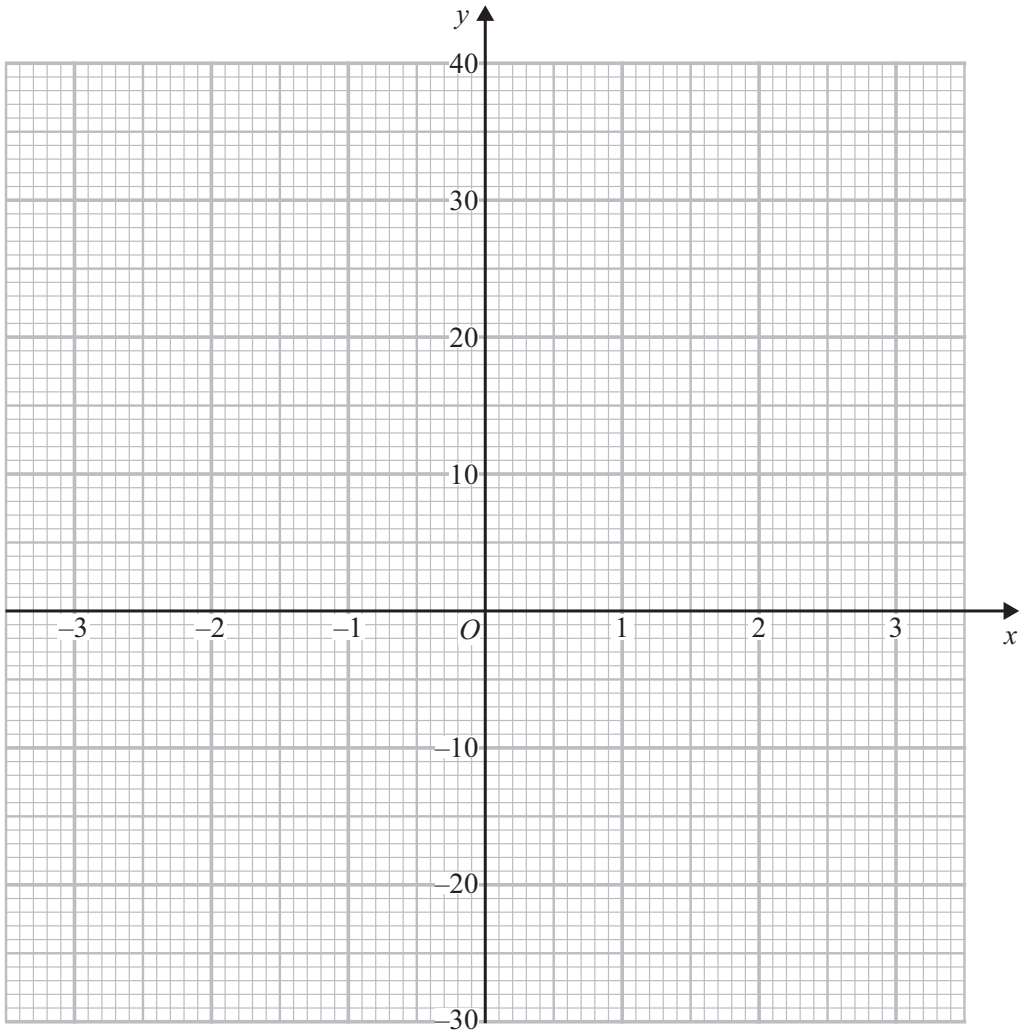
(Total for Question 12 is 3 marks)

10 (a) Complete the table of values for $y = x^3 + 2x + 3$

x	–3	–2	–1	0	1	2	3
y		–9	0	3	6		36

(1)

(b) On the grid, draw the graph of $y = x^3 + 2x + 3$ for $-3 \leqslant x \leqslant 3$



(2)

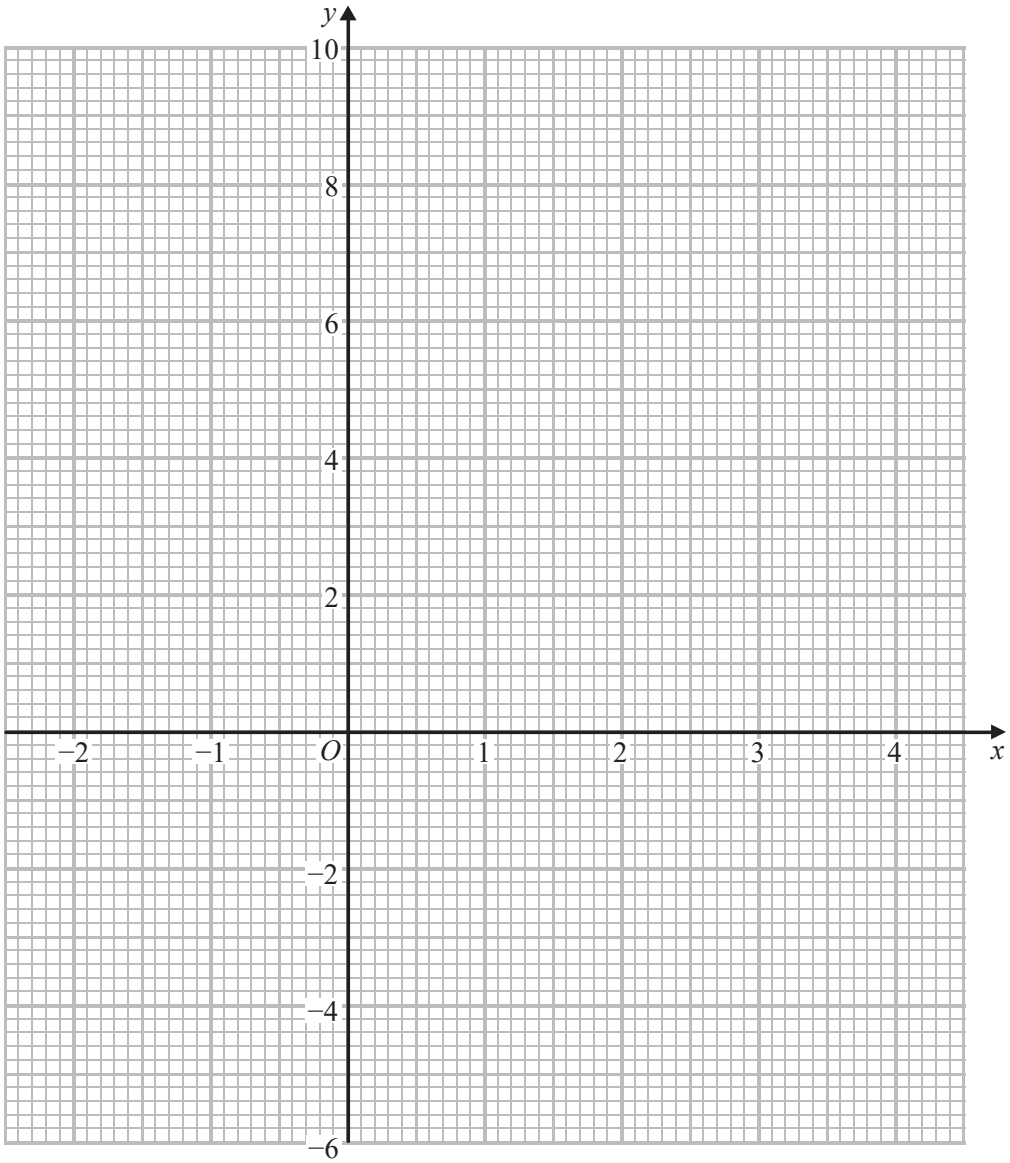
(Total for Question 10 is 3 marks)

4 (a) Complete the table of values for $y = x^2 - 3x - 1$

x	−2	−1	0	1	2	3	4
y			−1		−3		3

(2)

(b) On the grid, draw the graph of $y = x^2 - 3x - 1$ for all values of x from −2 to 4



(2)

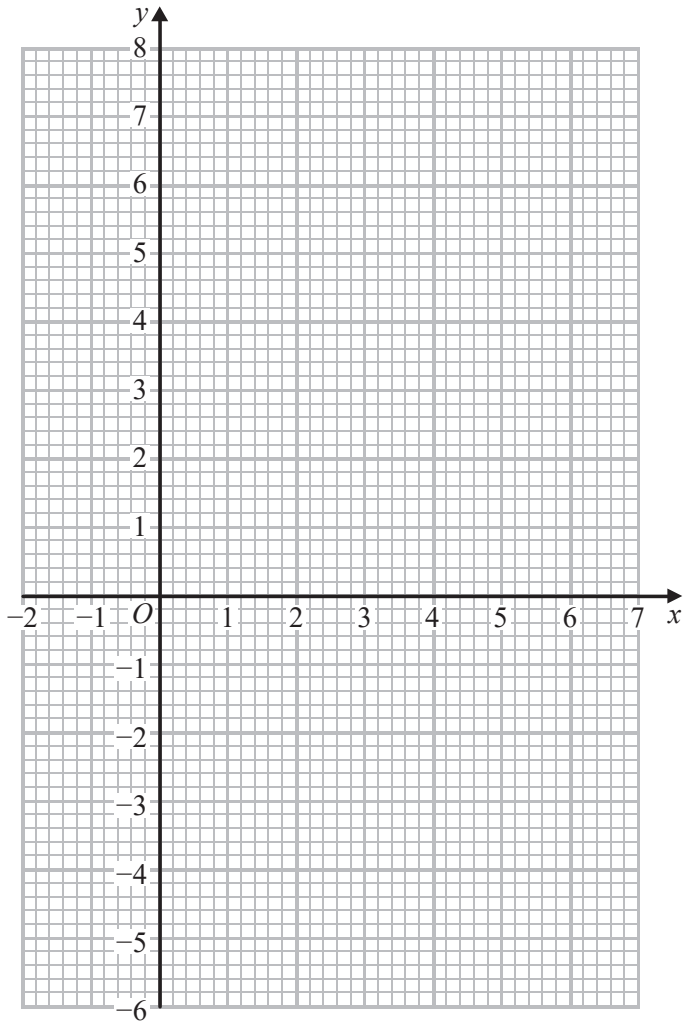
(Total for Question 4 is 4 marks)

3 (a) Complete the table of values for $y = 1 + 5x - x^2$

x	−1	0	1	2	3	4	5	6
y		1		7	7		1	

(2)

(b) On the grid, draw the graph of $y = 1 + 5x - x^2$ for values of x from −1 to 6



(2)

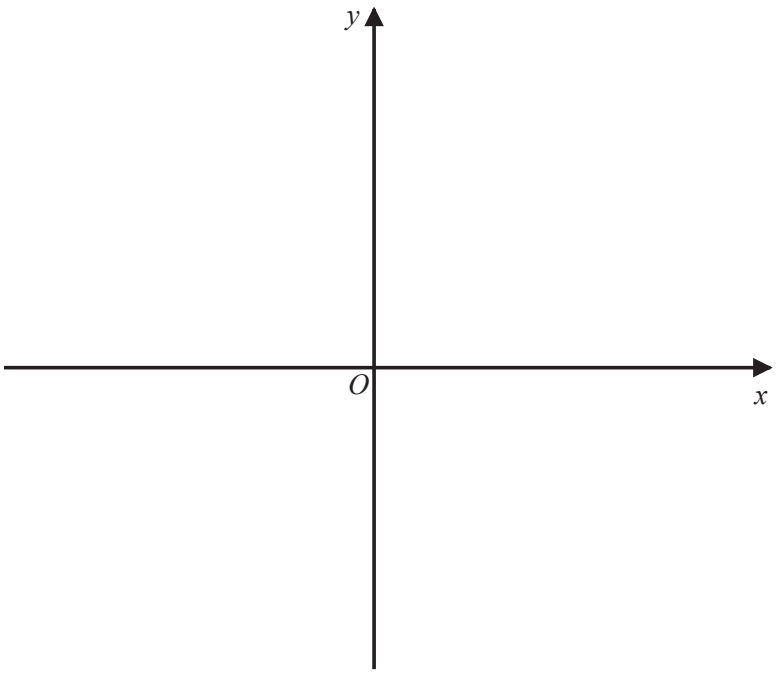
(Total for Question 3 is 4 marks)

20 The curve **C** has equation $y = 4(x - 1)^2 - a$ where $a > 4$

Using the axes below, sketch the curve **C**.
On your sketch show clearly, in terms of a,

(i) the coordinates of any points of intersection of **C** with the coordinate axes,

(ii) the coordinates of the turning point.



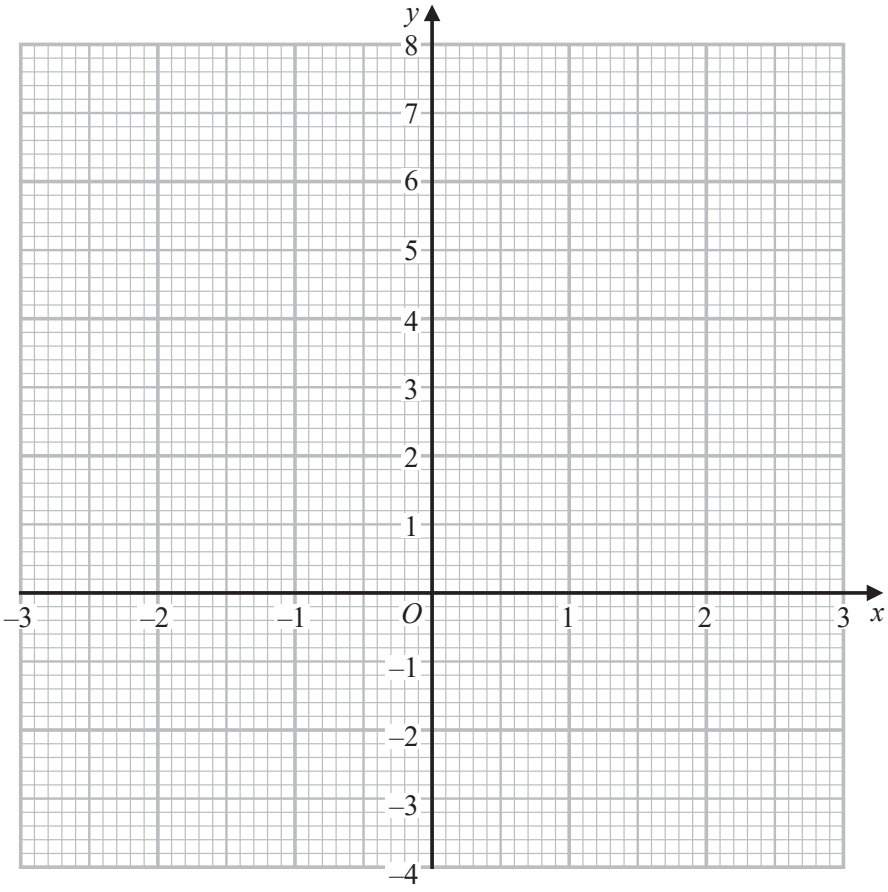
(Total for Question 20 is 4 marks)

15 (a) Complete the table of values for $y = x^2 - \frac{x}{2} - 3$

x	–3	–2	–1	0	1	2	3
y	7.5				–2.5		4.5

(2)

(b) On the grid, draw the graph of $y = x^2 - \frac{x}{2} - 3$ for values of x from –3 to 3



(2)

(Total for Question 15 is 4 marks)

14 Simplify fully $\left(\frac{9x^4}{16y^{10}}\right)^{-\frac{1}{2}}$

.....

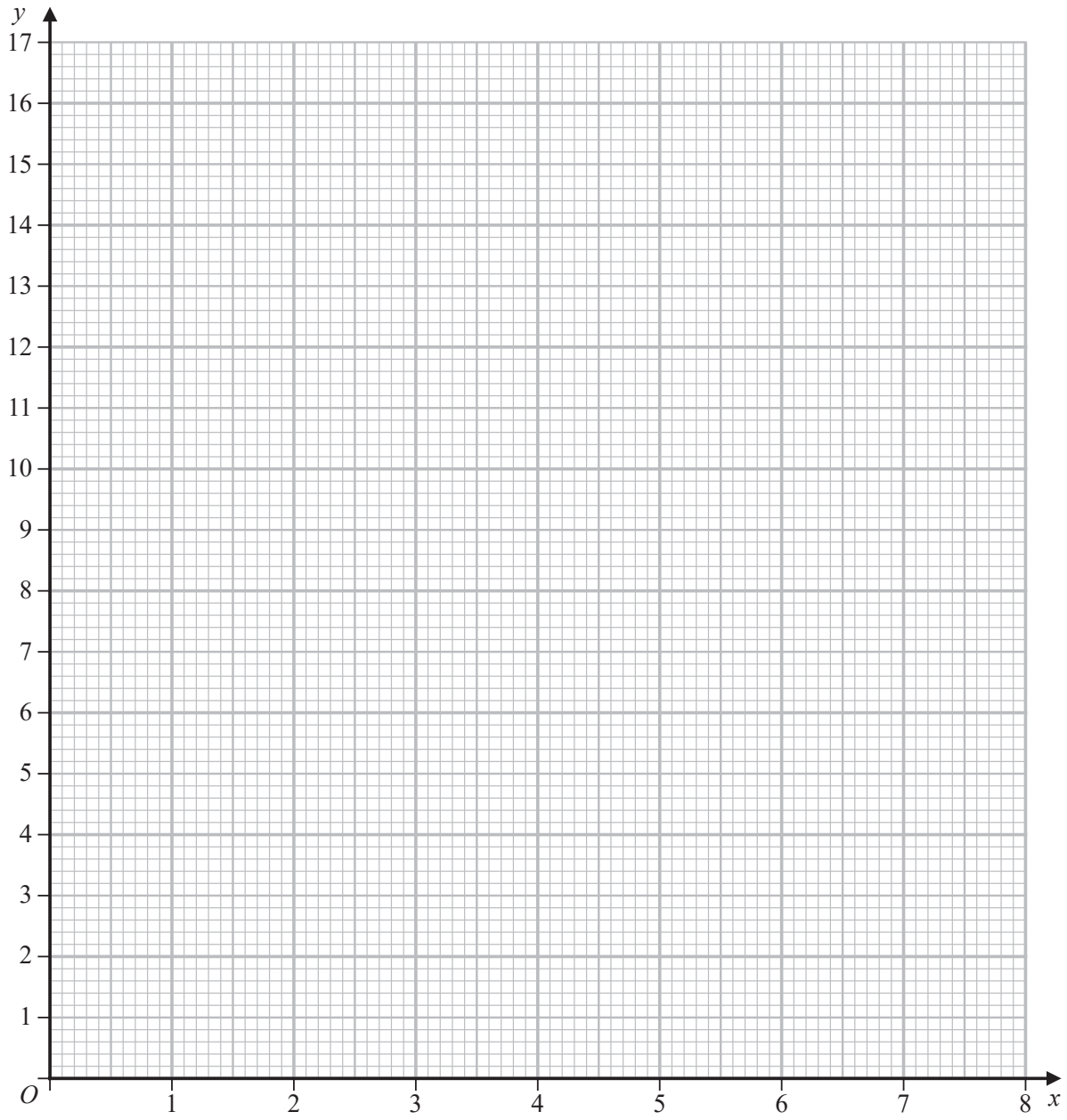
(Total for Question 14 is 3 marks)

15 (a) Complete the table of values for $y = \frac{1}{x}(x^2 + 4)$

x	0.25	0.5	1	2	4	8
y	16.25					8.5

(2)

(b) On the grid, draw the graph of $y = \frac{1}{x}(x^2 + 4)$ for $0.25 \leqslant x \leqslant 8$



(2)

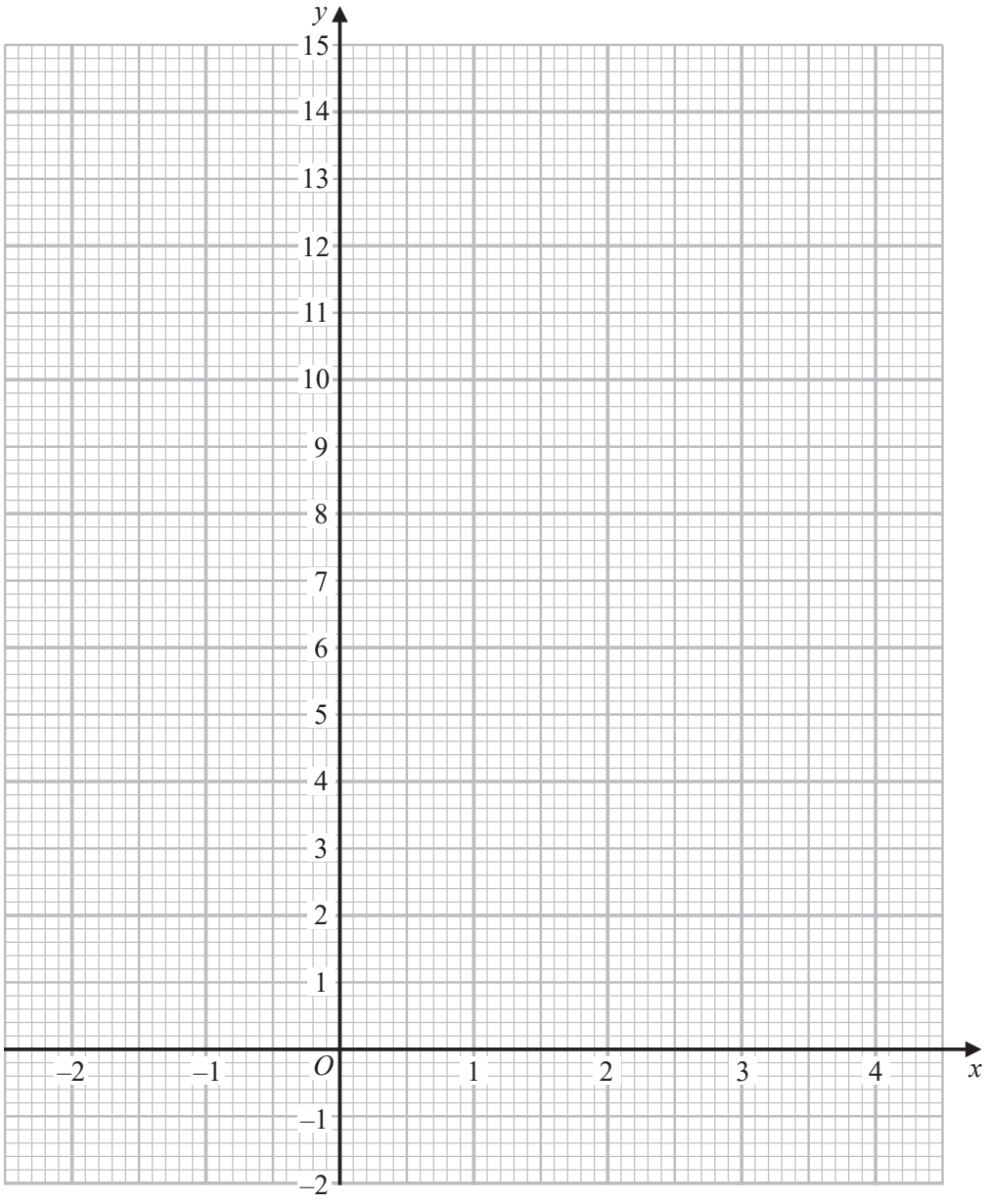
(Total for Question 15 is 4 marks)

4 (a) Complete the table of values for $y = x^2 - 4x + 3$

x	–2	–1	0	1	2	3	4
y		8	3			0	

(2)

(b) On the grid, draw the graph of $y = x^2 - 4x + 3$ for values of x from –2 to 4



(2)

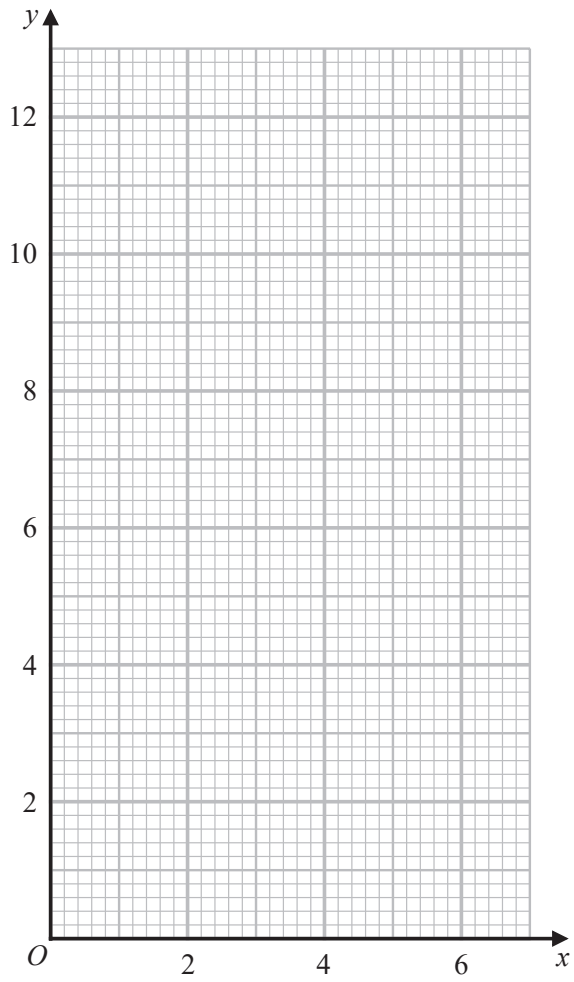
(Total for Question 4 is 4 marks)

11 (a) Complete the table of values for $y = \frac{6}{x}$

x	0.5	1	2	3	4	5	6
y		6		2			1

(2)

(b) On the grid, draw the graph of $y = \frac{6}{x}$ for $0.5 \leqslant x \leqslant 6$



(2)

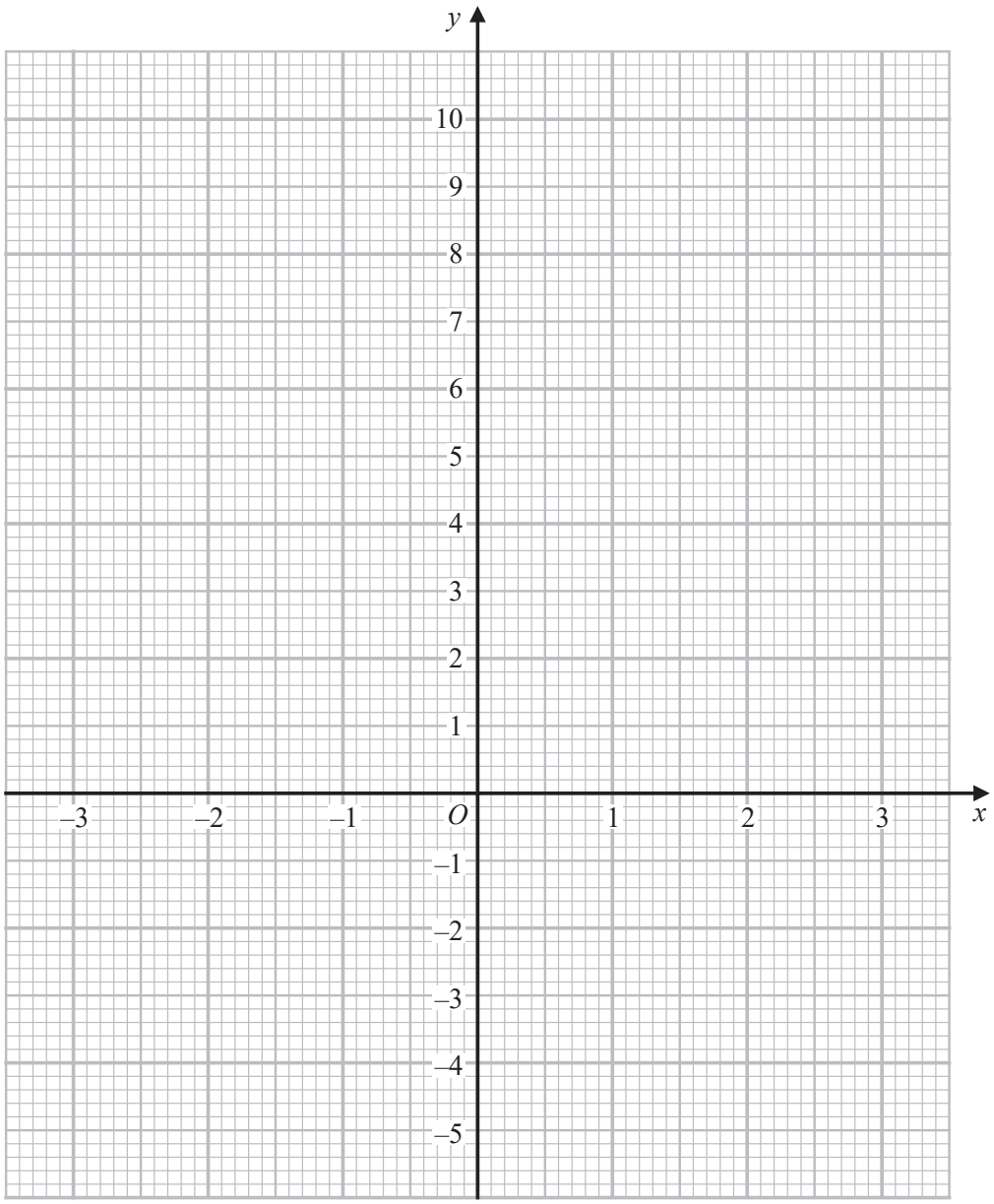
(Total for Question 11 is 4 marks)

4 (a) Complete the table of values for $y = x^2 - x - 4$

x	–3	–2	–1	0	1	2	3
y		2			–4		

(2)

(b) On the grid below, draw the graph of $y = x^2 - x - 4$ for values of x from –3 to 3



(2)

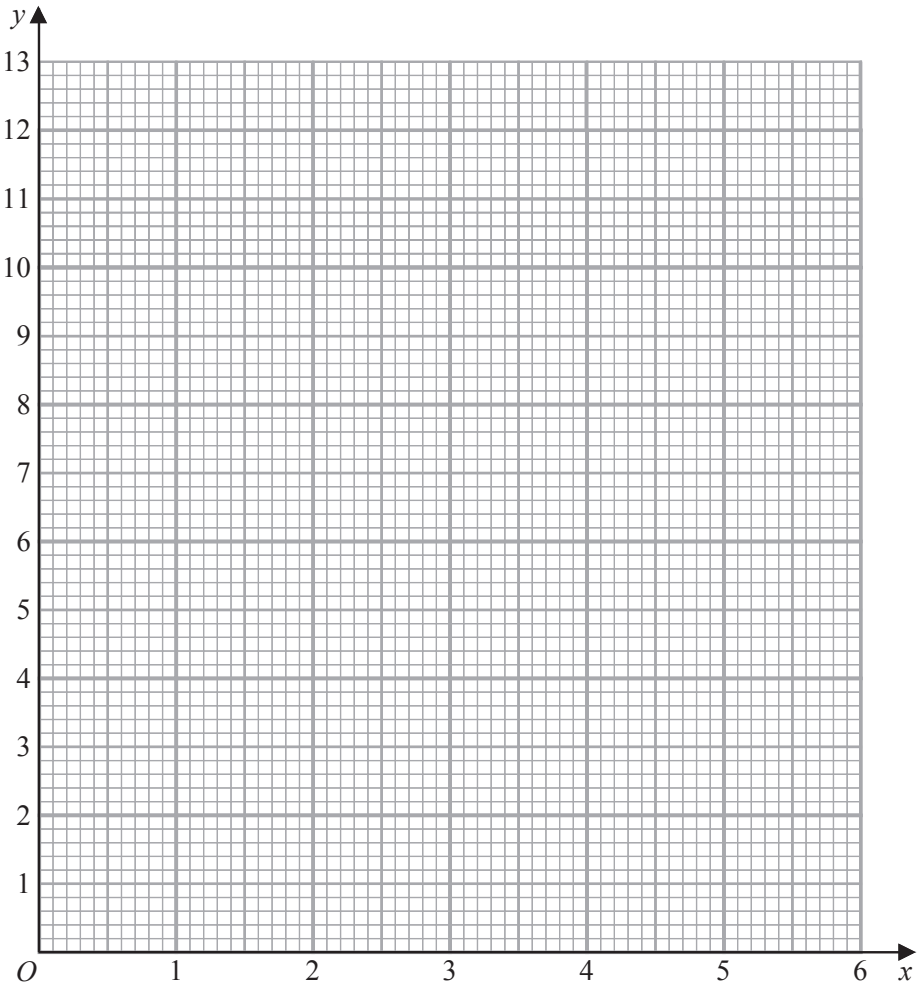
(Total for Question 4 is 4 marks)

11 (a) Complete the table of values for $y = 2\left(x + \frac{1}{x}\right)$

x	0.5	1	2	3	4	5	6
y			5	6.7			12.3

(2)

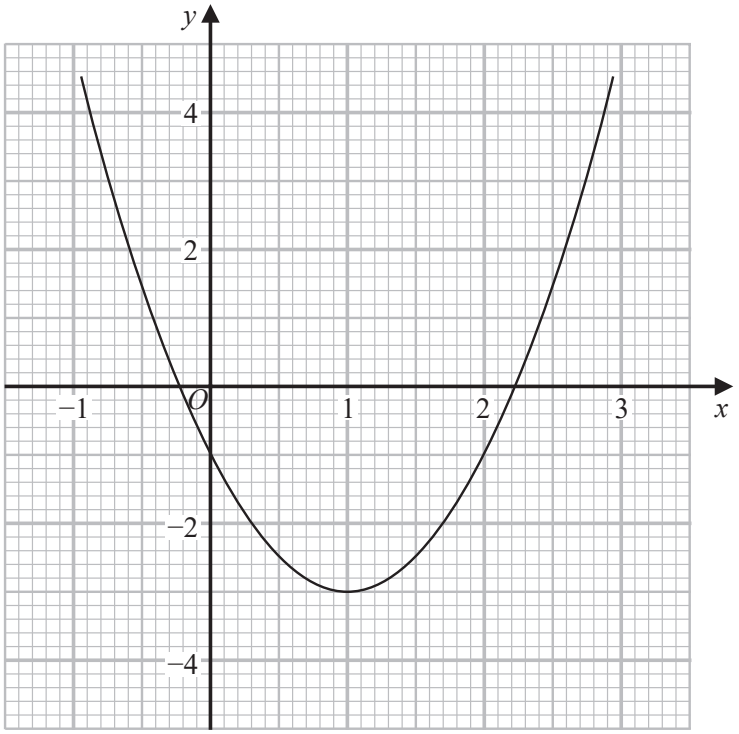
(b) On the grid, draw the graph of $y = 2\left(x + \frac{1}{x}\right)$ for $0.5 \leqslant x \leqslant 6$



(2)

(Total for Question 11 is 4 marks)

21 Part of the graph of $y = 2x^2 - 4x - 1$ is shown on the grid.



(a) Use the graph to find estimates for the solutions of the equation $2x^2 - 4x - 1 = 0$
Give your solutions correct to one decimal place.

