

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

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Forename(s)

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Candidate signature

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# GCSE MATHEMATICS

# H

Higher Tier

Paper 3 Calculator

Tuesday 13 June 2017

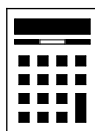
Morning

Time allowed: 1 hour 30 minutes

### Materials

For this paper you must have:

- a calculator
- mathematical instruments.



### Instructions

- Use black ink or black ball-point pen. Draw diagrams in pencil.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.

### Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.
- You may ask for more answer paper, graph paper and tracing paper. These must be tagged securely to this answer book.

### Advice

- In all calculations, show clearly how you work out your answer.

| For Examiner's Use |      |
|--------------------|------|
| Pages              | Mark |
| 2–3                |      |
| 4–5                |      |
| 6–7                |      |
| 8–9                |      |
| 10–11              |      |
| 12–13              |      |
| 14–15              |      |
| 16–17              |      |
| 18–19              |      |
| 20–21              |      |
| 22–23              |      |
| 24–25              |      |
| 26                 |      |
| <b>TOTAL</b>       |      |



Please note that these worked solutions have neither been provided nor approved by AQA and may not necessarily constitute the only possible solutions. Please refer to the original mark schemes for full guidance.

Any writing in blue indicates what must be written in order to answer the questions and get the marks. The worked solutions have been designed to show the smallest amount of work which needs to be done to answer the question.

Anything written in green in a cloud doesn't have to be written in the exam.

Anything written in orange in a rectangle doesn't have to be written in the exam and is there to show what should be put into a calculator or measured using a ruler or protractor.

If you find any mistakes or have any requests or suggestions, please send an email to [curtis@cgmaths.co.uk](mailto:curtis@cgmaths.co.uk)

Answer **all** questions in the spaces provided

1  $\mathbf{a} = \begin{pmatrix} -4 \\ -1 \end{pmatrix}$  and  $\mathbf{b} = \begin{pmatrix} 3 \\ -1 \end{pmatrix}$

Circle the vector  $2\mathbf{a} + \mathbf{b}$

$$n \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} nx \\ ny \end{bmatrix}, \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} w \\ z \end{bmatrix} = \begin{bmatrix} x+w \\ y+z \end{bmatrix}$$

[1 mark]

$$\begin{pmatrix} -5 \\ -3 \end{pmatrix}$$

$$\begin{pmatrix} -11 \\ -3 \end{pmatrix}$$

$$\begin{pmatrix} -5 \\ -1 \end{pmatrix}$$

$$\begin{pmatrix} -11 \\ -1 \end{pmatrix}$$

- 2 Which of these values of  $n$  makes  $2.7 \times 10^n$  a **cube number**?  
Circle your answer.

e.g. 8 is a cube number  
as  $2^3 = 2 \times 2 \times 2 = 8$

0

1

2

3

[1 mark]

Its quite a common cube number. How many times do we multiply 2.7 by 10 to get it? Otherwise put each value of  $n$  into the expression then cube root to see if you get a whole number.

- 3 Rearrange  $2x = \frac{y}{w}$  to make  $w$  the subject.

Circle your answer.

[1 mark]

$$w = \frac{2y}{x}$$

$$w = \frac{2x}{y}$$

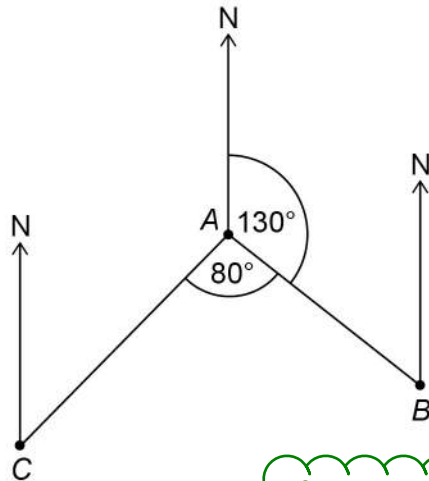
$$w = \frac{y}{2x}$$

$$w = \frac{x}{2y}$$

First multiply both sides by  $w$  to remove it from the fraction. We should get  $2xw = y$ . Next we need to eliminate the  $2x$  to get  $w$  on its own.



4

Not drawn  
accurately

If you were at A and facing north, how many degrees would you turn clockwise to face C?

Work out the bearing of C from A.

Circle your answer.

