

National 5  
Mathematics  
**Past Papers**



## FORMULAE LIST

The roots of  $ax^2 + bx + c = 0$  are  $x = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a}$

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

Cosine rule:  $a^2 = b^2 + c^2 - 2bc \cos A$  or  $\cos A = \frac{b^2 + c^2 - a^2}{2bc}$

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

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

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

Volume of a pyramid:  $V = \frac{1}{3} Ah$

Standard deviation:  $s = \sqrt{\frac{\sum(x - \bar{x})^2}{n-1}} = \sqrt{\frac{\sum x^2 - (\sum x)^2/n}{n-1}}$ , where  $n$  is the sample size.

1. Evaluate  $\frac{5}{12} \times 2\frac{2}{9}$ .

Give the answer in simplest form.

2

2. Multiply out the brackets and collect like terms:  
 $(2x - 5)(3x + 1)$ .

2

[Turn over



\* X 7 4 7 7 5 0 1 0 2 \*

Page two



\* X 7 4 7 7 5 0 1 0 3 \*

Page three

3. Express  $x^2 - 14x + 44$  in the form  $(x - a)^2 + b$ .

MARKS  
DO NOT  
WRITE IN  
MARGIN  
2

4. Find the resultant vector  $2u - v$  when  $u = \begin{pmatrix} -2 \\ 3 \\ 5 \end{pmatrix}$  and  $v = \begin{pmatrix} 0 \\ -4 \\ 7 \end{pmatrix}$ .

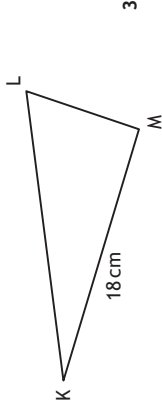
Express your answer in component form.

2

5. In triangle KLM

- $KM = 18$  centimetres
- $\sin K = 0.4$
- $\sin L = 0.9$

Calculate the length of LM.



MARKS  
DO NOT  
WRITE IN  
MARGIN  
3

[Turn over



\* X 7 4 7 7 5 0 1 0 4 \*

Page four



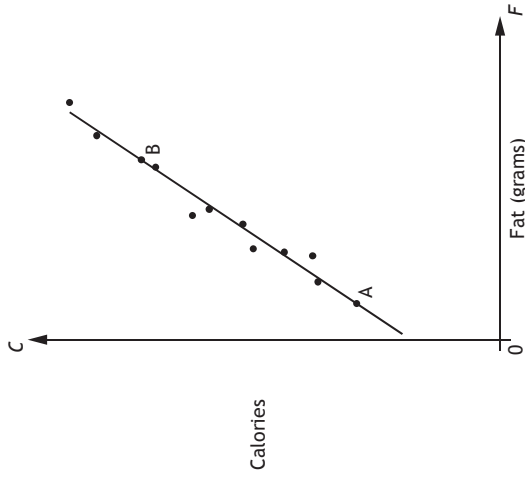
\* X 7 4 7 7 5 0 1 0 5 \*

Page five

MARKS  
DO NOT  
WRITE IN  
THIS  
MARGIN

6. McGregor's Burgers sells fast food.

The graph shows the relationship between the amount of fat,  $F$  grams, and the number of calories,  $C$ , in some of their sandwiches.



A line of best fit has been drawn.

Point A represents a sandwich which has 5 grams of fat and 200 calories.

Point B represents a sandwich which has 25 grams of fat and 500 calories.

MARKS  
DO NOT  
WRITE IN  
THIS  
MARGIN

6. (continued)

(a) Find the equation of the line of best fit in terms of  $F$  and  $C$ .

(b) A Super Deluxe sandwich contains 40 grams of fat.

Use your answer to part (a) to estimate the number of calories this sandwich contains.

Show your working.

Total marks 4



\* X 7 4 7 7 5 0 1 0 7 \*

Page seven

[Turn over

MARKS  
DO NOT  
WRITE IN  
THIS  
MARGIN

6. (continued)

(a) Find the equation of the line of best fit in terms of  $F$  and  $C$ .

(b) A Super Deluxe sandwich contains 40 grams of fat.

Use your answer to part (a) to estimate the number of calories this sandwich contains.

Show your working.

Total marks 4



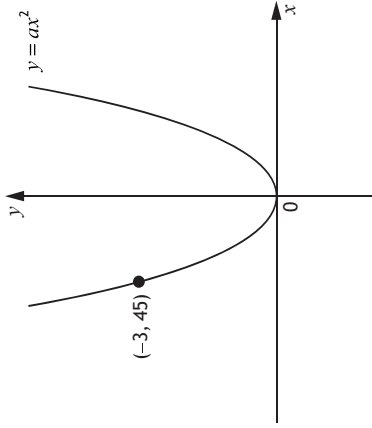
\* X 7 4 7 7 5 0 1 0 7 \*

Page seven

[Turn over

MARKS DO NOT WRITE IN MARGIN

7. The diagram below shows part of the graph of  $y = ax^2$



Find the value of  $a$ .

2

[Turn over

MARKS DO NOT WRITE IN MARGIN

8. Express  $\sqrt{40} + 4\sqrt{10} + \sqrt{90}$  as a surd in its simplest form.

3

9. 480 000 tickets were sold for a tennis tournament last year.  
This represents 80% of all the available tickets.  
Calculate the total number of tickets that were available for this tournament.

3



\* X 7 4 7 7 5 0 1 0 8 \*

Page eight



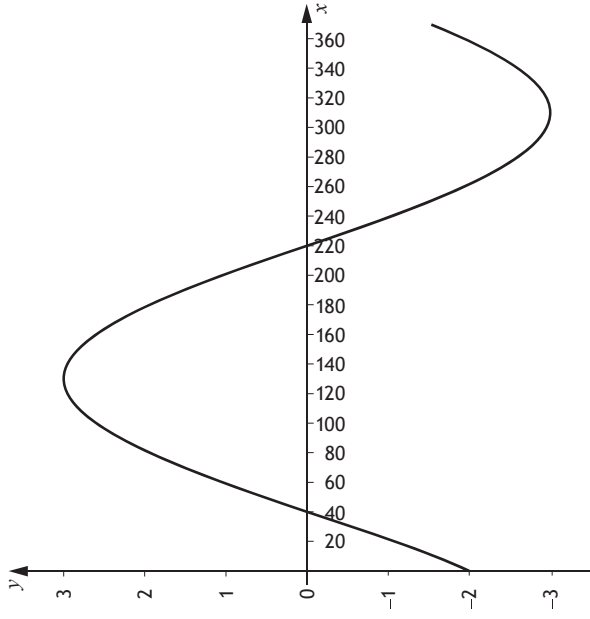
\* X 7 4 7 7 5 0 1 0 9 \*

Page nine

DO NOT  
WRITE IN  
MARGIN

DO NOT  
WRITE IN  
MARGIN

10. The graph of  $y = a \sin(x + b)^\circ$ ,  $0 \leq x \leq 360$ , is shown below.



Write down the values of  $a$  and  $b$ .

2

DO NOT  
WRITE IN  
MARGIN

DO NOT  
WRITE IN  
MARGIN

11. (a) A straight line has equation  $4x + 3y = 12$ .  
Find the gradient of this line.

(b) Find the coordinates of the point where this line crosses the  $x$ -axis.

2

Total marks 4

[Turn over



\* X 7 4 7 7 5 0 1 1 0 \*

Page ten



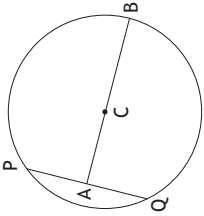
\* X 7 4 7 7 5 0 1 1 1 \*

Page eleven

DO NOT  
WRITE IN  
THIS  
MARGIN

MARKS

12. The diagram below shows a circle, centre C.



The radius of the circle is 15 centimetres.

A is the mid-point of chord PQ.

The length of AB is 27 centimetres.

Calculate the length of PQ.

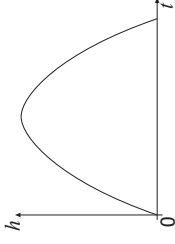
4

DO NOT  
WRITE IN  
THIS  
MARGIN

MARKS

13. The diagram below shows the path of a small rocket which is fired into the air. The height,  $h$  metres, of the rocket after  $t$  seconds is given by

$$h(t) = 16t - t^2$$



- (a) After how many seconds will the rocket first be at a height of 60 metres? 4

- (b) Will the rocket reach a height of 70 metres?  
Justify your answer. 3

Total marks 7

[END OF QUESTION PAPER]



Page thirteen



Page twelve

MARKS  
DO NOT  
WRITE IN  
MARGIN

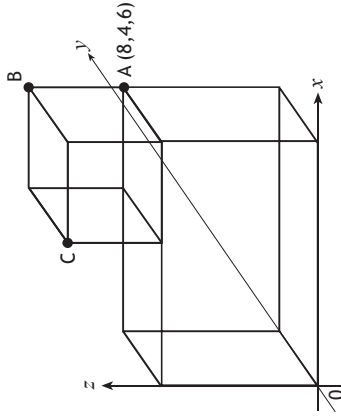
1. There are 964 pupils on the roll of Aberleven High School. It is forecast that the roll will decrease by 15% per year. What will be the expected roll after 3 years? Give your answer to the nearest ten.

3

[Turn over

MARKS  
DO NOT  
WRITE IN  
MARGIN

2. The diagram shows a cube placed on top of a cuboid, relative to the coordinate axes.



A is the point  $(8, 4, 6)$ .  
Write down the coordinates of B and C.

2



\* X 7 4 7 7 5 0 2 0 3 \*



\* X 7 4 7 7 5 0 2 0 4 \*



MARKS  
DO NOT  
WRITE IN  
THIS  
MARGIN

3. Two groups of people go to a theatre.  
Bill buys tickets for 5 adults and 3 children.  
The total cost of his tickets is £158.25.
- (a) Write down an equation to illustrate this information. 1
- (b) Ben buys tickets for 3 adults and 2 children.  
The total cost of his tickets is £98.  
Write down an equation to illustrate this information. 1
- (c) Calculate the cost of a ticket for an adult and the cost of a ticket for a child. 4

Total marks 6

[Turn over



\* X 7 4 7 7 5 0 2 0 5 \*

MARKS  
DO NOT  
WRITE IN  
THIS  
MARGIN

4. A runner has recorded her times, in seconds, for six different laps of a running track.
- |    |    |    |    |    |    |
|----|----|----|----|----|----|
| 53 | 57 | 58 | 60 | 55 | 56 |
|----|----|----|----|----|----|
- (a) (i) Calculate the mean of these lap times.  
Show clearly all your working. 1

- (ii) Calculate the standard deviation of these lap times.  
Show clearly all your working. 3

Total marks 6

[Turn over



\* X 7 4 7 7 5 0 2 0 6 \*

DO NOT  
WRITE IN  
MARGIN

MARKS

4. (continued)

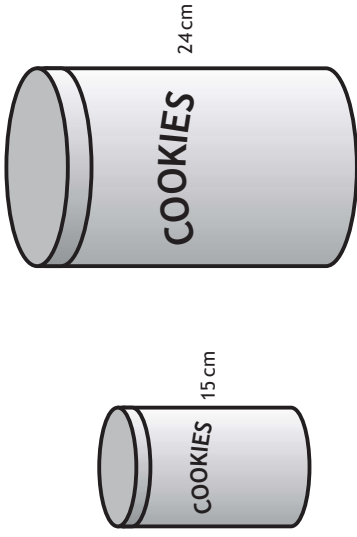
- (b) She changes her training routine hoping to improve her consistency. After this change, she records her times for another six laps. The mean is 55 seconds and the standard deviation 3.2 seconds. Has the new training routine improved her consistency?  
Give a reason for your answer.

1

DO NOT  
WRITE IN  
MARGIN

MARKS

5. A supermarket sells cylindrical cookie jars which are mathematically similar.



The smaller jar has a height of 15 centimetres and a volume of 750 cubic centimetres.

The larger jar has a height of 24 centimetres.

Calculate the volume of the larger jar.

3

Total marks 5

[Turn over



Page seven

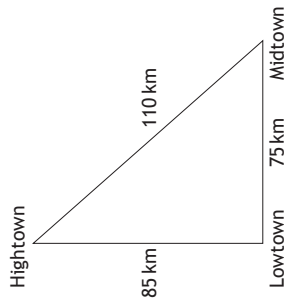


Page eight

DO NOT  
WRITE IN  
THIS  
MARGIN

MARKS

6. The diagram below shows the position of three towns.  
Lowtown is due west of Midtown.  
The distance from
- Lowtown to Midtown is 75 kilometres.
  - Midtown to Hightown is 110 kilometres.
  - Hightown to Lowtown is 85 kilometres.



Is Hightown directly north of Lowtown?

Justify your answer.

4

[Turn over



\* X 7 4 7 7 5 0 2 0 9 \*

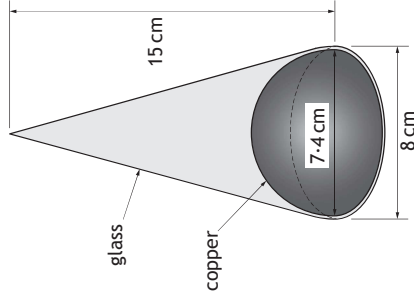
Page nine

DO NOT  
WRITE IN  
THIS  
MARGIN

MARKS

7. An ornament is in the shape of a cone with diameter 8 centimetres and height 15 centimetres.

The bottom contains a hemisphere made of copper with diameter 7.4 centimetres. The rest is made of glass, as shown in the diagram below.