.....

(2)

(b) By drawing a suitable straight line on the grid, find estimates for the solutions of the equation $x^2 - x - 1 = 0$
Show your working clearly.
Give your solutions correct to one decimal place.

.....

(3)

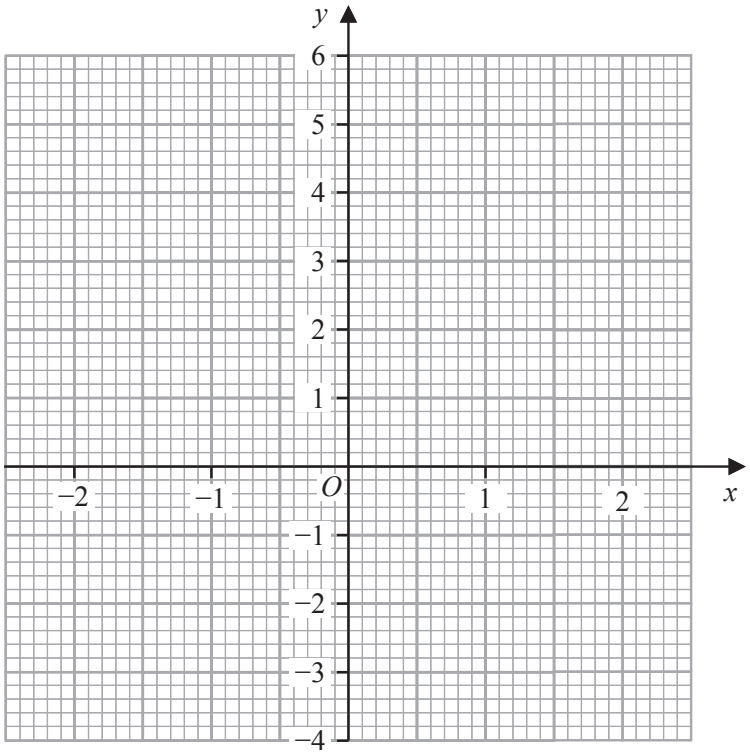
(Total for Question 21 is 5 marks)

12 (a) Complete the table of values for $y = x^3 - 3x + 1$

x	−2	−1	0	1	2
y				−1	

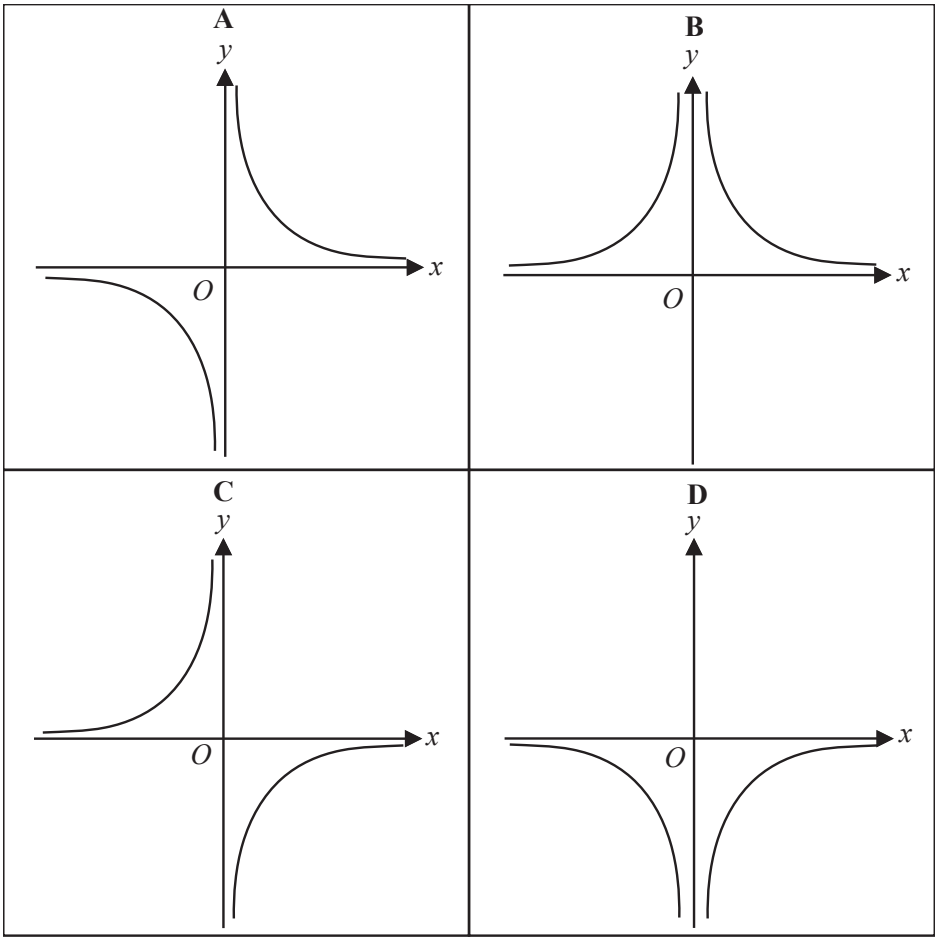
(2)

(b) On the grid, draw the graph of $y = x^3 - 3x + 1$ for values of x from − 2 to 2



(2)

Here are four graphs.



(c) Write down the letter of the graph that could have the equation $y = -\frac{1}{x^2}$

.....

(1)

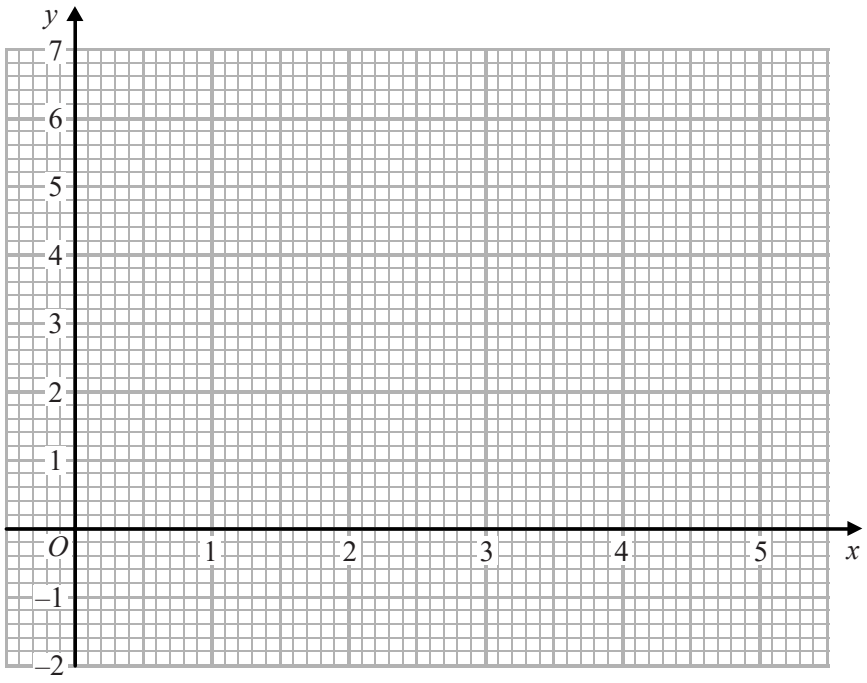
(Total for Question 12 is 5 marks)

6 (a) Complete the table of values for $y = x^2 - 5x + 6$

x	0	1	2	3	4	5
y	6		0	0	2	

(1)

(b) On the grid, draw the graph of $y = x^2 - 5x + 6$ for $0 \leqslant x \leqslant 5$



(2)

(c) By drawing a suitable straight line on the grid, find estimates for the solutions of the equation

$$x^2 - 5x = x - 7$$

(3)

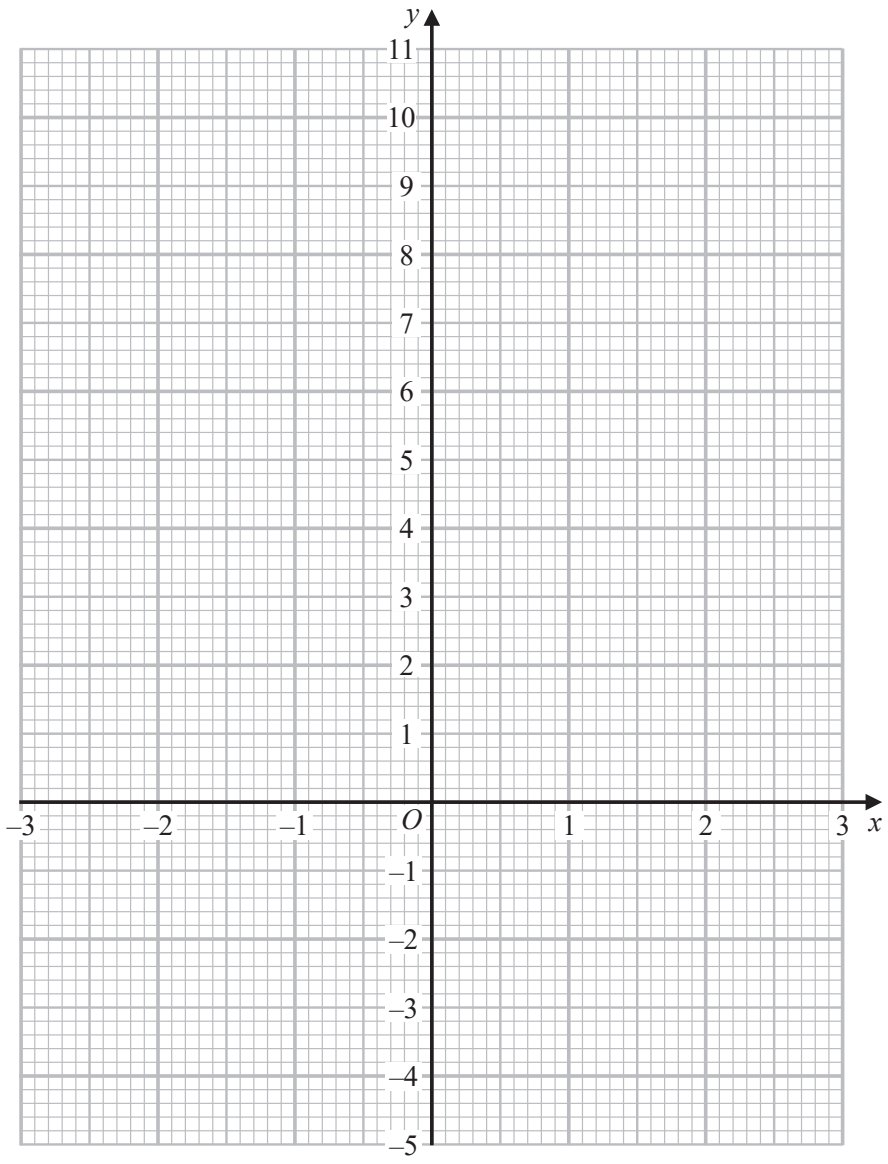
(Total for Question 6 is 6 marks)

18 (a) Complete the table of values for $y = \frac{1}{2}x^3 - 2x + 3$

x	–3	–2	–1	0	1	2	3
y	–4.5			3		3	

(2)

(b) On the grid, draw the graph of $y = \frac{1}{2}x^3 - 2x + 3$ for $-3 \leqslant x \leqslant 3$



(2)

(c) By drawing a suitable straight line on the grid, find an estimate for the solution of the equation $\frac{1}{2}x^3 - x + 4 = 0$

$x =$.....

(2)

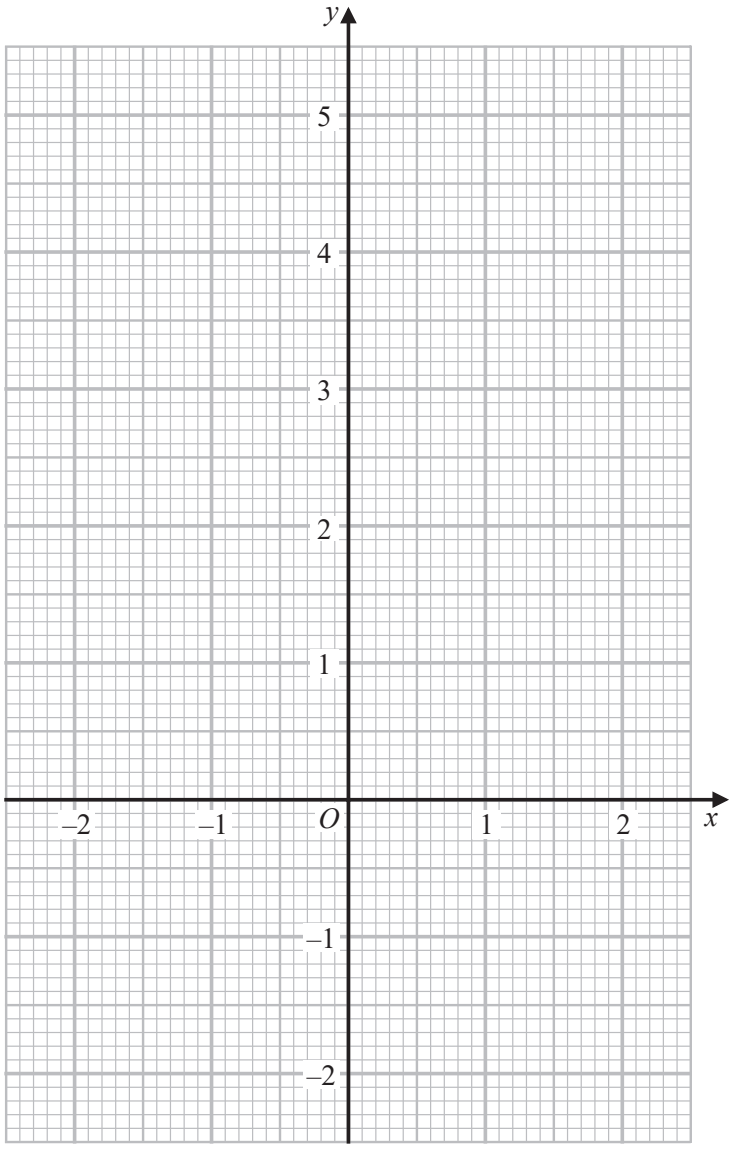
(Total for Question 18 is 6 marks)

15 (a) Complete the table of values for $y = x^3 - 3x + 2$

x	–2	–1	–0.5	0	1	1.5	2
y		4	3.4		0	0.9	

(2)

(b) On the grid, draw the graph of $y = x^3 - 3x + 2$ for values of x from –2 to 2



(2)

(c) By drawing a suitable straight line on the grid, use your graph to find an estimate for the solution of

$$2x^3 - 3x + 4 = 0$$

Give your answer correct to one decimal place.

.....

(3)

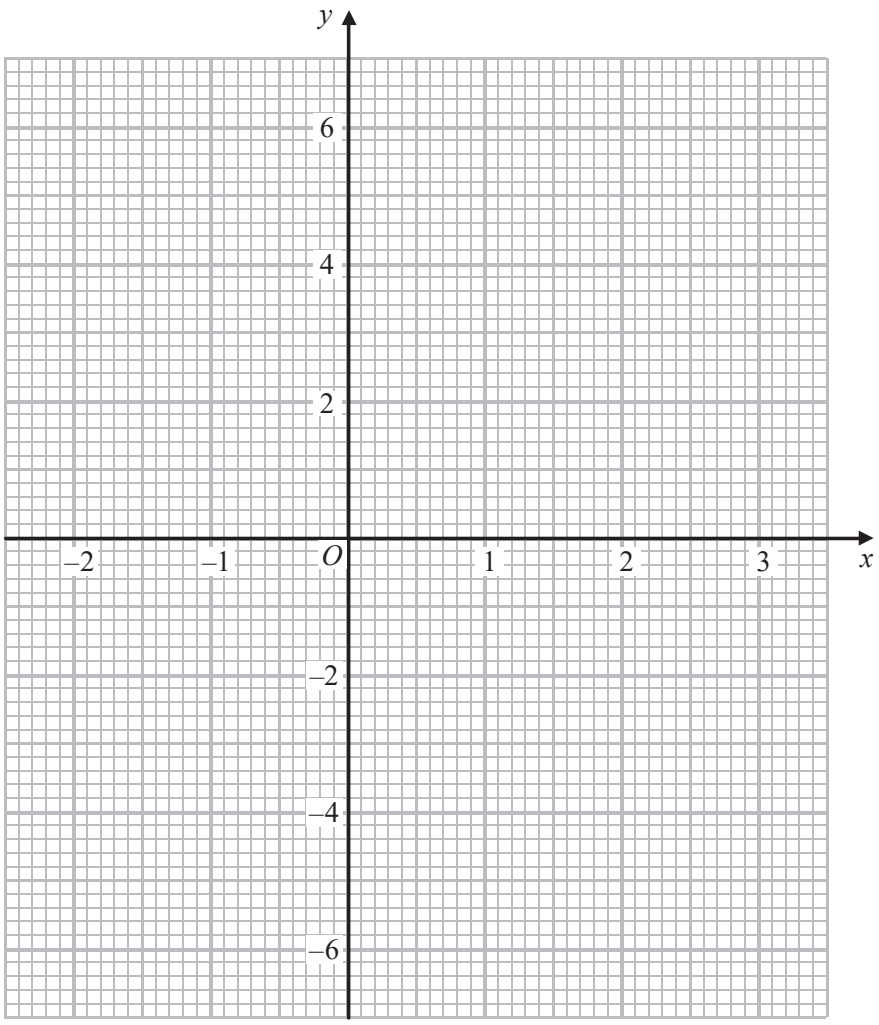
(Total for Question 15 is 7 marks)

14 (a) Complete the table of values for $y = x^3 - 2x^2 - 3x + 4$

x	–2	–1	–0.5	0	1	1.5	2	3
y			4.875	4		–1.625		

(2)

(b) On the grid, draw the graph of $y = x^3 - 2x^2 - 3x + 4$ for values of x from –2 to 3



(2)

(c) By drawing a suitable straight line on the grid,
find estimates for the solutions of the equation $x^3 - 2x^2 - x + 1 = 0$
Give your solutions correct to 1 decimal place.

.....

(4)

(Total for Question 14 is 8 marks)

15 $e = 8.31$ correct to 2 decimal places
$f = 0.65$ correct to 2 decimal places

Work out the lower bound for the value of $e - f$
Show your working clearly.

.....

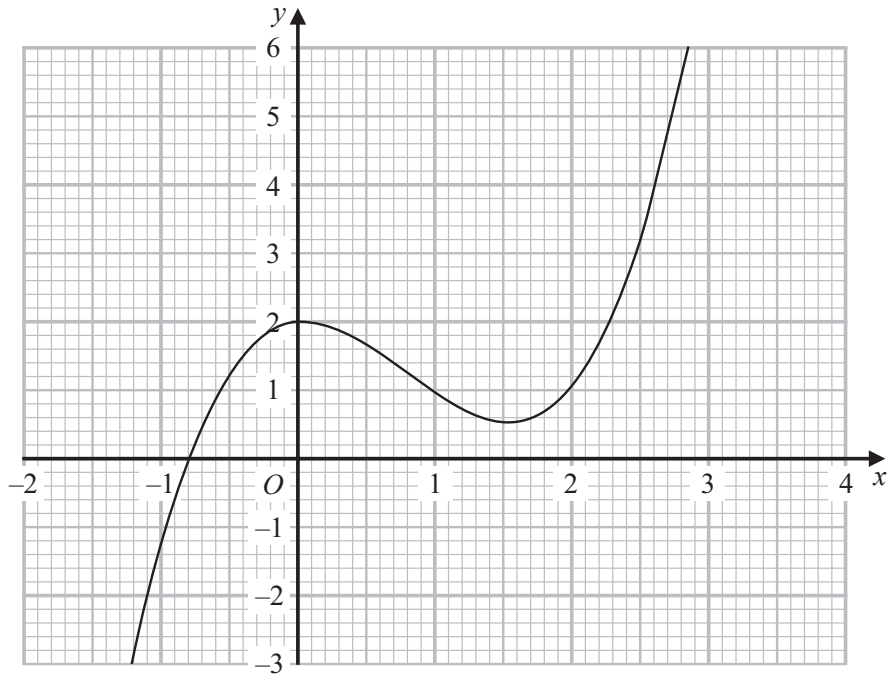
(Total for Question 15 is 2 marks)

SUB-TOPIC A4c

REAL-LIFE GRAPHS & RATES OF CHANGE

Sub-topic A4c · 4 questions · 19 marks · lowest tariff first

17 Part of the curve with equation $y = f(x)$ is shown on the grid.

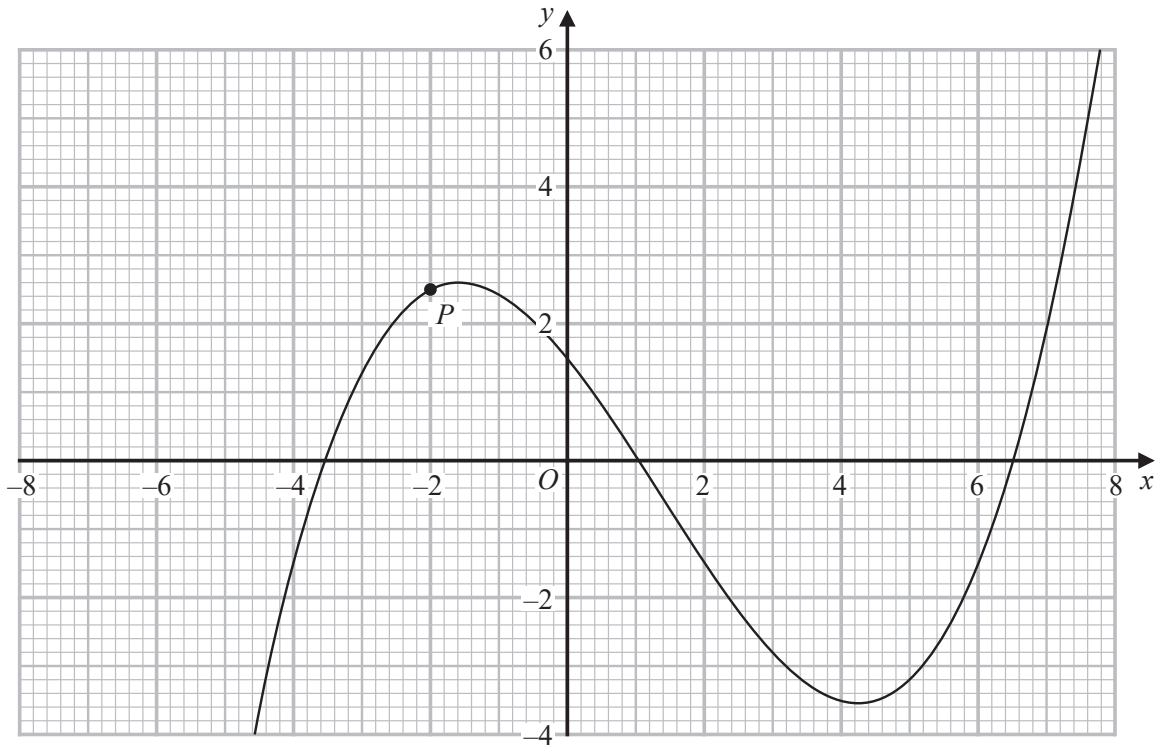


Find an estimate for the gradient of the curve at the point where $x = 2$
Show your working clearly.

.....

(Total for Question 17 is 3 marks)

21 The diagram shows the graph of $y = f(x)$



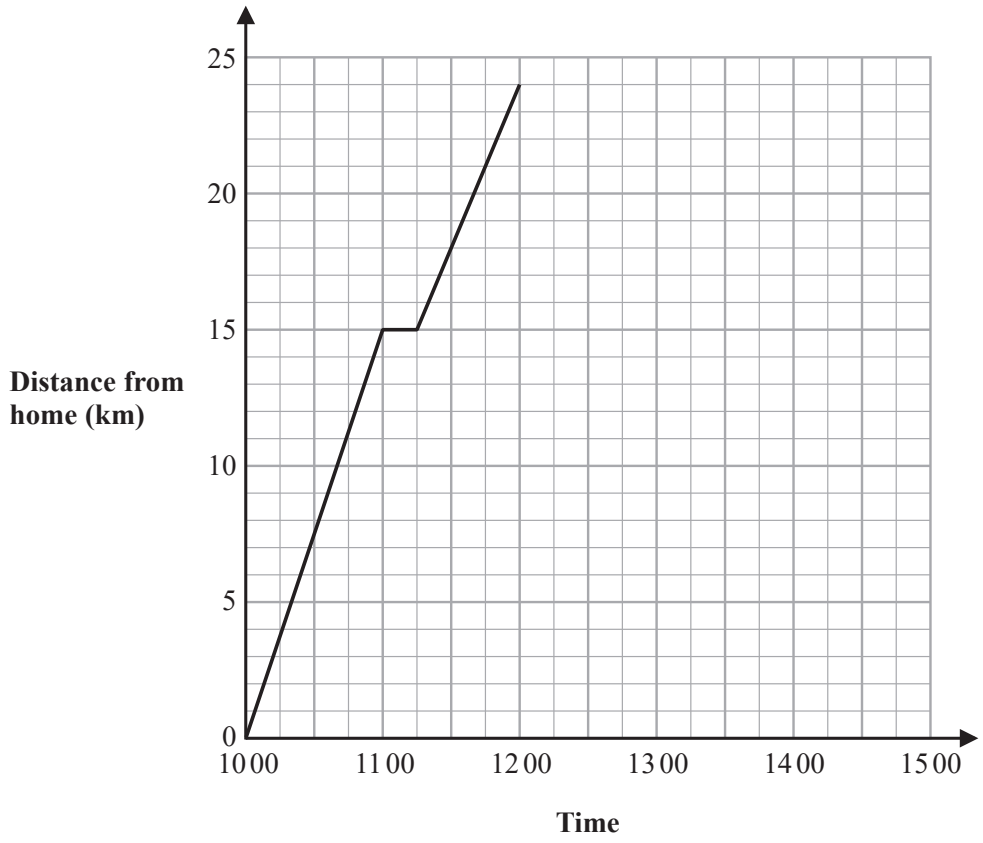
The point P has x coordinate -2

Use the graph to find an estimate for the gradient of the curve at P

.....