[1 mark]

030°

130°

150°

210°

Turn over for the next question

Turn over ►



- 5 A coin lands on Tails 200 times.  
The relative frequency of Tails is 0.4

Work out the number of times the coin was thrown.

Let  $x$  be the number of times the coin was thrown.  
 $0.4x = 200$

[2 marks]

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Answer \_\_\_\_\_

- 6 How are the whole number solutions to A and B different?

A Solve  $3 \leq 3x < 18$

B Solve  $3 < 3x \leq 18$

[2 marks]

Simplify the inequality so that it is in terms of  $x$  instead of  $3x$ . Inequalities can be simplified in a similar way to equations. Then list out all of the whole numbers which satisfy the inequality for A and B to show how they are different.

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**7 (a)** The length of a pipe is 6 metres to the nearest metre.

Complete the error interval for the length of the pipe.

**[2 marks]**

The lowest number which  
would round up to 6.

The lowest number which  
would round up to 7.

Answer \_\_\_\_\_ m  $\leq$  length < \_\_\_\_\_ m

**7 (b)** The length of a different pipe is 4 metres to the nearest metre.

Olly says,

“The total length of the two pipes is 11 metres to the nearest metre.”

Give an example to show that he could be correct.

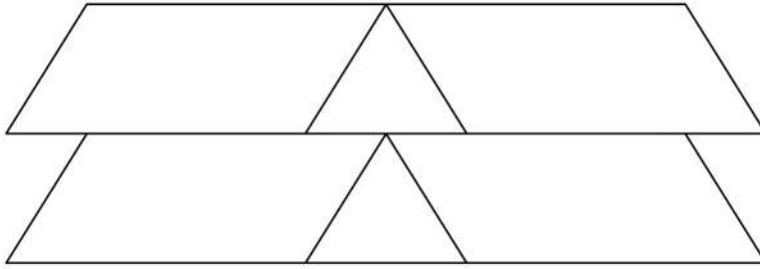
**[2 marks]**

The first pipe could be more than 6 and this pipe could be more than 4. Adding them together gives a result which rounds to 11.  
Be careful that we select values which are actually possible.

**Turn over for the next question**



- 8 This shape is made from two triangles and four congruent parallelograms.



Not drawn  
accurately

For each statement, tick the correct box.

- 8 (a) The triangles are **equilateral**.

All the sides are equal and  
the angles are all  $60^\circ$ .

[1 mark]

Must be true

Could be true

Must be false

The triangles in the diagram look like they could be equilateral. But is there any way the parallelograms could be altered so that the sides and angles in the triangles aren't all the same?

- 8 (b) The triangles are **congruent**.

All of the sides and  
angles are the same  
in both triangles.

[1 mark]

Must be true

Could be true

Must be false

The parallelograms are congruent and they share sides with the triangles. They also determine the angles within the triangles as angles around a point on a straight line are  $180^\circ$ .



9 There are 720 boys and 700 girls in a school.

The probability that a boy chosen at random studies French is  $\frac{2}{3}$

The probability that a girl chosen at random studies French is  $\frac{3}{5}$

9 (a) Work out the number of students in the school who study French.

[3 marks]

$\frac{2}{3}$  of the 720 boys and  
 $\frac{3}{5}$  of the 700 girls.

Answer \_\_\_\_\_

9 (b) Work out the probability that a student chosen at random from the whole school does **not** study French.

[2 marks]

The number of students who do not study French out of the total number of students in the school. This can be expressed as a fraction and represents the probability.