Calculate the volume of the glass part of the ornament.

Give your answer correct to 2 significant figures.

5



\* X 7 4 7 7 5 0 2 1 0 \*

Page ten

8. Simplify  $\frac{n^5 \times 10n}{2n^2}$ .

MARKS  
DO NOT  
WRITE IN  
MARGIN  
3

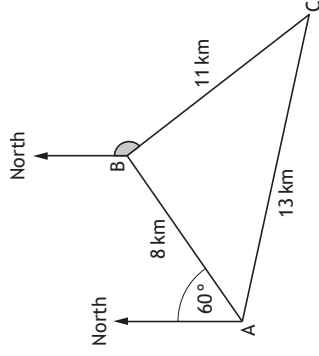
9. Express  $\frac{7}{x+5} - \frac{3}{x}$  as a single fraction in its simplest form.

MARKS  
DO NOT  
WRITE IN  
MARGIN  
3

[Turn over

10. In a race, boats sail round three buoys represented by A, B, and C in the diagram below.

MARKS  
DO NOT  
WRITE IN  
MARGIN



- B is 8 kilometres from A on a bearing of  $060^\circ$ .  
 C is 11 kilometres from B.  
 A is 13 kilometres from C.
- (a) Calculate the size of angle ABC.

3

- (b) Hence find the size of the shaded angle.

2

Total marks 5



\* X 7 4 7 7 5 0 2 1 1 \*

Page eleven



\* X 7 4 7 7 5 0 2 1 2 \*

Page twelve

DO NOT  
WRITE IN  
THIS  
MARGIN

MARKS

3

11. Change the subject of the formula  $s = ut + \frac{1}{2}at^2$  to  $a$ .

12. Solve the equation  $11\cos x^\circ - 2 = 3$ , for  $0 \leq x \leq 360$ .

[Turn over



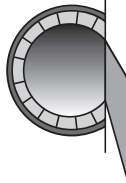
\* X 7 4 7 7 5 0 2 1 3 \*

Page thirteen

DO NOT  
WRITE IN  
THIS  
MARGIN

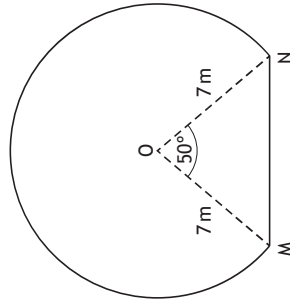
MARKS

13. The picture shows the entrance to a tunnel which is in the shape of part of a circle.



The diagram below represents the cross-section of the tunnel.

- The centre of the circle is  $O$ .
- $MN$  is a chord of the circle.
- Angle  $MON$  is  $50^\circ$ .
- The radius of the circle is 7 metres.



Calculate the area of the cross-section of the tunnel.

5

[END OF QUESTION PAPER]



\* X 7 4 7 7 5 0 2 1 4 \*

Page fourteen

MARKS DO NOT WRITE IN THIS MARGIN

2

- Evaluate  $6\frac{1}{5} - 2\frac{1}{3}$ .

- Solve algebraically the inequality

$$11 - 2(1 + 3x) < 39$$

3

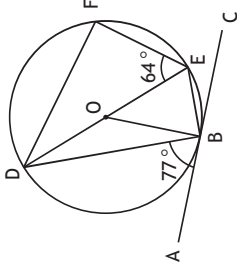
[Turn over



\* X 7 4 7 7 5 0 1 0 3 \*

MARKS DO NOT WRITE IN THIS MARGIN

3.



- AC is a tangent to the circle, centre O, with point of contact B.  
 DE is a diameter of the circle and F is a point on the circumference.  
 Angle ABD is  $77^\circ$  and angle DEF is  $64^\circ$ .  
 Calculate the size of angle BDF.

3

- Multiply out the brackets and collect like terms

$$(x - 4)(x^2 + x - 2)$$

3



\* X 7 4 7 7 5 0 1 0 4 \*

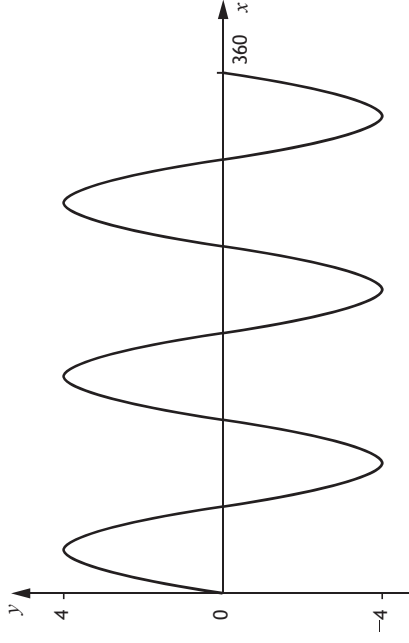
MARKS DO NOT WRITE IN THIS MARGIN

5. The standard deviation of 1, 2, 2, 2, 8 is equal to  $\sqrt{a}$ .  
Find the value of  $a$ .

3

MARKS DO NOT WRITE IN THIS MARGIN

6. Part of the graph of  $y = a \sin bx^\circ$  is shown in the diagram.



State the values of  $a$  and  $b$ .

2

[Turn over



\* X 7 4 7 7 5 0 1 0 5 \*

Page five



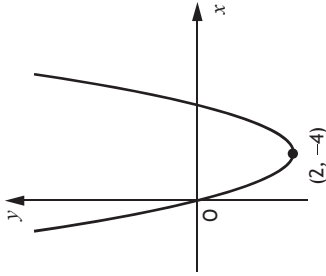
\* X 7 4 7 7 5 0 1 0 6 \*

Page six

MARKS DO NOT WRITE IN THIS MARGIN

7. The graph below shows part of the parabola with equation of the form

$$y = (x+a)^2 + b.$$



The minimum turning point  $(2, -4)$  is shown in the diagram.

(a) State the values of

(i)  $a$

(ii)  $b$ .

1

1

(b) Write down the equation of the axis of symmetry of the graph.

1

[Turn over



\* X 7 4 7 7 5 0 1 0 7 \*

MARKS DO NOT WRITE IN THIS MARGIN

8. Find the equation of the line joining the points  $(-2, 5)$  and  $(3, 15)$ .  
Give the equation in its simplest form.

3

9. Write the following in order of size starting with the smallest.

$$\cos 90^\circ \quad \cos 100^\circ \quad \cos 300^\circ$$

Justify your answer.

2



\* X 7 4 7 7 5 0 1 0 8 \*



MARKS DO NOT WRITE IN THIS MARGIN

10. Ten couples took part in a dance competition. The couples were given a score in each round. The scores in the first round were

16 27 12 18 26 21 27 22 18 17

(a) Calculate the median and semi-interquartile range of these scores.

3

MARKS DO NOT WRITE IN THIS MARGIN

11. Solve algebraically the system of equations

$$3x + 2y = 17$$

$$2x + 5y = 4.$$

3

MARKS DO NOT WRITE IN THIS MARGIN

(b) In the second round, the median was 26 and the semi-interquartile range was 2.5.

Make two valid comparisons between the scores in the first and second rounds.

2

[Turn over



\* X 7 4 7 7 5 0 1 0 9 \*



\* X 7 4 7 7 5 0 1 1 0 \*

12. Simplify  $\frac{x^2 - 4x}{x^2 + x - 20}$ .

MARKS DO NOT WRITE IN THIS MARGIN  
3

13. Express  $\frac{4}{\sqrt{8}}$  with a rational denominator.  
Give your answer in its simplest form.

MARKS DO NOT WRITE IN THIS MARGIN  
3

14. Evaluate  $8^{\frac{5}{3}}$ .

2

[Turn over for Question 13 on Page twelve]

[END OF QUESTION PAPER]



\* X 7 4 7 7 5 0 1 1 1 \*

Page eleven



\* X 7 4 7 7 5 0 1 1 2 \*

Page twelve

MARKS DO NOT WRITE IN THIS MARGIN

1. A house is valued at £240000.  
Its value is predicted to rise by 2.8% per annum.  
Calculate its predicted value after 2 years.

3

[Turn over



\* X 7 4 7 7 5 0 2 0 3 \*

MARKS DO NOT WRITE IN THIS MARGIN

3. Triangle ABC is shown below.



Calculate the length of AB.

3

MARKS DO NOT WRITE IN THIS MARGIN



\* X 7 4 7 7 5 0 2 0 4 \*

MARKS DO NOT WRITE IN THIS MARGIN

2

4. Find  $|u|$ , the magnitude of vector  $u = \begin{pmatrix} 6 \\ -13 \\ 18 \end{pmatrix}$ .

[Turn over

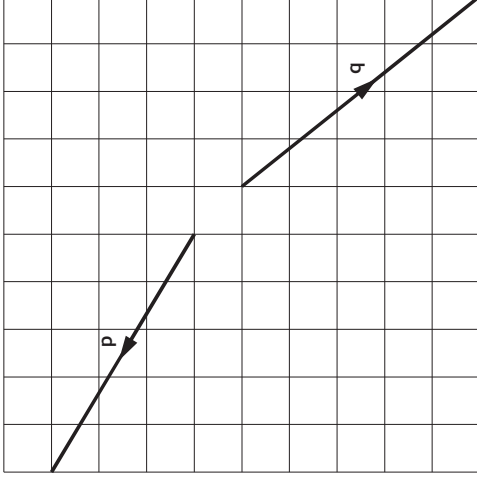


\* X 7 4 7 7 5 0 2 0 5 \*

MARKS DO NOT WRITE IN THIS MARGIN

2

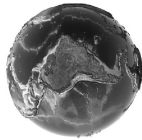
5. The vectors  $p$  and  $q$  are shown in the diagram below. Find the resultant vector  $p + q$ . Express your answer in component form.



\* X 7 4 7 7 5 0 2 0 6 \*

MARKS DO NOT WRITE IN THIS MARGIN

6. (a) The Earth is approximately spherical with a radius of 6400 kilometres. Calculate the volume of the Earth giving your answer in scientific notation, correct to 2 significant figures.



3

- (b) The approximate volume of the Moon is  $2.2 \times 10^{10}$  cubic kilometres. Calculate how many times the Earth's volume is greater than the Moon's.

2

[Turn over



\* X 7 4 7 7 5 0 2 0 7 \*

Page seven

MARKS DO NOT WRITE IN THIS MARGIN

7. Express  $\frac{5t}{s} + \frac{t}{2s^2}$  in its simplest form.

3

8. James paid £297.50 for a laptop in a sale. The discount in the sale was 15%. Calculate the original price of the laptop.

3

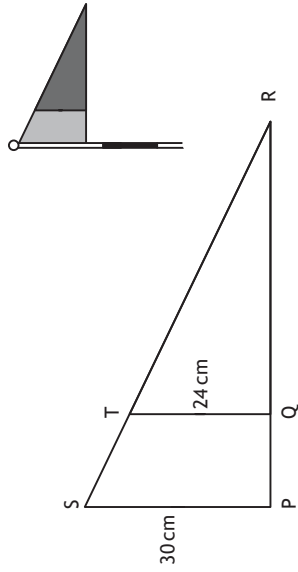


\* X 7 4 7 7 5 0 2 0 8 \*

Page eight

MARKS DO NOT WRITE IN THIS MARGIN

9. The flag at each hole on a golf course is coloured red and blue. The diagram below represents a flag. Triangle QRT represents the red section. PQTS represents the blue section.



Triangles PRS and QRT are mathematically similar. The area of triangle QRT is 400 square centimetres. Calculate the area of PQTS, the blue section of the flag.

4

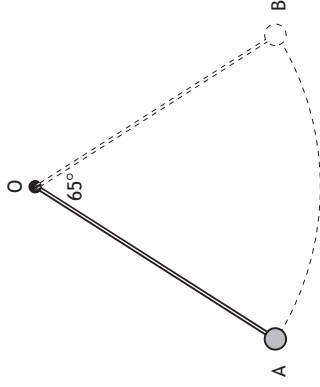
[Turn over



\* X 7 4 7 7 5 0 2 0 9 \*

MARKS DO NOT WRITE IN THIS MARGIN

10. The pendulum of a clock swings along an arc of a circle, centre O.



The pendulum swings through an angle of  $65^\circ$ , travelling from A to B. The length of the arc AB is 28.4 centimetres. Calculate the length of the pendulum.

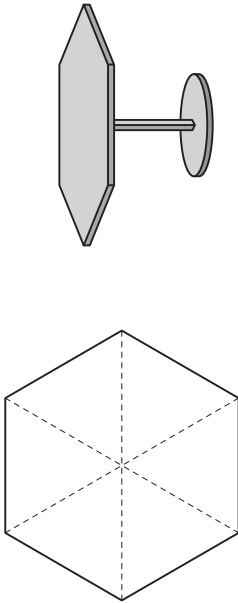
4



\* X 7 4 7 7 5 0 2 1 0 \*

MARKS DO NOT WRITE IN THIS MARGIN

11. The top of a table is in the shape of a regular hexagon. The three diagonals of the hexagon which are shown as dotted lines in the diagram below each have length 40 centimetres.



Calculate the area of the top of the table.

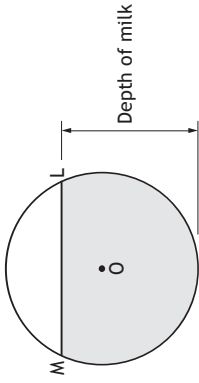
4

[Turn over



MARKS DO NOT WRITE IN THIS MARGIN

12. The diagram below shows the circular cross-section of a milk tank.



The radius of the circle, centre O, is 1.2 metres.

