

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

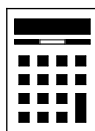
Morning

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>	



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  $2\mathbf{a} + \mathbf{b}$ 

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

$$2\mathbf{a} = \begin{pmatrix} -8 \\ -2 \end{pmatrix} + \mathbf{b} = \begin{pmatrix} 3 \\ -1 \end{pmatrix}$$

$$\begin{aligned} -8 + 3 &= -5 \\ -2 - 1 &= -3 \end{aligned}$$

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

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

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

[1 mark]

2 Which of these values of  $n$  makes  $2.7 \times 10^n$  a cube number?

Circle your answer.

27 is a cube number

0

1

2

3

$$2.7 \times 10^1 = 27$$

[1 mark]

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

Circle your answer.

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

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

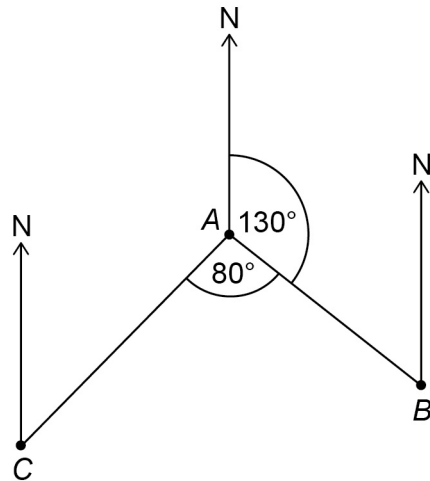
$$w = \frac{y}{2x}$$

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

[1 mark]



4

Not drawn  
accurately

Work out the bearing of C from A,  
Circle your answer.

$$130 + 80 = 210$$

[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.

[2 marks]

$$\frac{\text{Number of times}}{\text{coin is thrown}} \times 0.4 = 200$$

$$\begin{aligned} \text{Times} &= 200 \div 0.4 \\ &= 500 \end{aligned}$$

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]

A :  $3 \leq 3x < 18$  Solutions:  
 $1 \leq x < 6$  1, 2, 3, 4, 5

B :  $3 < 3x \leq 18$   
 $1 < x \leq 6$  2, 3, 4, 5, 6

A includes 1, B doesn't. } because of  
B includes 6, A doesn't } signs  
 $\leq$  and  $<$   
 $\geq$  and  $>$



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]

values that round to 6

Answer 5.5 m  $\leq$  length < 6.5 m

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

Olly says,

$$3.5 \leq m < 4.5$$

“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]

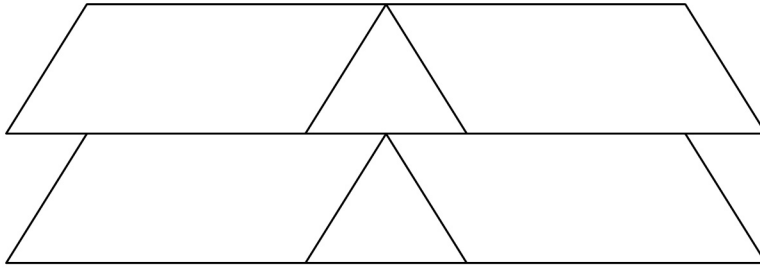
could :  $6.4 + 4.4 = 10.8\text{m}$  - rounds to 11m

BUT :  $5.5 + 3.5 = 9\text{m}$  - doesn't round to 9

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.

[1 mark]

Must be true

Could be true

*could be isosceles*

Must be false

- 8 (b) The triangles are congruent.