Answer \_\_\_\_\_

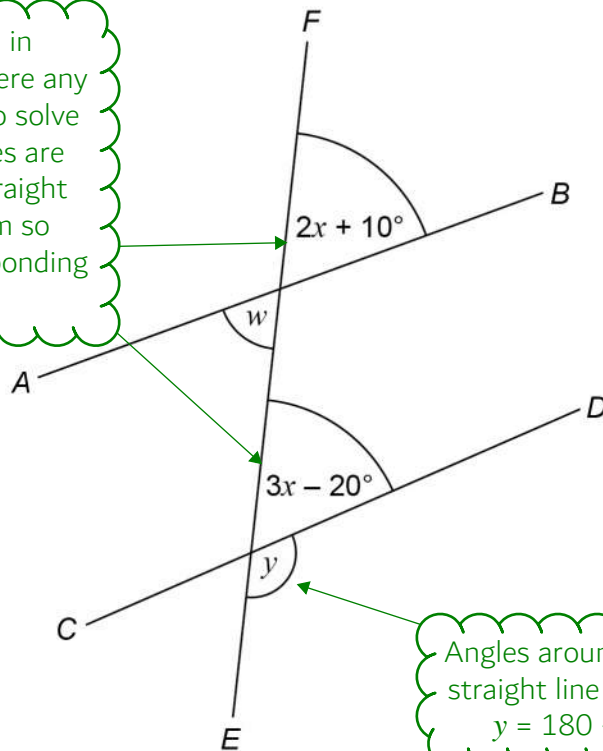
Turn over for the next question





10  $AB$ ,  $CD$  and  $EF$  are straight lines.

The only numbers are in expressions with  $x$ . Are there any equations we can make to solve  $x$ ? Consider that the lines are parallel and there is a straight line going through them so either alternate or corresponding angles can be used.



Not drawn  
accurately

Angles around a point on a straight line equal to  $180^\circ$ .  
 $y = 180 - (3x - 20)$

10 (a) Ava assumes that  $AB$  and  $CD$  are parallel.

What answer should she get for the size of angle  $y$ ?

[4 marks]

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Answer \_\_\_\_\_ degrees



- 10 (b)** In fact,  
 $AB$  and  $CD$  are **not** parallel  
 angle  $w$  is  $60^\circ$

What effect does this have on the size of angle  $y$ ?

Tick a box.

$y$  is bigger

$y$  is the same

$y$  is smaller

Show working to support your answer.

[3 marks]

$2x + 10$  and  $3x - 20$  are no longer corresponding so  
 $x$  will no longer be 30. Instead we can use the fact  
 that vertically opposite angles are equal to find  $x$ .

Turn over for the next question

Turn over ►



- 11 Purple paint is made by mixing red paint and blue paint in the ratio 5 : 2  
Yan has 30 litres of red paint and 9 litres of blue paint.

What is the **maximum** amount of purple paint he can make?

[3 marks]

The volume of the purple paint can be found by adding the volume of the red and blue paint mixed together. Assume all the red paint is used. We can use the ratio to work out how much blue paint would be needed. If there isn't enough blue paint to use all the red paint, all of the blue paint will be used and we need to work out how much red paint would be needed.

Answer \_\_\_\_\_ litres

- 12  $(ar^b)^4 = 16r^{20}$  where  $a$  and  $b$  are positive integers.

Work out  $a$  and  $b$

Laws of indices:

$$(a^x)^y = a^{xy}$$

[2 marks]

$$a^4 = 16$$

$$r^{b \times 4} = r^{20}$$

These can be dealt with separately.

$a =$  \_\_\_\_\_  $b =$  \_\_\_\_\_



- 13 In a class of 28 students  
the mean height of the 12 boys is 1.58 metres  
the mean height of all 28 students is 1.52 metres.

The mean must be less than 1.52 as the boys are more than 1.52.

Work out the mean height of the girls.

[4 marks]

$$\text{Mean for the girls} = \frac{\text{total height of the girls}}{\text{number of the girls}}$$

$$\text{total height of the girls} = \text{total height of the students} - \text{total height of the boys}$$

$$\text{total height} = \text{mean} \times \text{number}$$

$$\text{number of the girls} = \text{number of students} - \text{number of boys}$$

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Answer \_\_\_\_\_ metres

- 14  $xy = c$  where  $c$  is a constant.  
Circle the correct statement.

Increasing  $x$  must decrease  $y$  in order for it to equal to a constant value.  
Doubling  $x$  would have to half  $y$ .

[1 mark]