(Total for Question 21 is 3 marks)

2 Jalina left her home at 10 00 to cycle to a park.
On her way to the park, she stopped at a friend's house and then continued her journey to the park.
Here is the distance-time graph for her journey to the park.



(a) On her journey to the park, did Jalina cycle at a faster speed before or after she stopped at her friend's house?
Give a reason for your answer.

.....

.....

.....

(1)

Jalina stayed at the park for 45 minutes.
She then cycled, without stopping, at a constant speed of 16 km/h from the park back to her home.

(b) Show all this information on the distance-time graph.

(2)

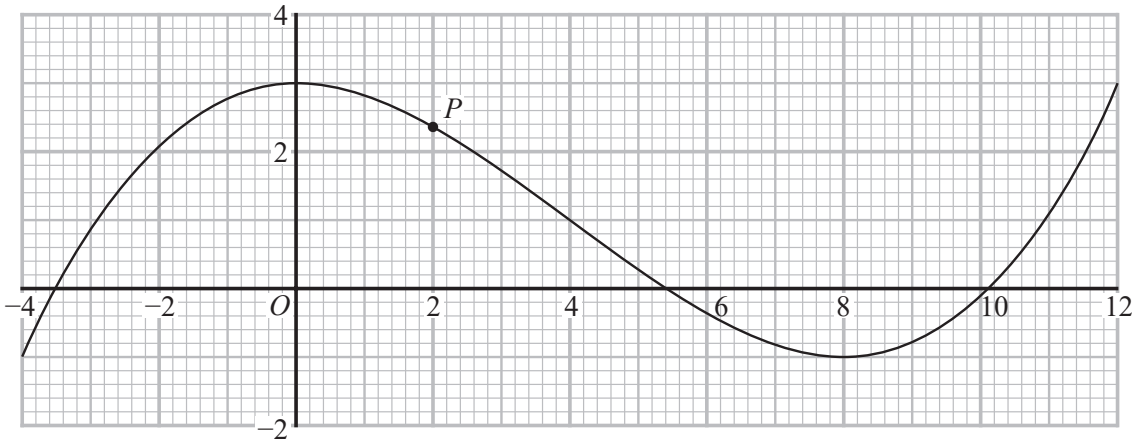
(c) Work out Jalina's average cycling speed, in kilometres per hour, for the complete journey to the park and back.
Do **not** include the times when she was not cycling in your calculation.
Give your answer correct to 1 decimal place.

..... km/h

(3)

(Total for Question 2 is 6 marks)

18 The diagram shows the graph of $y = f(x)$ for $-4 \leqslant x \leqslant 12$



The point P on the curve has x coordinate 2

(a) (i) Use the graph to find an estimate for the gradient of the curve at P.

.....

(3)

(ii) Hence find an equation of the tangent to the curve at P.
Give your answer in the form $y = mx + c$

.....

(2)

The equation $f(x) = k$ has exactly two different solutions for $-4 \leqslant x \leqslant 12$

(b) Use the graph to find the two possible values of k.

..... , ...

(2)

(Total for Question 18 is 7 marks)

SUB-TOPIC A4d

GRAPH TRANSFORMATIONS & CIRCLE EQUATIONS

Sub-topic A4d · 34 questions · 120 marks · lowest tariff first

20 A curve has equation $y = f(x)$
There is only one maximum point on the curve.
The coordinates of this maximum point are $(-3, 4)$

Write down the coordinates of the maximum point on the curve with equation

(i) $y = f(x) - 6$

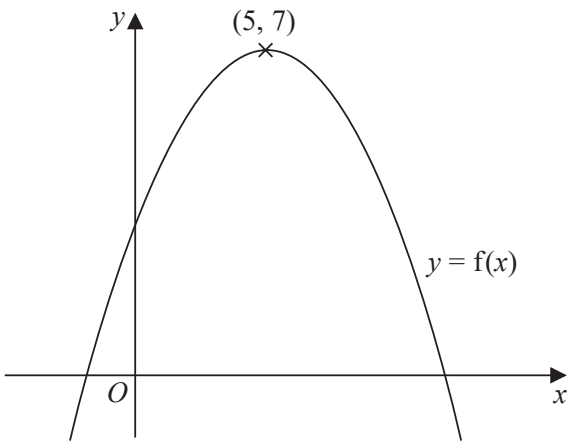
(.....,.....)

(ii) $y = f(2x)$

(.....,.....)

(Total for Question 20 is 2 marks)

23 The diagram shows a sketch of the curve with equation $y = f(x)$



There is only one maximum point on the curve.
The coordinates of this maximum point are (5, 7)

Write down the coordinates of the maximum point on the curve with equation

(i) $y = f(x + 9)$

(..... , ...)

(ii) $y = f(x) + 3$

(..... , ...)

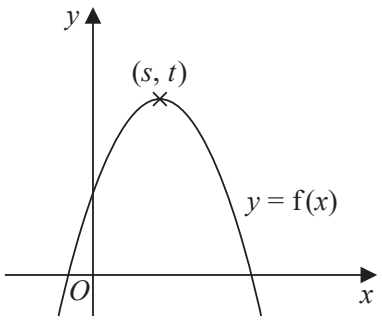
(Total for Question 23 is 2 marks)

Question 19 continued.

$r =$ .....

(Total for Question 19 is 5 marks)

20 The diagram shows a sketch of part of the curve with equation $y = f(x)$



There is one maximum point on this curve.
The coordinates of this maximum point are (s, t)

Find, in terms of s and t, the coordinates of the maximum point on the curve with equation

(i) $y = f(x - 2)$

(..... , ...)
(1)

(ii) $y = 3f(x)$

(..... , ...)
(1)

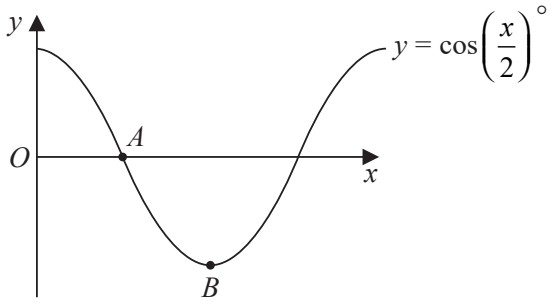
(Total for Question 20 is 2 marks)

(..... , ...)

(..... , ...)

(Total for Question 22 is 7 marks)

23 The diagram shows a sketch of the graph of $y = \cos\left(\frac{x}{2}\right)^\circ$



(i) Find the coordinates of the point A

(..... , ...)

(1)

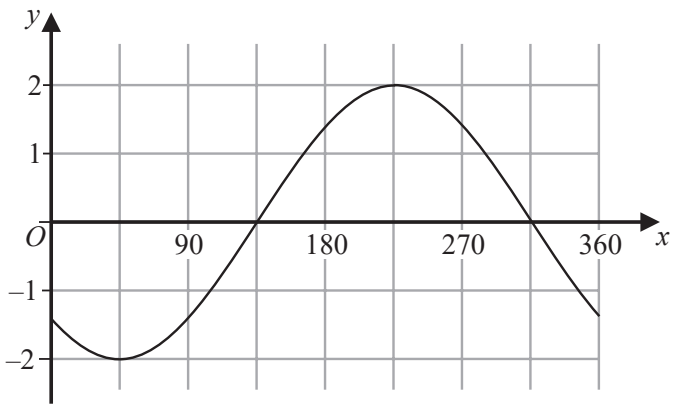
(ii) Find the coordinates of the point B

(..... , ...)

(1)

(Total for Question 23 is 2 marks)

20 Here is a sketch of the curve $y = a\cos(x + b)°$ for $0 \leqslant x \leqslant 360$



Given that $0 < b < 180$

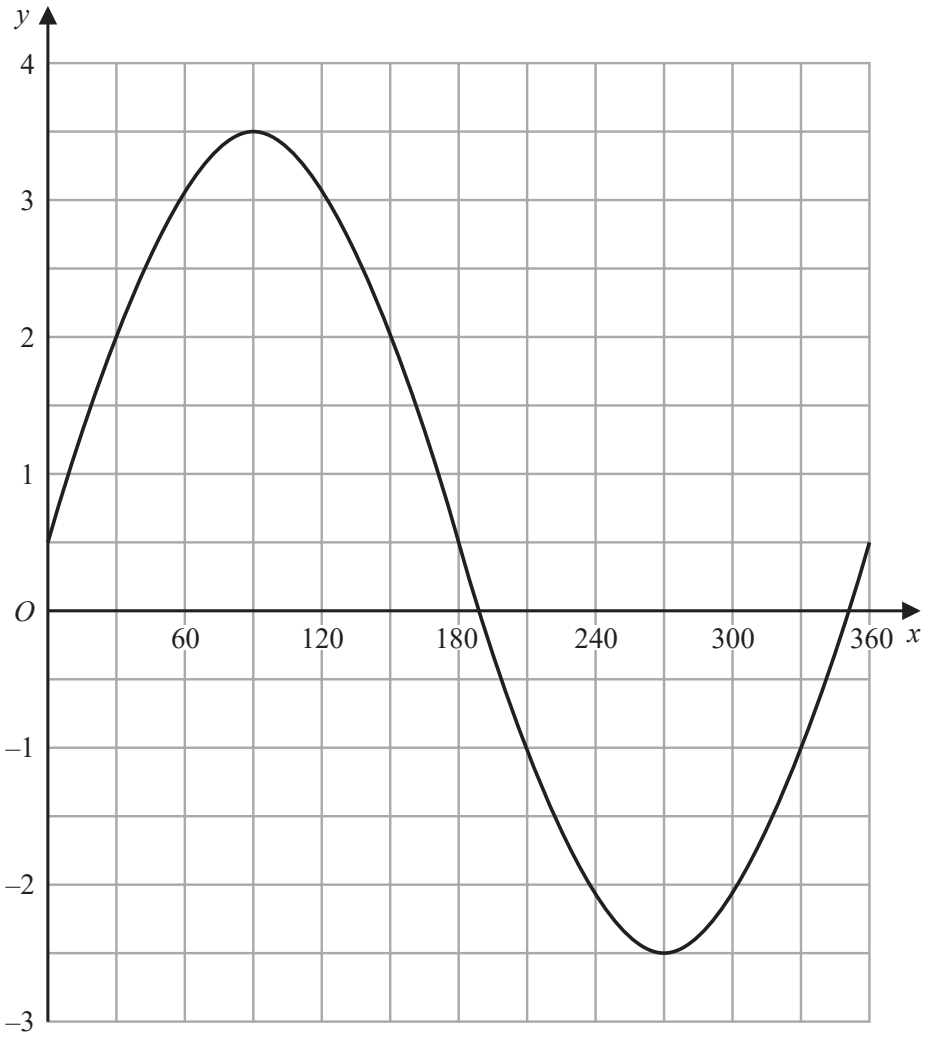
find the value of a and the value of b

$a =$ .....

$b =$ .....

(Total for Question 20 is 2 marks)

24 The graph of $y = a\sin x° + b$ is drawn on the grid.



Find the value of a and the value of b

$a =$ .....

$b =$ .....

(Total for Question 24 is 2 marks)

$X =$ .....

(Total for Question 20 is 6 marks)

21 A curve has equation $y = f(x)$

There is only one turning point on the curve.
The coordinates of this turning point are (6, 5)

Write down the coordinates of the turning point on the curve with equation

(a) $y = f(x - 4)$

(..... , ...)
(1)

(b) $y = f(3x)$

(..... , ...)
(1)

(Total for Question 21 is 2 marks)

21 A curve has equation $y = f(x)$

There is one minimum point on this curve.
The coordinates of this minimum point are $(5, -4)$

Write down the coordinates of the minimum point on the curve with equation

(i) $y = f(x + 7)$

(..... , ...)

(1)

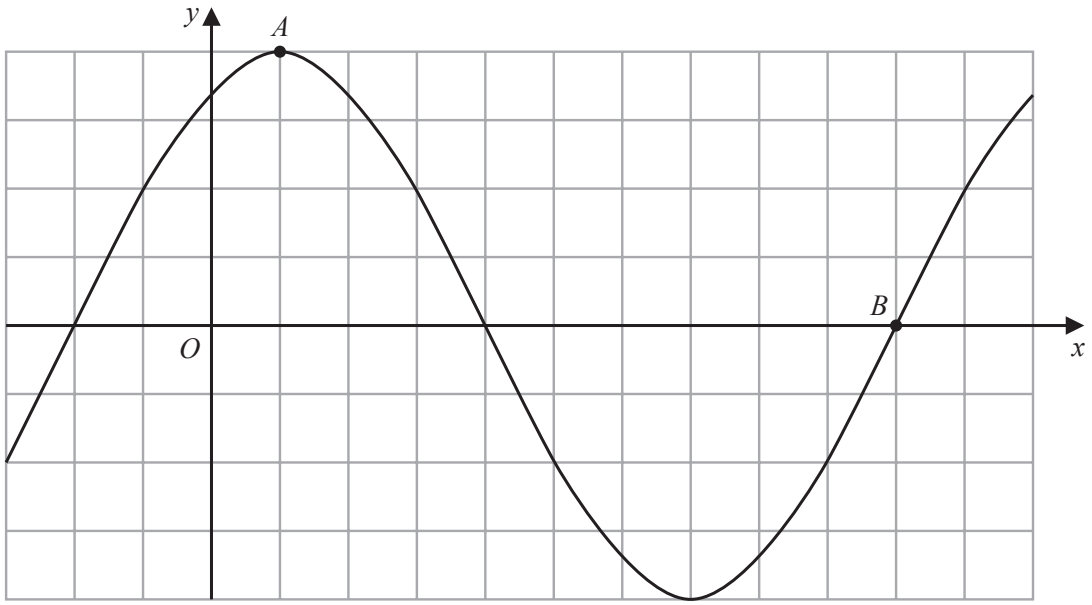
(ii) $y = f(x) - 6$

(..... , ...)

(1)

(Total for Question 21 is 2 marks)

25 The diagram shows a sketch of the graph of $y = 2\sin(x + 60)°$



(i) Find the coordinates of the point A

(..... , ...)

(1)

(ii) Find the coordinates of the point B

(..... , ...)

(1)

(Total for Question 25 is 2 marks)

TOTAL FOR PAPER IS 100 MARKS

23 A curve has equation $y = f(x)$
The coordinates of the minimum point on this curve are $(6, -3)$

Write down the coordinates of the minimum point on the curve with equation

(i) $y = f(x) + 10$

(.....,.....)
(1)

(ii) $y = f(3x)$

(.....,.....)
(1)

(Total for Question 23 is 2 marks)

18 y is inversely proportional to x^3

$y = 4$ when $x = 3$

Work out the value of x when $y = 864$

$x =$ .....

(Total for Question 18 is 4 marks)

19 The equation of a curve is $y = f(x)$

There is only one minimum point on the curve.
The coordinates of this minimum point are $(8, -12)$

Write down the coordinates of the minimum point on the curve with equation

(i) $y = f(x) + 3$

(..... , ...)

(1)

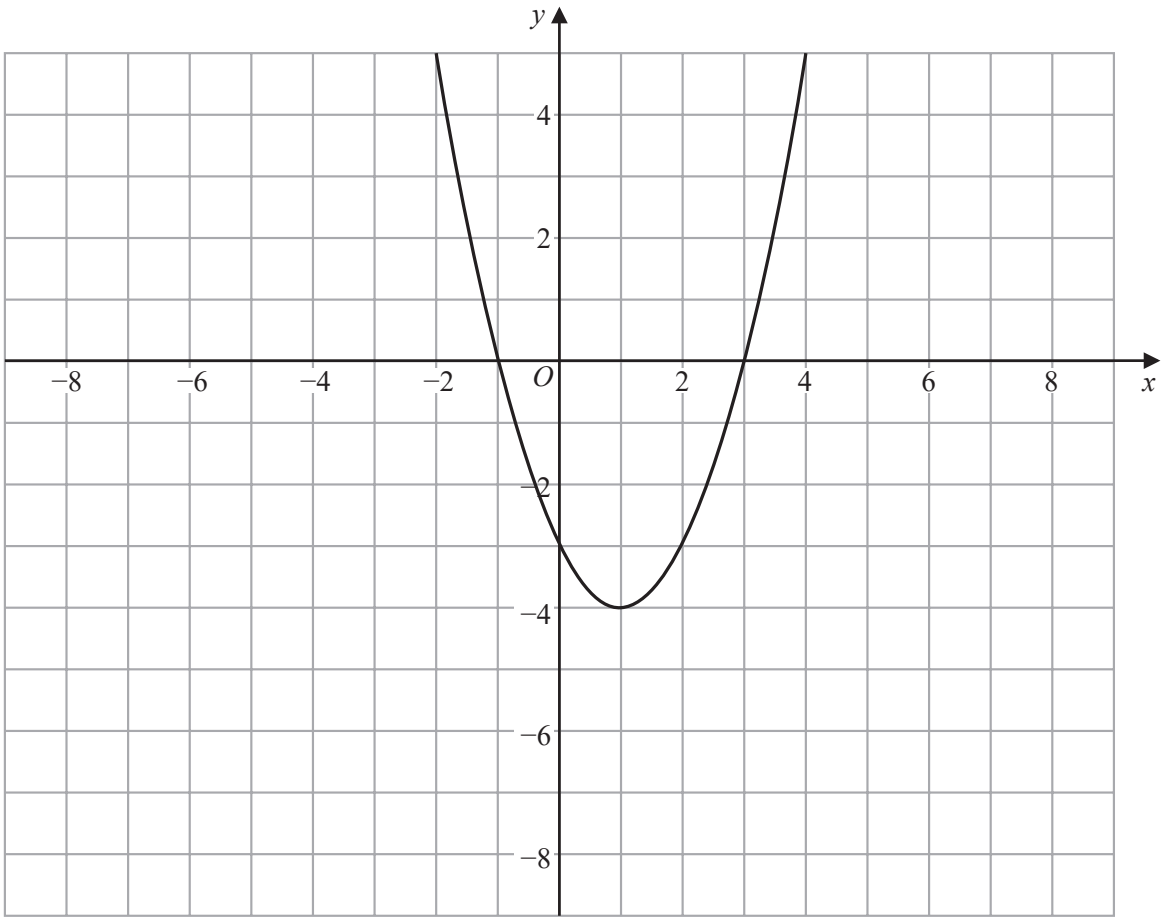
(ii) $y = f(2x)$

(..... , ...)

(1)

(Total for Question 19 is 2 marks)

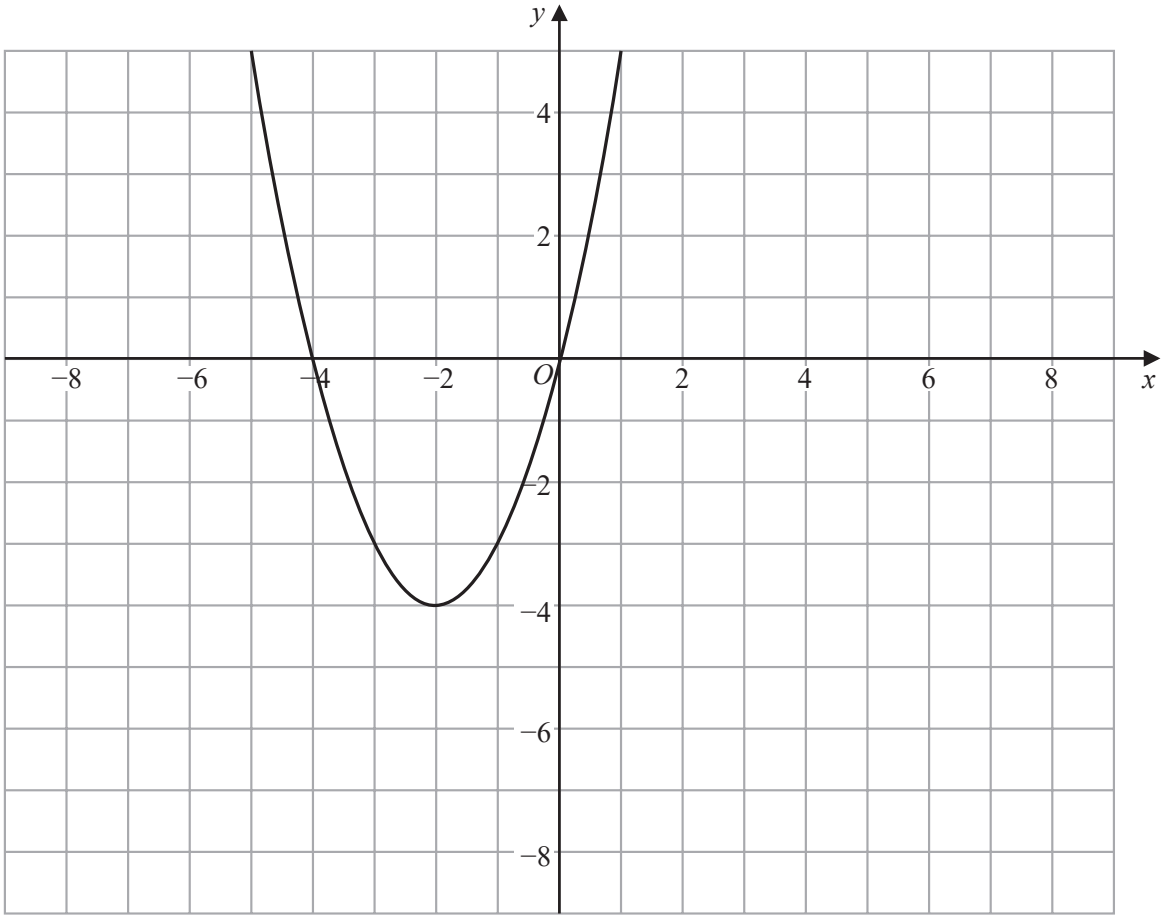
18 The graph of $y = f(x)$ is shown on the grid.



(a) On the grid above, sketch the graph of $y = f\left(\frac{1}{2}x\right)$

(2)

The graph of $y = f(x + k)$ is shown on the grid below.



(b) Write down the value of k

(1)

(Total for Question 18 is 3 marks)

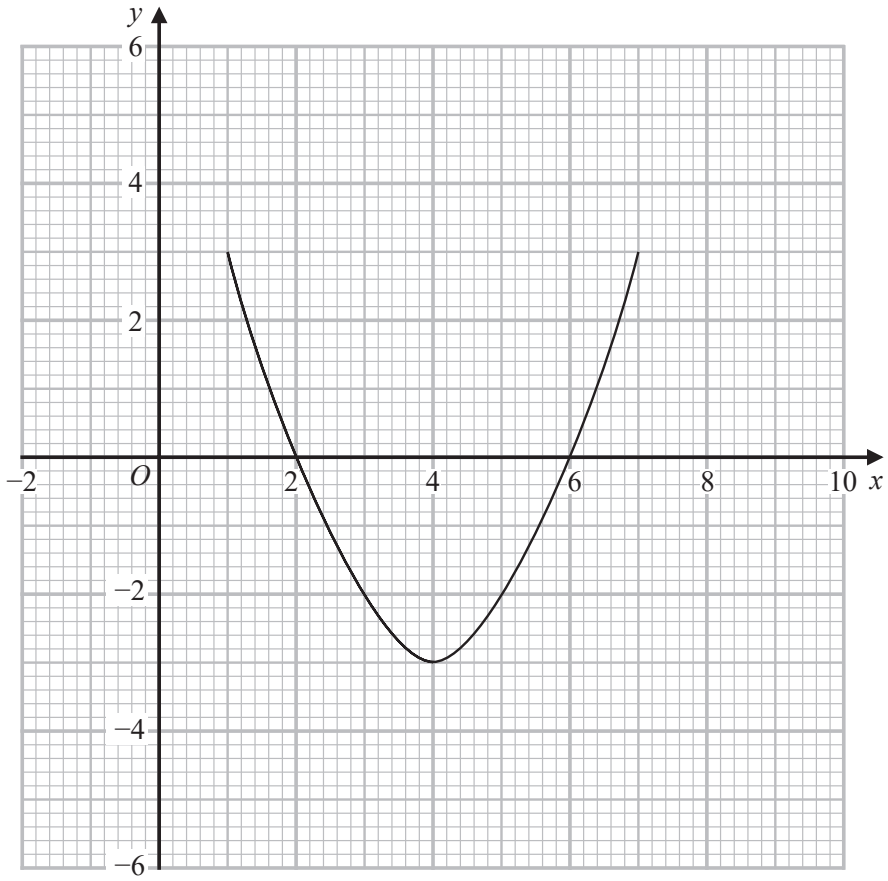
25 The curve with equation $y = g(x)$ is transformed to the curve with equation $y = -g(x)$ by the single transformation **T**.

(a) Describe fully the transformation **T**.

.....

(1)

The diagram shows the graph of $y = f(x)$



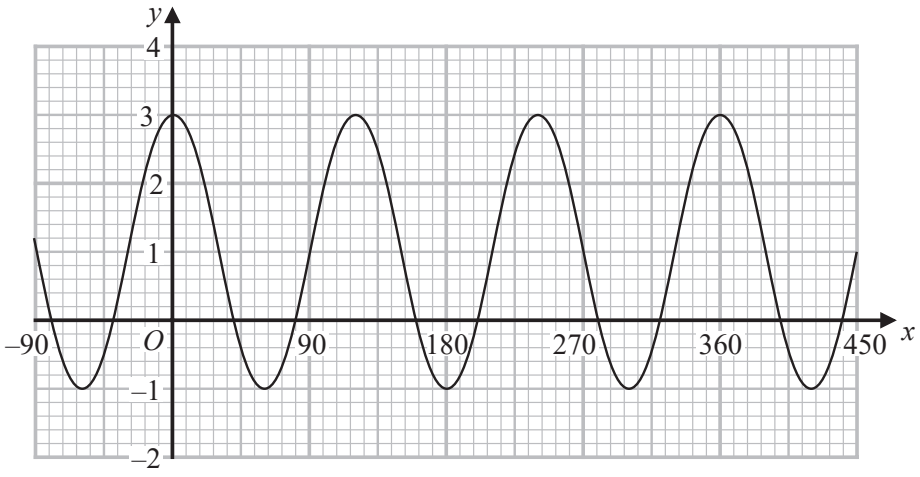
(b) On the grid, draw the graph of $y = 2f(x - 1)$

(2)

(Total for Question 25 is 3 marks)

TOTAL FOR PAPER IS 100 MARKS

26 Here is a sketch of the curve with equation $y = a\cos bx° + c$ where $-90 \leqslant x \leqslant 450$



Find the value of a, the value of b and the value of c

$a =$ .....

$b =$ .....

$c =$ .....

(Total for Question 26 is 3 marks)

TOTAL FOR PAPER IS 100 MARKS

19 A curve has equation $y = f(x)$

There is only one minimum point on the curve.
The coordinates of this minimum point are (5, 4)

Write down the coordinates of the minimum point on the curve with equation

(i) $y = f(x + 5)$

(..... , ...)
(1)

(ii) $y = 3f(x)$

(..... , ...)
(1)

(iii) $y = f(x) - 7$

(..... , ...)
(1)

(Total for Question 19 is 3 marks)

20 Solve the inequality $10x^2 + 11x - 21 < 0$
Show clear algebraic working.

.....

(Total for Question 20 is 3 marks)

21 The curve with equation $y = f(x)$ has one turning point.
The coordinates of this turning point are $(-6, 9)$

(a) Write down the coordinates of the turning point on the curve with equation $y = f(3x)$

(.....,.....)

(1)

The curve **C** with equation $y = g(x)$ is transformed to give the curve **S** with equation $y = g(x + a) + b$

The point $(4, -5)$ on **C** is mapped to the point $(1, -16)$ on **S**

(b) Write down the value of a and the value of b

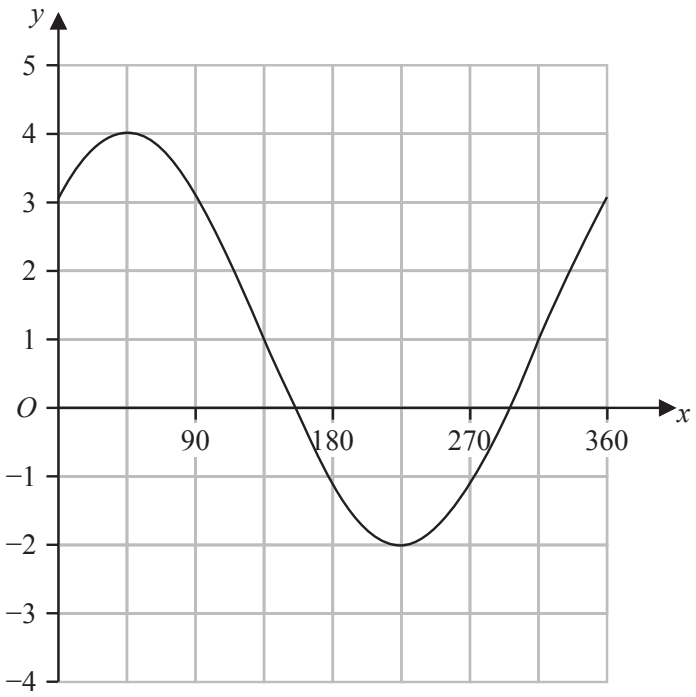
$a =$ .....

$b =$ .....

(2)

(Total for Question 21 is 3 marks)

25 The graph of $y = a\sin(x + b)^\circ + c$ for $0 \leqslant x \leqslant 360$ is drawn on the grid below.



Find a suitable value for a, for b and for c

$a =$ .....