The width of the surface of the milk in the tank, represented by ML in the diagram, is 1.8 metres.

Calculate the depth of the milk in the tank.

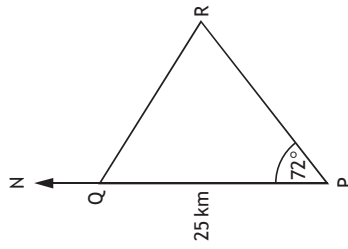
4



DO NOT  
WRITE IN  
THIS  
MARGIN

MARKS

13. In the diagram below P, Q and R represent the positions of Portlee, Queenstown and Rushton respectively.



Portlee is 25 kilometres due South of Queenstown.  
From Portlee, the bearing of Rushton is 072°.  
From Queenstown, the bearing of Rushton is 128°.  
Calculate the distance between Portlee and Rushton.  
Do not use a scale drawing.

4

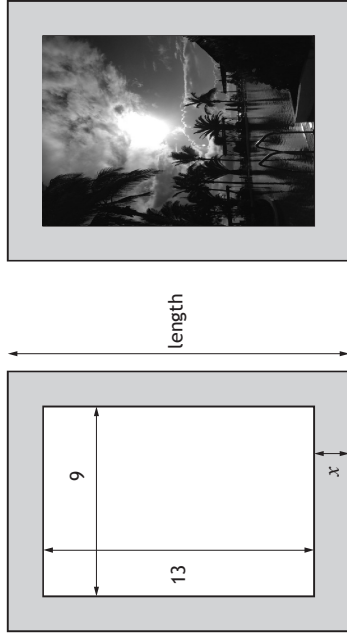
[Turn over



DO NOT  
WRITE IN  
THIS  
MARGIN

MARKS

14. A rectangular picture measuring 9 centimetres by 13 centimetres is placed on a rectangular piece of card.  
The area of the card is 270 square centimetres.  
There is a border  $x$  centimetres wide on all sides of the picture.



- (a) (i) Write down an expression for the length of the card in terms of  $x$ .

1

(ii) Hence show that  $4x^2 + 44x - 153 = 0$ .

2





14. (continued)

- (b) Calculate  $x$ , the width of the border.  
Give your answer correct to one decimal place.

MARKS  
DO NOT  
WRITE IN  
THIS  
MARGIN

4

[END OF QUESTION PAPER]



\* X 7 4 7 7 5 0 2 1 5 \*

Page fifteen

MARKS DO NOT WRITE IN THIS MARGIN

Total marks — 40

Attempt ALL questions

1. Given  $\mathbf{p} = \begin{pmatrix} 4 \\ -6 \end{pmatrix}$  and  $\mathbf{q} = \begin{pmatrix} -5 \\ -1 \end{pmatrix}$ .

Find the resultant vector  $\frac{1}{2}\mathbf{p} + \mathbf{q}$ .

Express your answer in component form.

2

2. Evaluate  $\frac{3}{4} \left( \frac{1}{3} + \frac{2}{7} \right)$ .

Give your answer in its simplest form.

2

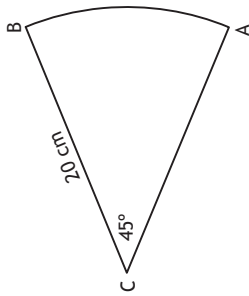
[Turn over



\* X 7 4 7 7 5 0 1 0 3 \*

MARKS DO NOT WRITE IN THIS MARGIN

3. The diagram shows a sector of a circle, centre C.



The radius of the circle is 20 centimetres and angle ACB is  $45^\circ$ .

Calculate the area of the sector.

Take  $\pi = 3.14$ .

3



\* X 7 4 7 7 5 0 1 0 4 \*

4. Charlie is making costumes for a school show.  
One day he made 2 cloaks and 3 dresses.  
The total amount of material he used was 9.6 square metres.

(a) Write down an equation to illustrate this information. 1

(b) The following day Charlie made 3 cloaks and 4 dresses.  
The total amount of material he used was 13.3 square metres.  
Write down an equation to illustrate this information. 1

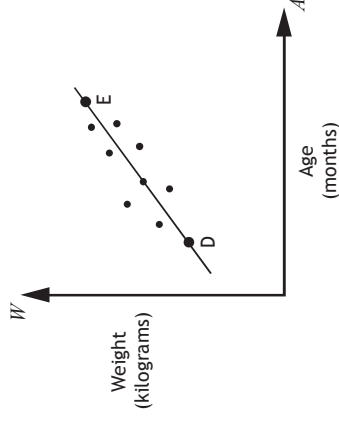
(c) Calculate the amount of material required to make one cloak and the amount of material required to make one dress. 4

[Turn over



\* X 7 4 7 7 5 0 1 0 5 \*

5. A cattle farmer records the weight of some of his calves.  
The scattergraph shows the relationship between the age,  $A$  months, and the weight,  $W$  kilograms, of the calves.



- A line of best fit is drawn.  
Point D represents a 3 month old calf which weighs 100 kilograms.  
Point E represents a 15 month old calf which weighs 340 kilograms.  
(a) Find the equation of the line of best fit in terms of  $A$  and  $W$ .  
Give the equation in its simplest form. 3



\* X 7 4 7 7 5 0 1 0 6 \*

MARKS DO NOT WRITE IN THIS MARGIN

5. (continued)

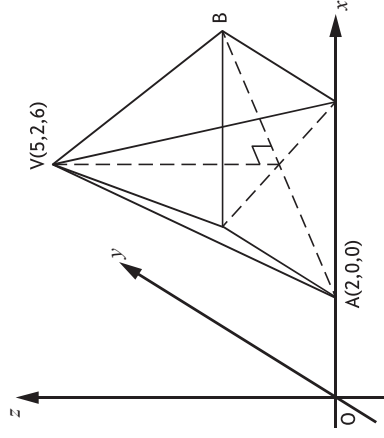
- (b) Use your equation from part (a) to estimate the weight of a one year old calf.

Show your working.

1

MARKS DO NOT WRITE IN THIS MARGIN

7. The diagram shows a rectangular based pyramid, relative to the coordinate axes.



- A is the point  $(2,0,0)$ .
- V is the point  $(5,2,6)$ .

(a) Write down the coordinates of B.

1

(b) Calculate the length of edge AV of the pyramid.

3

MARKS DO NOT WRITE IN THIS MARGIN

5. (continued)

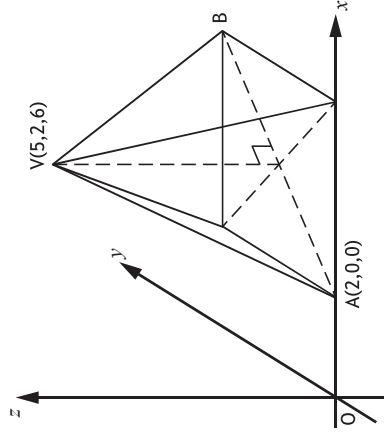
- (b) Use your equation from part (a) to estimate the weight of a one year old calf.

Show your working.

1

MARKS DO NOT WRITE IN THIS MARGIN

7. The diagram shows a rectangular based pyramid, relative to the coordinate axes.



- A is the point  $(2,0,0)$ .
- V is the point  $(5,2,6)$ .

(a) Write down the coordinates of B.

1

(b) Calculate the length of edge AV of the pyramid.

3



\* X 7 4 7 7 5 0 1 0 7 \*

Page 07



\* X 7 4 7 7 5 0 1 0 8 \*

Page 08

[Turn over

MARKS DO NOT WRITE IN THIS MARGIN

8. Solve the equation

$$\frac{2x}{3} - \frac{5}{6} = 2x.$$

Give your answer in its simplest form.

3

MARKS DO NOT WRITE IN THIS MARGIN

10. Sketch the graph of  $y = (x-3)^2 + 1$ .

On your sketch, show clearly the coordinates of the turning point and the point of intersection with the  $y$ -axis.

3

9. The function  $f(x)$  is defined by  $f(x) = \frac{2}{\sqrt{x}}$ ,  $x > 0$ .

Express  $f(5)$  as a fraction with a rational denominator.

2



\* X 7 4 7 7 5 0 1 0 9 \*



\* X 7 4 7 7 5 0 1 1 0 \*

MARKS DO NOT WRITE IN THIS MARGIN

11. Simplify

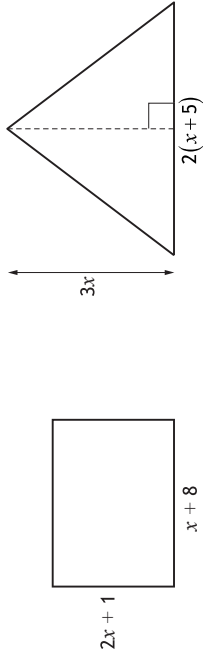
$$\tan^2 x^\circ \cos^2 x^\circ.$$

Show your working.

2

MARKS DO NOT WRITE IN THIS MARGIN

12. The diagrams below show a rectangle and a triangle.  
All measurements are in centimetres.



(a) Find an expression for the area of the rectangle.

1

(b) Given that the area of the rectangle is equal to the area of the triangle, show that  $x^2 - 2x - 8 = 0$ .

3

MARKS DO NOT WRITE IN THIS MARGIN

[Turn over



\* X 7 4 7 7 5 0 1 1 1 \*



\* X 7 4 7 7 5 0 1 1 2 \*

Total marks — 50

Attempt ALL questions

12. (continued)

- (c) Hence find, algebraically, the length and breadth of the rectangle.

3

1. A drinks manufacturer is reducing the sugar content of one of their fizzy drinks by 8% per year over the next 3 years.

The sugar content of a standard can is currently 35 grams.  
Calculate the sugar content of a standard can after 3 years.

3

2. A pollen sample weighs 12 grams  
and contains  $1.5 \times 10^9$  pollen grains.



Calculate the weight of one pollen grain in grams.  
Give your answer in scientific notation.

2

[END OF QUESTION PAPER]

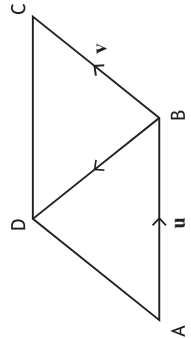


\* X 7 4 7 7 5 0 1 1 3 \*



\* X 7 4 7 7 5 0 2 0 3 \*

3. The diagram below shows parallelogram ABCD.



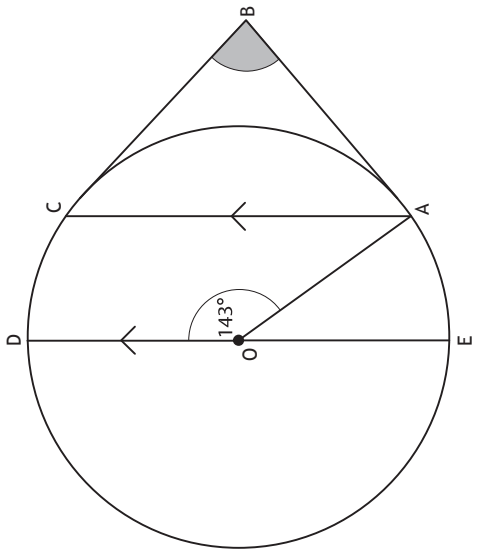
$\vec{AB}$  represents vector  $\mathbf{u}$  and  $\vec{BC}$  represents vector  $\mathbf{v}$ .  
Express  $\vec{BD}$  in terms of  $\mathbf{u}$  and  $\mathbf{v}$ .

1

4. Factorise fully  $3x^2 - 48$ .

2

5. The diagram below shows a circle, centre O.



- AB and CB are tangents to the circle.
- AC and ED are parallel.
- Angle AOD is  $143^\circ$ .

Calculate the size of angle ABC.

3



\* X 7 4 7 7 5 0 2 0 4 \*



\* X 7 4 7 7 5 0 2 0 5 \*



6. (continued)

(b) Sophie also called the same internet provider, on several occasions, to report connection problems.

Her mean waiting time was 15 minutes and the standard deviation was 4.3 minutes.

Make two valid comments comparing Sophie's waiting times with Jack's waiting times.

2

[Turn over



\* X 7 4 7 7 5 0 2 0 7 \*

6. Jack called his internet provider on six occasions to report connection problems.

On each occasion he noted the length of time he had to wait before speaking to an adviser.

The times (in minutes) were as follows:

13 16 10 22 5 12

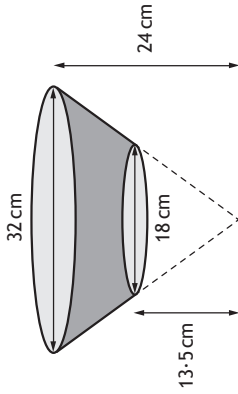
(a) Calculate the mean and standard deviation of these times.

4



\* X 7 4 7 7 5 0 2 0 6 \*

7. A carton is in the shape of a large cone with a small cone removed. The large cone has diameter of 32 cm and height 24 cm. The small cone has diameter of 18 cm and height 13.5 cm.



Calculate the volume of the carton.  
Give your answer correct to 2 significant figures.

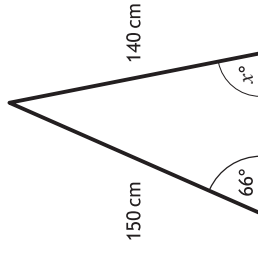
5



8. A set of stepladders has legs 150 centimetres and 140 centimetres long.



When the stepladder is fully open, the angle between the longer leg and the ground is  $66^\circ$ .