$y$  is directly proportional to  $x$

$y$  is directly proportional to  $\frac{1}{x}$

$y$  is inversely proportional to  $\frac{1}{x}$

$x$  is directly proportional to  $y$

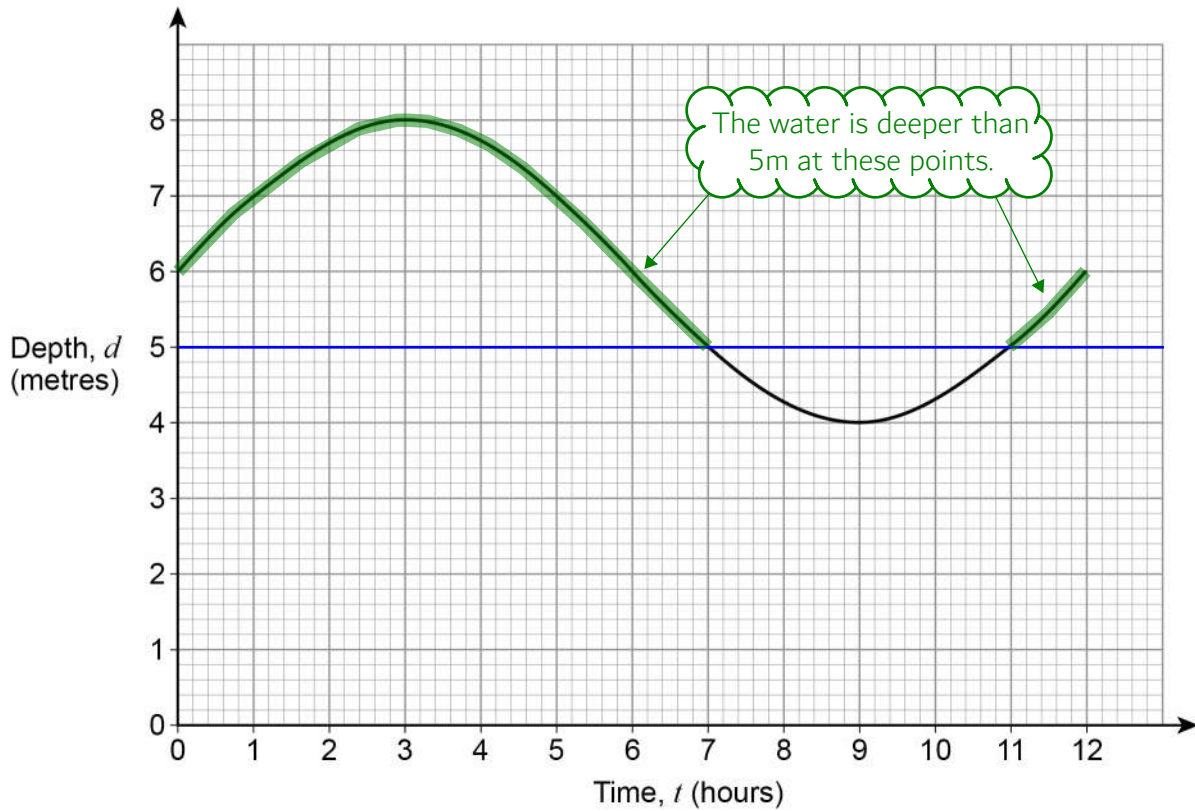
Turn over for the next question



**15** The graph shows the depth of water in a harbour for 12 hours.

$d$  is the depth of water in a harbour in metres

$t$  is the number of hours after 9 am



**15 (a)** For how many of the 12 hours is the depth more than 5 metres?

[1 mark]

Answer \_\_\_\_\_

12 noon is represented by  $t = 3$  as it is 3 hours after 9am. 4pm is when  $t = 7$ .

**15 (b)** By how much does the depth change between 12 noon and 4 pm?

[1 mark]

Answer \_\_\_\_\_ metres



- 16** The value of a new car is £18 000  
The value of the car decreases by  
25% in the first year  
12% in each of the next 4 years.

Work out the value of the car after 5 years.

**[3 marks]**

$$100\% - 25\% = 75\%$$
$$75\% \text{ of } 18000 = 18000 \times 0.75$$
$$100\% - 12\% = \dots$$

Answer £ \_\_\_\_\_

**Turn over for the next question**

Turn over ►



17

Liam drives his car.

He drives the first 9 miles in 9 minutes.

1 mile per minute can be  
converted to miles per hour.

He then drives at an average speed of 70 miles per hour for 1 hour 36 minutes.

He finds this information about his car.

Distance = speed  $\times$  time in hours

| Average speed               | Miles travelled per gallon |
|-----------------------------|----------------------------|
| 65 miles per hour or less   | 50                         |
| More than 65 miles per hour | 40                         |

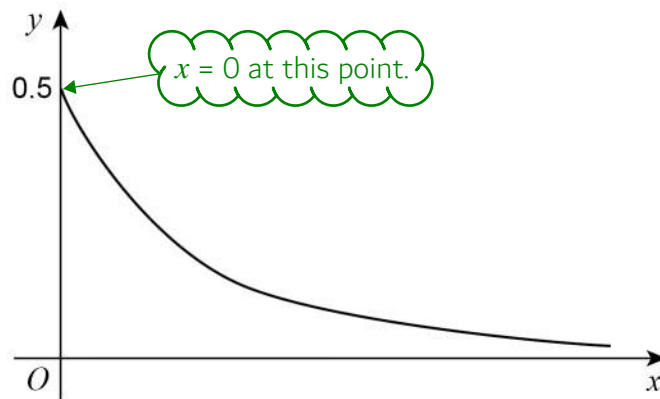
Use the information to show that his car uses less than 3 gallons of petrol for the drive.