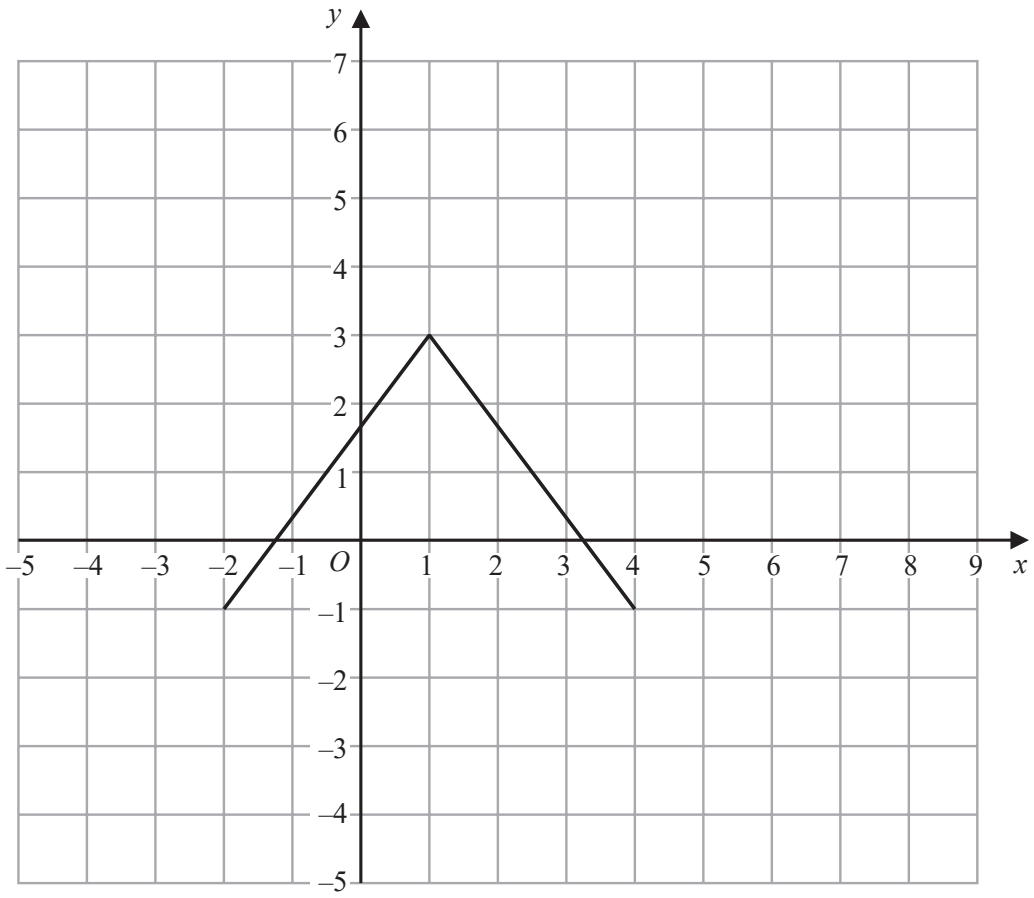
$b =$ .....

$c =$ .....

(Total for Question 25 is 3 marks)

Turn over for Question 26

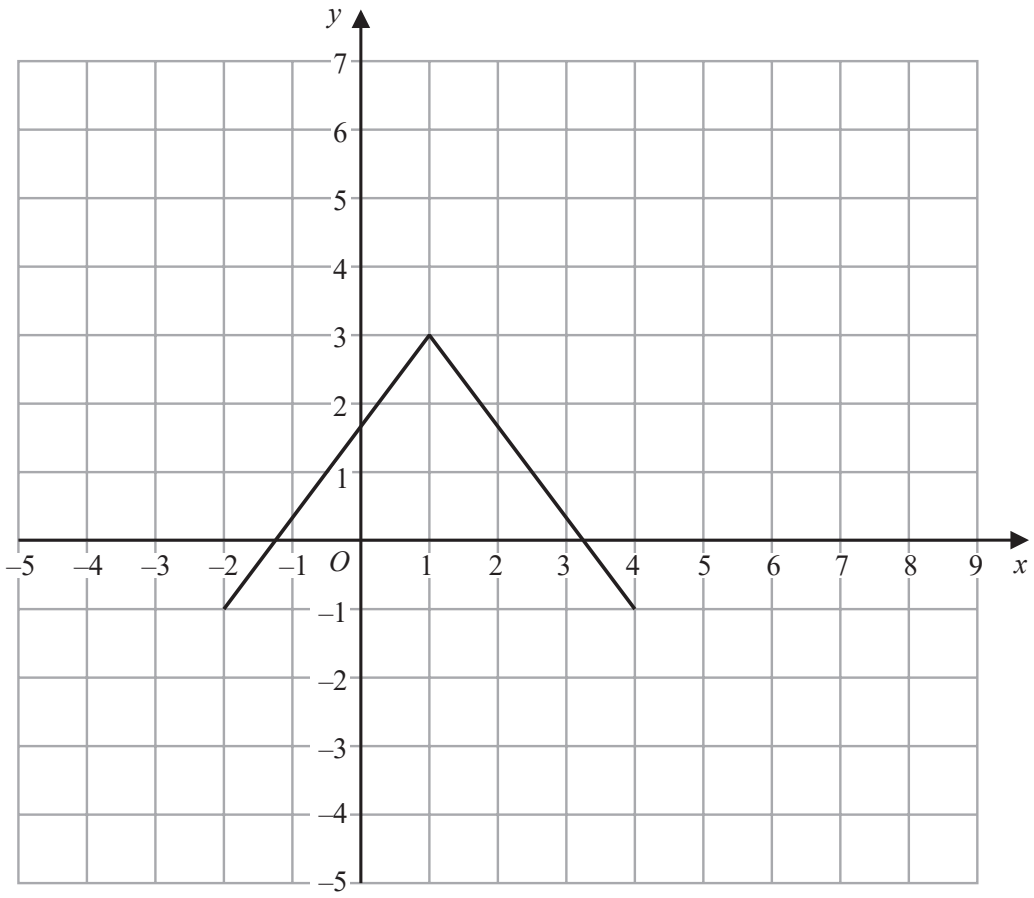
21 Here is the graph of $y = f(x)$



(a) On the grid above, draw the graph of $y = 2f(x)$

(2)

Here is the graph of $y = f(x)$

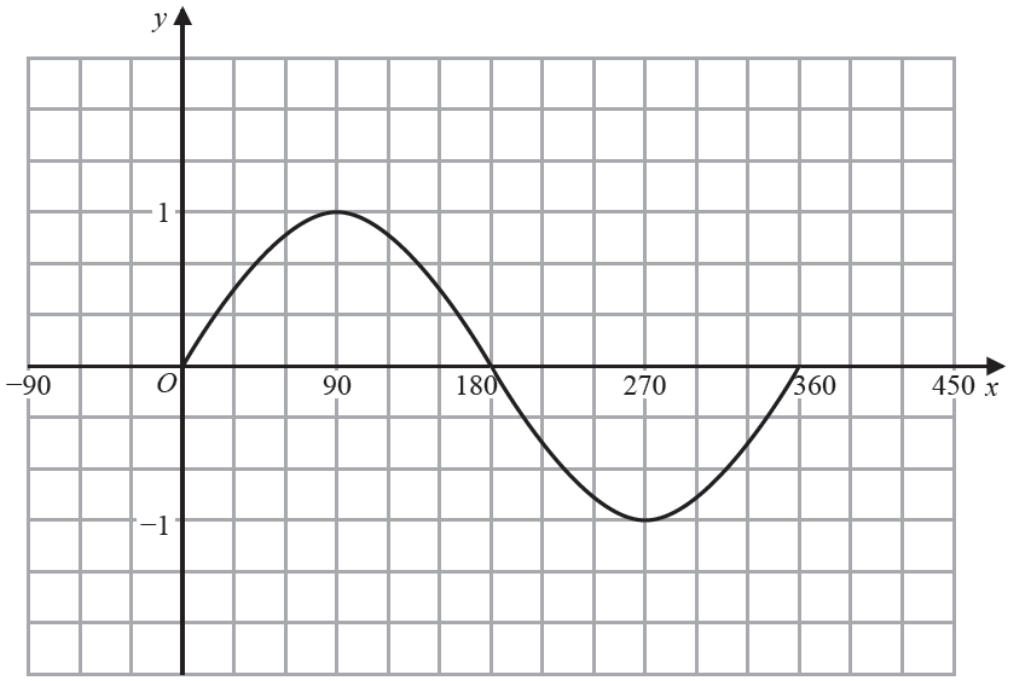


(b) On the grid above, draw the graph of $y = f(-x)$

(2)

(Total for Question 21 is 4 marks)

18 Here is the graph of $y = \sin x°$ for $0 \leqslant x \leqslant 360$



(a) On the grid above, sketch the graph of $y = \sin(x + 90)°$ for $0 \leqslant x \leqslant 360$

(2)

In $0 \leqslant x \leqslant 360$, the graph of $y = \sin\left(\frac{x}{2}\right)° + 3$ has a maximum at the point A.

(b) Write down the coordinates of A.

(,)

(2)

(Total for Question 18 is 4 marks)

21 A curve has equation $y = f(x)$

There is only one maximum point on the curve.
The coordinates of this maximum point are (4, 3)

(a) Write down the coordinates of the maximum point on the curve with equation

(i) $y = f(x - 5)$

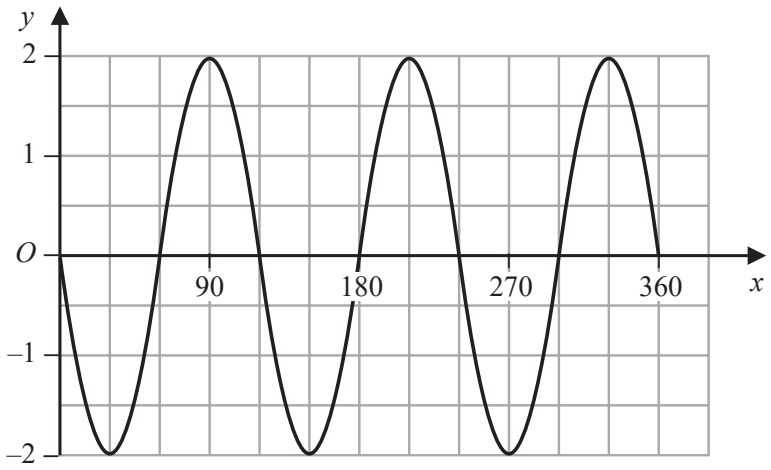
(.....,.....)

(ii) $y = 3f(x)$

(.....,.....)

(2)

Here is the graph of $y = a\sin(bx)°$ for $0 \leqslant x \leqslant 360$



(b) Find the value of a and the value of b.

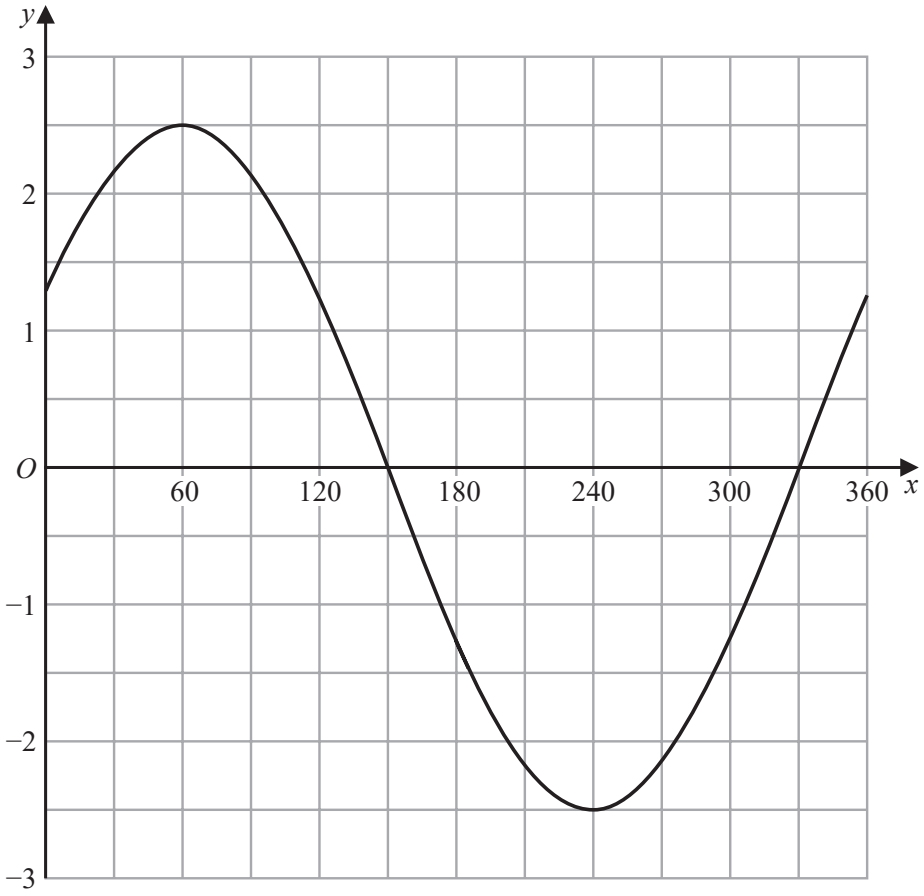
$a =$ .....

$b =$ .....

(2)

(Total for Question 21 is 4 marks)

22 The graph of $y = a\cos(x + b)°$ for $0 \leqslant x \leqslant 360$ is drawn on the grid.



(a) Find the value of a and the value of b.

$a =$ .....

$b =$ .....

(2)

Another curve C has equation $y = f(x)$
The coordinates of the minimum point of C are (4, 5)

(b) Write down the coordinates of the minimum point of the curve with equation

(i) $y = f(2x)$

(..... , ...)

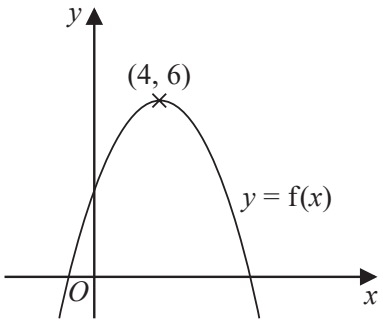
(ii) $y = f(x) - 7$

(..... , ...)

(2)

(Total for Question 22 is 4 marks)

21 The diagram shows a sketch of part of the curve with equation $y = f(x)$



There is one maximum point on this curve.
The coordinates of this maximum point are (4, 6)

(a) Write down the coordinates of the maximum point on the curve with equation

(i) $y = f(x + 4)$

(..... , ...)

(ii) $y = f(2x)$

(..... , ...)

(2)

The equation of a curve **C** is $y = x^2 + 3x + 4$

The curve **C** is transformed to curve **S** under the translation $\begin{pmatrix} 4 \\ 6 \end{pmatrix}$

(b) Find an equation of curve **S**.

You do not need to simplify the equation.

.....

(2)

(Total for Question 21 is 4 marks)

21 A curve has equation $y = f(x)$

The coordinates of the minimum point on this curve are (–9, 15)

(a) Write down the coordinates of the minimum point on the curve with equation

(i) $y = f(x + 3)$

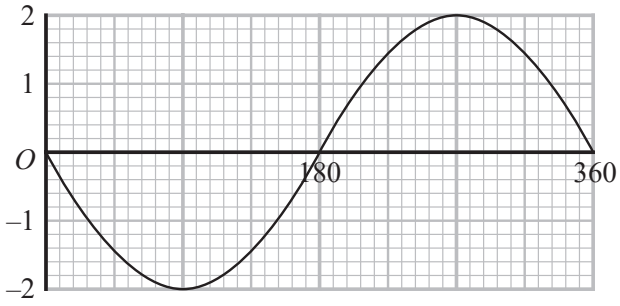
(..... , ...)

(ii) $y = \frac{1}{3} f(x)$

(..... , ...)

(2)

The graph of $y = a\cos(x + b)°$ for $0 \leqslant x \leqslant 360$ is drawn on the grid below.



Given that $a > 0$ and that $0 < b < 360$

(b) find the value of a and the value of b.

$a =$ .....

$b =$ .....

(2)

(Total for Question 21 is 4 marks)

22 The curve **S** has equation $y = f(x)$ where $f(x) = x^2$
The curve **T** has equation $y = g(x)$ where $g(x) = 2x^2 - 12x + 13$

By writing $g(x)$ in the form $a(x - b)^2 - c$, where a, b and c are constants,
describe fully a series of transformations that map the curve **S** onto the curve **T**.

.....

.....

.....

(Total for Question 22 is 4 marks)

10 Two circles, C_1 and C_2, are drawn on a centimetre grid, with a scale of 1 cm for 1 unit on each axis.

The centre of circle C_1 is at the point with coordinates (–1, 3) and the radius of C_1 is 13 cm.

The centre of circle C_2 is at the point with coordinates (7, 18) and the radius of C_2 is 6 cm.

(a) Work out the distance between the centre of C_1 and the centre of C_2

..... cm

(3)

(b) Explain why circle C_1 intersects circle C_2

.....

.....

(1)

(Total for Question 10 is 4 marks)

20 The centre O of a circle has coordinates (4, 7)

The point A, on the circle, has coordinates (6, 11) and AOP is a diameter of the circle.

Find an equation of the tangent to the circle at the point P

.....

(Total for Question 20 is 4 marks)

22 The point A with coordinates $(-3, 2)$ lies on the straight line with equation $y = f(x)$

(a) Find the coordinates of the image of the point A on the straight line with equation

(i) $y = f(x) - 3$

(.....,.....)

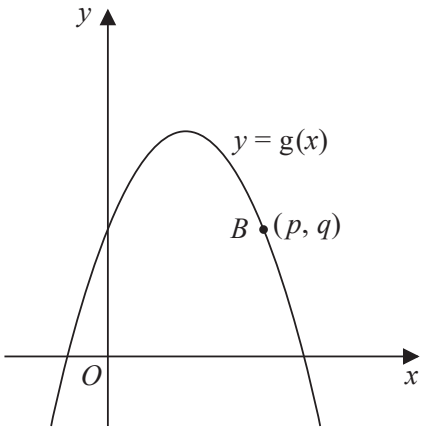
(1)

(ii) $y = f\left(\frac{x}{2}\right)$

(.....,.....)

(1)

Here is a sketch of part of the curve with equation $y = g(x)$



The point B with coordinates (p, q) lies on the curve.

(b) Find the coordinates of the image of the point B on the curve with equation

$$y = -g(x - c)$$

where c is a constant.

(.....,.....)

(2)

(Total for Question 22 is 4 marks)

24 The curve with equation $f(x) = 5x^2 + 9x + 2$ is transformed to the curve with equation

$g(x) = 5(x+4)^2 + 9(x+4) + 8$ by the translation $\begin{pmatrix} a \\ b \end{pmatrix}$

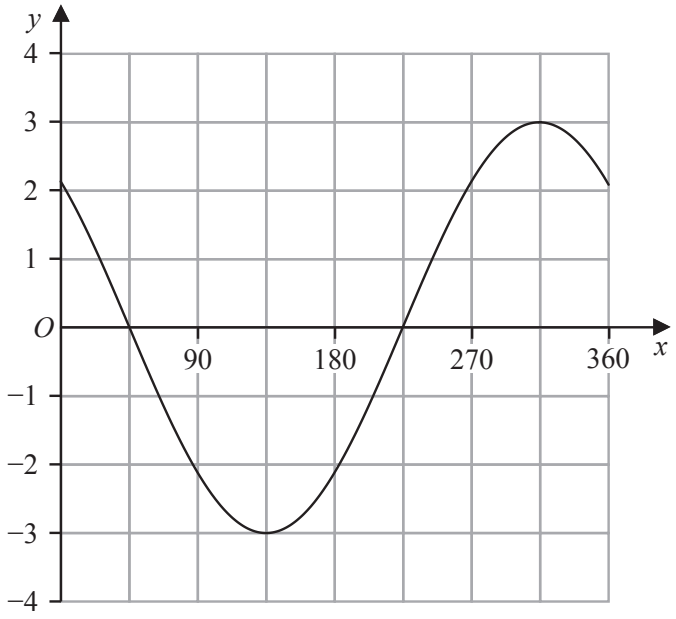
(a) Write down the value of a and the value of b

$a =$ .....

$b =$ .....

(2)

The graph of $y = p\cos(x+q)^\circ$ for $0 \leqslant x \leqslant 360$ is drawn on the grid below.



Given that $p > 0$ and $0 < q < 360$

(b) find the value of p and the value of q

$p =$ .....

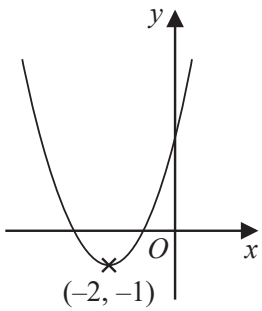
$q =$ .....

(2)

(Total for Question 24 is 4 marks)

TOTAL FOR PAPER IS 100 MARKS

18



The diagram shows the curve with equation $y = f(x)$
The coordinates of the minimum point of the curve are $(–2, –1)$

(a) Write down the coordinates of the minimum point of the curve with equation

(i) $y = f(x – 5)$

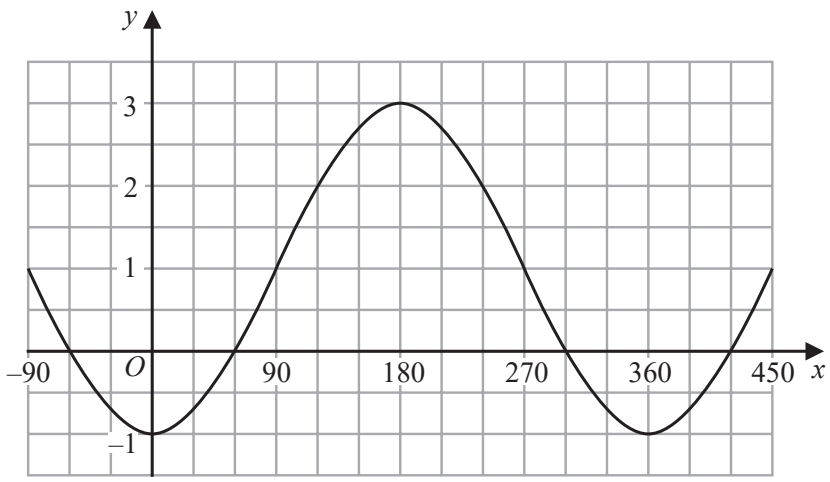
(..... , ...)

(ii) $y = \frac{1}{2} f(x)$

(..... , ...)

(2)

The graph of $y = a\sin(x – b)° + c$ for $–90 \leqslant x \leqslant 450$ is drawn on the grid below.



(b) Find the value of a, the value of b and the value of c.

$a =$ .....

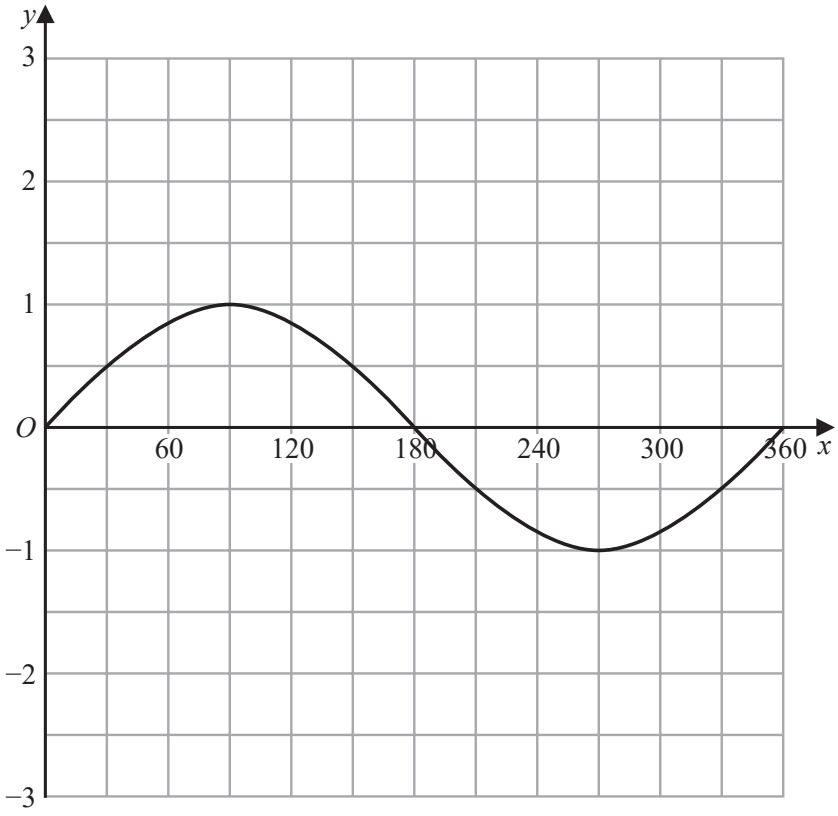
$b =$ .....

$c =$ .....

(3)

(Total for Question 18 is 5 marks)

22 The graph of $y = \sin x°$ for $0 \leqslant x \leqslant 360$ is drawn on the grid.



(a) On the grid, draw the graph of $y = 2\sin(x + 30)°$ for $0 \leqslant x \leqslant 360$

(2)

(b) (i) Write $x^2 - 6x + 10$ in the form $(x - a)^2 + b$ where a and b are integers.

.....

(2)

(ii) Hence, describe fully the single transformation that maps the curve with equation $y = x^2$ onto the curve with equation $y = x^2 - 6x + 10$

.....

.....

(2)

(Total for Question 22 is 6 marks)

21 The curve **C** has equation $y = f(x)$ where $f(x) = 9 - 3(x + 2)^2$
The point A is the maximum point on **C**.

(a) Write down the coordinates of A.

(..... , ...)

(1)

The curve **C** is transformed to the curve **S** by a translation of $\begin{pmatrix} 4 \\ 0 \end{pmatrix}$

(b) Find an equation for the curve **S**.

.....

(1)

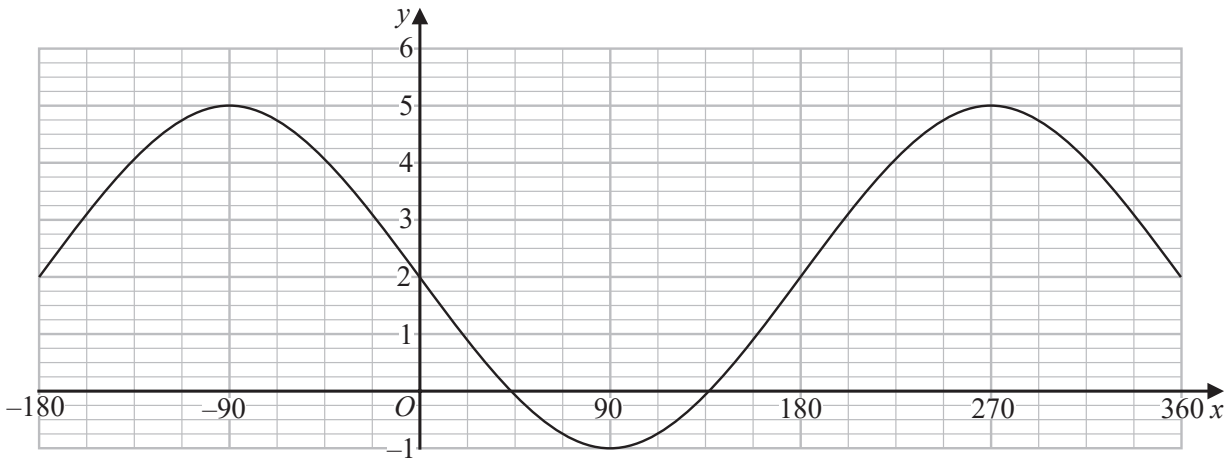
The curve **C** is transformed to the curve **T**.
The curve **T** has equation $y = 3(x + 2)^2 - 9$

(c) Describe fully the transformation that maps curve **C** onto curve **T**.

.....

(1)

The graph of $y = a\cos(x - b)° + c$ for $-180 \leqslant x \leqslant 360$ is drawn on the grid below.



(d) Find the value of a, the value of b and the value of c.

$a =$ .....

$b =$ .....

$c =$ .....

(3)

(Total for Question 21 is 6 marks)

20 The curve with equation $y = f(x)$ has one turning point.

The coordinates of this turning point are $(-6, -4)$

(a) Write down the coordinates of the turning point on the curve with equation

(i) $y = f(x) + 5$

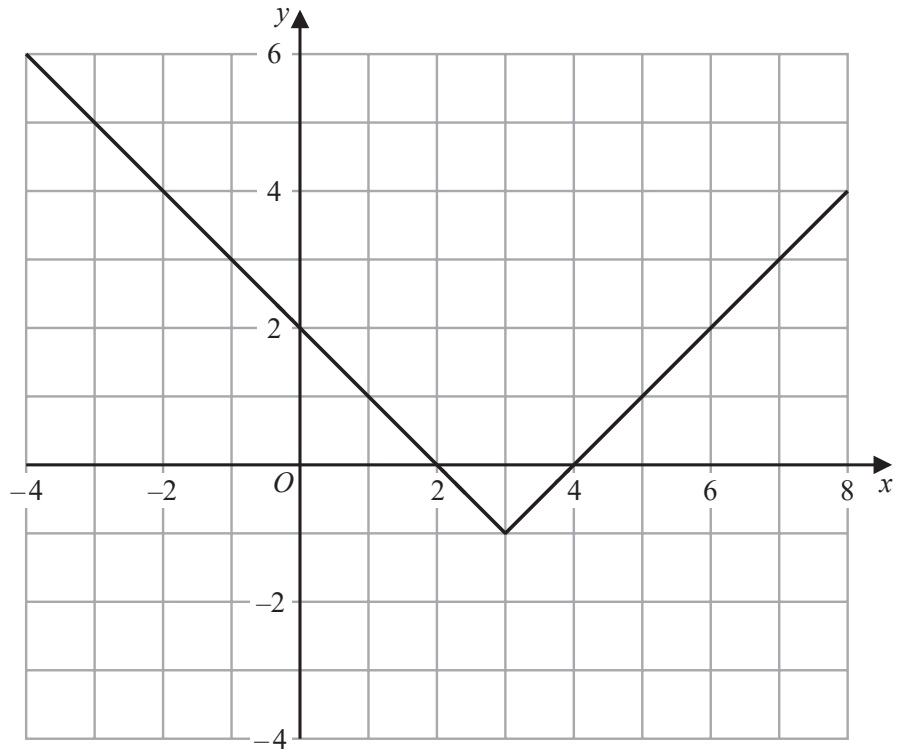
(.....,.....)

(ii) $y = f(3x)$

(.....,.....)

(2)

The graph of $y = g(x)$ is shown on the grid below.



(b) On the grid, sketch the graph of $y = 2g(x)$ for $-1 \leqslant x \leqslant 7$

(2)

The graph of $y = h(x)$ intersects the x-axis at two points.
The coordinates of the two points are $(-1, 0)$ and $(6, 0)$

The graph of $y = h(x + a)$ passes through the point with coordinates $(2, 0)$, where a is a constant.

(c) Find the two possible values of a

..... , ...