Calculate  $x^\circ$ , the size of the angle between the shorter leg and the ground.

3



MARKS DO NOT WRITE IN THIS MARGIN

9. Express  $x^2 + 8x - 7$  in the form  $(x+a)^2 + b$ .

2

10. Simplify  $(n^2)^3 \times n^{-10}$ .

Give your answer with a **positive** power.

3

MARKS DO NOT WRITE IN THIS MARGIN

11. Two pictures are mathematically similar in shape.



100 cm



60 cm

The cost of each picture is proportional to its area.

The large picture costs £13.75.

Find the cost of the small picture.

3

MARKS DO NOT WRITE IN THIS MARGIN



\* X 7 4 7 7 5 0 2 1 0 \*



\* X 7 4 7 7 5 0 2 1 1 \*

MARKS DO NOT WRITE IN THIS MARGIN

3

12. Change the subject of the formula  $L = \sqrt{4kt - p}$  to  $k$ .

13. Express

$$\frac{3}{x-2} + \frac{5}{x+1}, \quad x \neq 2, x \neq -1$$

as a single fraction in its simplest form.

3

MARKS DO NOT WRITE IN THIS MARGIN

3

14. Solve the equation  $2 \tan x^\circ + 5 = -4$ , for  $0 \leq x \leq 360$ .

[Turn over

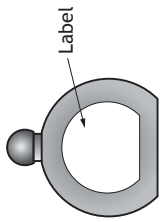


\* X 7 4 7 7 5 0 2 1 2 \*

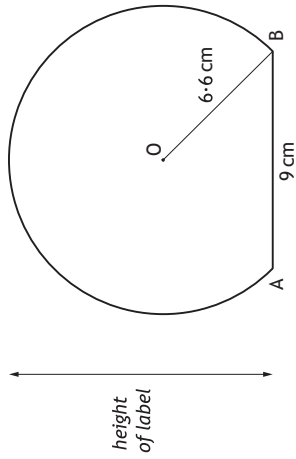


\* X 7 4 7 7 5 0 2 1 3 \*

15. This perfume bottle has a label in the shape of part of a circle.



A diagram of the label is shown below.



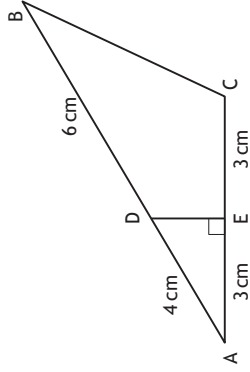
- The centre of the circle is O.
- The chord AB is 9 centimetres.
- The radius OB is 6.6 centimetres.

Find the height of the label.

4

16. In the diagram below:

- DE is perpendicular to AC.
- AD = 4 centimetres.
- DB = 6 centimetres.
- AE = EC = 3 centimetres.



Calculate the length of BC.

Give your answer correct to one decimal place.

4

[END OF QUESTION PAPER]



\* X 7 4 7 7 5 0 2 1 4 \*



\* X 7 4 7 7 5 0 2 1 5 \*

MARKS  
DO NOT  
WRITE IN  
THIS  
MARGIN

Total marks — 40  
Attempt ALL questions

1. Given that  $f(x) = x^2 + 3x$ , evaluate  $f(-5)$ .

2

2. The number of calls received by the police was recorded over 10 days.  
The results are shown below.

198 216 218 230 232 247 248 250 265 267

Find the semi-interquartile range of this data.

2

[Turn over



\* X 7 4 7 7 5 0 1 0 3 \*

MARKS  
DO NOT  
WRITE IN  
THIS  
MARGIN

3. Evaluate  $1\frac{5}{6} \div \frac{3}{4}$ .

Give your answer in its simplest form.

2

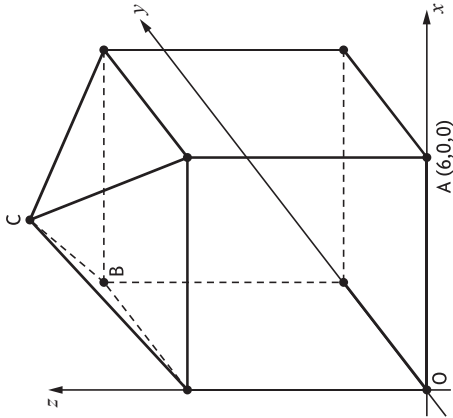
4. Expand and simplify  $(2x+3)(x^2-4x+1)$ .

3



\* X 7 4 7 7 5 0 1 0 4 \*

5. The diagram shows a square-based pyramid placed on top of a cube, relative to the coordinate axes.



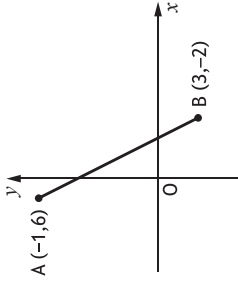
The height of the pyramid is half of the height of the cube.  
 A is the point  $(6,0,0)$ .  
 The point C is directly above the centre of the base.  
 Write down the coordinates of B and C.

2

[Turn over



6. The diagram below shows the straight line joining points A and B.



Find the equation of the line AB.  
 Give the equation in its simplest form.

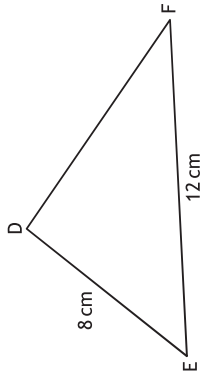
3



MARKS DO NOT WRITE IN THIS MARGIN

7. In triangle DEF:

- $DE = 8$  centimetres
- $EF = 12$  centimetres
- $\sin E = \frac{2}{3}$



Calculate the area of triangle DEF.

2

[Turn over



\* X 7 4 7 7 5 0 1 0 7 \*

MARKS DO NOT WRITE IN THIS MARGIN

8. Solve, algebraically, the inequality

$$19 + x > 15 + 3(x - 2).$$

3

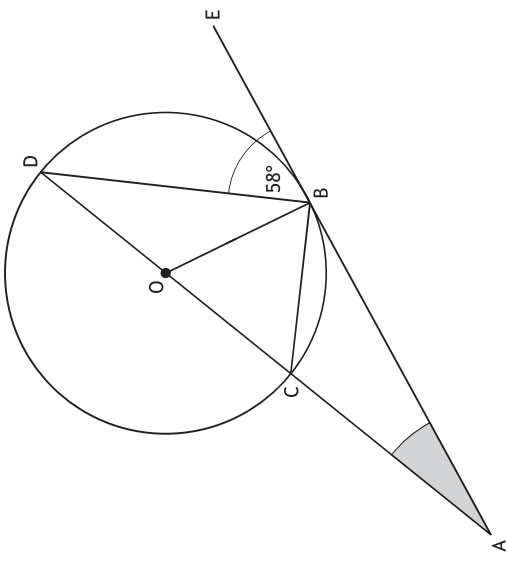


\* X 7 4 7 7 5 0 1 0 8 \*



MARKS DO NOT WRITE IN THIS MARGIN

9. In the diagram shown below:
- ABE is a tangent to the circle centre O
  - Angle DBE is  $58^\circ$



Calculate the size of angle CAB.

3

[Turn over



MARKS DO NOT WRITE IN THIS MARGIN

10. Change the subject of the formula  $F = \frac{f^2 + 4b}{c}$  to  $b$ .

3

11. Express  $\frac{3}{a^2} - \frac{2}{a}$ ,  $a \neq 0$ , as a single fraction in its simplest form.

2



12. Gym members are asked to fill out a questionnaire to rate the quality of service provided.

They are asked to give a rating on a scale of 1 to 6.

The ratings given by five members were as follows:

- 1
- 4
- 6
- 3
- 6

In its simplest form, the standard deviation of these ratings can be written as  $\frac{a\sqrt{b}}{2}$ .

Find the values of  $a$  and  $b$ .

4

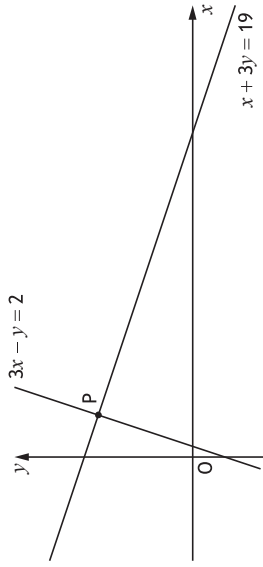
[Turn over



\* X 7 4 7 7 5 0 1 1 1 \*

13. The graph below shows two straight lines with the equations:

- $3x - y = 2$
- $x + 3y = 19$



The lines intersect at the point P.  
Find, algebraically, the coordinates of P.

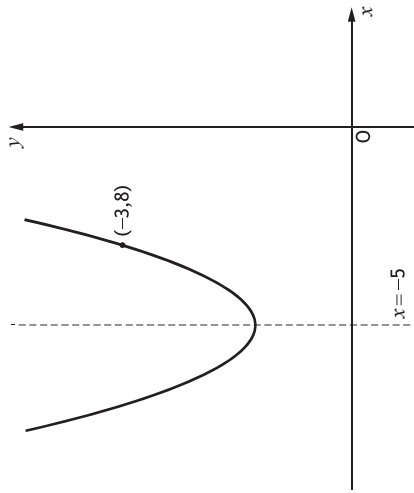
3



\* X 7 4 7 7 5 0 1 1 2 \*

MARKS DO NOT WRITE IN THIS MARGIN

14. The graph below shows a parabola with equation of the form  $y = (x+a)^2 + b$ .



The equation of the axis of symmetry of the parabola is  $x = -5$ .

- (a) State the value of  $a$ .

1

The point  $(-3, 8)$  lies on the parabola.

- (b) Calculate the value of  $b$ .

2

[Turn over for next question]

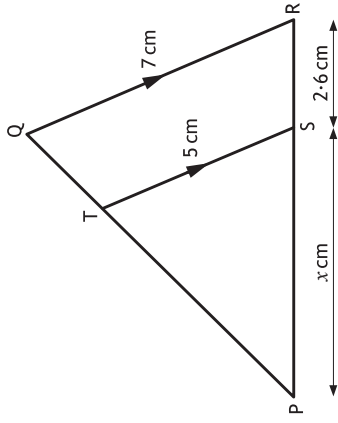


\* X 7 4 7 7 5 0 1 1 3 \*

MARKS DO NOT WRITE IN THIS MARGIN

15. In the diagram below:

- TS is parallel to QR
- TS = 5 centimetres
- QR = 7 centimetres
- SR = 2.6 centimetres



The length of PS is  $x$  centimetres.

Calculate the value of  $x$ .

3

[END OF QUESTION PAPER]



\* X 7 4 7 7 5 0 1 1 4 \*

Total marks — 50  
Attempt ALL questions

1. Find  $|\mathbf{v}|$ , the magnitude of vector  $\mathbf{v} = \begin{pmatrix} 18 \\ -14 \\ 3 \end{pmatrix}$ .

2

2. A necklace is valued at £1200.  
Its value is expected to increase by 4.5% per year over the next 3 years.  
Calculate the expected value of the necklace after this time.  
Give your answer to the nearest pound.

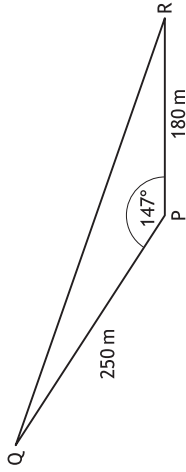
3

[Turn over



\* X 7 4 7 7 5 0 2 0 3 \*

3. A piece of land is in the shape of a triangle as shown.



- $PQ = 250$  metres
- $PR = 180$  metres
- angle  $QPR = 147^\circ$

The owner wishes to build a fence along the side QR.  
Calculate the length of the fence.

3



\* X 7 4 7 7 5 0 2 0 4 \*

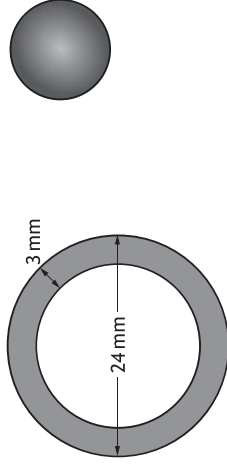
MARKS DO NOT WRITE IN THIS MARGIN

4. Solve the equation  $2x^2 + 5x - 4 = 0$ .  
Give your answers correct to one decimal place.

3

MARKS DO NOT WRITE IN THIS MARGIN

6. A spherical sweet is made by coating a caramel sphere evenly with chocolate.  
A cross-section of the sweet is shown below.



The diameter of the sweet is 24 millimetres and the thickness of the chocolate coating is 3 millimetres.

Calculate the volume of the chocolate coating.  
Give your answer correct to 3 significant figures.

5

MARKS DO NOT WRITE IN THIS MARGIN

5. A theatre group sold 4830 tickets for their show.  
This was 15% more than they sold last year.  
How many tickets did they sell last year?

3

[Turn over

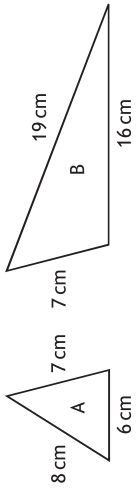


\* X 7 4 7 7 5 0 2 0 5 \*

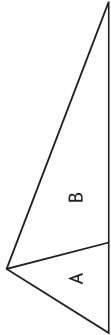


\* X 7 4 7 7 5 0 2 0 6 \*

7. Triangles A and B are shown below.



The triangles are placed together to form the larger triangle shown below.