[1 mark]

Must be true

*parallelograms are congruent*

Could be true

Must be false



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]

$$\text{Boys} : \frac{2}{3} \times 720 = 480$$

$$\text{Girls} : \frac{3}{5} \times 700 = 420$$

$$\text{Total} = 480 + 420$$

Answer 900 students

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

[2 marks]

$$\text{Total students} : 700 + 720 = 1420$$

$$\text{Don't do French} : 1420 - 900 = 520$$

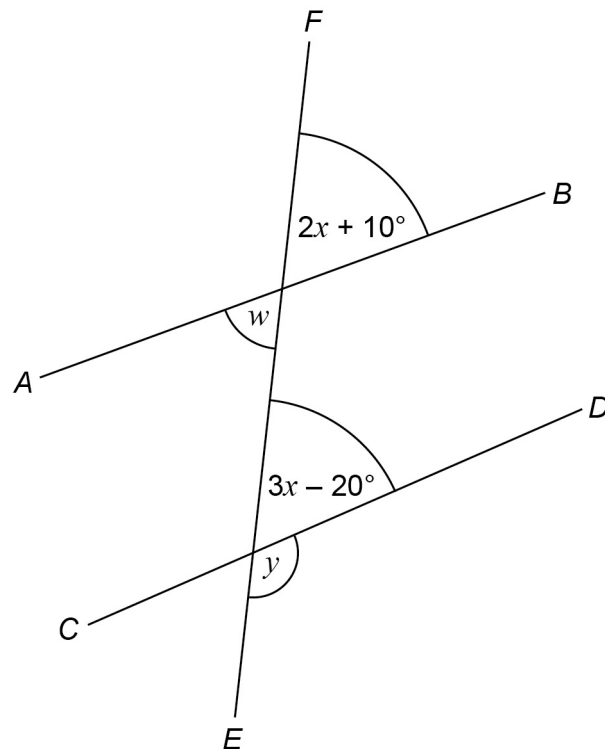
$$\text{Probability} = \frac{520}{1420}$$

Answer =  $\frac{26}{71}$

Turn over for the next question



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



Not drawn  
accurately

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

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

[4 marks]

If parallel, can use congruent angle rule

$$3x - 20 = 2x + 10$$

$$x = \begin{matrix} +20 \\ -2x \end{matrix} 30^\circ$$

angles on straight line add to 180

$$y = 180 - (3(30) - 20)$$

$$= 180 - 70$$

Answer 110 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]

$$w = 60, \quad 2x + 10 = 60 \quad - \text{opposite angles are equal}$$

$$\therefore 2x = 50$$

$$x = 25$$

$$y = 180 - (3 \times 25 - 20)$$

$$= 180 - 55 = 125^\circ$$

$$125 > 110$$

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]

Using 30l red :  $\begin{array}{c} r \quad b \\ 5 : 2 \\ \times 6 \quad \quad \times 6 \\ \hline 30 : 12 \end{array}$  not enough blue

Using 9l blue :  $\begin{array}{c} 5 : 2 \\ \times 4.5 \quad \quad \times 4.5 \\ \hline 22.5 : 9 \end{array}$

$$22.5 + 9 =$$

Answer 31.5 litres

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

Work out  $a$  and  $b$

[2 marks]

$$(ar^b)^4 = a^4 r^{4b}$$

equate

$$a^4 = 16$$

$$4b = 20$$

$$a = \sqrt[4]{16} = 2$$

$$b = 5$$

$$a = \underline{2} \quad b = \underline{5}$$



- 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.

Work out the mean height of the girls.

[4 marks]

$$\begin{aligned} \text{Total height of boys: } & 12 \times 1.58 = 18.96 \\ \text{Total height of all: } & 28 \times 1.52 = 42.56 \end{aligned}$$

$$\begin{aligned} \text{Total height of girls: } & 42.56 - 18.96 = 23.6 \\ \text{Number of girls} &= 28 - 12 = 16 \\ \text{Mean: } & 23.6 \div 16 \end{aligned}$$