(2)

(Total for Question 20 is 6 marks)

22 [In this question 1 cm = 1 unit on the x-axis and 1 cm = 1 unit on the y-axis]

P is a point on a circle with centre (0, 0)
The coordinates of P are (8, −10)

The line **L** is the tangent to the circle at the point P
L crosses the x-axis at the point Q and crosses the y-axis at the point R

Work out the length of RQ
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 22 is 6 marks)

20 Curve **C** has equation $y = f(x)$
The graph of curve **C** has one maximum point.
The coordinates of this maximum point are (3, 5)

(a) Write down the coordinates of the maximum point on the curve with equation

(i) $y = 2f(x)$

(.....,.....)
(1)

(ii) $y = f(x) - 7$

(.....,.....)
(1)

(iii) $y = f(-x)$

(.....,.....)
(1)

Curve **L** has equation $y = x^2 + 7x + 20$

Curve **L** is transformed to curve **S** under the translation $\begin{pmatrix} 2 \\ 0 \end{pmatrix}$

(b) Find an equation for **S**
Give your answer in the form $y = ax^2 + bx + c$

$y =$ .....
(4)

(Total for Question 20 is 7 marks)

MARK SCHEMES

official mark schemes, in the same order as the questions

5	(a)	8265 – 7500 (= 765) **or** $\frac{8265}{7500}$ (=1.102)		3	M1	8265 – 7500 could be embedded in another calculation.
		$\frac{"765"}{7500}\times 100$ oe **or** "1.102" × 100 – 100 oe			M1	
			10.2		A1	oe
	(b)	e.g. 31.5(0) ÷ (1 – 0.3)		3	M2	for a complete method e.g. 31.5(0) ÷ (1 – 0.3)
					(M1)	for 31.5(0) ÷ (100 – 30) (= 0.45) **or** e.g. (1 – 0.3)x = 31.5(0)
			45		A1	
						Total 6 marks

6	e.g. $a = (-3 + 47) \div 2$ (= 22) **or** $\frac{11+b}{2} = -19$ ($b = -38$ $-11 = -49$) **or** method to add 25 to −3 **or** method to subtract 25 from 47 **or** method to subtract 30 from −19 **or** method to subtract 60 from 11		2	M1	for a correct method to find either coordinate or one coordinate correct. Look for correct method on their diagram, if used.
		a = 22, b = −49		A1	both correct
					Total 2 marks

6				M1 for $y = 3x + c$ oe **or** $y = mx - 2$ oe **or** $3x - 2$ **or** eg $L = 3x - 2$ **or** $y = 3(x \pm a)$
		$y = 3x - 2$	2	A1 oe eg $y - 4 = 3(x - 2)$ $y - 1 = 3(x - 1)$ $y - a = 3(x - b)$ where (a, b) is any coordinate on the line
				Total 2 marks

7	$\tan x = \frac{3.4}{4.7}$ oe eg $\cos x = \frac{4.7}{\sqrt{3.4^2 + 4.7^2}}$ oe			M1 or $\sin x = \frac{3.4\sin 90}{\sqrt{3.4^2 + 4.7^2}}$ oe
	$(x =) \tan^{-1}\left(\frac{3.4}{4.7}\right)$ oe eg $(x =) \cos^{-1}\left(\frac{4.7}{\sqrt{3.4^2 + 4.7^2}}\right)$			M1 or $(x =) \sin^{-1}\left(\frac{3.4\sin 90}{\sqrt{3.4^2 + 4.7^2}}\right)$ oe
		35.9	3	A1 accept 35.7 - 36.1
				Total 3 marks

8	$8.5^2 - (8 \div 2)^2$ (= 56.25) **or** $\cos x = \frac{4}{8.5}$ oe			M1 **or** eg $\cos A = \frac{8^2 + 8.5^2 - 8.5^2}{2 \times 8 \times 8.5}$
	$\sqrt{"56.25"}$ (= 7.5) **or** $x = \cos^{-1}\left(\frac{4}{8.5}\right)$ (= 61.927...) oe			M1 **or** eg $(A =) \cos^{-1}\left(\frac{8^2 + 8.5^2 - 8.5^2}{2 \times 8 \times 8.5}\right)$ (61.927...) (other angle = 56.144...)
	8 × "7.5" ÷ 2 oe **or** 0.5 × 8 × 8.5 × sin "61.927..."			M1 **or** eg 0.5 × 8.5 × 8 × sin"61.927..." oe
		30	4	A1
				Total 4 marks

12	$y=\frac{7-5x}{2}$ or $y=\frac{7}{2}-\frac{5}{2}x$ or $y=3.5-2.5x$ or $2y=7-5x$ oe		2	M1 for making y or $2y$ the subject Allow $y=-\frac{5}{2}x+c$ oe
		-2.5		A1 for $-\frac{5}{2}$ or -2.5
				Total 3 marks

13	$\cos 35°=\frac{15}{AB}$ or $\sin 55°=\frac{15}{AB}$ or $\frac{15}{\sin 55}=\frac{JB}{\sin 35}$ **and** $(AB^2=)("10.50")^2+15^2$ or $\tan 35°=\frac{JB}{15}$ **and** $(AB^2=)("10.50")^2+15^2$		5	M1 oe eg x for AB
	$(AB=)\frac{15}{\cos 35°}$ (=18.3…) **or** $(AB=)\frac{15}{\sin 55°}$ (=18.3…) **or** $(AB=)\sqrt{("10.50")^2+15^2}$ **or** $(AB=)\sqrt{(15\tan 35)^2+15^2}$			M1
	'18.3' × 4 (= 73.2)			M1 dep 1st M1
	80 – '18.3' × 4 or 80 – '73.2'			M1 dep 1st M1
		6.75		A1 accept 6.75 – 6.8
				Total 5 marks

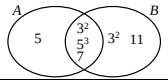
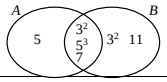
Question	Working	Answer	Mark	Notes
9		$y = 1.5x - 3$	2	B2 oe accept $y = 1.5x + -3$ oe B1 for $y = 1.5x + c$ (where c can be zero) or $y = mx - 3$ (where m is any value but $m \neq 0$ or 1.5) or $1.5x - 3$ or Gradient = 1.5 oe eg $m = \frac{3}{2}$ or a clear calculation for gradient oe (must be labelled or the meaning shown by their diagram or working)
				Total 2 marks

18	Gradient of **P** = $-\frac{2}{5}$ or $y=\frac{7-2x}{5}$ oe or $y = –0.4x + ….$ or $\frac{5}{2}x$ or $y=\frac{5}{2}x(+....)$		2	M1 oe for the given equation rearranged so it is possible to see the gradient or for an equation with gradient of 2.5 oe or $\frac{5}{2}x$ oe
	Correct answer scores full marks (unless from obvious incorrect working)	$\frac{5}{2}$		A1 oe gradient must be stated but isw if seen and then used in an equation SCB1 for the equation of a line with gradient $\frac{5}{2}$ if $\frac{5}{2}$ not seen separately and no other mark awarded
				Total 2 marks

10		eg $y = -5x$ (+ k) **or** $y - a = -5(x - b)$ **or** eg $y = mx + 6$ **or** $y - 6 = m(x - 0)$ **or** eg $-5x + 6$ **or** **L** $= -5x + 6$		2	M1	for the equation of any line with gradient -5 other than $y = 2 - 5x$ **or** for the equation of any line passing through the point (0, 6) **or** the correct line missing '$y =$' or with the wrong subject
		Correct answer scores full marks (unless from obvious incorrect working)	$y = -5x + 6$		A1	oe equation eg $y = 6 - 5x$ **or** $y - 6 = -5(x - 0)$ **or** $y + 5x = 6$
						Total 2 marks

Question	Working	Answer	Mark	Notes
9	e.g. $4x + 5y = 4$ $4x - 2y = 18$ with the operation of subtraction $4x + 5y = 4$ $10x - 5y = 45$ With the operation of adding $y = 2x - 9$ and $4x + 5(2x - 9) = 4$	$x = 3.5$ oe, $y = -2$	3	M1 for correct method to eliminate one variable – multiplying one or both equations so the coefficient of x or y is the same in both with the intention to add or subtract to eliminate one variable(condone one arithmetic error) or isolating x or y in one equation and substituting into the other equation M1 (dep) for substitution of found variable into one equation or correct method to eliminate second variable A1 Dep on M1
10	$3 \div 2$ (=1.5) or eg $\frac{4-1}{2(-0)}$ or $c = 1$ $y =$ "1.5"$x + c$ **or** $y = mx + 1$ or eg $y - 4 = m(x - 2)$	$y = 1.5x + 1$ oe	3	M1 for correct method to find gradient – may see this on grid. For $c = 1$, could be $(L =) mx + 1$ oe or for $1.5x + c$ M1 for use of $y = mx + c$ with either m or c or for $(L =) 1.5x + 1$ A1 oe eg $y - 4 = \frac{3}{2}(x - 2)$

Question	Working	Answer	Mark	Notes
11	e.g. $y = 2 - \frac{1}{2}x$ or $y = 2 - \frac{x}{2}$ or $y = \frac{4-x}{2}$ or gradient of $L_1 = -0.5$ oe	Yes, with correct gradients shown to make −1 when multiplied	3	M1
	e.g. $\frac{9--7}{7--1}$ (=2) or $\frac{-7-9}{-1-7}$ (=2)			M1
				A1 $2 \times -0.5 = -1$ and yes
Alternative scheme for 11				
	e.g. $y = 2 - \frac{1}{2}x$ or $y = 2 - \frac{x}{2}$ or $y = \frac{4-x}{2}$ or gradient of $L_1 = -0.5$ oe	Yes, with correct equation shown to be valid by using the given points	3	M1
	$-7 = 2(-1) + c$ or $9 = 2(7) + c$ ($c = -5$)			M1 dep on M1 for substituting $(-1, -7)$ or $(7, 9)$ into $y = 2x + c$ to find value of c
				A1 Uses the other point in $y = 2x - 5$ to show it is valid and yes

Question		Working	Answer	Mark	Notes	
8	(a)		7875	2	M1 A1	$3^2 \times 5^3 \times 7$ oe or correct Venn diagram
	(b)		3 898 125	2	M1 A1	$3^4 \times 5^4 \times 7 \times 11$ oe or correct Venn diagram
						Total 4 marks

9	(a)		8.4×10^5	1	B1	
	(b)	$\frac{60000000}{0.08}$ or 750000000 oe (e.g 0.75×10^9)	7.5×10^8	2	M1 A1	M1 for 60000000 or 0.08
						Total 3 marks

10		150000×0.82^3	82705	3	M2 A1	If not M2 then M1 for 1st year e.g 150000 x 0.82 (= 123000) or 150000 x 0.18 (= 27000) SC B1 for 150000 x 1.18 (= 177000) or 150000×1.18^3 (= 246454.8)or 150000 x 0.54 (=81000) or 150000 x 0.46 (= 69000) Accept 82705.2
						Total 3 marks

11		Gradient = (−)4 ÷ 2 oe	$y = -2x - 1$ oe	3	M1 A2	Correct method to work out the gradient (±) accept 4 ÷ 2 oe or "m" = 2 If not A2 then A1 for $L = -2x - 1$ or $-2x - 1$ or $y = 2x - 1$ or $y = -2x + c$
						Total 3 marks

3	x −2 −1 0 1 2 3 y 15 11 7 3 −1 −5 (−2, 15) (−1, 11) (0, 7) (1, 3) (2, −1) (3, −5)	Correct line between $x = -2$ and $x = 3$	3	B3 for a correct line between $x = -2$ and $x = 3$ (B2 for a correct straight line segment through at least 3 of (−2, 15) (−1, 11) (0, 7) (1, 3) (2, −1) (3, −5) **or** for all of (−2, 15) (−1, 11) (0, 7) (1, 3) (2, −1) (3, −5) plotted but not joined) (B1 for at least 2 correct points stated (may be in a table) **or** plotted **or** for a line drawn with a negative gradient through (0, 7) **or** for a line with a gradient of −4)
				Total 3 marks

4	$\frac{x+10}{2} = 9$ **or** $x = 8$		4	M1 (indep)
	$\frac{4+7+x+10+y+y}{6} = 11$ oe **or** '66' – 4 – 7 – 10 (= 45)			M1 where x may be a number $7 < x < 10$
	(y =) (6 × 11 – 4 – 7 – 10 – '8') ÷ 2			M1 ft their median provided $7 < x < 10$ for a fully correct method
		$x = 8$ and $y = 18.5$ oe		A1
				Total 4 marks

13	(a)	$\frac{8--4}{5-9}\left(=\frac{12}{-4}\right)$ oe or $\frac{-4-8}{9-5}\left(=\frac{-12}{4}\right)$ oe		2	M1	condone correct gradient embedded in an equation e.g. $y = -3x + c$ **or** expression e.g. $-3x$ **or** for an answer of 3
			-3		A1	
	(b)		$\frac{1}{4}$	1	B1	accept 0.25 or $-\frac{1}{-4}$ oe
						Total 3 marks

14	(a)	0.6×0.9		2	M1	oe
			0.54		A1	oe e.g. $\frac{27}{50}, \frac{54}{100}$, 54%
	(b)	0.6×0.1 (= 0.06) **or** 0.4×0.25 (= 0.1) **or** 0.4×0.75 (= 0.3)		3	M1	oe
		$0.6 \times 0.1 + 0.4 \times 0.25$ **or** $1 - (0.4 \times 0.75)$ – "0.54"			M1	oe, ft their answer from (a)
			0.16		A1	oe e.g. $\frac{4}{25}, \frac{8}{50}, \frac{16}{100}$, 16%
						Total 5 marks

10	(a)	eg $2y = -7x(+10)$		2	M1	for $2y = -7x(+10)$ **or** an answer of $-3.5x$ oe **or** an answer of 3.5 oe
			-3.5		A1	oe
	(b)		(0, 5)	1	B1	cao
						Total 3 marks

11	eg 200 000 × 0.018 (= 3600) **or** 200 000 × 1.018 (= 203 600)		3	M1	for method to find 1.8% or 101.8% of 200 000
	eg $\sqrt{209\ 754} \div$ "203 600" (= 1.015000…)			M1	for a complete method to find the multiplier for the compound interest for 2nd and 3rd year
		1.5		A1	or better eg 1.500045971…
					Total 3 marks

9	$-4x \leq 11-3$ **or** $-4x \leq 8$ **or** $-x \leq 2$ **or** $3-11 \leq 4x$ **or** $-8 \leq 4x$		2	M1	allow equals sign or condone incorrect inequality sign for M1 only
		$x \geq -2$		A1	allow $-2 \leq x$ SCB1 for x and -2 with an incorrect sign between them or -2 as an answer
					Total 2 marks

10	$3 \div 2$ (=1.5 or $\frac{3}{2}$) **or** eg $\frac{5--1}{4(-0)}$ **or** $c = -1$		3	M1	for correct method to find gradient or the correct value of c for gradient, may see a correct calculation **or** $\frac{3}{2}$ oe **or** $1.5x$ (+ c) oe for value of c, allow $c = -1$, $y = -1$, ($L =$) $mx - 1$ oe
	$y =$ "1.5"x (+ c) **or** $y = mx - 1$ **or** eg $y - 5 = m(x - 4)$			M1	for use of $y = mx + c$ with either m or c correct (NB: $m \neq 0$) **or** for ($L =$) $1.5x - 1$ oe
		$y = \frac{3}{2}x - 1$		A1	oe eg $y = 1.5x - 1$
					Total 3 marks

Question	Working	Answer	Mark	Notes
6	$[k =] \frac{6+17}{2}$ **or** $[k =] 6+\frac{17-6}{2}$ oe **or** $[j =]\ 4+2(15-4)$ **or** $[j =]\ 15+(15-4)$ **or** $\frac{4+j}{2}=15$ oe		3	M1
	Correct answers score full marks (unless from obvious incorrect working) *1 correct answer will score M1A1 and both will score M1A1A1*	26		A1
		11.5		A1 oe eg $\frac{23}{2}$ both answers the wrong way round scores M1A1 unless the correct answers are clearly labelled in working space
				Total 3 marks

4		Fully correct angle bisector with all relevant arcs shown	2	B2 for a fully correct angle bisector with all relevant arcs shown If not B2 then B1 for all arcs and no angle bisector drawn or for a correct angle bisector within the guidelines but no correct arcs or insufficient correct arcs
				Total 2 marks

5	<table><tr><td>x</td><td>−2</td><td>−1</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td></tr><tr><td>y</td><td>10</td><td>7.5</td><td>5</td><td>2.5</td><td>0</td><td>−2.5</td><td>−5</td></tr></table>	Correct line	3	B3 for a correct line between $x = -2$ and $x = 4$ If not B3 then award B2 for a line segment through at least 3 of (−2, 10), (−1, 7.5), (0, 5), (1, 2.5), (2, 0), (3, −2.5), (4, −5) **or** all points plotted correctly If not B2 then award B1 for at least 2 correct points plotted or stated (may be seen in a table) **or** for a line drawn with a negative gradient through (0, 5) **or** for a line with a gradient of −2.5
				Total 3 marks

13	eg (gradient =) $\frac{12--48}{-5-19}\ (=-2.5)$ oe		3	M1 for a method to find the gradient
	eg $12 = \text{“}-2.5\text{”} \times -5 + c$ oe $y - 12 = \text{“}-2.5\text{”}(x - -5)$ oe			M1 ft their gradient
	Correct answer scores full marks (unless from obvious incorrect working)	$y = -2.5x - 0.5$		A1 oe eg $y - 12 = -2.5(x + 5)$ **or** $2y + 5x + 1 = 0$
				Total 3 marks

14		$2(5g + 3)(5g - 3)$	3	B3 for $2(5g + 3)(5g - 3)$ B2 for $2(5g \pm 3)(5g \pm 3)$ oe eg $2(5g - 3)^2$ B1 for $2(25g^2 - 9)$ **or** $(10g + 6)(5g - 3)$ **or** $(5g + 3)(10g - 6)$ **or** $(5g + 3)(5g - 3)$
				Total 3 marks

9		$y=-\frac{1}{2}x+1$	3	B3 for $y=-\frac{1}{2}x+1$ oe but must be in form $y = mx + c$ eg $y=-0.5x+1$ (B2 for $(L=)\ -\frac{1}{2}x+1$ **or** for $y=-\frac{1}{2}x+c$ **or** for $y=mx+1$ where $m\neq 0$ **or** for a correct equation in the incorrect form eg $2y + x = 2$) (B1 for $(L=)\ -\frac{1}{2}x+c$ **or** $(L=)\ mx+1$ where $m\neq 0$ **or** $m=-\frac{1}{2}$ **or** gradient = $-\frac{1}{2}$ oe eg $\frac{3-(-1)}{-4-4}$)
				Total 3 marks

10	2 **and** 7 correctly identified		2	M1 may also identify median (4)
	Correct answer scores full marks (unless from obvious incorrect working)	5		A1
				Total 2 marks

Question	Working	Answer	Mark	Notes
12	eg (*COA*=) 360 − (2 × 90 + 74) (=106) or (*COA*=) 180 − 74 (=106) or *OAB* = 90 or *OCB* = 90		3	M1 Fully correct method to find *COA* or *OAB* or *OCB*
	"106" ÷ 2			M1
		53		A1 values may be seen on diagram throughout
				Total 3 marks

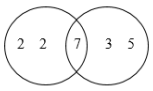
13	eg $m = \frac{1}{2}$ or $y = \frac{1}{2}x + c$		4	M1 for gradient = $\frac{1}{2}$
	eg $7 = \frac{1}{2} \times 4 + c$ or $y - 7 = \frac{1}{2}(x - 4)$			M1 for substituting (4,7) into an equation with gradient = $\frac{1}{2}$
	eg $\frac{1}{2}x + 5 = 0$ or $-7 = \frac{1}{2}(x - 4)$			M1 Inputting $y = 0$ into their correct equation
		(−10, 0)		A1 SC B2 for an answer of (18,0) or (0.5,0) oe or (7.5,0) oe
				Total 4 marks

Q20 contd	**Alternative method where students assume *CDA* = 2*x* and must work to show that *BCQ* = *x***				
	eg angle ABC = 180 – 2*x* Angle *CAB* = angle *ACB* = [180 – (180 – 2x)] ÷ 2 = *x* *BCQ* = *CAB* = *x*			M1 M1 M1 B1 A1	 Dep on M1 for any one appropriate circle theorem reason For complete proof with reasons e.g. opposite angles of cyclic quadrilateral sum to 180° angles in triangle sum to 180° isosceles triangle alternate segment theorem
21	$y = \frac{6}{4}x(+33)$ **or** (gradient =) $\frac{6}{4}$ oe $m \times \frac{6}{4} = -1$ **or** (gradient of **M** =) $-\frac{2}{3}$ oe $\frac{k-6}{-4-5} = "-\frac{2}{3}"$	12	4	M1 M1 M1 dep A1	 or complete method to find equation of line ($3y = -2x + 28$) and then substitution of $x = -4$

15	(Gradient of $\mathbf{L_1}$ =) 6 ÷ 2 (=3)		4	M1	could be seen as part of an equation. Ignore constant term if candidate rearranges $\mathbf{L_1}$
	$m \times$ "3" = −1 **or** $m = -\frac{1}{"3"}$			M1	for use of $m_1m_2 = -1$ could be seen as part of an equation
	$-1 = "-\frac{1}{3}" \times 9 + c$ **or** $y - -1 = "-\frac{1}{3}"(x-9)$ **or** $c = 2$			M1	
		$y + \frac{1}{3}x = 2$		A1	oe in required form eg $3y + x = 6$, $6y + 2x = 12$ etc
					Total 4 marks

16 (a)	$3 \times 4t^2 - 2 \times 6t + 5$		2	M1	For 2 terms correct
		$12t^2 - 12t + 5$		A1	Fully correct
(b)	$24t - 12$		3	M1	Method to differentiate their v, ft a 3 term quadratic expression from (a)
	"$24t - 12$" = 6			M1	ft if previous M1 awarded
		0.75		A1	oe
					Total 5 marks

Question		Working	Answer	Mark	Notes
Apart from questions (where the mark scheme states otherwise) the correct answer, unless clearly obtained by an incorrect method, should be taken to imply a correct method					
1	(a)	$\frac{5+13}{2}$ or $\frac{-4+1}{2}$		2	M1 for a correct method to find one coordinate **or** for one coordinate correct **or** for (−1.5, 9)
			(9, −1.5)		A1 oe
	(b)		−3	1	B1
	(c)		No with reason	1	B1 No (oe) and e.g. line goes through (100, −298) or (101.3(3..), −302) or $\left(\frac{304}{3}, -302\right)$ or (3 × 100) – 302 = −2 not (+)2
					Total 4 marks

2		28, 56, 84, 112… **and** 105, 210, 315, 420… **or** 2, 2, 7 **and** 3, 5, 7 **or**  **or** $\frac{28\times105}{7}$ **or** 2, 2, 3, 5, 7 oe		2	M1for any correct valid method e.g. for starting to list at least **four** multiples of each number **or** 2, 2, 7 **and** 3, 5, 7 seen (may be in a factor tree and ignore 1) **or** a fully correct Venn diagram
			420		A1 cao
					Total 2 marks

22	$y=-\frac{7}{2}x(+10)$ **or** (gradient =) $-\frac{7}{2}$		4	B1	for correct gradient which may be seen in an equation. Condone $-\frac{7}{2}x$
	$'-\frac{7}{2}'m=-1$ **or** $(m=)'\frac{2}{7}'$			M1	ft their gradient for use of $m_1 \times m_2 = -1$
	$-11='\frac{2}{7}'\times 6+c$ **or** $y--11='\frac{2}{7}'(x-6)$ oe			M1	ft dep on M1
		$\left(0, -\frac{89}{7}\right)$		A1	accept $\left(0, -12\frac{5}{7}\right)$ must be exact values
					Total 4 marks

23	$\left(\frac{dy}{dx}=\right)3px^2-m$		4	M1	for $3px^2$ **or** $-m$
	$3px^2-m<0$ oe			M1	ft dep on M1 for setting up an inequality with their $'3px^2'-'m'$ must be a two-term expression in the form $apx^2 \pm m$
	$\pm\sqrt{\frac{m}{3p}}$			B1	for both critical values
		$-\sqrt{\frac{m}{3p}} < x < \sqrt{\frac{m}{3p}}$		A1	may be seen as two separate inequalities
					Total 4 marks

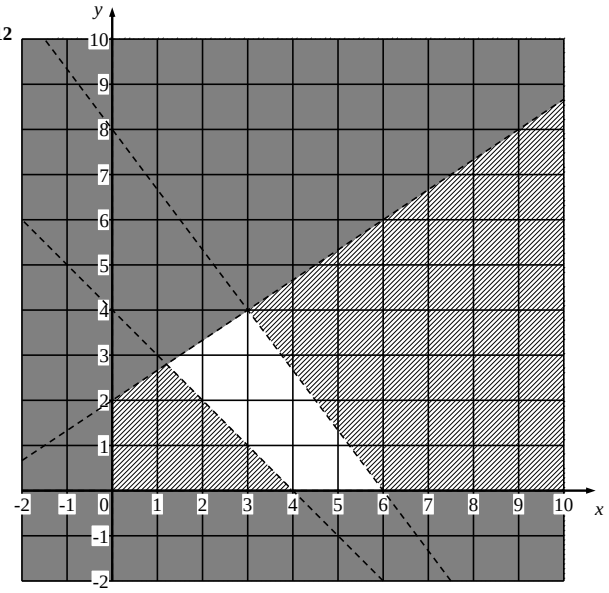
Question	Working	Answer	Mark	Notes
17	eg $\frac{4-(-1)}{6-4}$ $(=\frac{5}{2}=2.5)$		4	M1 for a method to find the gradient of **L**
	eg $\frac{-1}{"2.5"}$ $(=-\frac{2}{5}=-0.4)$ or $\frac{-1}{\textit{their}\text{ gradient}}$ oe			M1 ft for a method to find the gradient of **M** if *their* gradient of **L** clearly stated (even if no method shown for gradient of **L**)
	$y =$ "-0.4"$x + 8$ oe eg $y-8=-\frac{2}{5}(x-0)$ **or** $(8 \div 2) \times 5\ (=20)$ oe **or** $8 \div$ (–'*their gradient of* **M**')			M1 dep on previous M1 for substitution of (0, 8) into equation for a line **or** use of $(8 \div 2) \times 5\ (=20)$ (maybe on diagram) NB: 20 gains M3 if clearly intended as x coordinate (stated or on a diagram)
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	(20, 0)		A1
				Total 4 marks

21	eg $\frac{5-2}{3-(-5)}\left(=\frac{3}{8}=0.375\right)$ oe or (2 = –5*m* + *c* and 5 = 3*m* + *c* leading to) $(m=)\frac{3}{8}(=0.375)$ or (*C* =) (6, −3) or (0, 13)		4	M1	for a method to find the gradient of *AB* **or** for finding the possible coordinates of *C*
	eg $\left[\frac{3}{8}\right]\times m=-1$ oe or $(m=)"-\frac{8}{3}"$ oe or $\frac{5-(-3)}{3-6}\left(=-\frac{8}{3}=-2.6(666...)\right)$ or $\frac{5-13}{3-0}\left(=-\frac{8}{3}=-2.6(666...)\right)$			M1ft	(indep) for finding the gradient of *BC* Allow perpendicular gradient to be truncated or rounded to 1 dp $\left[\frac{3}{8}\right]$ means their gradient of *AB*
	eg $5="-\frac{8}{3}"\times 3+c$ or *c* = 13 or $y="-\frac{8}{3}"x+13$ or $y-5="-\frac{8}{3}"(x-3)$ oe or $y--3="-\frac{8}{3}"(x-6)$ oe or $y-13="-\frac{8}{3}"(x-0)$ oe or $y-13="-\frac{8}{3}"x$ oe			M1ft	(ft dep on previous M1 for their perpendicular gradient) for substitution to find '*c*' or to find an equation for *BC* If students find the coordinates of *D* [(–2, –6) or (–8, 10)] then allow for this mark $y--6="-\frac{8}{3}"(x--2)$ oe or $y-10="-\frac{8}{3}"(x--8)$ oe
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	$8x+3y-39=0$		A1	oe *a*, *b* and *c* must be integers eg. $16x+6y=78$ or $-8x-3y+39=0$ or $3y=-8x+39$
					Total 4 marks

18	$y = -2x(+9)$ or gradient of line = –2		4	M1	a rearrangement with the correct x term or stating that the gradient of given line is –2
	Gradient of perpendicular = $\frac{1}{2}$ oe eg $\frac{-1}{-2}$			M1ft	For a statement that the gradient of the perpendicular line is $\frac{1}{2}$ or implication by equation of line with gradient $\frac{1}{2}$ (if a student goes straight to this stage then M2 is awarded) **This mark can also be awarded for the perpendicular gradient of what they indicate the gradient of the original line to be**
	eg $11 = "\frac{1}{2}" \times 8 + c$ or $y - 11 = "\frac{1}{2}"(x - 8)$ oe or $c = 7$			M1dep	dep on previous M1 being awarded; a correct method to find the equation of the perpendicular line by using their gradient of the perpendicular line and (8, 11)
	Correct answer scores full marks (unless from obvious incorrect working)	$y = \frac{1}{2}x + 7$		A1oe	a correct equation for the line in the form $y = mx + c$ (as requested) If no other marks awarded then award SCB1 for $y = -\frac{1}{2}x + 15$
					Total 4 marks

20	$y=\frac{2}{3}x\left(+\frac{12}{3}\right)$ **or** $y=\frac{2x+12}{3}$ **or** gradient = $\frac{2}{3}$ (gradient of perpendicular line =) $-\frac{3}{2}$ oe **or** $\frac{-1}{"\frac{2}{3}"}$ oe $37="-\frac{3}{2}"\times 4+c$ **or** $c = 43$ $y=-\frac{3}{2}x+43$	$3x + 2y = 86$	5	M1 M1 ft from their gradient M1 (dep on previous M1) and ft from their gradient — M1 for $y-37="-\frac{3}{2}"(x-4)$ A1 correct equation (equation in any form) — A1 for $y-37=-\frac{3}{2}(x-4)$ A1 for $3x + 2y = 86$ oe for a simplified equation with integer coefficients e.g. $3x = 86 – 2y$
	Alternative scheme $2y = −3x + c$ oe $2 \times 37 = -3 \times 4 + c$	$3x + 2y = 86$	5	M2 M1 A2 for $3x + 2y = 86$ oe for a simplified equation with integer coefficients e.g. $3x = 86 – 2y$

Question 12



23		$\left(\frac{10+2}{2}, \frac{7+19}{2}\right)$ **or** (6, 13)		5	M1	
		$\frac{19-7}{10-2}\left(=\frac{12}{8}\right)$ oe **or** 1.5 oe			M1	
		$m \times \frac{3}{2} = -1$ oe **or** $m = -\frac{2}{3}$			M1	for use of $m_1m_2 = -1$
		"13" = "$-\frac{2}{3}$" × "6" + c **or** $c = 17$ oe **or** $y - "13" = "-\frac{2}{3}"(x - "6")$			M1	Or for $y = -\frac{2}{3}x + 17$ [NB: "13", "6" and "$-\frac{2}{3}$" must come from correct working]
			$3y + 2x = 51$		A1	for $3y + 2x = 51$ **or** $3y = -2x + 51$ etc but must be integer coefficients
						Total 5 marks