Is this larger triangle right-angled?  
Justify your answer.

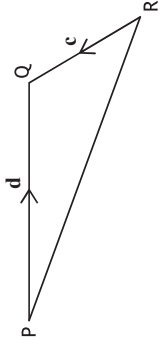
3

[Turn over



\* X 7 4 7 7 5 0 2 0 7 \*

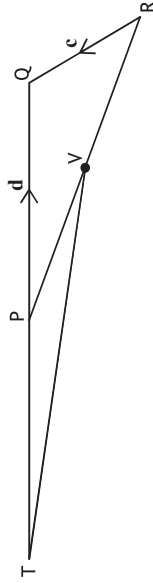
8. In the diagram below,  $\vec{RQ}$  and  $\vec{PQ}$  represent the vectors  $\mathbf{c}$  and  $\mathbf{d}$  respectively.



(a) Express  $\vec{PR}$  in terms of  $\mathbf{c}$  and  $\mathbf{d}$ .

1

The line QP is extended to T.



- $TP = PQ$
  - V is the midpoint of PR
- (b) Express  $\vec{TV}$  in terms of  $\mathbf{c}$  and  $\mathbf{d}$ .  
Give your answer in simplest form.

2



\* X 7 4 7 7 5 0 2 0 8 \*

MARKS DO NOT WRITE IN THIS MARGIN

9. (a) Factorise  $4x^2 - 25$ .

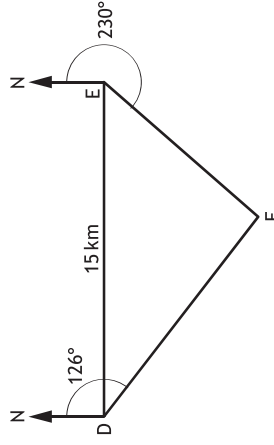
1

(b) Hence simplify  $\frac{4x^2 - 25}{2x^2 - x - 10}$ .

3

MARKS DO NOT WRITE IN THIS MARGIN

10. In the diagram below D, E and F represent the positions of Dunbridge, Earlsford and Fairtown respectively.



Dunbridge is 15 kilometres west of Earlsford.

From Dunbridge, the bearing of Fairtown is  $126^\circ$ .

From Earlsford the bearing of Fairtown is  $230^\circ$ .

Calculate the distance between Dunbridge and Fairtown.

Do not use a scale drawing.

4

[Turn over



\* X 7 4 7 7 5 0 2 0 9 \*



\* X 7 4 7 7 5 0 2 1 0 \*

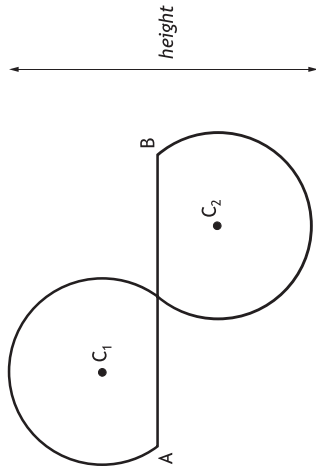
MARKS DO NOT WRITE IN THIS MARGIN

11. A straight line has equation  $3x - 5y - 10 = 0$ .  
Find the gradient of this line.

2

MARKS DO NOT WRITE IN THIS MARGIN

13. Two identical shapes are used to form a logo.  
Each shape is part of a circle.



- The circles have centres  $C_1$  and  $C_2$ .
  - The radius of each circle is 14 centimetres.
  - The logo has half-turn symmetry about the mid-point of AB.
  - AB is 48 centimetres long.
- Calculate the height of the logo.

4

MARKS DO NOT WRITE IN THIS MARGIN

12. Express  $\frac{1}{\sqrt[3]{x}}$  in the form  $x^a$ .

2

MARKS DO NOT WRITE IN THIS MARGIN

[Turn over



\* X 7 4 7 7 5 0 2 1 1 \*

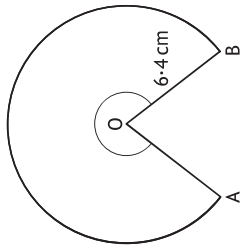


\* X 7 4 7 7 5 0 2 1 2 \*



MARKS DO NOT WRITE IN THIS MARGIN

14. The diagram below shows part of a circle, centre O.



The radius of the circle is 6.4 centimetres.  
Major arc AB has length 31.5 centimetres.  
Calculate the size of the reflex angle AOB.

3

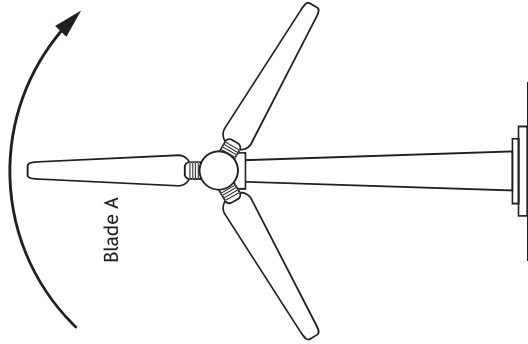
[Turn over



\* X 7 4 7 7 5 0 2 1 3 \*

MARKS DO NOT WRITE IN THIS MARGIN

15. A wind turbine has three blades as shown below.



The height,  $h$  metres, of the tip of blade A above the ground in each rotation is given by

$$h = 40 + 23 \cos x^\circ, \quad 0 \leq x < 360$$

where  $x$  is the angle blade A has turned clockwise from its vertical position.

- (a) Calculate the height of the tip of blade A after it has turned through an angle of  $60^\circ$ .

1



\* X 7 4 7 7 5 0 2 1 4 \*

MARKS DO NOT  
WRITE IN  
THIS  
MARGIN

15. (continued)

(b) Find the minimum height of the tip of blade A above the ground.

1

(c) Calculate the values of  $x$  for which the tip of blade A is 61 metres above the ground.

4

[END OF QUESTION PAPER]



MARKS  
DO NOT  
WRITE IN  
THIS  
MARGINTotal marks — 50  
Attempt ALL questions

1. Evaluate  $2\frac{1}{3} + \frac{4}{5}$ .

2

2. Expand and simplify  $(3x+1)(x-1) + 2(x^2 - 5)$ .

3

3. Solve, algebraically, the system of equations

$$4x + 5y = -3$$
$$6x - 2y = 5.$$

3

4. Two vectors are given by  $\mathbf{u} = \begin{pmatrix} 1 \\ 5 \\ 1 \end{pmatrix}$  and  $\mathbf{u} + \mathbf{v} = \begin{pmatrix} 6 \\ -4 \\ 3 \end{pmatrix}$ .

Find vector  $\mathbf{v}$ .

Express your answer in component form.

2

MARKS  
DO NOT  
WRITE IN  
THIS  
MARGIN

\* X 8 4 7 7 5 0 1 0 3 \*



\* X 8 4 7 7 5 0 1 0 4 \*

MARKS  
DO NOT  
WRITE IN  
THIS  
MARGIN

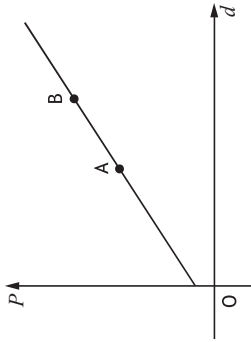
5. Solve

$$x^2 - 11x + 24 = 0.$$

2

MARKS  
DO NOT  
WRITE IN  
THIS  
MARGIN

7. The cost of a journey with Tom's Taxis depends on the distance travelled. The graph below shows the cost,  $P$  pounds, of a journey with Tom's Taxis against the distance travelled,  $d$  miles.



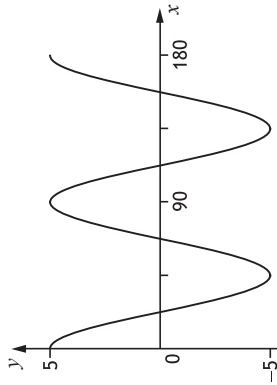
Point A represents a journey of 8 miles which costs £14.  
Point B represents a journey of 12 miles which costs £20.

- (a) Find the equation of the line in terms of  $P$  and  $d$ .  
Give the equation in its simplest form.

3

MARKS  
DO NOT  
WRITE IN  
THIS  
MARGIN

6. Part of the graph of  $y = a \cos bx^\circ$  is shown in the diagram.



State the values of  $a$  and  $b$ .

2



\* X 8 4 7 7 5 0 1 0 5 \*

page 05



\* X 8 4 7 7 5 0 1 0 6 \*

page 06

[Turn over

MARKS DO NOT WRITE IN THIS MARGIN

7. (continued)

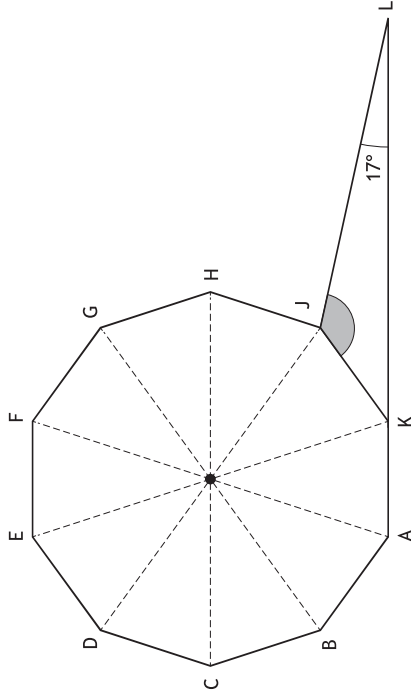
- (b) Calculate the cost of a journey of 5 miles.

1

MARKS DO NOT WRITE IN THIS MARGIN

9. In the diagram shown below, ABCDEFGHJK is a regular decagon.

- Angle KJL is  $17^\circ$ .
- AKL is a straight line.



8. Determine the nature of the roots of the function  $f(x) = 2x^2 + 4x + 5$ .

2

Calculate the size of shaded angle KJL.

2



\* X 8 4 7 7 5 0 1 0 7 \*

page 07



\* X 8 4 7 7 5 0 1 0 8 \*

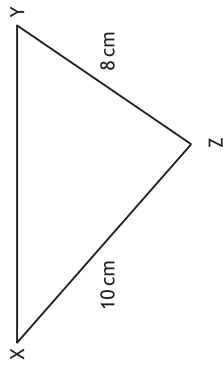
page 08

[Turn over

MARKS DO NOT WRITE IN THIS MARGIN

10. In triangle XYZ:

- $XZ = 10$  centimetres
- $YZ = 8$  centimetres
- $\cos Z = \frac{1}{8}$ .



Calculate the length of XY.

3

11. Express  $\frac{9}{\sqrt{6}}$  with a rational denominator.  
Give your answer in its simplest form.

2

12. Given that  $\cos 60^\circ = 0.5$ , state the value of  $\cos 240^\circ$ .

1

MARKS DO NOT WRITE IN THIS MARGIN

[Turn over

page 10

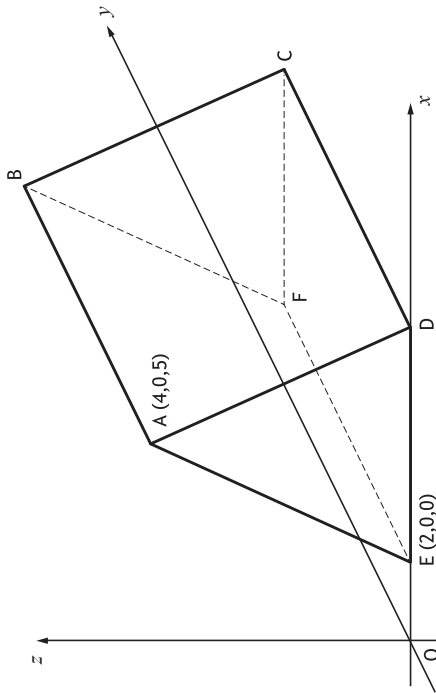


page 09



MARKS DO NOT WRITE IN THIS MARGIN

13. The diagram shows a triangular prism, ABCDEF, relative to the coordinate axes.



- $AD = AE$ .
- $DC = 8$  units.
- Edges EF, DC and AB are parallel to the  $y$ -axis.

Write down the coordinates of B and C.

2

MARKS DO NOT WRITE IN THIS MARGIN

14. Change the subject of the formula  $y = g\sqrt{x+h}$  to  $x$ .

3

MARKS DO NOT WRITE IN THIS MARGIN

15. Remove the brackets and simplify  $\left(\frac{2}{3}p^4\right)^2$ .

2

MARKS DO NOT WRITE IN THIS MARGIN



\* X 8 4 7 7 5 0 1 1 1 \*

page 11

[Turn over



\* X 8 4 7 7 5 0 1 1 2 \*

page 12

MARKS DO NOT WRITE IN THIS MARGIN

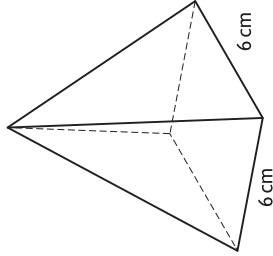
16. Sketch the graph of  $y = (x - 6)(x + 4)$ .

On your sketch, show clearly the points of intersection with the  $x$ -axis and the  $y$ -axis, and the coordinates of the turning point.

3

MARKS DO NOT WRITE IN THIS MARGIN

17. A square based pyramid is shown in the diagram below.



The square base has length 6 centimetres.  
The volume is 138 cubic centimetres.  
Calculate the height of the pyramid.