Answer 1.475 metres

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

$$y = \frac{c}{x}$$

$$y = k \times \frac{1}{x} = y = \frac{k}{x}$$

[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  $y$

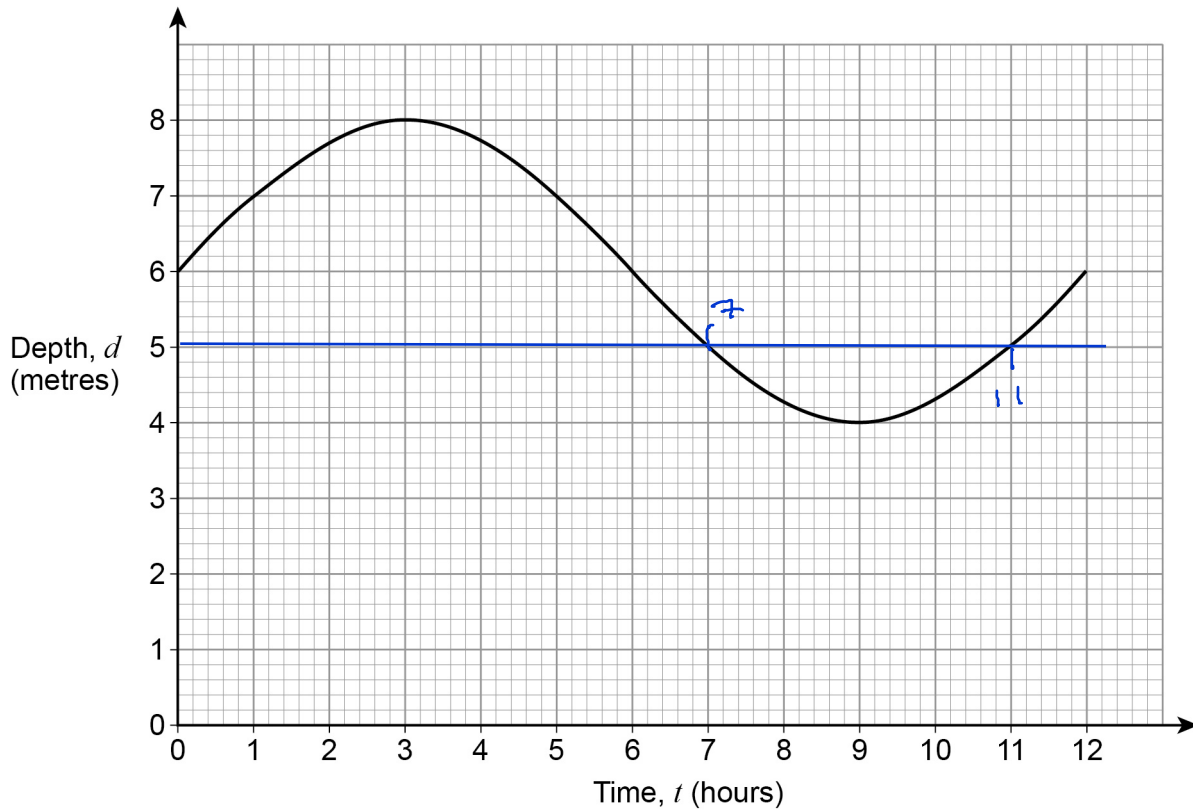
Turn over for the next question



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]

$$7 + 1 =$$

Answer 8 hours

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

[1 mark]

At 12  $t=3$ ,  $d=8$

$$8 - 5 = 3$$

At 4,  $t=7$ ,  $d=5$  Answer 3 metres



16

The value of a new car is £18 000

The value of the car decreases by

25% in the first year

$$-100\% - 25\% = 75\% = 0.75 \times$$

12% in each of the next 4 years.

$$100\% - 12\% = 88\% = \times 0.88$$

Work out the value of the car after 5 years.

**[3 marks]**

$$\text{First year} : 18,000 \times 0.75 = 13500$$

$$\text{Fifth year } (n=4) \quad 13500 \times 0.88^4 \\ = 8095.89$$

Answer £ 8095.89**Turn over for the next question****Turn over ►**

17

Liam drives his car.

- ① He drives the first 9 miles in 9 minutes.  
② He then drives at an average speed of 70 miles per hour for 1 hour 36 minutes.

He finds this information about his car.