24		($v =$) $3t^2 - 6 \times 2t + 5$ (+ 0)		4	M1	for differentiating at least 2 terms correctly
		($a =$) $3 \times 2t - 12$			M1	dep ft
		$6t - 12 = 3$			M1	dep on at least M1 for equating their acceleration in terms of t to 3
			2.5 oe		A1	
						Total 4 marks

19	(a)		$y = -4x + k$ (oe)	1	B1	for $y = -4x$ or $y = -4x + k$ where k is any numerical value $k \neq 7$ Could be written in another form e.g. $3y + 12x = 20$
	(b)	$m = \frac{-2-1}{2--3}$ *or* $m = \frac{1--2}{-3-2}$ or $-\frac{3}{5}$ or -0.6		4	M1	for using $m = \frac{y_2-y_1}{x_2-x_1}$
		$m_p = \frac{5}{3}$			M1ft	for using $m_1 \times m_2 = -1$
		$4 = \frac{5}{3}(-6) + c$ oe eg $4 = -10 + c$ ($c = 14$) $y - 4 = \frac{5}{3}(x - -6)$			M1ft	dep on previous M1 for substituting $(-6, 4)$ into linear equation formula $4 = \frac{5}{3}x + c$ to find value of c or $y = \frac{5}{3}x + 14$ or $y = 1.66...x + 14$
			Eg $5x - 3y + 42 = 0$		A1	for correct simplified equation where all values are integers $10x - 6y + 84 = 0$ or $3y = 5x + 42$ oe
						Total 5 marks

Question	Working	Answer	Mark	Notes
23	$-2(x^2+6x-3.5)$ or $-2(x^2+6x)+7$		3	M1 Factorising by -2
	$-2[(x+3)^2-9\ -3.5]$ or $-2[(x+3)^2-9]+7$			M1 Completing the square
		$25-2(x+3)^2$		A1
	Alt : $a+b(x^2+2cx+c^2)$			
	$2bc=-12$ or $a+bc^2=7$ or $b=-2$			M1 Equating coefficients or stating value of b
	$2\times-2\times c=-12$ or $c=3$			M1 Equating coefficients or stating value of c
	$a+-2\times(3)^2=7$ or $a=25$ seen			A1 Equating coefficients or stating value of a
				Special Cases: SC B2 for answer of $-2(x+3)^2+$ constant or $25-2(x+$ positive constant$)^2$ SC B1 for answer of $-2(x-3)^2+$ constant
				Total 3 marks

24	Gradient of $\mathbf{L_2}=-10\div-5)\ (=2)$		5	M1 Method to find gradient of $\mathbf{L_2}$
	$6=2\times8+c\ \rightarrow c=-10$ $y=2x-10$ oe			A1 Equation for $\mathbf{L_2}$
	$0=2x-10\ \rightarrow x=5$ or (5, 0) $y=2\times-3-10\ \rightarrow y=-16$ or $(-3,-16)$			A1 Finding point A and point B
	(Area =) $0.5\times5\times16$ or $(0.5\times5\times10)+(0.5\times10\times3)$ or $0.5\times5\times\sqrt{265}\times\sin100.6°$ or $0.5\times\sqrt{320}\times\sqrt{265}\times\sin15.9°$			M1 Method to find area of triangle
		40		A1 cao Dep on M2
				Total 5 marks

22	$\left(\frac{-1+2}{2}, \frac{5+10}{2}\right)$ **or** (0.5, 7.5) oe		5	M1
	$\frac{10-5}{2-(-1)}\left(=\frac{5}{3}\right)$ oe			M1
	$m \times$ '$\frac{5}{3}$' $= -1$ oe **or** $m = -\frac{3}{5}$oe			M1 ft their gradient for use of $m_1 \times m_2 = -1$
	'7.5' = '$-\frac{3}{5}$' × '0.5' + c **or** $c = 7.8$ oe **or** $y - '7.5' = '-\frac{3}{5}'(x - '0.5')$			M1 ft dep on first M1 and third M1
		$5y + 3x = 39$		A1 oe where p, q and r must be integers
				Total 5 marks

22	(gradient AB =) $\frac{10--5}{p--1}\left(=\frac{10+5}{p+1}=\frac{15}{p+1}\right)$ oe or (gradient BC =) $\frac{q--5}{8--1}\left(=\frac{q+5}{8+1}=\frac{q+5}{9}\right)$ oe or (gradient AC =) $\frac{10-q}{p-8}$ oe **or** $\sqrt{(p--1)^2+(10--5)^2}$ or $(p--1)^2+(10--5)^2$ or $\sqrt{(8--1)^2+(q--5)^2}$ or $(8--1)^2+(q--5)^2$ or $\sqrt{(8-p)^2+(q-10)^2}$ or $(8-p)^2+(q-10)^2$ oe		5	M1 for finding the gradient of AB or BC or AC This may be seen embedded in $m_1 \times m_2 = -1$ **or** for finding the length of AB or BC or AC (or AB^2 etc)
	• $'\frac{15}{p+1}'\times'\frac{q+5}{9}'=-1$ or $'\frac{15}{p+1}'=-'\frac{9}{q+5}'$ or $9p+15q=-84$ oe • $'\frac{10-q}{p-8}'=-\frac{6}{7}$ or $6p-7q=-22$ oe • $(p--1)^2+(10--5)^2+(8--1)^2+(q--5)^2=(8-p)^2+(q-10)^2$ or $18p+30q=-168$ **Alternative for the second point** • $\frac{6}{7}p+10=-8\times-\frac{6}{7}+q$ oe			M2 for two out of the three of: • using $m_1 \times m_2 = -1$ • using the gradient of AC to form an equation. • using Pythagoras theorem If not M2, then M1 for one of the equations. **Alternative for the second point** obtaining this equation by using $y=mx+c$ with coordinates of A and C separately, and then eliminating c)

	Elimination E.g. $54p + 90q = -504$ $54p - 63q = -198$ With subtraction **or** $153q = -306$ **or** $63p + 105q = -588$ $90p - 105q = -330$ With the operation of addition **or** $153p = -918$	Substitution E.g. $6\left(\frac{-84-15q}{9}\right) = -22$ or $6p - 7\left(\frac{-84-9p}{15}\right) = -22$ or $9\left(\frac{-22+7q}{6}\right) + 15q = -84$ or $9p + 15\left(\frac{6p+22}{7}\right) = -84$			M1 (dep M3) for correct method to eliminate one variable – multiplying one or both equations so the coefficient of x or y is the same in both, with the correct operation to eliminate one variable (condone one arithmetic error) **or** isolating p or q in one equation and substituting into the other (condone one arithmetic error).
			$p = -6$ and $q = -2$		A1 for $p = -6$ and $q = -2$ Must be clearly identified
					Total 5 marks

25	$\left(\frac{4+8}{2}, \frac{7-5}{2}\right)$ oe or (6, 1)		5	M1	for finding the midpoint of *PR*
	$\frac{7--5}{4-8}\left(=-\frac{12}{4}=-3\right)$ oe			M1	for method to find the gradient of *PR*
	$"-3" \times m = -1$ oe or $(m=)\frac{-1}{"-3"}$ or $(m=)\frac{1}{3}$			M1ft	for finding the gradient of *QS*, may be seen embedded in an equation, ft their gradient of *PR*
	$"1" = "\frac{1}{3}"("6") + c$ oe or $c = -1$ **or** $y-1=\frac{1}{3}(x-6)$ **or** $y=\frac{1}{3}x-1$			M1ft	(dep on previous M1) for finding the equation through *QS*, ft their gradient of *PR* and their midpoint of *PR*, do not allow (4, 7) or (8, –5) as midpoint *PR*
	Correct answer scores full marks (unless from obvious incorrect working)	$3y = x - 3$		A1	oe eg $6y = 2x - 6$ or $3y - x + 3 = 0$ etc but must be integer coefficients accept $a = 3$, $b = 1$, $c = -3$
					Total 5 marks

22	gradient of $JK = -0.5$ **or** $m \times 2 = -1$		6	M1 for finding the gradient of JK using $m_1 \times m_2 = -1$
	$\frac{k-15}{6-j} = -\frac{1}{2}$ **or** $2k - j = 24$ **or** $j = 2k - 24$ **or** $k = \frac{j+24}{2}$ oe			M1 for expressing the gradient of JK in terms of j and k or a correct equivalent equation
	$(j-6)^2 + (k-15)^2 = 80$ oe **or** $\left(\frac{j+6}{2}, \frac{k+15}{2}\right)$ oe **or** $(j+4)^2 + 196 = 100 + (k-1)^2$ oe			M1 for finding equation of JK in terms of j and k **or** for finding the midpoint of M **or** for equating length HJ with length HK
	eg $3k^2 - 78k + 495 = 0$ oe **or** $5j^2 - 60j - 140 = 0$ oe **or** $5k^2 - 150k + 1045 = 0$ oe **or** $3j^2 - 12j - 36 = 0$ **oe** **or** gradient HM: eg $\frac{\frac{k+15}{2} - 1}{\frac{j+6}{2} + 4} = 2$ **or** $k = 2j + 15$ **or** $j = \frac{k-15}{2}$ oe			M1 (dep on M3) writing a correct quadratic expression in the form $ax^2 + bx + c\ (= 0)$ (allow $ax^2 + bx = c$) **or** A correct equation for the gradient of HM in terms of j and k or a correct equivalent equation
	eg $(k-15)(k-11)(=0)$ **or** $\frac{78 \pm \sqrt{(-78)^2 - 4 \times 3 \times 495}}{2 \times 3}$ **or** $(k-13)^2 - 169 + 165 (= 0)$	eg $(j-6)(j+2)(=0)$ **or** $\frac{12 \pm \sqrt{(-12)^2 - 4 \times 3 \times -36}}{2 \times 3}$ **or** $(j-2)^2 - 4 - 12 (= 0)$		M1 (dep on M3) for a complete method to solve their 3-term quadratic equation (allow one sign error in the use of the quadratic formula) **or** a correct method to eliminate either j or k eg $2k - 24 = \frac{k-15}{2}$ oe **or** $\frac{j+24}{2} = 2j + 15$ oe
		$j = -2$, $k = 11$		A1
				Total 6 marks

22		$\left(\frac{j+6}{2}, \frac{k+15}{2}\right)$ oe		6	M1 for finding the midpoint of M
ALT		$\frac{\frac{k+15}{2}-1}{\frac{j+6}{2}+4} = 2$ **or** $k - 2j = 15$ **or** $k = 2j + 15$ **or** $j = \frac{k-15}{2}$ oe			M1 for expressing the gradient of JK in terms of j and k or a correct equivalent equation
		$(j-6)^2 + (k-15)^2 = 80$ oe **or** $(j+4)^2 + 196 = 100 + (k-1)^2$ oe			M1 for finding the length of JK in terms of j and k **or** for equating length HJ with length HK
		E.g. $5j^2 - 12j - 44 = 0$ **or** $3j^2 + 48j + 84 = 0$ oe	E.g. $5k^2 - 174k + 1309 = 0$ **or** $3k^2 + 6k - 429 = 0$ oe		M1 (dep on M3) writing the correct quadratic expression in form $ax^2 + bx + c\ (= 0)$ allow $ax^2 + bx = c$
		E.g. $(5j - 22)(j + 2)(= 0)$ **or** $\frac{12 \pm \sqrt{(-12)^2 - 4\times5\times-44}}{2\times5}$ **or** $(j+8)^2 - 64 + 28 (= 0)$	E.g. $(5k - 119)(k - 11)(= 0)$ **or** $\frac{174 \pm \sqrt{(-174)^2 - 4\times5\times1309}}{2\times5}$ **or** $(k+1)^2 - 1 - 143 (= 0)$		M1 (dep on M3) for a complete method to solve their 3-term quadratic equation (allow one sign error in the use of the quadratic formula)
		$j = -2$, $k = 11$			A1
					Total 6 marks

23	$\left(\frac{-1+5}{2}, \frac{6-4}{2}\right)$ or $\left(\frac{4}{2}, \frac{2}{2}\right)$ or (2, 1)		6	M1 for finding midpoint
	$\frac{-4-6}{5--1}$ or $\frac{6--4}{-1-5}$ or $-\frac{10}{6}$ or $-\frac{5}{3}$			M1 indep for finding the gradient of *PQ*
	$\frac{-1}{-\frac{10}{6}}$ or $\frac{6}{10}$ or $\frac{-1}{-\frac{5}{3}}$ or $\frac{3}{5}$ or 0.6			M1 for finding the perpendicular gradient to *PQ* (ft their stated gradient)
	$1=\frac{3}{5}(2)+c$ or $c = -\frac{1}{5}$ or $c = -\frac{2}{10}$ or $c=-0.2$			M1 dep on 1st and 3rd M1 for substituting '(2, 1)' into $y='\frac{3}{5}'x+c$ or find the value of *c* oe eg $y-'1'='\frac{3}{5}'(x-'2')$
	$y=\frac{3}{5}x-\frac{1}{5}$ or $y=0.6x-0.2$ or $5y=3x-1$			A1 for a correct equation in any form
		$3x-5y-1=0$		A1 for $3x-5y-1=0$ or $5y-3x+1=0$ or $6x-10y-2=0$ oe accept in the form $ax+by=-c$ eg $3x-5y=1$ or $5y-3x=-1$ oe
				Total 6 marks

Alternative Mark Scheme for Q23					
23	$(x+1)^2+(y-6)^2$ or $(x-5)^2+(y+4)^2$		6	M1	
	$(x+1)^2+(y-6)^2=(x-5)^2+(y+4)^2$			M1	using $PA^2 = QA^2$ (for some point A on the line)
	$x^2+2x+1+y^2-12y+36$ or $x^2-10x+25+y^2+8y+16$			M1	
	$x^2+2x+1+y^2-12y+36=x^2-10x+25+y^2+8y+16$			M1	
	eg $2x+1-12y+36=-10x+25+8y+16$ or $12x+37=20y+41$			A1	for a correct linear equation in x and y
		$3x-5y-1=0$		A1	for $3x-5y-1=0$ oe
					Total 6 marks

23	$y=\frac{3}{5}x\left(+\frac{6}{5}\right)$ or $y=0.6x(+1.2)$ **or** (gradient =) $\frac{3}{5}$ or 0.6 oe		6	M1 for correct gradient which may be seen in an equation. Condone $\frac{3}{5}x$ or $0.6x$
	$k=-2$			B1 for $k=-2$
	$\left(\frac{"-2"+8}{2},\frac{1+7}{2}\right)$ oe or (3, 4)			M1 for finding the midpoint (use of their k where $k<0$)
	$"\frac{3}{5}"m=-1$ **or** $(m=)"-\frac{5}{3}"$			M1ft their gradient for use of $m_1\times m_2=-1$ Allow $-\frac{5}{3}=-1.67$ or better
	$"4"="-\frac{5}{3}"\times"3"+c$ or $c=9$ or $y-"4"="-\frac{5}{3}"(x-"3")$			M1 dep on M3
	Working required	$5x + 3y = 27$		A1 allow equation in any form where p, q and r are integers
				Total 6 marks

25	eg $\left(\frac{-4+2}{2}, \frac{6+3}{2}\right)$ **or** (−1, 4.5) oe		6	M1	for method to find the midpoint of *AB*
	eg $\frac{6-3}{-4-2}\left(=\frac{3}{-6}\right)$ oe **or** $-\frac{1}{2}$ oe **or** −0.5			M1	for method to find the gradient of *AB*
	eg $m \times "-0.5" = -1$ oe **or** $m = 2$			M1	for use of $m_1 m_2 = -1$ to find the gradient of the line of symmetry
	eg $y-8="-0.5"(x-(-1))$ **or** 8 = "–0.5" × −1 + *c* **or** $\frac{y-8}{x-(-1)}="-0.5"$ **or** $y-4.5="2"(x-(-1))$ **or** 4.5 = "2" × −1 + *c* **or** $\frac{y-4.5}{x-(-1)}="2"$			M1	for method to find an equation for *CD* **or** the line of symmetry
	eg $2x + 6.5 = -0.5x + 7.5$ **or** $\frac{y-6.5}{2}=\frac{y-7.5}{-0.5}$			M1	for a correct linear equation to find the *x* or *y* coordinate of *E*
	Correct answer scores full marks (unless from obvious incorrect working)	(0.4, 7.3)		A1	oe
					Total 6 marks

ALTERNATIVE (using the length of *CD*):

25	eg $\frac{6-3}{-4-2}\left(=\frac{3}{-6}\right)$ oe **or** $-\frac{1}{2}$ oe **or** −0.5		6	M1	for method to find the gradient of *AB*
	eg $y-8="-0.5"(x+1)$ **or** 8 = "–0.5" × −1 + *c* **or** $\frac{y-8}{x-(-1)}="-0.5"$			M1	for method to find an equation for *CD*
	eg $\sqrt{(-1-(-4))^2+(8-6)^2}\ (=\sqrt{13})$			M1	for method to find the length of *AD* or AD^2
	eg $\sqrt{(x-2)^2+(7.5-0.5x-3)^2}="\sqrt{13}"$ **or** $\sqrt{(15-2y-2)^2+(y-3)^2}="\sqrt{13}"$			M1	for setting up an equation for the *x* or *y* coordinate of *C*
	(1.8, 6.6) oe			M1	for the correct coordinates for *C*
	Correct answer scores full marks (unless from obvious incorrect working)	(0.4, 7.3)		A1	oe
					Total 6 marks

24	$\frac{-5-10}{4--2}\ (=-\frac{5}{2})$		6	M1	A correct method to find the gradient of *AC*
	$y-10=-\frac{5}{2}(x+2)$ oe eg $y=-\frac{5}{2}x+5$ or $y--5=-\frac{5}{2}(x-4)$ oe or $5x+2y=10$ oe			M1	ft (if M1 scored) correct equation of *AC*
	$y-4=\frac{2}{5}(x--\frac{27}{5})$ oe or $4=\frac{2}{5}\left(-\frac{27}{5}\right)+c\ \left(y=\frac{2}{5}x+6.16\right)$ $\frac{4-y}{-\frac{27}{5}-x}=\frac{2}{5}$ oe or $5y-2x=\frac{154}{5}$ oe			M1	ft (if first M1 scored) equation of *BD* or correct equation using gradient of *BD*
	solves $-\frac{5}{2}x+5=\frac{2}{5}x+6.16$ oe eg $\begin{matrix}10x+4y=20\\-10x+25y=154\end{matrix}$ oe, with operation of addition **or** $\begin{matrix}25x+10y=50\\-4x+10y=61.6\end{matrix}$ oe, with operation of subtraction **or** $x=\frac{5}{2}y-\frac{154}{10}$ oe or $y=\frac{2}{5}x+\frac{154}{25}$ oe substituted in other equation			M1	Solve equation OR Solve simultaneously the correct equations of lines of *AC* and *BD* or correct equation from gradient or other correct equation. If elimination: same coefficient of *x* or *y* with suitable sign used to eliminate. If substitution: *x* or *y* substituted into other equation.
	Coordinates of intersection of *AC* and *BD* : $x=-\frac{2}{5}$, $y=6$			M1	oe value of *x* and *y* at intersection of *AC* and *BD*
	Correct answer scores full marks (unless from obvious incorrect working)	(4.6, 8)		A1	oe coordinates of *D*
	See next page for working with *AD = AB, CD = CB* or gradients				**Total 6 marks**

25	(gradient of AB =) "$-\frac{1}{2}$" or "2"$m = -1$		6	M1 for the use of $m_1 \times m_2 = -1$ or for "$-\frac{1}{2}$" embedded in a linear equation eg $y =$"$-\frac{1}{2}$"$x + c$
	(gradient of AB =) $\frac{k-7}{6-j}$ oe **or** (midpoint of AB =)$\left(\frac{j+6}{2}, \frac{k+7}{2}\right)$ oe			M1 for a correct expression for the gradient which may be seen in an equation **or** for a correct expression for the midpoint which may be seen in an equation.
	$\frac{k-7}{6-j} = -\frac{1}{2}$ oe or $2k - j = 8$ oe **or** $\left(\frac{k+7}{2}\right) - 2\left(\frac{j+6}{2}\right) = 7$ oe or $k - 2j = 19$ oe			M1 for setting up a **correct** equation for AB in terms of gradient **or** for setting up a **correct** equation for the line given and the midpoint
	$\frac{k-7}{6-j} = -\frac{1}{2}$ oe or $2k - j = 8$ oe **and** $\left(\frac{k+7}{2}\right) - 2\left(\frac{j+6}{2}\right) = 7$ oe or $k - 2j = 19$ oe			A1 for 2 **correct** equations
	$k = -1$ **and** $j = -10$			A1 for a correct value of k **and** a correct value of j
	Working required	(−2, 3)		A1 dep on previous M1
				Total 6 marks

24		eg $\sqrt{(3a-a)^2+(7--5)^2}=4\sqrt{10}$ oe **or** $(2a)^2+12^2=(4\sqrt{10})^2$ oe **or** $4a^2+144=160$ oe		6	M1	for forming a correct equation in terms of a; brackets must be used correctly, but allow recovery from missing or incorrect brackets to be recovered condone $4\sqrt{10}^2$ in place of $(4\sqrt{10})^2$
		$a=\sqrt{\frac{"160"-"144"}{4}}$ $(=\sqrt{4}=2)$			M1	dep on M1 for a complete method to solve a correct equation for a; condone inclusion of ±
		$(m_{PQ}=)\ \frac{3a-a}{7--5}\left(=\frac{2a}{12}=\frac{a}{6}\right)$ oe **or** $(m_{PQ}=)\ \frac{3\times[2]-[2]}{7--5}\left(=\frac{4}{12}=\frac{1}{3}\right)$ oe			M1ft	for a method to find the gradient of PQ where [2] is what they believe the value of a to be; must be positive and clearly identified
		$\left[\frac{a}{6}\right]\times m_{perp}=-1$ **or** $(m_{perp}=)\ -1\div\left[\frac{a}{6}\right]\left(=-\frac{6}{a}\right)$ oe **or** $\left[\frac{1}{3}\right]\times m_{perp}=-1$ **or** $(m_{perp}=)\ -1\div\left[\frac{1}{3}\right]$ $(=-3)$ oe			M1ft	for a method to find the gradient of the perpendicular bisector where $\left[\frac{a}{6}\right]$ or $\left[\frac{1}{3}\right]$ is what they believe to be the gradient of PQ; must be clearly identified
		$\frac{-5+7}{2}$ $(=1)$ **and** $\frac{3a+a}{2}$ $(=2a)$ **or** $\frac{-5+7}{2}$ $(=1)$ **and** $\frac{3\times[2]+[2]}{2}$ $(=4)$			M1ft	for a method to find the x coordinate and y coordinate of the midpoint of PQ; condone if the coordinates are the wrong way around where [2] is what they believe the value of a to be; must be positive and clearly identified
		Correct answer only scores full marks (unless from obviously incorrect working)	$y=-3x+7$		A1	oe correct equation in required form eg $y=7-3x$
						Total 6 marks

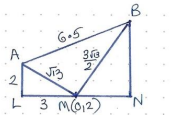
18	(a)			4	B1	$b = 14$
		(Gradient AB =) $\frac{12}{5}$ oe or eg $\frac{10--2}{1--4}$ oe			M1	For the gradient of AB
		(Gradient BC =) $-\frac{5}{12}$ oe			M1	Ft correct use of $m_1 \times m_2 = -1$ for *their* gradient of AB or $a = 2.5$ or $c = -9.5$
			$a = 2.5$, $c = -9.5$		A1	for $a = 2.5$ and $c = -9.5$
	(b)	$(AB =) \sqrt{(1--4)^2 + (10--2)^2}$ $(=\sqrt{5^2 + 12^2}\ (=13))$		3	M1	
		$(BC =) \sqrt{(19-1)^2 + (10-2.5)^2}$ $(=\sqrt{18^2 + 7.5^2}\ (= 19.5))$ **or** $\sqrt{(19-1)^2 + (10 - \text{their } a)^2}$ **or** $1.5 \times$ "13"			M1	ft their value of a
			65		A1	
						Total 7 marks

20	$\left(\frac{-6+5}{2}, \frac{2+3}{2}\right) = \left(-\frac{1}{2}, \frac{5}{2}\right)$ oe		7	M1 for finding the midpoint of AB
	$\frac{2-3}{-6-5}\left(=\frac{-1}{-11}=\frac{1}{11}\right)$ oe			M1 for finding the gradient of AB
	$\frac{1}{11} = -1$ **or** $(m =) -11$			M1ft their gradient of AB (indep) for the correct use of $m_1 \times m_2 = -1$
	$"\frac{5}{2}" = "-11"\left("-\frac{1}{2}"\right) + c$ oe **or** $y - "\frac{5}{2}" = "-11"\left(x - "-\frac{1}{2}"\right)$ **and** $(y =) "-11"(-1) - 3 (= 8)$ **or** $(y =) "-11"\left(-1 - "-\frac{1}{2}"\right) + "\frac{5}{2}" (= 8)$			M1 for an expression that gives the y value at C
See alt methods	(Perp =) $\sqrt{\left(8-\frac{5}{2}\right)^2 + \left(-1--\frac{1}{2}\right)^2}\left(=\frac{\sqrt{122}}{2}\right)$ **and** $(AB =) \sqrt{3-2^{\ 2} + 5--6^{\ 2}}\ (=\sqrt{122})$			M1
	(Area of triangle =) $\frac{1}{2} \times \sqrt{122} \times \frac{\sqrt{122}}{2}$			M1 for a complete method
	Correct answer scores full marks (unless from obvious incorrect working)	30.5		A1 oe Allow answers in the range 30.4 – 30.5
				Total 7 marks

Q20 Alternative ways of finding the area of the triangle (final 2 M marks)				
Alt1	$(11 \times 6) - (0.5 \times 1 \times 11) - (0.5 \times 5 \times 6) - (0.5 \times 5 \times 6)$			M1 for any 3 correct triangles
	$(11 \times 6) - (0.5 \times 1 \times 11) - (0.5 \times 5 \times 6) - (0.5 \times 5 \times 6)$			M1 for a complete method
	Correct answer scores full marks (unless from obvious incorrect working)			
Alt 2	$(AC = BC =)\sqrt{5^2 + 6^2}\ (= \sqrt{61})$			M1 for AC is perp to BC
	(Area of triangle =) $\frac{1}{2} \times \sqrt{61} \times \sqrt{61}$			M1 for a complete method
	Correct answer scores full marks (unless from obvious incorrect working)			
Alt 3	$\sqrt{\left(8 - \frac{5}{2}\right)^2 + \left(-1 - -\frac{1}{2}\right)^2}\left(= \frac{\sqrt{122}}{2}\right)$ **and** $(AM =)\sqrt{\left(-6 - -\frac{1}{2}\right)^2 + \left(2 - \frac{5}{2}\right)^2}\left(= \frac{\sqrt{122}}{2}\right)$ or $(BM =)\sqrt{\left(5 - -\frac{1}{2}\right)^2 + \left(3 - \frac{5}{2}\right)^2}\left(= \frac{\sqrt{122}}{2}\right)$			M1 for the height of the triangle, AM and BM where M is the midpoint of AB
	(Area of triangle =) $2 \times \frac{1}{2} \times \frac{\sqrt{122}}{2} \times \frac{\sqrt{122}}{2}$			M1 for a complete method
	Correct answer scores full marks (unless from obvious incorrect working)			
Alt 4	$(AC = BC =)\sqrt{5^2 + 6^2}\ (= \sqrt{61})$ and $(AB =)\sqrt{3 - 2^{\ 2} + 5 - -6^{\ 2}}\ (= \sqrt{122})$			M1 for finding AC, BC and AB
	$\sqrt{\left(\frac{\sqrt{122} + 2\sqrt{61}}{2}\right)\left(\frac{\sqrt{122} + 2\sqrt{61}}{2} - \sqrt{122}\right)\left(\frac{\sqrt{122} + 2\sqrt{61}}{2} - \sqrt{61}\right)\left(\frac{\sqrt{122} + 2\sqrt{61}}{2} - \sqrt{61}\right)}$			M1 for applying Heron's formula
	Correct answer scores full marks (unless from obvious incorrect working)			

22	(gradient AM =) $\frac{4-2}{-3-0}$ oe $(=-\frac{2}{3})$		7	M1	A correct method to find gradient of AM
	$y=\frac{3}{2}x+2$ or eg $\frac{y-2}{x}=\frac{3}{2}$ oe			M1	For the correct equation of the line passing through BD or for a correct expression involving the x and y coordinates of point B or point D
	$(x--3)^2+(y-4)^2=6.5^2$ or $(x-0)^2+(y-2)^2=6.5^2-[(-3-0)^2+(4-2)^2]$ oe eg $x^2+(y-2)^2=29.25$			M1	A correct equation in x and y to find the coordinates of B and D
	eg $x^2+6x+9+y^2-8y+16-42.25=0$ oe or $x^2+y^2-4y+4-29.25=0$ oe			M1	Brackets expanded
	eg $x^2+6x+9+\left(\frac{3}{2}x+2\right)^2-8\left(\frac{3}{2}x+2\right)+16-42.25=0$ $\left(\frac{2y-4}{3}\right)^2+y^2-4y+4-29.25=0$ oe			M1	For a correct substitution into a correct equation to get an equation in either x only or y only
	eg $\frac{13}{4}x^2=\frac{117}{4}$ or $13y^2-52y-211.25=0$ oe			M1	A fully correct simplified equation in x or in y – all brackets expanded and like terms grouped.
		(3, 6.5) (−3, −2.5)		A1	correct coordinates SCB3 for one pair of correct coordinates or both x values correct or both y values correct
					Total 7 marks