3

MARKS DO NOT WRITE IN THIS MARGIN

MARKS DO NOT WRITE IN THIS MARGIN



page 13



page 14

[Turn over



MARKS DO NOT WRITE IN THIS MARGIN

18. Express  $\sin x^\circ \cos x^\circ \tan x^\circ$  in its simplest form.  
Show your working.

2

MARKS DO NOT WRITE IN THIS MARGIN

19. (a) (i) Express  $x^2 - 6x - 81$  in the form  $(x - p)^2 + q$ .

2

- (ii) Hence state the equation of the axis of symmetry of the graph of  $y = x^2 - 6x - 81$ .

1



\* X 8 4 7 7 5 0 1 1 5 \*

page 15



\* X 8 4 7 7 5 0 1 1 6 \*

page 16

[Turn over

Total marks — 60  
Attempt ALL questions

19. (continued)
- (b) The roots of the equation  $x^2 - 6x - 81 = 0$  can be expressed in the form  $x = d \pm d\sqrt{e}$ .  
Find, algebraically, the values of  $d$  and  $e$ .

4

1. Households in a city produced a total of 125 000 tonnes of waste in 2017. The total amount of waste is expected to fall by 2% each year. Calculate the total amount of waste these households are expected to produce in 2020.

3

[END OF QUESTION PAPER]



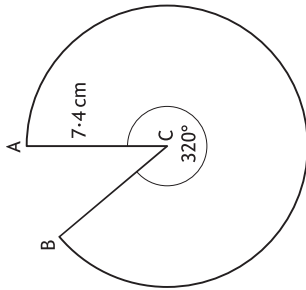
\* X 8 4 7 7 5 0 1 1 7 \*



\* X 8 4 7 7 5 0 2 0 3 \*

MARKS DO NOT WRITE IN THIS MARGIN

2. The diagram below shows a sector of a circle, centre C.



The radius of the circle is 7.4 centimetres.  
Calculate the length of the major arc AB.

3

MARKS DO NOT WRITE IN THIS MARGIN

3. Find  $|\mathbf{r}|$ , the magnitude of vector  $\mathbf{r} = \begin{pmatrix} 24 \\ -12 \\ 8 \end{pmatrix}$ .

2

4. Solve, algebraically, the inequation

$$3x < 6(x-1) - 12.$$

3

MARKS DO NOT WRITE IN THIS MARGIN



\* X 8 4 7 7 5 0 2 0 4 \*

page 04



\* X 8 4 7 7 5 0 2 0 5 \*

page 05

5. A farmers' market took place one weekend. Stallholders were asked to record the number of customers who visited their stall.

The number of customers who visited six of the stalls on Saturday were as follows:

120 126 125 131 130 124

(a) Calculate the mean and standard deviation of the number of customers. 4

5. (continued)

The mean number of customers who visited these six stalls on Sunday was 117 and the standard deviation was 6.2.

(b) Make two valid comments comparing the number of customers who visited these stalls on Saturday and Sunday. 2

6. A function is defined as  $f(x) = 5 + 4x$ . Given that  $f(a) = 73$ , calculate  $a$ . 2



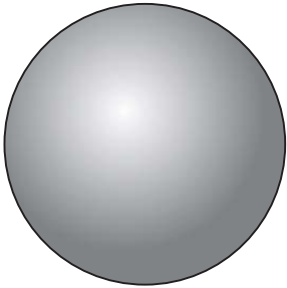
\* X 8 4 7 7 5 0 2 0 6 \*



\* X 8 4 7 7 5 0 2 0 7 \*

MARKS DO NOT WRITE IN THIS MARGIN

7. A toy company makes juggling balls in the shape of a sphere with a diameter of 6.4 centimetres.



6.4 cm

Calculate the volume of one juggling ball.  
Give your answer correct to 2 significant figures.

3

MARKS DO NOT WRITE IN THIS MARGIN

8. Solve the equation  $7 \sin x^\circ + 2 = 3$ , for  $0 \leq x < 360$ .

3



\* X 8 4 7 7 5 0 2 0 8 \*

page 08

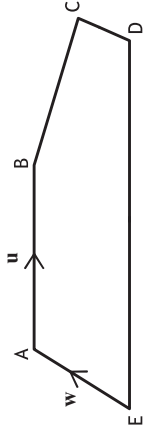


\* X 8 4 7 7 5 0 2 0 9 \*

page 09

[Turn over

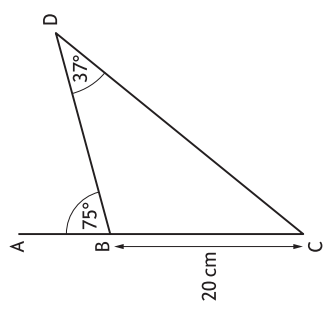
10. In the diagram below,  $\vec{AB}$  and  $\vec{EA}$  represent the vectors  $\mathbf{u}$  and  $\mathbf{w}$  respectively.



- $\vec{ED} = 2\vec{AB}$
- $\vec{EA} = 2\vec{DC}$

Express  $\vec{BC}$  in terms of  $\mathbf{u}$  and  $\mathbf{w}$ .  
Give your answer in its simplest form.

2



9. In this diagram:
- angle  $ABD = 75^\circ$
  - angle  $BDC = 37^\circ$
  - $BC = 20$  centimetres.

Calculate the length of  $DC$ .

3



\* X 8 4 7 7 5 0 2 1 1 \*



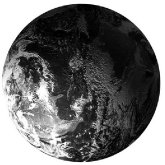
\* X 8 4 7 7 5 0 2 1 0 \*

MARKS DO NOT WRITE IN THIS MARGIN

11. Venus and Earth are two planets within our solar system.



Venus



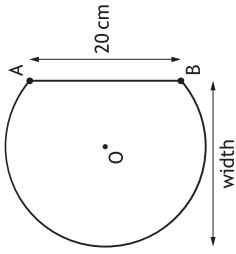
Earth

The volume of Venus is approximately  $9.3 \times 10^{11}$  cubic kilometres.  
This is 85% of the volume of Earth.  
Calculate the volume of Earth.

3

MARKS DO NOT WRITE IN THIS MARGIN

12. The shape below is part of a circle, centre O.



The circle has radius 13 centimetres.  
AB is a chord of length 20 centimetres.  
Calculate the width of the shape.

4

MARKS DO NOT WRITE IN THIS MARGIN

MARKS DO NOT WRITE IN THIS MARGIN



\* X 8 4 7 7 5 0 2 1 2 \*

page 12

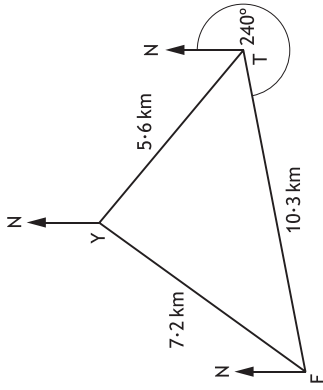


\* X 8 4 7 7 5 0 2 1 3 \*

page 13

[Turn over

13. A ferry and a trawler receive a request for help from a stranded yacht.  
On the diagram the points F, T and Y show the positions of the ferry, the trawler and the yacht respectively.



- FY is 7.2 kilometres.
- TY is 5.6 kilometres.
- FT is 10.3 kilometres.
- F is on a bearing of  $240^\circ$  from T.

Calculate the bearing of the yacht from the trawler.

4



\* X 8 4 7 7 5 0 2 1 4 \*

14. A straight line has equation  $2x - 5y = 20$ .  
Find the coordinates of the point where this line crosses the  $y$ -axis.

2

15. Express

$$\frac{n}{n^2 - 4} \div \frac{3}{n - 2}, \quad n \neq -2, n \neq 2$$

as a single fraction in its simplest form.

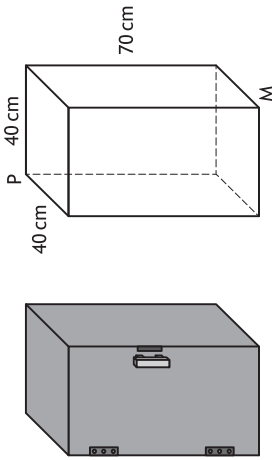
3



\* X 8 4 7 7 5 0 2 1 5 \*



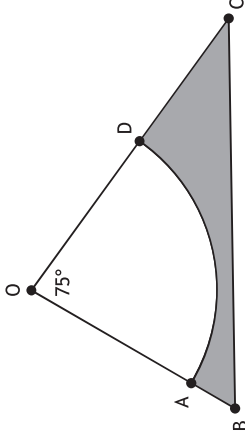
16. Chris wants to store his umbrella in a locker. The locker is a cuboid with internal dimensions of length 40 centimetres, breadth 40 centimetres and height 70 centimetres.



The umbrella is 85 centimetres long. He thinks it will fit into the locker from corner P to corner M. Is he correct? **Justify your answer.**

4

17. In the diagram below AOD is a sector of a circle, with centre O, and BOC is a triangle.



In sector AOD:

- radius = 30 centimetres
- angle AOD =  $75^\circ$ .

In triangle OBC:

- OB = 38 centimetres
- OC = 55 centimetres.

Calculate the area of the shaded region, ABCD.

5



\* X 8 4 7 7 5 0 2 1 6 \*



\* X 8 4 7 7 5 0 2 1 7 \*

MARKS DO NOT WRITE IN THIS MARGIN

18. A cinema sells popcorn in two different sized cartons.



The small carton is 16 centimetres deep and has a volume of 576 cubic centimetres.

The large carton is 24 centimetres deep and has a volume of 1125 cubic centimetres.

- (a) Show that the two cartons are **not** mathematically similar. 3

MARKS DO NOT WRITE IN THIS MARGIN

18. (continued)

The large carton is redesigned so that the two cartons are now mathematically similar.

The volume of the redesigned large carton is 1500 cubic centimetres.

- (b) Calculate the depth of the redesigned large carton. 2

[END OF QUESTION PAPER]



MARKS DO NOT WRITE IN THIS MARGIN

Total marks — 50  
Attempt ALL questions

1. Given that  $f(x) = 5x^3$ , evaluate  $f(-2)$ .

2

2. Evaluate  $\frac{3}{8} \times 1\frac{5}{7}$ .

Give your answer in its simplest form.

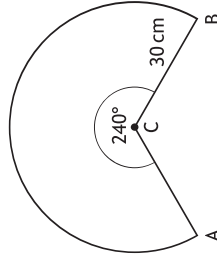
2

MARKS DO NOT WRITE IN THIS MARGIN

3. Expand and simplify  $(x+5)(2x^2-7x-3)$ .

3

4. The diagram below shows a sector of a circle, centre C.



The radius of the circle is 30 centimetres.

Calculate the length of the major arc AB.

Take  $\pi = 3.14$ .

3



\* X 8 4 7 7 5 0 1 0 3 \*

page 03



\* X 8 4 7 7 5 0 1 0 4 \*

page 04

[Turn over

5. The midday temperatures in Grantford were recorded over a nine day period. The temperatures, in °C, were

- 4 7 4 3 6 10 9 5 3

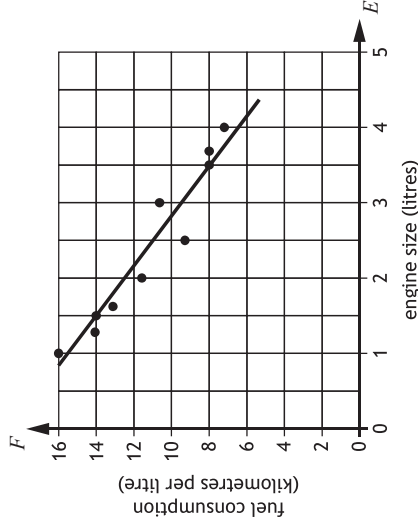
(a) Calculate the median and semi-interquartile range for these temperatures. 3

Over the same nine day period the midday temperatures in Endoch were also recorded.

The median temperature was 8 °C, and the semi-interquartile range was 1.5 °C.

(b) Make two valid comments comparing the midday temperatures of Grantford and Endoch during this period. 2

6. The fuel consumption of a group of cars is recorded. The scattergraph shows the relationship between the fuel consumption,  $F$  kilometres per litre, and the engine size,  $E$  litres, of the cars.



A line of best fit has been drawn.

(a) Find the equation of the line of best fit in terms of  $F$  and  $E$ . Give the equation in its simplest form. 3



MARKS DO NOT WRITE IN THIS MARGIN

6. (continued)

Amaar's car has an engine size of 1.1 litres.

- (b) Use your equation from part (a) to estimate how many kilometres per litre he should expect to get.

1

MARKS DO NOT WRITE IN THIS MARGIN

8. John bought 7 bags of cement and 3 bags of gravel. The total weight of these bags was 215 kilograms.

- (a) Write down an equation to illustrate this information.

1

Shona bought 5 bags of cement and 4 bags of gravel. The total weight of her bags was 200 kilograms.

- (b) Write down an equation to illustrate this information.

1

- (c) Calculate the weight of one bag of cement and the weight of one bag of gravel.

4

MARKS DO NOT WRITE IN THIS MARGIN

7. The area of a trapezium is given by the formula

$$A = \frac{1}{2}h(x + y).$$

Make  $x$  the subject of the formula.

3



\* X 8 4 7 7 5 0 1 0 7 \*

page 07



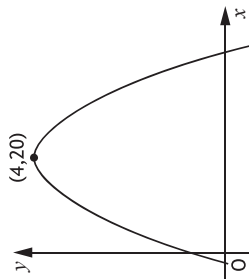
\* X 8 4 7 7 5 0 1 0 8 \*

page 08

[Turn over

MARKS DO NOT WRITE IN THIS MARGIN

9. The graph shows a parabola.



The maximum turning point has coordinates (4,20) as shown in the diagram.