**[5 marks]**

The distance travelled as a fraction of the miles  
travelled per gallon is the amount of gallons used.



- 18 Nick sketches the graph of  $y = 0.5^x$  for  $x \geq 0$



Make **one** criticism of his sketch.

[1 mark]

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Turn over for the next question

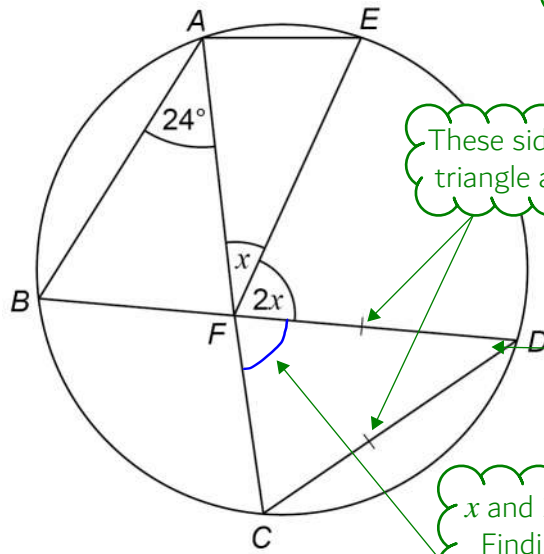
Turn over ►





19

$A, B, C, D$  and  $E$  are points on a circle.  
 $BFD$  and  $AFC$  are straight lines.  
 $DC = DF$



Diagrams are typically reasonably accurate. Check if any steps we make look reasonable.

These sides on the triangle are equal.

Angles in the same segment are equal.

$x$  and  $2x$  lie on straight line  $AFC$ . Finding angle  $CFD$  can help to create an equation in terms of  $x$  as angles around a point on a straight line are  $180^\circ$ .

Not drawn accurately

Work out the size of angle  $x$ .

You **must** show your working which may be on the diagram.

[4 marks]

The base angles of an isosceles triangle are equal

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Answer \_\_\_\_\_ degrees



20 This sign shows when a lift is safe to use.

Total mass of people must be 450 kg or less

Ben and some other people are in the lift.

Their total mass is 525 kg to the nearest 5 kg

Ben gets out.

He has a mass of 78 kg to the nearest kg

Is the lift now safe to use?

You **must** show your working.

[4 marks]

The mass left in the lift = starting mass - Ben's mass  
Consider bounds; what would be the worst-case scenario?  
Adding or subtracting half of the resolution of the measurement calculates the bounds.

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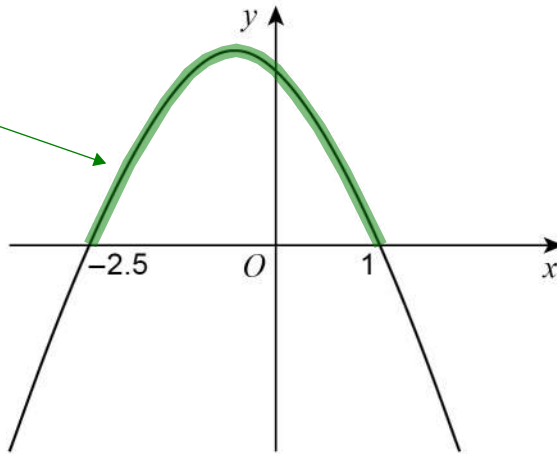
Answer \_\_\_\_\_

Turn over for the next question



- 21 Here is a sketch of  $y = f(x)$  where  $f(x)$  is a quadratic function.  
The graph intersects the  $x$ -axis where  $x = -2.5$  and  $x = 1$

This section of the curve is greater than 0.



Not drawn  
accurately

Circle the solution of  $f(x) > 0$

[1 mark]

$x < -2.5$  or  $x > 1$

$x > -2.5$  or  $x > 1$

$-2.5 < x < 1$

$x > -2.5$  or  $x < 1$



22

Work out an expression for the  $n$ th term of the quadratic sequence

2      17      40      71      ....