See next page for alternative scheme

22 Alt 1	$(AM=)\sqrt{3^2+2^2}\ (=\sqrt{13}=3.605...)$ or $(AM^2=)3^2+2^2(=13)$		7	M1	Use of Pythagoras for point *A* to point *M*
	$(BM=)\sqrt{6.5^2-"\sqrt{13}"^2}\ (=\sqrt{29.25}=\frac{3\sqrt{13}}{2}5.4083...)$			M1	A correct method to find the length of *BM* or *DM*
	$(\text{SF}=)\frac{\sqrt{29.25}}{\sqrt{13}}=\frac{3}{2}$ oe **or** $MN = x$, $BN = 1.5x$ (*see diag*) or $(LAM=)\sin^{-1}\frac{3}{\sqrt{13}}(=56.3...)$ oe **or** $(LMA=)\cos^{-1}\frac{3}{\sqrt{13}}(=33.6...)$ **or**			M1	A correct method to find the SF of the enlargement of the sides *AM* to *BM* or angle *LAM* OR *LMA* 
	eg $\overrightarrow{MB}_x=\frac{3}{2}\times2$ or $\overrightarrow{MB}_y=\frac{3}{2}\times3$ or $\overrightarrow{MD}_x=-\frac{3}{2}\times2$ or $\overrightarrow{MD}_y=-\frac{3}{2}\times3$ oe or $x^2+(1.5x)^2=\sqrt{29.25}^2$ **or** $MN=\sqrt{29.25}\cos56.3...(=3)$ oe **or** $BN=\sqrt{29.25}\sin56.3...(=4.5)$ oe *turn over*			M1	A correct method to find the translation of at least one component of *MB* or *MD* (need not be written in vector form) OR correct Pythagoras statement using the SF to find *x* coordinates OR 1 correct trig statement to find translations from *M*
	$\overrightarrow{MB}_x=\frac{3}{2}\times2$ **and** $\overrightarrow{MB}_y=\frac{3}{2}\times3$ **or** $\overrightarrow{MD}_x=-\frac{3}{2}\times2$ **and** $\overrightarrow{MD}_y=-\frac{3}{2}\times3$ oe **or** $x^2+2.25x^2=29.25$ **or** $MN=\frac{3\sqrt{13}}{2}\cos56.309...(=3)$ **and** $BN=\frac{3\sqrt{13}}{2}\sin56.309...(=4.5)$ oe			M1	A correct method to find the translation of both components of *MB* or *MD* (need not be written in vector form) OR correct Pythagoras statement with no brackets using the SF to find *x* coordinates OR 2 correct trig statements to find translations from *M*

	eg (0, 2) is translated $\begin{pmatrix}3\\4.5\end{pmatrix}$ or $(0+3,\ 2+4.5)$ (= (3, 6.5)) or (0, 2) is translated $\begin{pmatrix}-3\\-4.5\end{pmatrix}$ or $(0-3,\ 2-4.5)$ (= (−3, −2.5)) oe **or** $3.25x^2 = 29.25$			M1	correct method to find the coordinates of *B* or *D* or one pair of correct coordinates or a correct method to find both *x* coordinates or both *y* coordinates OR a fully correct simplified equation in *x* all brackets expanded and like terms grouped.
		(3, 6.5) (−3, −2.5)		A1	correct coordinates SCB3 for one correct coordinate or both *x* values correct or both *y* values correct
					Total 7 marks

23	(i)		(180, 0)	1	B1
	(ii)		(360, −1)	1	B1
					Total 2 marks

15	360 ÷ 5 (= 72) oe or (5 – 2)×180 ÷ 5 (= 108) oe or 540 ÷ 5 (= 108) oe		3	M1 for a method to find an exterior or interior angle for a regular pentagon Do not award this mark if 108 is assigned as an exterior angle or 72 is assigned as an interior angle Ignore angles on the diagram other than exterior/interior angles of the pentagon even if incorrectly labelled
	$\frac{1}{2}\times 6.5\times 3\times \sin[\textit{angle DCE}]$ oe or $(h=)6.5\times \sin[\textit{angle DCE}]$ (= 6.18….) **and** $\frac{1}{2}\times 3\times$"6.18..." oe			M1 ft their angle *DCE* when substituting in $\frac{1}{2}\times 6.5\times 3\times \sin[\textit{angle DCE}]$ [*angle DCE*] means their angle *DCE* provided it is less than 90°
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	9.27		A1 accept 9.26 – 9.28 SC B2 for $\frac{1}{2}\times 6.5\times 3\times \sin$"108" = 9.27…
				Total 3 marks

16	(i)		**E**	1	B1
	(ii)		**A**	1	B1
					Total 2 marks

Question		Working	Answer	Mark	Notes
14	(a)		B	1	B1 cao
	(b)		C	1	B1 cao
					Total 2 marks

Question	Working	Answer	Mark	Notes
15		$125a^{12}c^6$	3	B3 for $125a^{12}c^6$ oe eg $\frac{125a^{12}}{c^{-6}}$ or $\frac{125c^6}{a^{-12}}$ or $\frac{125}{a^{-12}c^{-6}}$ or $\frac{a^{12}}{125^{-1}c^{-6}}$ or $\frac{1}{125^{-1}a^{-12}c^{-6}}$ or $\frac{a^{12}c^6}{125^{-1}}$ B2 for 2 correct terms (Allow eg $125a^{12}$ or $125c^6$ or $ka^{12}c^6$ as long as not added to any other terms) B1 for one correct term (allow eg a^{12} or $a^{-12}c^6$ or $\frac{1}{125^{-1}}$ or $\frac{1000a^{21}c^6}{8a^9}$ as long as not added to any other terms)
				Total 3 marks

14 (a)			2	B1	for $\frac{13}{20}$ and $\frac{7}{20}$ on the first branch (0.65 and 0.35)
		Correct probabilities on the tree diagram		B1	for $\frac{12}{19}, \frac{7}{19}, \frac{13}{19}$ and $\frac{6}{19}$ on the second branch (accept 2 dp or better 0.6315..., 0.3684..., 0.6842..., 0.3157...)
(b)	$\frac{7}{20} \times \frac{6}{19}$ oe only		2	M1	ft from (a) as long as probabilities less than 1
	$\frac{21}{190}$	$\frac{21}{190}$		A1	for $\frac{21}{190}$ oe or 0.11… (at least 2 dp)
					Total 4 marks

15		C, B, E	3	B3 for all 3 correct (B2 for 2 correct) (B1 for 1 correct)
				Total 3 marks

15	$\frac{1}{2}\times 6\times 11\times \sin 118 (= 29.1...)$		3	M1 for the area of half of the kite
	eg $2\times\frac{1}{2}\times 6\times 11\times \sin 118$			M1 for a complete method
		58.3		A1 accept 58.2 – 58.3
				Total 3 marks

16		C, F, D, H	3	B3 for all 4 correct (B2 for 2 or 3 correct) (B1 for 1 correct)
				Total 3 marks

14	(a)		12 and 4.5	1	B1 allow $\frac{9}{2}$ oe May be awarded if plotted correctly on the graph
	(b)		Correct graph	2	M1 ft for at least 5 points plotted correctly (± half square)
		Correct answer scores full marks (unless from obvious incorrect working)			A1 for correct curve between $x = 0.5$ and $x = 5$ (clear intention to go through all the points and which must be curved) **Note**: If a fully correct graph is shown, but an incomplete table is shown in (a), then award the marks for (a)
					Total 3 marks

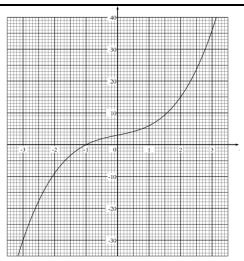
Question	Working	Answer	Mark	Notes
11		B	3	B1
		A		B1
		F		B1
				Total 3 marks

17 (b)	$w^2 = \frac{e+g}{ef-d}$		4	M1 for removing square root
	$w^2ef - w^2d = e+g$ oe			M1 for multiplying by denominator and expanding in a correct equation
	$w^2ef - e = g + w^2d$ oe			M1ft ft their equation dep on 2 terms in e and two other terms for gathering terms in e on one side and other terms the other side
	Correct answer scores full marks (unless from obvious incorrect working)	$e = \frac{g+w^2d}{w^2f-1}$		A1 oe eg $e = \frac{-g-w^2d}{1-w^2f}$, $e = -\frac{g+w^2d}{1-w^2f}$ oe must see e = on answer line or in working.
				Total 7 marks

18		**C**	3	B1 check diagrams
		F		B1 check diagrams
		A		B1 check diagrams
				Total 3 marks

11		$\frac{m^9k^{15}}{125}$	2	B2 oe for all 3 correct eg $125^{-1}m^9k^{15}$ or $\frac{1}{125}m^9k^{15}$ Accept a =9, b = 15 and c = 125 B1 for a quotient in the form of $\frac{m^pk^q}{r}$ or a product in the form $r^{-1}m^pk^q$ where 2 from p or q or r are correct eg $\frac{m^9k^{15}}{25}$ or $125m^9k^{15}$ Allow m^9k^{15} or $\frac{m^9}{125}$ or $125^{-1}m^9$ or $\frac{k^{15}}{125}$ or $125^{-1}k^{15}$ so long as not added to any other terms Accept two from a = 9 or b = 15 or c = 125 Accept $y125^{-1}m^9k^{15}$ or $\frac{ym^9k^{15}}{125}$ where y is constant
				Total 2 marks

12	(a)		D	1	B1 allow d
	(b)		C	1	B1 allow c
	(c)		B	1	B1 allow b
					Total 3 marks

10	(a)		−30, 15	1	B1	for −30 and 15 in the correct place, this may be awarded if plotted correctly on the graph
	(b)			2	M1ft	for at least 6 points plotted correctly (within the circles on the overlay) ft their incorrect table
		 *Correct answer scores full marks (unless from obvious incorrect working)*	Correct graph		A1	for correct curve between $x = -3$ and $x = 3$ (clear intention to go through all the points and which must be curved) Ignore to the left of $x = -3$ and to the right of $x = 3$ **Note**: If a fully correct graph is shown, but a blank table is shown in (a), then award the mark for (a)
						Total 3 marks

11	eg $\pi \times 16^2 \times \frac{140}{360}$ oe eg $256\pi \times \frac{7}{18}$		2	M1 allow use of 3.14… or $\frac{22}{7}$ for π $\frac{140}{360}$ may be seen as an equivalent fraction or decimal eg $\frac{7}{18}$ or $0.3\dot{8}$ 0.388(8…) or 0.389
	Correct answer scores full marks (unless from obvious incorrect working)	313		A1 accept 311.8 – 313
				Total 2 marks

3	(a)		e^4	1	B1	
	(b)		y^{16}	1	B1	
	(c)	$x^2 + 9x - 2x - 18$		2	M1	for 3 correct terms **or** 4 correct terms ignoring signs **or** $x^2 + 7x + c$ **or** .... $+ 7x - 18$
			$x^2 + 7x - 18$		A1	
	(d)		$4cp^2(4c^3 + 5p)$	2	B2	if not B2 then award B1 for any correct factorisation with at least 2 factors outside the bracket eg $4cp(4c^3p + 5p^2)$, $cp^2(16c^3 + 20p)$, $2p(8pc^4 + 10cp^2)$ etc **or** the correct common factor **and** a 2 term expression with just one error
						Total 6 marks

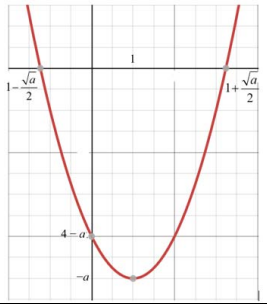
4	(a)		9, 3, (−1), −3, (−3), −1, (3)	2	B2	If not B2 then award B1 for at least 2 correct values
	(b)			2	M1	dep on B1 ft from (a) for at least 5 points plotted correctly
			correct graph		A1	for the correct graph (clear intention to go through all the points and which must be curved at the bottom)
						Total 4 marks

International GCSE Maths

Apart from Q2, 17, 18d, 20, & 24 (where the mark scheme states otherwise) the correct answer, unless obtained from an incorrect method, should be taken to imply a correct method

Question		Working	Answer	Mark		Notes
1	(a)		$x > -3$	1	B1	Accept $-3 < x$
	(b)	$4y - y \leq 8 + 13$		2	M1	Arranging y's on one side and the numbers on the other side. (allow $4y - y = 8 + 13$ oe or $4y - y < 8 + 13$ oe or $4y - y > 8 + 13$ oe or $4y - y \geq 8 + 13$ oe)
			$y \leq 7$ oe		A1	Allow $y \leq 21/3$
						Total 3 marks

2		$\frac{17}{3}(-)\frac{11}{4}$ or $5\frac{8}{12}(-)2\frac{9}{12}$ $\frac{68}{12} - \frac{33}{12}$ or $4\frac{20}{12} - 2\frac{9}{12}$ $\frac{35}{12} = 2\frac{11}{12}$ Alt: $3\,(+)(\frac{2}{3} - \frac{3}{4})$ $3\,(+)(\frac{8}{12} - \frac{9}{12})$ $3 - \frac{1}{12} = 2\frac{11}{12}$ Alt: $4\frac{5}{3}(-)\,2\frac{3}{4}$ $2\,(+)(\frac{5}{3} - \frac{3}{4})$ $2\,(+)(\frac{20}{12} - \frac{9}{12})$ $= 2\frac{11}{12}$		3	M1 M1 A1 M1 M1 A1 M1 M1 A1	Sight of $\frac{17}{3}$ and $\frac{11}{4}$ or $5\frac{8}{12}$ and $2\frac{9}{12}$ or $\frac{68n}{12n} - \frac{33n}{12n}$ Dep on M2 Dep on M2 Dep on M2
						Total 3 marks

20		graph drawn in shape of a quadratic with a minimum in any quadrant		4	M1 for a quadratic with a minimum
		$x = 1$, $y = 4 - (1 - 1)^2 - a$			M1 for finding the turning point (may be seen marked on the graph as $(1, -a)$)
		$x = 1 \pm \sqrt{\frac{a}{4}}$ oe **or** $y = 4 - a$			M1 for finding one of the intercepts (or award for any one correct coordinate shown on graph) $(0, 4 - a)$ or $(1 + \frac{\sqrt{a}}{2}, 0)$ or $(1 - \frac{\sqrt{a}}{2}, 0)$ Note: The 0's can be ignored (as shown in the diagram)
			Correct graph		A1 for a fully correct graph • quadratic shape with minimum in the fourth quadrant and marked as $(1, -a)$ oe • x-axis intercepts marked as $(1 + \frac{\sqrt{a}}{2}, 0)$ oe on the positive x-axis **and** $(1 - \frac{\sqrt{a}}{2}, 0)$ oe on the negative x-axis • y-axis intercept marked as $(0, 4 - a)$ oe Note: The 0's can be ignored (as shown in the diagram)
					Total 4 marks

Question	Working	Answer	Mark	Notes
12	180 – 2 × 66 (= 48) (360 – "48") ÷ 2 (= 156) 180 – "156" (= 24) 360 ÷ "24"		3	M1 Could be marked on diagram M1ft Final stage of calculation
	Alt : 180 – 2 × 66 (= 48) 360 ÷ (0.5 × "48")			M1 Could be marked on diagram M1ft Final stage of calculation
	Alt:180 – 2 × 66 (= 48) (360 – "48") ÷ 2 (= 156) $\frac{180\,(n-2)}{n}$ = "156" "24"n = 360 or $\frac{180\,(15-2)}{15}$ (= 156)			M1 Could be marked on diagram M1ft Final stage of calculation or embedded correct answer.
		15		A1
				Total 3 marks

13	$\frac{h}{2}$ × (7+12) × 10 = 608 oe		3	M2 M1 for $\frac{h}{2}$ × (7 + 12) × 10
		6.4		A1
				Total 3 marks

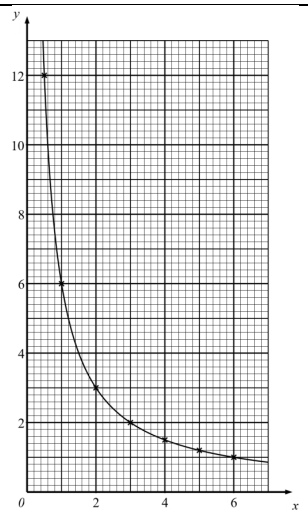
14	5, 7, 11, 12, 13, 14, 15, 16, 17, 18, 18		3	M1 Ordering marks (allow 1 error)
	11 and 17 selected			M1 LQ = 11 and UQ =17 identified
		6		A1
				Total 3 marks

15 (a)		2, −1.5, −3, 0	2	B2 B1 for 2 or 3 values correct
(b)			2	M1ft At least 5 points plotted correctly ft from table dep on B1 in part (a)
				A1 For correct smooth curve.
				Total 4 marks

Question		Working	Answer	Mark	Notes	
15	(a)		8.5, 5, 4, 5	2	B2	all 4 correct (allow eg 5.0 for 5) (B1 for 2 or 3 correct)
	(b)				M1	ft their table dep on B1 scored in (a) for 5 or 6 points plotted correctly (tolerance 1 small square)
			fully correct graph	2	A1	A fully correct graph – correct points plotted correctly (within tolerance of 1 small square) and intention to join with a smooth curve (be generous if intention is clearly a smooth curve through all points)
						NB: If a student has nothing in the table for part (a) but draws a fully correct graph in part (b) award the marks in part (a)
						Total 4 marks

3	$12.8^2 + x^2 = 16^2$ oe or $163.84 + x^2 = 256$ or $(x^2 =) 16^2 - 12.8^2$ $(= 92.16)$ or $(x^2 =) 256 - 163.84$ $(= 92.16)$		4	M1 for applying Pythagoras theorem correctly Allow $\cos^{-1}\left(\frac{12.8}{16}\right)(= 36.9...)$ **and** $\frac{x}{\sin(36.9...)} = \frac{16}{(\sin 90)}$
	$(x =) \sqrt{16^2 - 12.8^2}$ $(= \sqrt{92.16})$ $(= 9.6)$ or $(x =) \sqrt{256 - 163.84}$ $(= \sqrt{92.16})$ $(= 9.6)$			M1 for square rooting Allow $x = \frac{16}{(\sin 90)} \times \sin(36.9...)$
	(12.8 – "9.6") + "9.6" + "9.6" + 16 + 16 + 16 oe			M1 (dep on M1) for a complete method to find the perimeter
		70.4		A1 oe e.g. $\frac{352}{5}$
				Total 4 marks

4	(a)		15, 0, −1, 3	2	B2 for 4 correct values (B1 for 2 or 3 correct values)
	(b)	(−2, 15) (−1, 8) (0, 3) (2, −1) (3, 0) (4, 3)		2	M1 (dep on B1) ft from (a) for at least 5 points plotted correctly
			correct graph		A1 for a correct graph (clear intention to go through all the points and which must be curved at the bottom) **Note**: If a fully correct graph is shown, but an incomplete table is shown in (a), then award the marks for (a)
					Total 4 marks

11 (a)	<table><tr><td>***x***</td><td>0.5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr><tr><td>***y***</td><td>**12**</td><td>6</td><td>**3**</td><td>2</td><td>**1.5**</td><td>**1.2**</td><td>1</td></tr></table>	Correct table	2	B2 for all 4 correct values oe (ie $\frac{6}{5}$ or $\frac{3}{2}$) (B1 for 2 or 3 correct values)
(b)		Correct graph 7 points joined by a smooth curve.	2	M1ft (dep B1 in (a)) for 6 or 7 points plotted correctly using their values (within the circles on overlay). May be implied by curve passing through correct point. A1ft only allow one incorrect value from the table in (a), and for a curve that is decreasing throughout for $x = 0.5$ to $x = 6$. Ignore graph to the right of (6, 1) and to the left of (0.5, 12)
				Total 4 marks

4 (a)	x	−3	−2	−1	0	1	2	3	2	B2	for all correct values, otherwise B1 for 3 or 4 correct values
	y	**8**	2	**−2**	**−4**	−4	**−2**	**2**			
(b)									2	M1	dep on B1 scored in (a) for at least 5 points plotted correctly (ft their table)
					correct curve					A1	for a fully correct curve (all coordinates correct and correctly plotted and joined with a curve and curved between (0, –4) and (1, –4))
											Total 4 marks

<table>
<tr>
<td>11 (a)</td>
<td>
<table>
<tr><td>x</td><td>0.5</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td>y</td><td>5</td><td>4</td><td>5</td><td>6.7</td><td>8.5</td><td>10.4</td><td>12.3</td></tr>
</table>
</td>
<td>Four correct values</td>
<td>2</td>
<td>B2 oe

(B1 for 2 or 3 correct values of y)

May be awarded if plotted correctly on the graph</td>
</tr>
<tr>
<td>(b)</td>
<td></td>
<td>Correct graph</td>
<td>2</td>
<td>M1 ft their table dep on B1for at least 6 points plotted correctly (within or on the circles on the overlay)</td>
</tr>
<tr>
<td></td>
<td>Correct answer scores full marks (unless from obvious incorrect working)</td>
<td></td>
<td></td>
<td>A1 for correct curve between $x = 0.5$ and $x = 6$

Note: If a fully correct graph is shown, but an incomplete table is shown in (a), then award the marks for (a)

Ignore curve drawn for $x < 0.5$ and $x > 6$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total 4 marks</td>
</tr>
</table>

21	(a)		–0.2 and 2.2	2	B2	Both correct to 1 decimal place (B1 for (–0.2, 0), (2.2, 0) **or** a single correct value to 1 decimal place **or** both values within –0.2 to –0.23 and 2.2 to 2.23)
	(b)	(y =) $–2x + 1$ oe seen		3	M1	Written – could be label on graph
		$y = –2x + 1$ drawn			M1	dep on previous M1 for drawing $y = –2x + 1$ passing through (–1, 3) and (2, –3) (allow 1 square tolerance)
			–0.6 and 1.6		A1	dep on M2 for both answers to 1 decimal place
						Total 5 marks

11	$\frac{9x}{12x}+\frac{2(5-x)}{12x}$ oe or $\frac{3(6x)}{24x}+\frac{4(5-x)}{24x}$ oe or $\frac{3(6x)}{4(6x)}+\frac{4(5-x)}{4(6x)}$ oe or or $\frac{18x}{24x}+\frac{20-4x}{24x}$ oe or $\frac{3\times3x+2(5-x)}{12x}$ oe		3	M1 for two correct fractions with common denominator with the intention to add **or** a single correct fraction
	$\frac{9x+10-2x}{12x}$ oe or $\frac{18x+20-4x}{24x}$ oe or $\frac{14x+20}{24x}$ oe or			M1 for a correct numerator over a single denominator with brackets expanded and correct signs Allow $\frac{7x}{12x}+\frac{10}{12x}$
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	$\frac{7x+10}{12x}$		A1 oe $\frac{10+7x}{12x}$
				Total 3 marks

12 (a)	x −2 −1 0 1 2 y **−1** **3** **1** (−1) **3**	Correct y values	2	B2 for all correct (B1 for 2 or 3 correct)
(b)			2	M1 ft their table dep on B1 scored in (a) for 4 or 5 points plotted correctly (tolerance within or on the circles on the overlay)
Tol				A1 for a fully correct graph – points plotted correctly (within or on the circles on the overlay) and intention to join with a smooth curve (be generous if intention is clearly a smooth curve through all points) Ignore curve drawn for $x < -2$ and $x > 2$
(c)		D	1	B1
				Total 5 marks

Question		Working	Answer	Mark	Notes	
6	(a)		(6),2,(0),(0),(2),6	1	B1	For both entries correct
	(b)	$(0,6),(1,2),(2,0),(3,0),(4,2),(5,6)$			M1	for at least 5 points plotted correctly (ft their table)
			Correct curve	2	A1	for a correct curve
	(c)	$x^2-5x+6=x-1$			M1	or for $y=x-1$
					M1	for $y=x-1$ drawn
			1.6 and 4.4	3	A1	dep on M2 ft from their graph in (b) if at least 1 mark scored in (b)
7	(a)		71 800 000	1	B1	
	(b)	Eg $1.88\times10^7+3.10\times10^8+2.64\times10^8+7.18\times10^7$ **or** 18 800 000 + 310 000 000 + 264 000 000 + 71 800 000 with at least 3 numbers correct			M1	for a complete method **or** for digits 6646
			6.646×10^8 oe	2	A1	for 6.646×10^8 oe eg 664 600 000
	(c)		9.88×10^6	1	B1	

18	(a)		(−4.5) 3 4.5 (3) 1.5 (3) 10.5	2	B2 (B1	for all correct for any two correct) No points in table but correctly plotted on grid, award mark
	(b)	(−3, −4.5) (−2,3) (−1,4.5) (0,3) (1,1.5) (2,3) (3,10.5)	Smooth curve	2	B2 (B1	for a correct smooth curve. Points or curve passing through correct values within half a small square. for at least 5 points plotted correctly; ft from table for plotting only provided B1 awarded in part (a))
	(c)			2	M1	for drawing $y = -x - 1$ with two correct points plotted and intersection with curve. **or** for stating $y = -x - 1$ **or** for $\frac{1}{2}x^3 - 2x + 3 = -x - 1$ seen
			−2.3 to −2.4		A1	ft their curve dep on M1 **and** line $y = -x - 1$ drawn
						Total 6 marks

14	$\frac{0.515}{6.25}$		2	M1	For either bound correct (used or seen)
	Working required	0.0824		A1	dep on M1 Allow $\frac{103}{1250}$
					Total 2 marks

15 (a)	<table><tr><td>x</td><td>−2</td><td>−1</td><td>−0.5</td><td>0</td><td>1</td><td>1.5</td><td>2</td></tr><tr><td>y</td><td>0</td><td></td><td></td><td>2</td><td></td><td></td><td>4</td></tr></table>		2	B2	(B1 for 1 or 2 correct)
(b)		correct curve	2	B2	For correct smooth curve. (**there is an overlay for the curve – check the line now for (c)**) If not B2, then B1 for at least 5 points plotted correctly ft from table dep on B1 or B2 in (a)
(c)	$2x^3-6x+4=-3x$ **or** $x^3-3x+2=-\frac{3}{2}x$ or $y=-\frac{3}{2}x$ seen (allow $-\frac{3}{2}x$)		3	M1	
	$y=-\frac{3}{2}x$ allow a correct line that intercepts with the curve eg of points on line (0, 0), (–1, 1.5), (–1.5, 2.25), (–2, 3)			M1	a correct line that intercepts with the curve (a correct line drawn implies M2)
	Answer dependent on a correct line being drawn	(x=) −1.6		A1ft	accept −1.6 or −1.7 or ft their curve/line intercept **dep on a correct line being drawn** NB: if y value given as well then M2 only
					Total 7 marks

Question		Working	Answer	Mark	Notes	
14	(a)		-6, 4, 0, -2, 4	2	B2	Award B1 for 2, 3 or 4 correct.
	(b)		correct curve	2	B2	For correct smooth curve. If B2 not awarded, award B1 for at least 5 points plotted correctly ft from table dep on B1 or B2 in (a) (plots ±1 sq)
	(c)	$x^3 - 2x^2 - 3x + 4 = -2x + 3$		4	M1	
		Plot $y = -2x + 3$			M1	Sufficient to cross curve at least once.
		-0.8 or 0.6 or 2.2			A1	Any one correct x value at intersection of graphs (or one or more points given as coordinates) ft dep on second M1 (Award even if curve in (a) is incorrect)
			−0.8 0.6 2.2		A1	Accept −0.9 to −0.7 Accept 0.4 to 0.7 Accept 2.1 to 2.4 (not coordinates) ft (±1 square) dep on second M1 must be 3 values SC B2 for all correct solutions from graph of $y = x^3 - 2x^2 - x + 1$
						Total 8 marks

15	$8.305 - 0.655$		2	M1	For either bound correct (used or seen). Accept $0.6549^{\dot{9}}$
		7.65		A1	dep on correct method shown
					Total 2 marks

17	Line drawn at (2, 1) with a positive gradient that does not intersect the curve at any other point.		3	M1 for a tangent drawn at $x = 2$
				M1 (dep M1) for a correct method to work out the gradient of the tangent.
		1.5 to 3		A1 for 1.5 to 3 accept answers in the range 1.5 – 3 so long as a tangent at $x = 2$ has been drawn.
				Total 3 marks

21			3	B1	tangent drawn at P ($x = -2$)
				M1	(dep on B1) for a method to find gradient eg $\frac{\text{difference in } y\text{-values}}{\text{difference in } x\text{-values}}$ **or** an answer in the range −0.8 to −0.2 oe
	Answer depends on tangent being drawn at P	0.5		A1	(dep on B1) oe accept answers in range 0.2 to 0.8 oe **and** from correct figures for their tangent
					Total 3 marks

2	(a)	15 km/h or $\frac{25}{6}$ m/sec or 0.25 km/min or $\frac{15}{4}$ oe 12 km/h or $\frac{10}{3}$ m/sec or 0.2 km/min or $\frac{9}{3}$ oe	'before' with reason	1	B1	e.g. before as gradient is steeper **or** before as speed before is 15 km/h speed after is 12 km/h **or** before as she goes over 11(allow 11-12) km in ¾ hour but only goes 9 km in ¾ hour after oe NB: any figures used for the reason must be accurate if they haven't used 'gradient is steeper' oe
	(b)		line from (12:00, 24) to (12:45, 24) to (14:15, 0)	2	B2	If not B2 then B1 for a line from (12:00, 24) to (12:45, 24) **or** for a line from (t, 24) to (t + 1.5, 0) **or** for a time of 1.5 hours (oe) seen
	(c)	1h 45m + 1h 30m **or** 1 + 0.75 + 1.5 **or** 3h 15m **or** 3.25h **or** 195m oe		3	M1	ft from their graph for total time when cycling
		(24 × 2) ÷ "3.25" oe eg (48 ÷ 195) × 60			M1	ft dep on M1 for full method
			14.8		A1	awrt 14.8
						Total 6 marks

18	ai				B1	tangent drawn at P ($x = 2$)
					M1	(dep on B1) for a method to find gradient e.g. $\frac{\text{difference in } y\text{-values}}{\text{difference in } x\text{-values}}$
			−0.6	3	A1	(dep on B1) accept answers in range −0.4 to −0.7 **and** from correct figures for their line
	aii	e.g. $y = -0.6x + c$ **or** $y = mx + 3.6$ **or** $2.4 = -0.6 \times 2 + c$			M1	for start of method to find the tangent equation e.g. $y = mx + c$ where m is their gradient **or** $y = mx + c$ where c is the y-intercept for their tangent **or** for substituting a point from their tangent e.g. (2, 2.4) into $y = mx + c$ where m is their gradient
			$y = -0.6x + 3.6$	2	A1	ft their gradient from (i) and intercept of their tangent, so long as intercept / value of c is > 3
	b		3		B1	
			−1	2	B1	
						Total 7 marks

19	8.35 **or** 7.25 **or** 6.15 **or** 5.25		3	B1	
	(8.35×7.25) – (6.15×5.25)			M1	Allow $UB_{AD}\times UB_{DC} - LB_{EH}\times LB_{HG}$ where $8.3 < UB_{AD} \leq 8.35$, $7.2 < UB_{DC} \leq 7.25$ $6.15 \leq LB_{EH} < 6.2$, $5.25 \leq LB_{HG} < 5.3$
		28.25		A1	oe, dep on M1
					Total 3 marks