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]**

$$\textcircled{1} \quad 9 \text{ miles in } 9 \text{ min at } 60 \text{ mph}$$

$$50 \text{ miles per gallon}$$

$$\text{so uses } \frac{9}{50} = 0.18 \text{ gallons}$$

$$\textcircled{2} \quad 70 \text{ mph} \times 1 \frac{36}{60} \text{ h} = 112 \text{ miles}$$

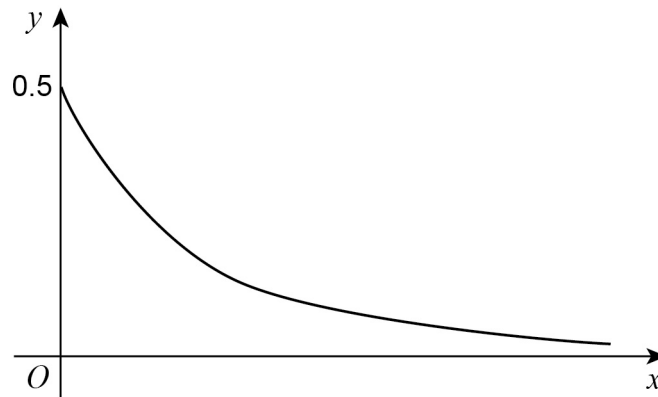
$$40 \text{ miles per gallon}$$

$$\text{so uses } \frac{112}{40} = 2.8 \text{ gallons}$$

$$2.8 + 0.18 = 2.98 \text{ gallons which is less than } 3 \text{ gallons}$$



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



Make **one** criticism of his sketch.

[1 mark]

when  $x=0$   $y=0.5^0=1$   
The curve is not drawn correctly

Turn over for the next question

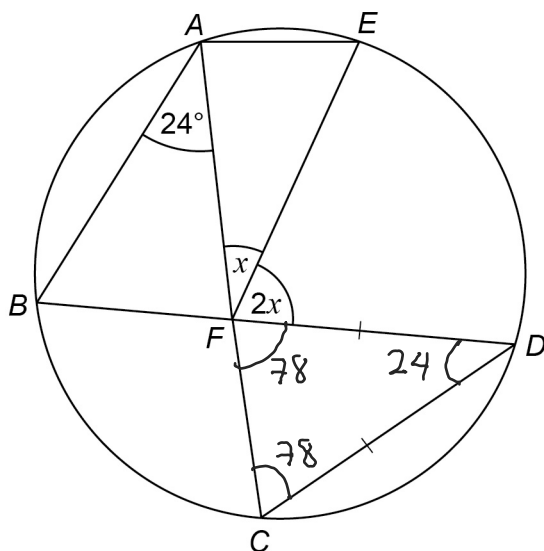


19

$A, B, C, D$  and  $E$  are points on a circle.

$BFD$  and  $AFC$  are straight lines.

$DC = DF$



Not drawn  
accurately

Work out the size of angle  $x$ .

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

[4 marks]

$$\angle BOC = 24^\circ$$

Angles in the same  
segment are equal

$$\angle OFC = \frac{180 - 24}{2} = 78^\circ$$

Base angles in  
isosceles triangle  
are equal

$$x + 2x + 78 = 180$$

$$3x = 102$$

$$x = 34$$

angles on a  
straight line add to  
 $180^\circ$

Answer 34 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

$$522.5 \leq \text{kg} < 527.5$$

Ben gets out.

He has a mass of 78 kg to the nearest kg

$$77.5 \leq \text{Ben} < 78.5$$

Is the lift now safe to use?

You **must** show your working.

[4 marks]

Maximum weight of the lift :

$$527.5 - 77.5 = 450\text{kg}$$

max weight  
of lift

min weight  
of Ben

So it is safe to use

Answer yes

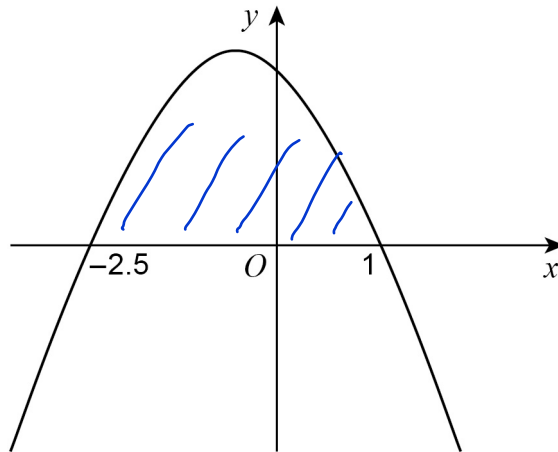
Turn over for the next question



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  $x = 1$



Not drawn  
accurately

Circle the solution of  $f(x) > 0$  *-above x axis in between solutions* [1 mark]