Give your answer in the form  $an^2 + bn + c$  where  $a$ ,  $b$  and  $c$  are constants.**[3 marks]**

Find the first difference and then the second difference.  $a$  is half of the second difference. Then work out the linear sequence which needs to be added to the  $an^2$  sequence to get the original quadratic sequence. Check your expression to see if it works.

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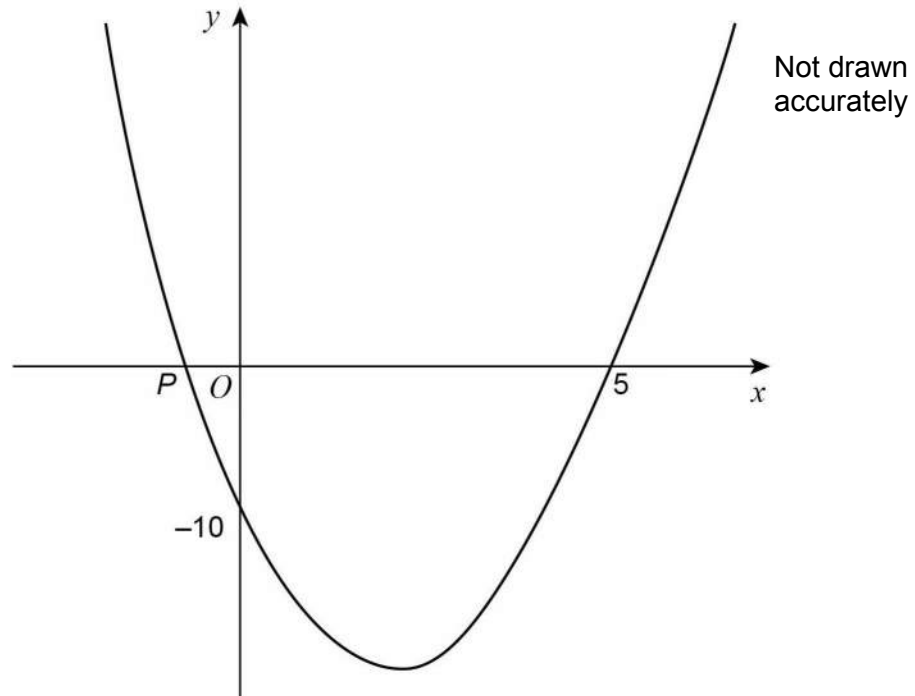
Answer \_\_\_\_\_

**Turn over for the next question****Turn over ►**

23

Here is a sketch of  $y = x^2 + bx + c$ 

The curve intersects

the  $x$ -axis at  $(5, 0)$  and point  $P$ the  $y$ -axis at  $(0, -10)$ Work out the  $x$ -coordinate of the turning point of the graph.**[4 marks]**

The turning point can be found by completing the square. It is also half way between the solutions as quadratics are symmetrical. Either way, we need to find the equation. Substitute in the  $x$  and  $y$  values from the coordinates given to find  $b$  and  $c$ .