20	(i)		(−3, −2)	1	B1	
	(ii)		(−1.5, 4)	1	B1	oe
						Total 2 marks

22	eg $\overrightarrow{ON} = 8\mathbf{a} + \frac{1}{2}(6\mathbf{b} - 8\mathbf{a})(= 3\mathbf{b} + 4\mathbf{a})$ **or** $\overrightarrow{ON} = 6\mathbf{b} + \frac{1}{2}(-6\mathbf{b} + 8\mathbf{a})(= 3\mathbf{b} + 4\mathbf{a})$ **or** $\overrightarrow{NO} = \frac{1}{2}(8\mathbf{a} - 6\mathbf{b}) - 8\mathbf{a}(= -4\mathbf{a} - 3\mathbf{b})$ **or** $\overrightarrow{NO} = -6\mathbf{b} + \frac{1}{2}(6\mathbf{b} - 8\mathbf{a})(= -3\mathbf{b} - 4\mathbf{a})$ **or** $\overrightarrow{AM} = -8\mathbf{a} + \frac{1}{3}(6\mathbf{b})(= 2\mathbf{b} - 8\mathbf{a})$ **or** $\overrightarrow{AM} = -8\mathbf{a} + 6\mathbf{b} - \frac{2}{3}(6\mathbf{b})(= 2\mathbf{b} - 8\mathbf{a})$ **or** $\overrightarrow{MA} = 8\mathbf{a} - \frac{1}{3}(6\mathbf{b})(= 8\mathbf{a} - 2\mathbf{b})$ **or** $\overrightarrow{MA} = \frac{2}{3}(6\mathbf{b}) + 8\mathbf{a} - 6\mathbf{b}(= 8\mathbf{a} - 2\mathbf{b})$		5	M1 a correct expression for $\overrightarrow{ON}$ **or** $\overrightarrow{NO}$ **or** $\overrightarrow{AM}$ **or** $\overrightarrow{MA}$
	$\overrightarrow{OP} = \mu(3\mathbf{b} + 4\mathbf{a})$ and one of eg $\overrightarrow{OP} = 8\mathbf{a} + x(2\mathbf{b} - 8\mathbf{a})$ $(= (8 - 8x)\mathbf{a} + 2x\mathbf{b})$ or $\overrightarrow{OP} = 2\mathbf{b} + y(8\mathbf{a} - 2\mathbf{b})(= (2 - 2y)\mathbf{b} + 8y\mathbf{a})$			M2 oe (M1 for one correct expression for $\overrightarrow{OP}$) (where μ, x, y are scalars)
	eg $\frac{4}{3} = \frac{8y}{2 - 2y}$ **or** $\frac{4}{3} = \frac{8 - 8x}{2x}$ oe **or** $3\mu = 2x$ **and** $4\mu = 8 - 8x$ **or** $3\mu = 2 - 2y$ **and** $4\mu = 8y$			M1 A correct expression to find the position of P along ON **or** two correct simultaneous equations coming from the expressions for $\overrightarrow{OP}$
		$2\mathbf{a} + \frac{3}{2}\mathbf{b}$		A1 dep on M3, oe eg $2\mathbf{a} + 1.5\mathbf{b}$
				Total 5 marks

23	(i)		(−4, 7)	1	B1
	(ii)		(5, 10)	1	B1
					Total 2 marks

20	(i)		(s + 2, t)	1	B1oe accept (2 + s, t)
	(ii)		(s, 3t)	1	B1oe accept (s, 3 × t) or (s, t × 3)
					Total 2 marks

21	10 ÷ 20 (= 0.5) or a correct value on the FD scale and no errors or 25 small squares = 5 children or 5 small squares = 1 child oe or 1 small square = 0.2 children oe or 29 oe or 48 oe or 10 (associated with 75-80 bar)		3	M1
	(10 × 2.9) + (15 × 3.2) + (5 × 2) or 29 + 48 + 10 or (5.8 + 9.6 + 2) × 5 oe or (145 + 240 + 50) × 0.2 oe			M1for a fully correct method
		87		A1
				Total 3 marks

20		$(a=)\ 2$ $(b=)\ 135$	2	B2	If not B2, then B1 for one correct value
					Total 2 marks

21	$(AD=)\dfrac{2.2}{\tan 18}$ (= 6.77...) or $(EA=)\dfrac{2.2}{\sin 18}(=7.11...)$		4	M1	a correct method to find *AD* or *AE*
	$(DB=)\sqrt{("6.77...")^2+6^2}$ (= 9.04...) or $(EB=)\sqrt{6^2+"7.11..."^2}$ (= 9.31...) or $(EB=)\sqrt{6^2+"6.77..."^2+2.2^2}(=9.31...)$			M1	a correct method to find *DB* or *EB*
	$\tan DBE=\dfrac{2.2}{"9.04..."}$ or $\sin DBE=\dfrac{2.2}{"9.31..."}$ or $\sin DBE=\dfrac{2.2\sin 90}{"9.31..."}$ $\cos DBE=\dfrac{"9.04..."}{"9.31..."}$ or use of cosine rule			M1	complete method to find one of tan*DBE* or sin*DBE* or cos*DBE*– NB: if using cosine, the student will need to have found *DB* and *EB* previously
	Correct answer scores full marks (unless from obvious incorrect working)	13.7		A1	Allow answers in range 13.59 – 13.8
					Total 4 marks

Q	Working	Answer	Mark	Notes
24		3	2	B1
		0.5		B1 oe
				Total 2 marks

20	$\frac{80}{2}(2a+79d)=470$ oe		6	M1	for substituting into the sum of arithmetic series formula
	$a + 74d = 14.5$ oe			M1	for substituting into the nth term of arithmetic sequence formula
	correct method to find the value of a or d eg $2a + 148d = 29$ $2a + 79d = 11.75$ _			M1	solve the correct equations simultaneously, eg make the coefficients of a or d the same and show the intention to subtract **or** rearrange one equation to make a or d the subject and substitute into the other equation
	correct values of $a = -4$ and $d = 0.25$ oe			A1	dep on M2
	$\frac{X}{2}(2\times"-4"+(X-1)"0.25")=171$ oe			M1	correctly substituting the found values of a and d into a correct equation, can be their values of a and d as long as clearly stated
	Working required	57		A1	dep on M2
					Total 6 marks

21	(a)	(10, 5)	1	B1	cao
	(b)	(2, 5)	1	B1	cao
					Total 2 marks

21	(i)		(–2, –4)	1	B1
	(ii)		(5, –10)	1	B1
					Total 2 marks

25	(i)		(30, 2)	1	B1 cao
	(ii)		(300, 0)	1	B1 cao
					Total 2 marks

23 (i)		(6, 7)	1	B1	
(ii)		(2, −3)	1	B1	
				Total 2 marks	

24	(a)	eg $\frac{1}{3}\times\pi\times x^2\times 3x\left(=\pi x^3\right)$ oe **or** $\frac{1}{2}\times\frac{4}{3}\times\pi\times x^3\left(=\frac{4}{6}\pi x^3=\frac{2}{3}\pi x^3\right)$ oe **or** $\frac{4}{3}\times\pi\times(kx)^3$ oe		4	M1	for an expression for the volume of the cone **or** the hemisphere **or** the sphere NB Ignore missing brackets around kx for this mark Allow r for x for all M marks
		eg $\frac{4}{3}\times\pi\times(kx)^3=12.5\times\left(\frac{1}{2}\times\frac{4}{3}\pi x^3+\frac{1}{3}\pi x^2(3x)\right)$ oe **or** $\frac{4}{3}\times\pi\times(kx)^3=12.5\left(\frac{2}{3}\pi x^3+\pi x^3\right)$ oe **or** $\frac{4}{3}\times\pi\times(kx)^3=12.5\times\frac{5}{3}\pi x^3$ oe **or** $\frac{4}{3}\times\pi\times(kx)^3=\frac{125}{6}\pi x^3$ oe			M1	for a **correct** equation for the volumes NB If $(kx)^3$ not expanded at this stage then must see brackets
		eg $\left(k^3=\right)\frac{\frac{125}{6}\pi}{\frac{4}{3}\pi}$ oe **or** $\left(k^3=\right)\frac{125}{8}$ oe **or** $\left(k=\right)\sqrt[3]{\frac{125}{8}}$ oe $k^3x^3=\frac{12.5\times\frac{5}{3}\pi x^3}{\frac{4}{3}\pi}$ oe **or** $kx=\frac{\sqrt[3]{12.5\times\frac{5}{3}\pi x^3}}{\sqrt[3]{\frac{4}{3}\pi}}$ **or** $kx=\sqrt[3]{\frac{125x^3}{8}}$ oe			M1	for a **correct** calculation for k or k^3 or for a **correct** equation for kx or k^3x^3
		Working not required, so correct answer scores full marks (unless from obvious incorrect working)	2.5		A1	oe
	(b)		64	1	B1	
						Total 5 marks

18	$y = \frac{k}{x^3}$	$hy = \frac{1}{x^3}$		4	M1 do not award for $y = \frac{1}{x^3}$ Constant of proportionality must be a symbol such as k Condone use of $\propto$ for method marks
	$4 = \frac{k}{3^3}$ **or** $k = 4 \times 3^3$ (= 108)	$h \times 4 = \frac{1}{3^3}$ **or** $h = \frac{1}{4 \times 3^3} \left(= \frac{1}{108}\right)$			M1 for substitution of x and y into a correct formula Condone use of $\propto$ for method marks
	eg $\left(x^3 =\right) \frac{4 \times 3^3}{864} \left(= \frac{1}{8}\right)$ **or** $\left(x^3 =\right) \frac{"108"}{864} \left(= \frac{1}{8}\right)$ oe				M1 for method to find x^3 Condone use of $\propto$ for method marks
	Correct answer scores full marks (unless from obvious incorrect working)		0.5		A1 oe
					Total 4 marks

19	(i)		8, –9	1	B1 cao
	(ii)		4, –12	1	B1 cao
					Total 2 marks

Question	Working	Answer	Mark	Notes
18 (a)		Parabola through $(-4,5),(-2,0),(0,-3),(2,-4),(4,-3)(6,0),(8,5)$	2	B2 For a parabola with minimum $(2,-4)$ through at least 5 of $(-4,5),(-2,0),(0,-3),(4,-3)(6,0),(8,5)$ If not B2 then B1 For u-shaped parabola with minimum $(2,-4)$ or For u-shaped parabola through $(-2,0),(6,0)$ or For u-shaped parabola through $(-4,5),(8,5)$
(b)		3	1	B1

25	(a)		Reflection in $y = 0$	1	B1	accept alternative for $y = 0$ e.g. x axis ; if more than one transformation then B0
	(b)		U shaped curve through (2, 6) (3, 0) (5, −6) (7, 0) (8, 6)	2	B2	for a U shaped curve passing through (2, 6) (3, 0) (5, −6) (7, 0) (8, 6) If not B2 then award B1 for either $2f(x - 1)$ passing through at least 3 points from (2, 6) (3, 0) (5, −6) (7, 0) (8, 6) **or** $2f(x + 1)$ passing through (0, 6) (1, 0) (3, −6) (5, 0) (6, 6) **or** $2f(x)$ passing through all of (1, 6) (2, 0) (4, −6) (6, 0) (7, 6) **or** $f(x - 1)$ passing through all of (2, 3) (3, 0) (5, −3) (7, 0) (8, 3) **or** $2f(x \pm k)$ passing through all of $(1 \pm k, 6)$ $(2 \pm k, 0)$ $(4 \pm k, -6)$ $(6 \pm k, 0)$ $(7 \pm k, 6)$ **or** A clear translation of the curve using the vector $\begin{pmatrix} 1 \\ k \end{pmatrix}$
						Total 3 marks

26	(a)		2	1	B1 cao
	(b)		3	1	B1 cao
	(c)		1	1	B1 cao
					Total 3 marks

19	(i)		(0, 4)	1	B1
	(ii)		(5, 12)	1	B1
	(iii)		(5, –3)	1	B1
					Total 3 marks

20	$(10x + 21)(x - 1)$ or $\frac{-11 \pm \sqrt{(11)^2 - 4\times10\times-21}}{2\times10}$ $10\left[\left(x + \frac{11}{20}\right)^2 - \frac{121}{400}\right] - 21 (= 0)$ oe		3	M1	A correct method to solve the quadratic; correct factors or correct substitution into the formula or can be simplified as far as $\frac{-11 \pm \sqrt{121 + 840}}{20}$ or correctly completing the square. $(10)(x + 2.1)(x - 1)$ is not a correct factorisation – it is working backwards from calculator answers.
	$(x =) 1, (x =) -2.1$			A1	dep on M1 for correct critical values
	Working required	$-2.1 < x < 1$		A1	dep on M1 oe eg $x > -2.1$ (and) $x < 1$ (do not penalise 'or') or $\frac{-21}{10} < x < 1$ etc including the open interval $(-2.1, 1)$ or $]-2.1, 1[$
					Total 3 marks

21	(a)		$(-2, 9)$	1	B1
	(b)		$a = 3$	2	B1
			$b = -11$		B1
					Total 3 marks

25		$a = 3$ $b = 45$ $c = 1$ **OR** $a = -3$ $b = 225$ $c = 1$	3	B1 for $a = 3$ **or** $a = -3$ B1 for $a > 0$ and $b = 45$ **or** for $a < 0$ and $b = 225$ if no answer for a is seen allow this mark for $b = 45$ B1 for $c = 1$ Allow correct alternative angles for the value of b, eg 45 or –315, 225 or –135
				Total 3 marks

Question		Working	Answer	Mark	Notes
21	(a)		(−2, −2), (1, 6), (4, −2) Plotted and joined	2	B2 Fully correct graph- professional judgment required. (B1 for (1, 6) plotted **OR** (−2, −2) and (4, −2) plotted)
	(b)		(2, −1), (−1, 3) (−4, −1) Plotted and joined	2	B2 Fully correct graph – professional judgment required. (B1 for 2 of the 3 points plotted) SC B1 for a correct reflection in the *x*-axis
					Total 4 marks

22	$\frac{(2x+5)(2x-5)}{(5x+7)(x-1)} \times \frac{2(2x-5)-3(x-3)}{(x-3)(2x-5)}$ $\frac{(2x+5)(2x-5)}{(5x+7)(x-1)} \times \frac{x-1}{(x-3)(2x-5)}$ $\frac{2x+5}{(5x+7)(x-3)}$	$\frac{2x+5}{(5x+7)(x-3)}$	4	M1 For $4x^2 - 25 = (2x + 5)(2x - 5)$ or $5x^2 + 2x - 7 = (5x + 7)(x - 1)$ M1 $\frac{2}{x-3} - \frac{3}{2x-5} = \frac{2(2x-5)-3(x-3)}{(x-3)(2x-5)}$ oe M1 $\frac{(2x+5)(2x-5)}{(5x+7)(x-1)} \times \frac{x-1}{(x-3)(2x-5)}$ oe may be partially simplified A1 Denominator may be expanded eg $\frac{2x+5}{5x^2-8x-21}$ isw for incorrect denominator expansion
				Total 4 marks

Question		Working	Answer	Mark	Notes	
17	(a)	4.75 × 0.255	1.21	2	M1	for 4.75 or 0.255 seen
					A1	1.21125
	(b)	2.735 ÷ 0.035	78	2	M1	2.735 or 0.035 seen
					A1	78.142857...
18	(a)	(0, 1), (90, 0), (180, −1), (270, 0), (360, 1)	Curve through given coordinates	2	M1	for a translation of the curve parallel to the *x* axis or for a curve going through 3 correct points
					A1	fully correct
	(b)		(180, 4)	2	M1	1 coordinate correct or a sketch of $\sin\left(\frac{x}{2}\right)^0$
					A1	for (180, 4)

21	(a)(i)		(9, 3)	1	B1
	(a)(ii)		(4, 9)	1	B1
	(b)		$a = -2$, $b = 3$	2	B2 **or** $a = 2$, $b = -3$ (B1) for $a = -2$ **or** $a = 2$ **or** $b = 3$ **or** $b = -3$
					Total 4 marks

22 a			2	M1	for one correct value
		2.5, −60		A1	oe e.g. −2.5 & 120
				SC	M1 for drawing cos curve
bi		(2, 5)	1	B1	
bii		(4, −2)	1	B1	
					Total 4 marks

23	$(v=)\ 3t^2+2\times4t-5$			M1	2 out of 3 terms differentiated correctly
	$3T^2+8T-5=V$ **OR** $3T^2+8T-5-V=0$			A1	correct equation
	$3(T^2+\frac{8}{3}T)-5$ **OR** $3(T^2+\frac{8}{3}T-\frac{5}{3})$	$(T=)\ \frac{-8\pm\sqrt{8^2-4\times3\times(-5-V)}}{2\times3}$		M1	attempt to complete the square **OR** use quadratic formula (condone one sign error in a, b or c and ft their quadratic with mistake in a or b) (condone + instead of ±)
	$\left(T+\frac{4}{3}\right)^2=\left(\frac{4}{3}\right)^2+\frac{V+5}{3}$	$(T=)\ \frac{-8\pm\sqrt{124+12V}}{6}$		M1	sight of this method mark implies the previous M1 (condone + instead of ±) (ft their quadratic with mistake in a or b)
	$T=\frac{-4}{3}\pm\frac{1}{3}\sqrt{16+3V+15}$	$(T=)\ \frac{-8\pm2\sqrt{31+3V}}{6}$		M1	(condone + instead of ±) (ft their quadratic with mistake in a or b)
			$\frac{-4+\sqrt{31+3V}}{3}$ 6	A1	accept $k=31$ and $m=3$
					Total 6 marks

20	$\frac{18}{\sqrt{7}+1}\times\frac{\sqrt{7}-1}{\sqrt{7}-1}$		3	M1 for $\frac{18}{\sqrt{7}+1}\times\frac{\sqrt{7}-1}{\sqrt{7}-1}$
	eg $\frac{18(\sqrt{7}-1)}{7-1}$			M1 Dep on M1 for a correct numerator **and** multiplying out the denominator to 7 – 1 or 6
	$3\sqrt{7}-3$	$3\sqrt{7}-3$		A1 Dep on M2 Allow $3(\sqrt{7}-1)$
				Total 3 marks

21	(a)(i)		(0, 6)	2	B1
	(iii)		(2, 6)		B1
	(b)	eg $(x-4)^2+3(x-4)+4$ oe or eg $(x+\frac{3}{2}-4)^2-\frac{9}{4}+4$ oe or eg $x^2+3x+10$ oe or eg $(x+\frac{3}{2})^2-\frac{9}{4}+4+6$ oe eg $y-6=x^2+3x+4$		2	M1 for applying one of the transformations to the equation
			$y=(x-4)^2+3(x-4)+10$ or $y=(x+\frac{3}{2}-4)^2-\frac{9}{4}+4+6$		A1 oe eg $y=(x-\frac{5}{2})^2+\frac{31}{4}$ or $y=x^2-5x+14$ oe
					Total 4 marks

20	$\sqrt[3]{\frac{4352}{1836}}$ **or** $\frac{4}{3}$ **or** 1.33(33...) **or** 4:3 **or** $\sqrt[3]{\frac{1836}{4352}}$ **or** $\frac{3}{4}$ **or** 0.75 **or** 3:4		3	M1	for a correct length scale factor or a correct length ratio
	e.g. $1120 \div \left("\frac{4}{3}"\right)^2$ oe **or** $1120 \times \left("\frac{3}{4}"\right)^2$ oe			M1	(dep on M1) for a correct method to work out the surface area of A
		630		A1	
					Total 3 marks

21	(a)(i)		(−12, 15)	1	B1	
	(ii)		(−9, 5)	1	B1	
	(b)		$a = 2$ and $b = 90$	2	B2	for both values correct (B1 for $a = 2$ **or** $b = 90$ **or** $a = -2$ **and** $b = -90$)
						Total 4 marks

Qu	Working	Answer	Mark	Notes
22	[g(x) =] $2(x-3)^2-5$		4	B2 for $a = 2$, $b = 3$ and $c = 5$ correct (stated or shown) (B1 for one of $a = 2$, $b = 3$ and $c = 5$ correct)
	stretch y direction scale factor 2 oe [ft their a] **or** translation $\begin{pmatrix}3\\-5\end{pmatrix}$ (ft correct use of their b and c) oe			M1 **Stretch** and a correct description of the stretch **or translation** and a correct description of the translation NB: must include the word translation (or translate) and stretch
		Correct transformations in correct order		A1 Stretch y direction scale factor 2 **followed by** translation $\begin{pmatrix}3\\-5\end{pmatrix}$ oe eg translation $\begin{pmatrix}3\\0\end{pmatrix}$, stretch SF2 in y direction followed by translation $\begin{pmatrix}0\\-5\end{pmatrix}$
				Total 4 marks
22 Alt	[g(x) =] $2(x-3)^2-5$		4	B2 for $a = 2$, $b = 3$ and $c = 5$ correct (stated or shown) (B1 for one of $a = 2$, $b = 3$ and $c = 5$ correct)
	translation $\begin{pmatrix}3\\-2.5\end{pmatrix}$ (ft correct use of their b and $0.5c$) oe **or** stretch y direction scale factor 2 (ft their a)			M1 A correct description of the stretch **or** the translation
		Correct transformations in correct order		A1 Translation $\begin{pmatrix}3\\-2.5\end{pmatrix}$ oe **followed by** stretch y direction scale factor 2
				Total 4 marks

10	(a)	$(18-3)^2+(7--1)^2$ oe or $15^2+8^2\,(=289)$ oe		3	M1
		$\sqrt{(18-3)^2+(7--1)^2}$ (= $\sqrt{"289"}$)			M1
			17		A1
	(b)	13 + 6 > "17"	correct reason	1	A1ft dep M1 **Acceptable examples** "They overlap by 2cm" "The distance between the centres is less than the sum of the radii" "17 is less than the distance than the total of the radii" "19 is bigger than the distance between the centres" **Not acceptable examples** "19 is greater than the distance between the circles" oe "The circumference of each circle overlaps"
					Total 4 marks

20	eg (x =) 4 – (6 – 4) (= 2) (y =) 7 – (11 – 7) (= 3) **or** (2, 3)		4	M1	for a method to find the coordinates of P (accept coordinates of P informally eg separately or as a vector)
	eg $\frac{11-7}{6-4}$ (= 2) or $\frac{11-[3]}{6-[2]}$ (= 2) oe or $\frac{[3]-7}{[2]-4}$ (= 2) oe			M1	(indep if using coordinates of A & O) for a method to find the gradient of AOP (can use **their** coordinates of P)
	eg −1 ÷ [2] (= −0.5) oe			M1ft	for a method to find the gradient of the tangent ft their stated gradient of AOP (or OA or OP) (could be embedded)
		$y-3=-0.5(x-2)$		A1	oe eg $y=-\frac{1}{2}x+4$
					Total 4 marks

22	(a)(i)		$(-3, -1)$	1	B1
	(ii)		$(-6, 2)$	1	B1
	(b)		$(p+c, -q)$	2	B2 for $(p+c, -q)$ (B1 for $p + c$ **or** $-q$ in the correct place)
					Total 4 marks

24	(a)		(a =) −4 (b =) 6	2	B1 for (a =) −4 B1 for (b =) 6
	(b)		(p =) 3 (q =) 45	2	B1 for (p =) 3 B1 for (q =) 45
					Total 4 marks

Question	Working	Answer	Mark	Notes
18 a (i)		(3, −1)	1	B1
(ii)		(−2, −0.5) oe	1	B1
b		e.g. 2, 90, 1	3	B3 for all 3 correct values e.g. 2, 90, 1 **or** −2, 270, 1 If not B3 then B2 for any 2 correct values NB. 2 values from 2, 90, 1 **OR** 2 values from −2, 270, 1 NB: accept a value of (90 + 360*n*) in place of 90 or (270 + 360*n*) in place of 270 where *n* is an integer (could be negative) If not B2 then B1 for any 1 correct value **or** the graph of $y = \sin x^{o}$ for $0 \leq x \leq 360$

22	(a)		correct graph (see end of mark scheme) [must go through (60, 2), (150, 0), (240, −2), (330, 0)] and not through (0, 0)	2	B2	if not B2 then award B1 for a graph of the correct shape going through 2 or 3 of the given points or for a clear stretch of SF2 (ie a maximum point on graph at (x_1, 2) and a minimum point at (x_2, −2)) or a clear translation of $\begin{pmatrix}-30\\0\end{pmatrix}$ (ie a point on graph at (150, y) and a point at (330, y))
	(b)(i)		$(x-3)^2+1$	2	B2	(B1 for $(x-\frac{6}{2})^2+n$ (where n ≠ 1) **or** for $(x-m)^2+1$ (where m ≠ 3) **or** for $x^2-ax-ax+a^2+b$ with $2a=6$ or $a^2+b=10$)
	(b)(ii)		translation of $\begin{pmatrix}3\\1\end{pmatrix}$	2	B1	for translation
					B1	For $\begin{pmatrix}3\\1\end{pmatrix}$ ft from (b)(i) must be column vector
						Total 6 marks

21	(a)		(−2, 9)	1	B1
	(b)		$(y =)\ 9-3(x-4+2)^2$	1	B1 oe eg $(y =)-3x^2+12x-3$ accept $f(x-4)$
	(c)		Reflection in the line $y = 0$ or x-axis	1	B1 with no mention of another transformation
	(d)	(3, −90, 2) (−3, 90, 2) ((3, 270, 2) (−3, 450, 2) etc	eg $a = 3$ $b = -90$ $c = 2$	3	B3 for all 3 correct values eg 3, −90, 2 or −3, 90, 2 (If not B3 then B2 for any 2 correct values NB. 2 values from 3, −90, 2 **or** 2 values from −3, 90, 2 NB: accept a value of $(90 + 360n)$ in place of 90 or $(-90 + 360n)$ in place of −90 where n is an integer (could be negative) If not B2 then B1 for any 1 correct value **or** the graph of $y = \cos x°$ for $0 \leq x \leq 360$)
					Total 6 marks

20	(a)(i)		(−6, 1)	2	B1
	(ii)		(−2, −4)		B1
	(b)	(−1, 6), (3, −2), (7, 6)	Fully correct graph	2	B2 for a fully correct graph (B1 for a V shape with least value at (3, −2))
	(c)		−3, 4	2	B2 for 2 correct values in any order (B1 for 1 correct value)
					Total 6 marks

21	16 ÷ 0.5 (= 32) or a correct value on the FD scale or 10 small squares =1 watermelon oe 25 small squares (1 large square) =16 ÷ 6.4 = 2.5 watermelon oe			M1 for use of area to represent frequency or one correct frequency from the 4 remaining bars
	15 × 1 + 16 + 23 × 1 + 30 × 1 + 12 × 1.5 **or** 15 + 16 + 23 + 30 + 18 **or** 16 + 0.1 × (15 × 10 + 23 × 10 + 30 × 10 + 12 × 15) oe **or** (150 + 160 + 230 +300 +180) × 0.1 oe **or** (6 + 6.4 + 9.2 + 12 + 7.2) × 2.5 oe			M1 (dep on M1) for a fully correct method, allow one error in products or number of squares but must be the sum of 5 parts
		102		A1
				Total 3 marks

22	$\frac{-10-0}{8-0}\left(=-\frac{10}{8}=-\frac{5}{4}\right)$ oe		6	M1 for the gradient of the radius
	$\left[-\frac{5}{4}\right]\times m=-1$ oe or $(m=)"\frac{4}{5}"$ oe			M1ft for finding the gradient of the line perpendicular to the gradient of *their* radius for the gradient of **L**
	$-10="\frac{4}{5}"(8)+c$ or $(c=)\ -\frac{82}{5}=-16.4$ or $y--10="\frac{4}{5}"(x-8)$			M1ft for substitution to find 'c' which is the y intercept (R)
	$0="\frac{4}{5}"x+"-\frac{82}{5}"$ oe or $10="\frac{4}{5}"(x-8)$ oe or $(x=)\frac{41}{2}=20.5$			M1ft for substitution to find x intercept (Q)
	$\sqrt{("-16.4")^2+("20.5")^2}$ or $\sqrt{("16.4")^2+("20.5")^2}$			M1ft for a complete method to find RQ
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	26.3		A1 allow 26.2 – 26.64
				Total 6 marks

22 ALT	(radius =) $\sqrt{8^2+10^2}\left(=2\sqrt{41}=12.8...\right)$		6	M1 for finding the radius of the circle
	$\tan^{-1}\left(\frac{10}{8}\right)(=51.3...)$ **or** $\tan^{-1}\left(\frac{8}{10}\right)(=38.7...)$			M1 for finding the angle between the *x*-axis and the radius **or** the angle between the *y*-axis and radius
	$(x=)\frac{"12.8"}{\cos"51.3"}(=20.4(7205...))$ or $(y=)\frac{"12.8"}{\cos"38.7"}(=16.4(0120...))$ $(PQ=)"12.8"\times\tan"51.3"(=15.9(7701...))$ or $(PR=)"12.8"\times\tan"38.7"(=10.2(5473...))$			M1ft For finding one of the lengths *x (OQ)* **or** *y (OR)* **or** *PQ* or *PR*
	$(x=)\frac{"12.8"}{\cos"51.3"}(=20.4(7205...))$ and $(y=)\frac{"12.8"}{\cos"38.7"}(=16.4(0120...))$ $(PQ=)"12.8"\times\tan"51.3"(=15.9(7701...))$ and $(PR=)"12.8"\times\tan"38.7"(=10.2(5473...))$			M1ft finding both of the lengths *x* and *y* **or** both of the lengths *PQ* and *PR*
	$\sqrt{("20.4...")^2+("16.4...")^2}$ or 15.9(7701...) + 10.2(5473...)			M1ft for a complete method to find *RQ*
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	26.3		A1 allow 26.2 – 26.64
				Total 6 marks

20	(a)(i)			(3, 10)	1	B1
	(ii)			(3, −2)	1	B1
	(iii)			(−3, 5)	1	B1
	(b)	$(x \pm 2)$	$(x+3.5\pm 2)$..... or $\left(x+\frac{7}{2}\pm 2\right)$...		4	M1 for sight or use of $(x \pm 2)$ or $(x + 1.5)$ or $(x + 5.5)$
		$(x-2)^2+7(x-2)+20$	$(x+3.5-2)^2-3.5^2+20$ or $(x+1.5)^2+7.75$			M1 for correct substitution or correct use of $(x – 2)$ for x into **L**
		$x^2-4x+4+7x-14+20$	$x^2+3x+2.25-12.25+20$ or $x^2+3x+2.25+7.75$			M1 dep on M2 for expanding brackets **correctly**
		Correct answer scores full marks (unless from obvious incorrect working)		$x^2+3x+10$		A1
						Total 7 marks