$$x < -2.5 \text{ or } x > 1$$

$$x > -2.5 \text{ or } x > 1$$

$$-2.5 < x < 1$$

$$x > -2.5 \text{ or } x < 1$$



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]**

$$\begin{array}{ccccccc}
 2 & , & 17 & , & 40 & , & 71 \\
 \underbrace{\hspace{1.5cm}} & & \underbrace{\hspace{1.5cm}} & & \underbrace{\hspace{1.5cm}} & & \\
 +15 & & +23 & & +31 & & \\
 & & \underbrace{\hspace{1.5cm}} & & \underbrace{\hspace{1.5cm}} & & \\
 & & +8 & & +8 & & 
 \end{array}$$

$$8/2 = 4 \quad \therefore 4n^2$$

$$n \quad 1 \quad 2 \quad 3 \quad 4$$

$$\text{seq} \quad 2, 17, 40, 71$$

$$4n^2 \quad 4, 16, 36, 64$$

$$\begin{array}{ccccccc}
 -5 & & -2 & , & 1 & , & 4 & , & 7 \\
 \underbrace{\hspace{1.5cm}} & & \underbrace{\hspace{1.5cm}} & & \underbrace{\hspace{1.5cm}} & & \underbrace{\hspace{1.5cm}} & & \\
 -3 & & +3 & & +3 & & +3 & & 
 \end{array}$$