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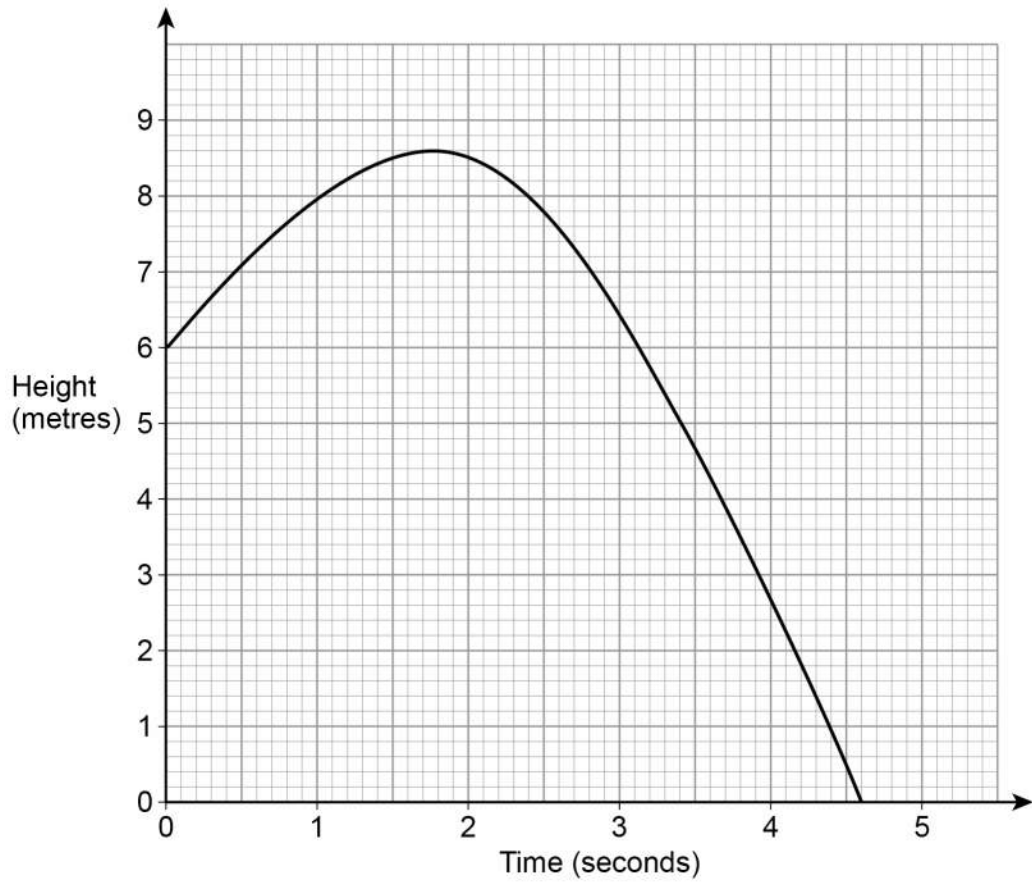
Answer \_\_\_\_\_



24

A ball is thrown from a point 6 metres above the ground.

The graph shows the height of the ball above the ground, in metres.



Estimate the speed of the ball, in m/s, after 1 second.

You **must** show your working.

[2 marks]

An estimate of the gradient on a distance-time graph gives the speed.  
Draw a tangent to the curve at the point where the time is 1 second.

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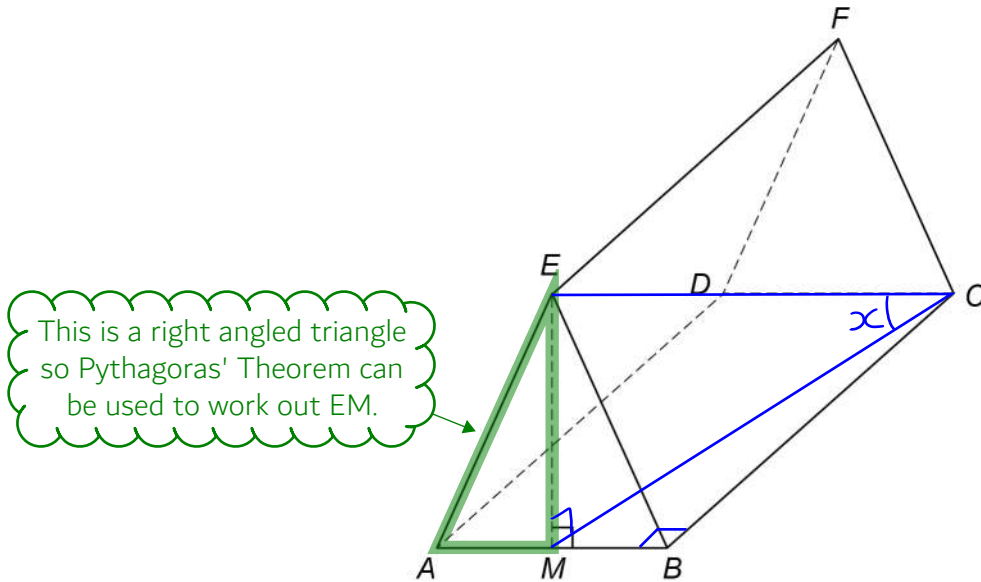


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Answer \_\_\_\_\_ m/s



- 25** Rectangle  $ABCD$  is the horizontal base of a triangular prism  $ABCDEF$ .  
 $AE = BE$   
 $E$  is vertically above  $M$ , the midpoint of  $AB$ .  
 $AB = 16$  cm       $AE = 17$  cm       $BC = 30$  cm



This is a right angled triangle  
so Pythagoras' Theorem can  
be used to work out  $EM$ .