(a) Write down the equation of the axis of symmetry of the graph.

1

The equation of the parabola is of the form  $y = b - (x + a)^2$ .

(b) State the values of

(i)  $a$

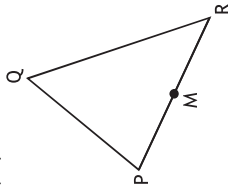
1

(ii)  $b$ .

1

MARKS DO NOT WRITE IN THIS MARGIN

10. In triangle PQR,  $\vec{PR} = \begin{pmatrix} 6 \\ -4 \end{pmatrix}$  and  $\vec{RQ} = \begin{pmatrix} -1 \\ 8 \end{pmatrix}$ .



(a) Express  $\vec{PQ}$  in component form.

1

M is the midpoint of PR.

(b) Express  $\vec{MQ}$  in component form.

2

MARKS DO NOT WRITE IN THIS MARGIN

MARKS DO NOT WRITE IN THIS MARGIN

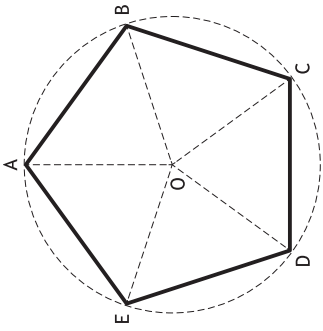


\* X 8 4 7 7 5 0 1 0 9 \*

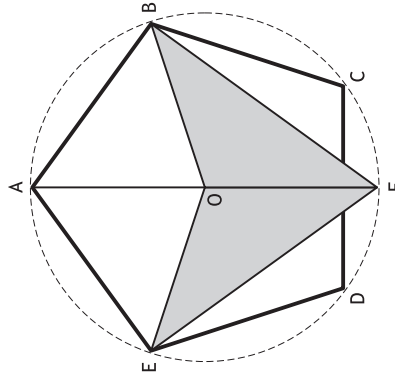


\* X 8 4 7 7 5 0 1 1 0 \*

11. Pam is designing a company logo.  
She starts by drawing a regular pentagon ABCDE.  
The vertices of the pentagon lie on the circumference of a circle with centre O.



She then adds to the design as shown in the diagram below.



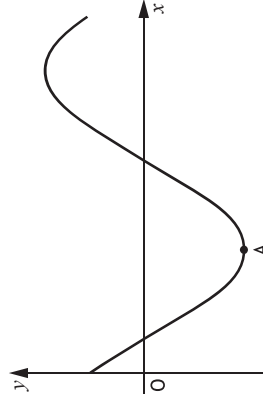
AF is a diameter of the circle.  
Calculate the size of angle OFB.

3

12. Express  $\frac{\sqrt{2}}{\sqrt{40}}$  as a fraction with a rational denominator.  
Give your answer in its simplest form.

3

13. Part of the graph of  $y = 3 \cos(x + 45)^\circ$  is shown in the diagram.



The graph has a minimum turning point at A.  
State the coordinates of A.

2

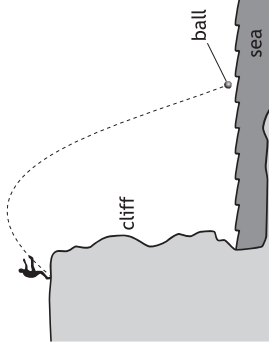


14. Solve the equation  $\frac{x}{2} - 1 = \frac{3-x}{5}$ .

MARKS DO NOT WRITE IN THIS MARGIN

3

15. A ball is kicked from a clifftop.



The height,  $h$  metres, of the ball relative to the cliff top after  $t$  seconds is given by  $h = 12t - 5t^2$ .

(a) Calculate the height of the ball above the cliff top after 2 seconds. 1

MARKS DO NOT WRITE IN THIS MARGIN



page 13



page 14

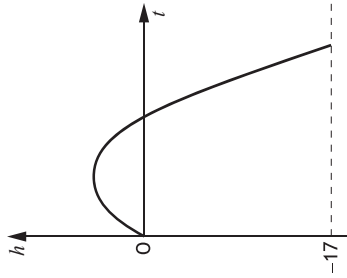
[Turn over



Total marks — 60  
Attempt ALL questions

15. (continued)

The graph below represents the height,  $h$  metres, of the ball relative to the cliff top after  $t$  seconds.



The sea is 17 metres below the cliff top.

(b) After how many seconds will the ball hit the sea?

4

[END OF QUESTION PAPER]



\* X 8 4 7 7 5 0 1 1 5 \*

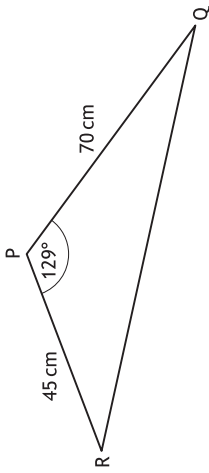
1. A charity distributed 80 000 emergency packages during 2018. This number is expected to increase by 15% each year. Calculate how many emergency packages the charity expects to distribute in 2021. 3

2. Find  $|\mathbf{p}|$ , the magnitude of vector  $\mathbf{p} = \begin{pmatrix} 6 \\ 27 \\ -18 \end{pmatrix}$ . 2



\* X 8 4 7 7 5 0 2 0 3 \*

3. The diagram shows triangle PQR.



- $PR = 45$  centimetres
- $PQ = 70$  centimetres
- Angle  $QPR = 129^\circ$

Calculate the area of triangle PQR.

2

4. A sesame seed weighs  $3.6 \times 10^{-6}$  kilograms.

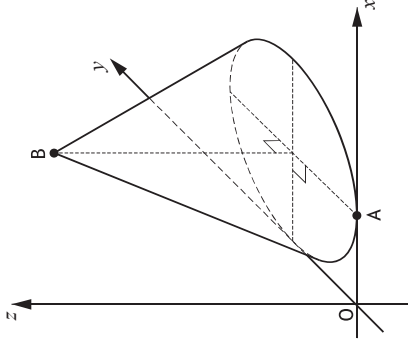
The weight of a poppy seed is 8% of the weight of a sesame seed.

Calculate the weight of a poppy seed in kilograms.

Give your answer in scientific notation.

2

5. The diagram shows a cone with diameter 6 units and height 8 units.



- The  $x$ -axis and the  $y$ -axis are tangents to the base
- A is the point of contact between the base and the  $x$ -axis
- B is directly above the centre of the base

Write down the coordinates of A and B.

2



\* X 8 4 7 7 5 0 2 0 4 \*



\* X 8 4 7 7 5 0 2 0 5 \*

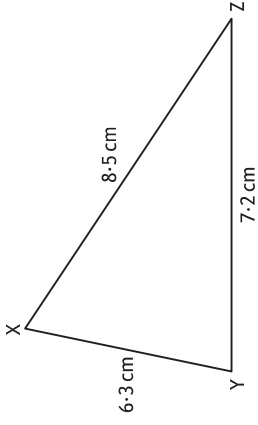
MARKS DO NOT WRITE IN THIS MARGIN

6. Solve the equation  $3x^2 + 9x - 2 = 0$ .  
Give your answers correct to 1 decimal place.

3

MARKS DO NOT WRITE IN THIS MARGIN

7. Triangle XYZ is shown below.



Calculate the size of the smallest angle in triangle XYZ.

3

MARKS DO NOT WRITE IN THIS MARGIN

3

MARKS DO NOT WRITE IN THIS MARGIN

3



\* X 8 4 7 7 5 0 2 0 6 \*



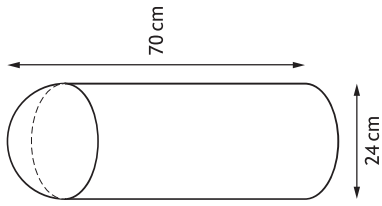
\* X 8 4 7 7 5 0 2 0 7 \*

MARKS DO NOT WRITE IN THIS MARGIN

8. A traffic bollard is in the shape of a cylinder with a hemisphere on top.

The bollard has

- diameter 24 centimetres
- height 70 centimetres.



Calculate the volume of the bollard.

Give your answer correct to 3 significant figures.

5

MARKS DO NOT WRITE IN THIS MARGIN

MARKS DO NOT WRITE IN THIS MARGIN

9. Georgie had her roof repaired.  
She was charged an extra 2.5% for late payment.  
She had to pay a total of £977.85.  
Calculate how much she would have saved if she had paid on time.

3

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

2



page 08



page 09

[Turn over

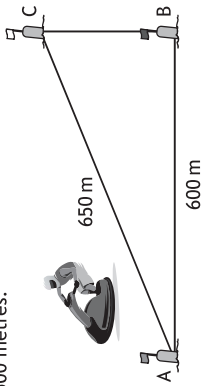
MARKS DO NOT WRITE IN THIS MARGIN

11. The diagram shows the course for a jet-ski race.

The course is indicated by markers A, B and C.

The total length of the course is 1500 metres.

- B is 600 metres from A
- C is 650 metres from A
- C is due north of B



Determine whether B is due east of A.

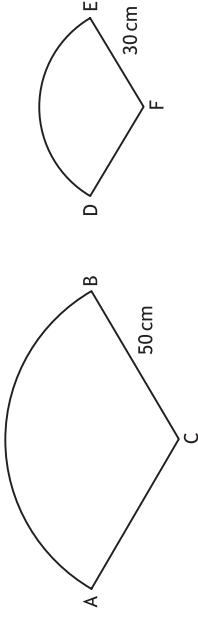
**Justify your answer.**

4

MARKS DO NOT WRITE IN THIS MARGIN

12. In the diagram

- ABC is a sector of a circle, centre C
- DEF is a sector of a circle, centre F.



The sectors are mathematically similar.

The area of the larger sector, ABC, is 2750 square centimetres.

- (a) Calculate the area of the smaller sector, DEF.

3

- (b) Calculate the size of angle ACB.

3

MARKS DO NOT WRITE IN THIS MARGIN



page 10

MARKS DO NOT WRITE IN THIS MARGIN



page 11

[Turn over

MARKS DO NOT WRITE IN THIS MARGIN

13. Find an expression for the gradient of the line joining point A(6,9) to point B(4p, 4p<sup>2</sup>).

Give your answer in its simplest form.

3

14. Solve the equation  $5 \cos x^\circ + 2 = 1$ ,  $0 \leq x < 360$ .

3



\* X 8 4 7 7 5 0 2 1 2 \*

page 12

MARKS DO NOT WRITE IN THIS MARGIN

15. Express

$$\frac{4}{x-2} - \frac{3}{x+5}, \quad x \neq 2, x \neq -5$$

as a single fraction in its simplest form.

3

16. Simplify  $\frac{a^4 \times 3a}{\sqrt{a}}$ .

3



\* X 8 4 7 7 5 0 2 1 3 \*

page 13

17. Expand and simplify

$$(\sin x^\circ + \cos x^\circ)^2$$

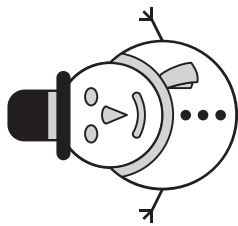
Show your working.

2

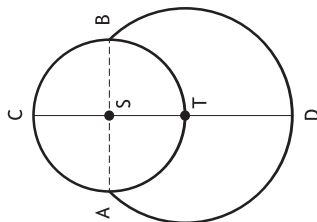


\* X 8 4 7 7 5 0 2 1 4 \*

18. The picture shows a cartoon snowman.



The diagram below represents the snowman.



- The head is a small circle, centre  $S$ , with diameter 15 centimetres
- The body is part of a larger circle, centre  $T$
- The point  $T$  lies on the circumference of the small circle
- The points  $A$  and  $B$  lie on the circumferences of both circles

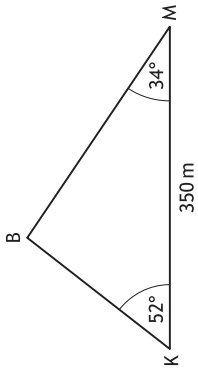
Calculate  $CD$ , the height of the snowman.

4



\* X 8 4 7 7 5 0 2 1 5 \*

19. Katy and Mona are looking up at a hot-air balloon. In the diagram below, K, M and B represent the positions of Katy, Mona and the balloon respectively.



- The angle of elevation of the balloon from Katy is 52°
- The angle of elevation of the balloon from Mona is 34°
- Katy and Mona are 350 metres apart on level ground

Calculate the height of the hot-air balloon above the ground.

5

[END OF QUESTION PAPER]





MARKS DO NOT WRITE IN THIS MARGIN

Total marks — 40  
Attempt ALL questions

1. Evaluate

$$\frac{2\left(\frac{1}{5} + \frac{3}{4}\right)}{3\left(\frac{5}{5} + \frac{3}{4}\right)}$$

Give your answer in its simplest form.

2

2. Given that  $f(x) = x^3 - 2$ , evaluate  $f(-3)$ .

2

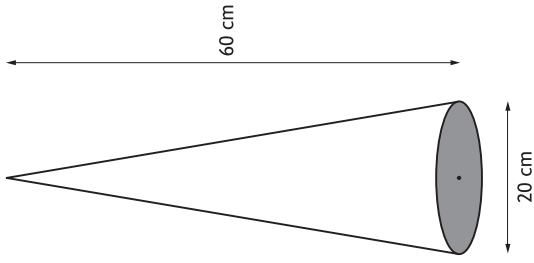


\* X 8 4 7 7 5 0 1 0 3 \*

MARKS

DO NOT WRITE IN THIS MARGIN

3. The diagram below shows a cone with diameter 20 centimetres and height 60 centimetres.



Calculate the volume of the cone.