- 25 (a)** Show that  $EM = 15$  cm

[2 marks]

$$a^2 + b^2 = c^2$$

Where  $c$  is the longest side.



25 (b) Work out the size of angle  $ECM$ .

[4 marks]

SOHCAHTOA

Right angled trigonometry can be used on triangle  $ECM$  to find the angle  $ECM$ . List SOH CAH TOA as formula triangles and tick what sides we have. We have sides  $EM$  and  $MC$ , which can be found using Pythagoras' Theorem on triangle  $ECB$ .

O: opposite

H: hypotenuse

A: adjacent

Answer \_\_\_\_\_ degrees

Turn over for the next question

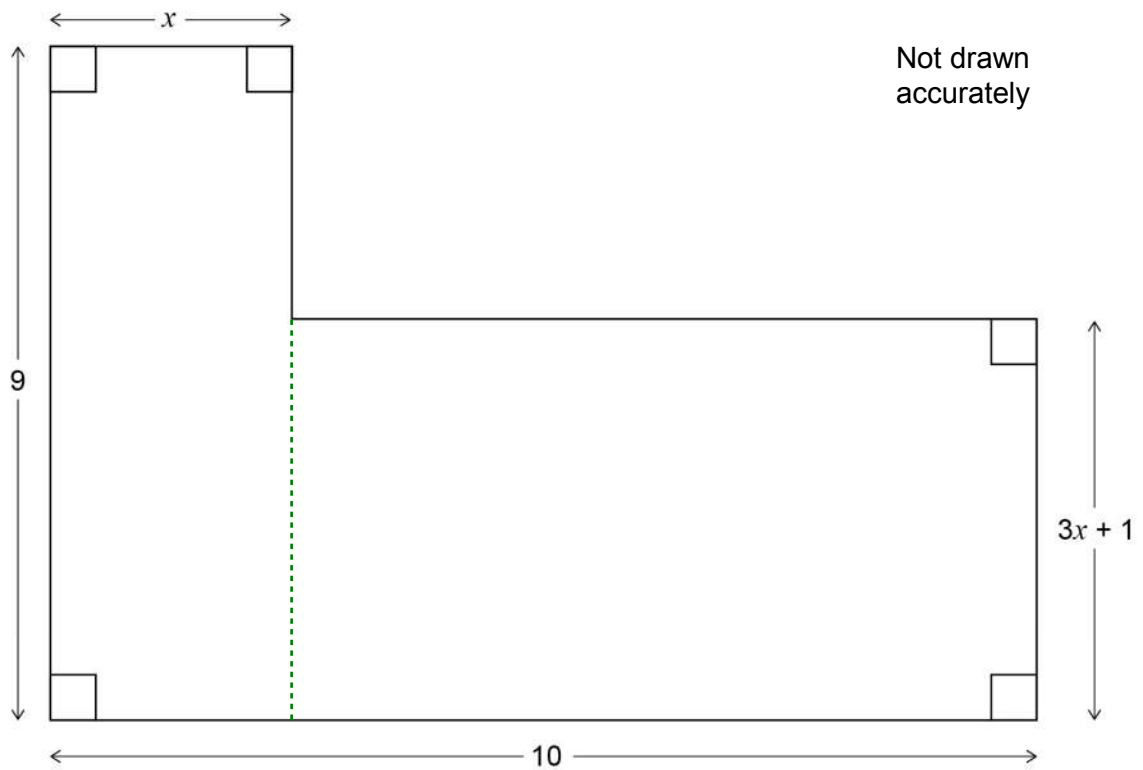




26

Here is an L-shape.

All dimensions are in centimetres.



The area of the L-shape is  $65 \text{ cm}^2$

Work out the value of  $x$ .

[6 marks]

Area of rectangle = base  $\times$  height

Adding together the area of the rectangles gives 65.

We should get a quadratic which can be solved by the quadratic formula.

Answer \_\_\_\_\_

Turn over for the next question

6

Turn over ►



27

Prove that  $x^2 + x + 1$  is always positive.**[3 marks]**

Completing the square finds the turning point (in this case the minimum point) of a quadratic.

$$y = ax^2 + bx + c = a\left(x + \frac{b}{2a}\right)^2 + c - a\left(\frac{b}{2a}\right)^2$$

**END OF QUESTIONS****3**