Take  $\pi = 3.14$ .

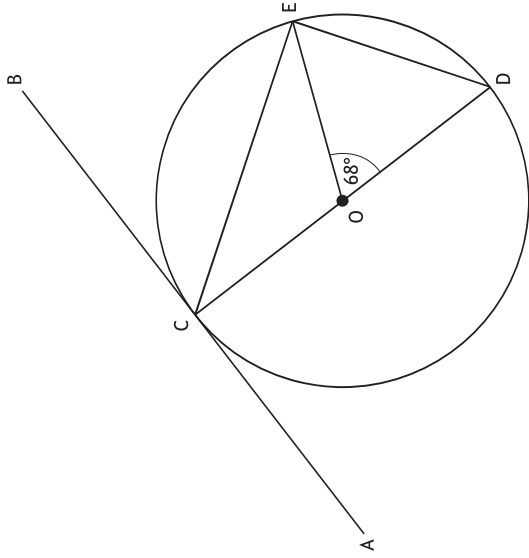
2



\* X 8 4 7 7 5 0 1 0 4 \*

MARKS DO NOT WRITE IN MARGIN

4. The diagram below shows a circle with centre O.



AB is a tangent to the circle at the point C.  
CD is a diameter of the circle.  
Angle EOD is 68°.  
Calculate the size of angle ACE.

Angle ACE =

3

MARKS DO NOT WRITE IN MARGIN

5. (a) Express  $x^2 + 8x + 15$  in the form  $(x + a)^2 + b$ .

2

- (b) Hence, or otherwise, state the coordinates of the turning point of the graph of  $f(x) = x^2 + 8x + 15$ .

1

6. Find the equation of the line passing through the points  $(-3, -1)$  and  $(-5, 7)$ .  
Give the equation in its simplest form.

3

MARKS DO NOT WRITE IN MARGIN

MARKS DO NOT WRITE IN MARGIN



\* X 8 4 7 7 5 0 1 0 5 \*

page 05

[Turn over



\* X 8 4 7 7 5 0 1 0 6 \*

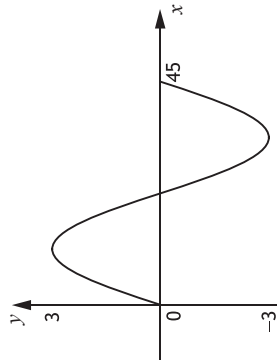
page 06

7. Change the subject of the formula  $D = \frac{B+4}{C^2}$  to  $B$ .

MARKS DO NOT WRITE IN MARGIN

2

8. Part of the graph of  $y = a \sin bx^\circ$  is shown in the diagram.



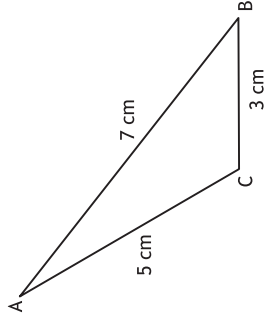
(a) State the value of  $a$ .

1

(b) State the value of  $b$ .

1

9. The diagram shows triangle ABC.



- $AB = 7$  centimetres
- $BC = 3$  centimetres
- $AC = 5$  centimetres

Calculate the value of  $\cos B$ .  
Give your answer in its simplest form.

2

MARKS DO NOT WRITE IN MARGIN



10. Tommy buys flower seeds from a website. Tommy is given a 30% discount. He pays £16.10 for the seeds. Calculate the cost of the flower seeds without the discount.

MARKS DO NOT WRITE IN THIS MARGIN

3

12. Express  $\frac{4}{x+2} + \frac{5}{(x+2)^2}$ ,  $x \neq -2$  as a single fraction in its simplest form.

MARKS DO NOT WRITE IN THIS MARGIN

2

11. Simplify  $(m^{-2})^4 \times m^{-5}$ .  
Give your answer with a positive power.

MARKS DO NOT WRITE IN THIS MARGIN

3

13. Expand and simplify  $\sqrt{10}(\sqrt{10} - \sqrt{2}) + 8\sqrt{5}$ .

MARKS DO NOT WRITE IN THIS MARGIN

3



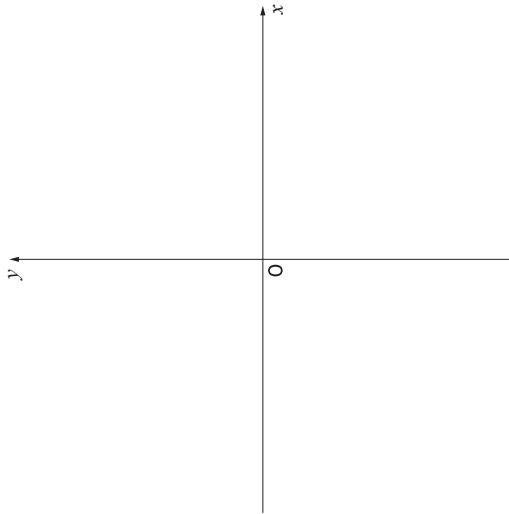
\* X 8 4 7 7 5 0 1 0 9 \*



\* X 8 4 7 7 5 0 1 1 0 \*

MARKS DO NOT WRITE IN MARGIN

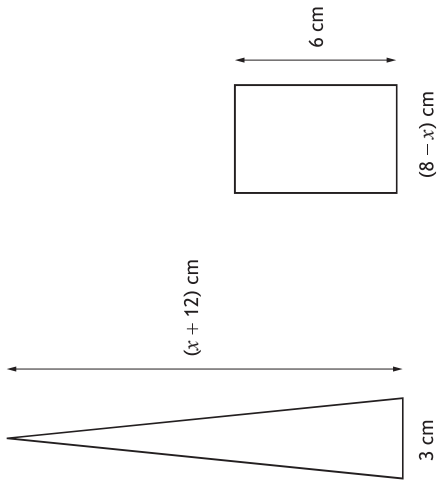
14. Sketch the graph of  $y = (x+1)(x-3)$  using the axes provided below. On your sketch, show clearly the points of intersection with the  $x$ -axis and the  $y$ -axis, and the coordinates of the turning point. (Additional axes, if required, can be found on page 14.)



3

MARKS DO NOT WRITE IN MARGIN

15. A triangle and rectangle are shown in the diagram.



- (a) Find an expression for the area of the triangle.

1

MARKS DO NOT WRITE IN MARGIN



\* X 8 4 7 7 5 0 1 1 1 \*



\* X 8 4 7 7 5 0 1 1 2 \*

MARKS DO NOT WRITE IN THIS MARGIN

15. (continued)

(b) Given that the area of the triangle is equal to the area of the rectangle, find algebraically the value of  $x$ .

4

MARKS DO NOT WRITE IN THIS MARGIN

Total marks — 50  
Attempt ALL questions

1. Expand and simplify  $(3x - 2)(2x^2 + 5x - 1)$ .

3

2. A company's annual profit at the end of 2021 was £215,000. The profit is expected to increase by 3% each year. Calculate the company's expected annual profit by the end of 2025. Give your answer correct to the nearest thousand pounds.

3

[END OF QUESTION PAPER]



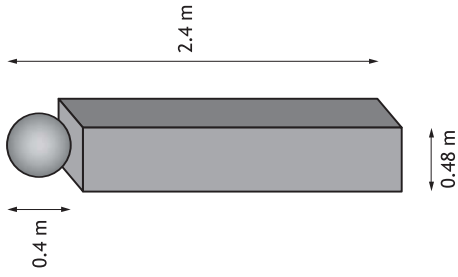
\* X 8 4 7 7 5 0 1 1 3 \*



\* X 8 4 7 7 5 0 2 0 3 \*

MARKS DO NOT WRITE IN THIS MARGIN

3. A concrete gatepost is made in the shape of a cuboid with a sphere on top.



The sphere has diameter 0.4 metres.  
The cuboid has a square base of length 0.48 metres.  
The total height of the gatepost is 2.4 metres.

Calculate the volume of concrete needed to make a gatepost.

3

MARKS DO NOT WRITE IN THIS MARGIN

4. Moira buys 4 mangoes and 3 apples at a fruit shop.  
The total cost is £4.25.

(a) Write down an equation to illustrate this information.

1

Sami buys 5 mangoes and 2 apples in the same fruit shop.  
The total cost is £4.70.

(b) Write down an equation to illustrate this information.

1

(c) Calculate, algebraically, the cost of a mango and the cost of an apple.

4



\* X 8 4 7 7 5 0 2 0 4 \*

page 04

[Turn over



\* X 8 4 7 7 5 0 2 0 5 \*

page 05

5. A school netball team recorded the number of sit-ups each player completed in a minute.

The numbers for the seven players were:

29 27 24 31 22 19 30

(a) Calculate the mean and standard deviation of the numbers of sit-ups. 4

5. (continued)

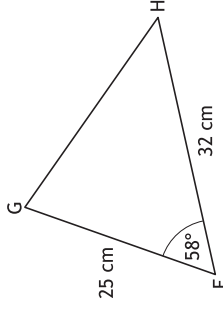
Some players in the school's hockey team also recorded the number of sit-ups they completed in a minute.

Their numbers gave a mean of 29 and a standard deviation of 3.2.

(b) Make two valid comments comparing the numbers of sit-ups of the players in the netball team and the hockey team. 2

6. The diagram shows triangle  $FGH$ .

- $FG = 25$  centimetres
- $FH = 32$  centimetres
- Angle  $GFH = 58^\circ$



Calculate the area of triangle  $FGH$ . 2



\* X 8 4 7 7 5 0 2 0 6 \*



\* X 8 4 7 7 5 0 2 0 7 \*

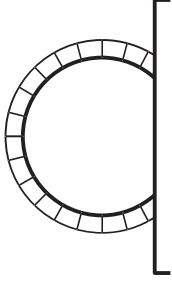


4

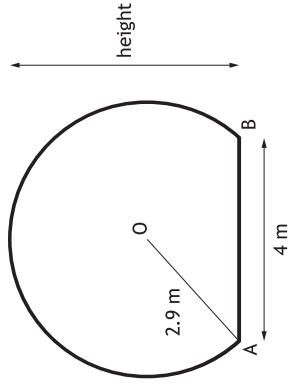
7. Solve the equation  $4x^2 + 2x - 7 = 0$ .  
Give your answers correct to 2 significant figures.



8. A train tunnel has a circular cross-section with a horizontal floor.



A diagram of the cross-section is shown below.



- The centre of the circle is O.
- Chord AB is 4 metres.
- The radius OA is 2.9 metres.

Calculate the height of the tunnel.

4



MARKS DO NOT WRITE IN MARGIN

9. Solve the equation  $3 \sin x^{\circ} + 4 = 6$ , for  $0 \leq x \leq 360$ .

3



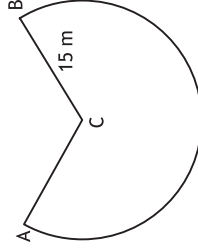
\* X 8 4 7 7 5 0 2 1 0 \*

MARKS DO NOT WRITE IN MARGIN

10. An attraction at a theme park has a carriage attached to an arm.



The arm swings from A to B along the arc of a circle, centre C, as shown in the diagram below.



- The length of the arm, CB, is 15 metres.
- The length of the major arc, AB, is 69.4 metres.

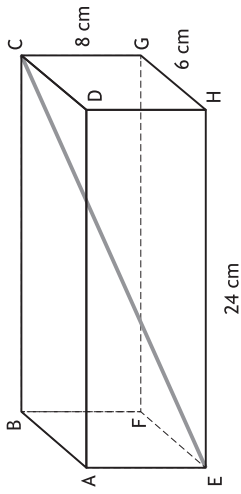
Calculate the size of the reflex angle ACB.

3



\* X 8 4 7 7 5 0 2 1 1 \*

11. The diagram shows a cuboid, ABCDEFGH.



- The length of the cuboid, EH, is 24 centimetres.
- The breadth of the cuboid, HG, is 6 centimetres.
- The height of the cuboid, CG, is 8 centimetres.

Calculate the length of EC, the space diagonal of the cuboid.

3

12. Simplify  $\frac{2ab+6a}{b^2-9}$ .

3

13. Simplify  $\frac{\sin x^\circ + 2 \cos x^\circ}{\cos x^\circ}$ .

2

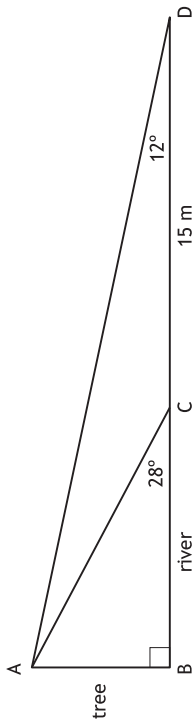


\* X 8 4 7 7 5 0 2 1 2 \*



\* X 8 4 7 7 5 0 2 1 3 \*

14. The width of a river is represented by BC in the diagram below.  
 AB represents a tree on the river bank.



- From C, the angle of elevation to A is  $28^\circ$ .
- From D, the angle of elevation to A is  $12^\circ$ .
- The distance from C to D is 15 metres.
- BCD is a straight line.

Calculate BC, the width of the river.

5

[END OF QUESTION PAPER]