$$\text{All together : } 4n^2 + 3n - 5$$

$$\text{Answer } \underline{4n^2 + 3n - 5}$$

Using Difference  
 $n$   
 $0$   $0^{\text{th}}$  term

$\leftarrow n^{\text{th}}$  term is  
 $3n - 5$

Turn over for the next question

Turn over ►

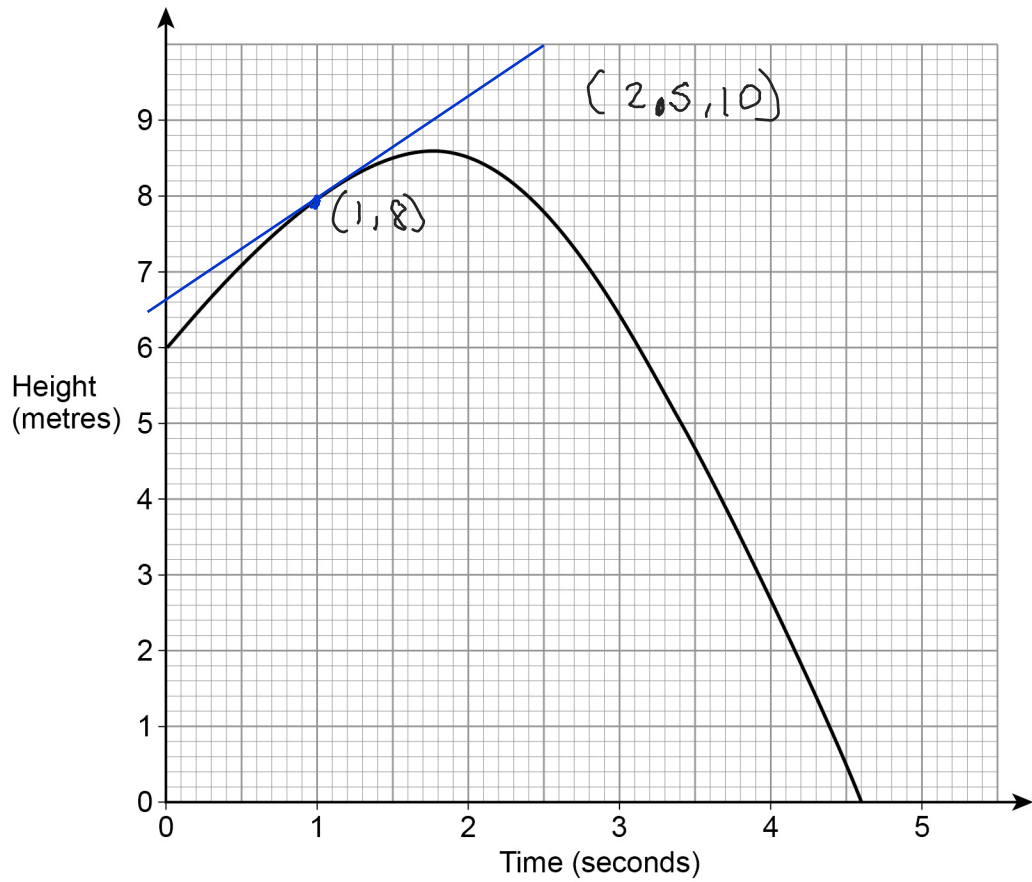




24

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.

*- tangent at 1*

You **must** show your working.

[2 marks]

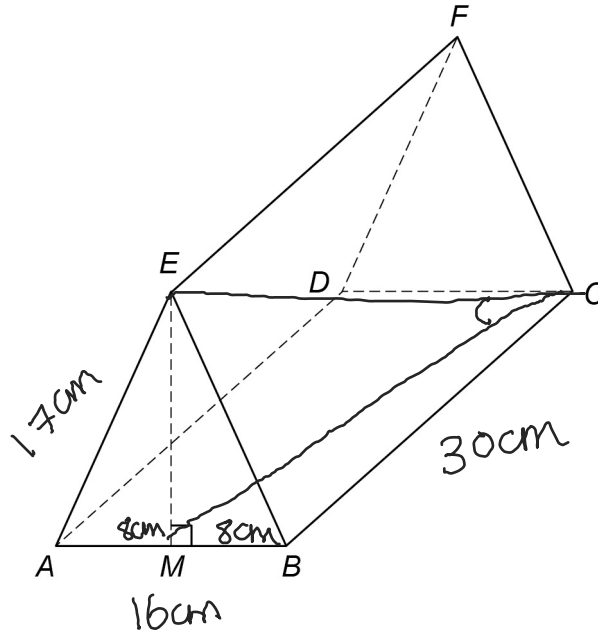
$$\text{gradient} = \frac{y_1 - y_2}{x_1 - x_2} = \frac{10 - 8}{2.5 - 1}$$

$$= \frac{2}{1.5} = \frac{4}{3}$$

Answer  $\frac{4}{3}$  m/s

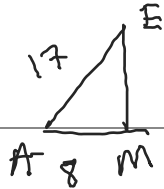


- 25** Rectangle  $ABCD$  is the horizontal base of a triangular prism  $ABCDEF$ .  
 $AE = BE$   
 $E$  is vertically above  $M$ , the midpoint of  $AB$ .  
 $AB = 16 \text{ cm}$      $AE = 17 \text{ cm}$      $BC = 30 \text{ cm}$



- 25 (a)** Show that  $EM = 15 \text{ cm}$

[2 marks]



$$\text{Pythagoras : } a^2 + b^2 = c^2$$

$$17^2 - 8^2 = EM^2$$

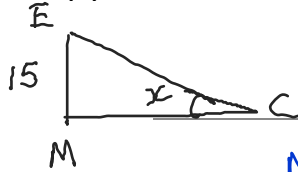
$$225 = EM^2$$

$$15 \text{ cm} = EM$$



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

[4 marks]

 $MC =$ 

$$MC^2 = 30^2 + 15^2$$

$$MC^2 = 964$$

$$MC = \sqrt{964}$$

$$\tan x = \frac{\text{opp}}{\text{adj}}$$

$$\tan x = \frac{15}{\sqrt{964}}$$

$$x = \tan^{-1} \left( \frac{15}{\sqrt{964}} \right)$$

$$= 25.8^\circ$$

Answer 25.8 degrees

Turn over for the next question

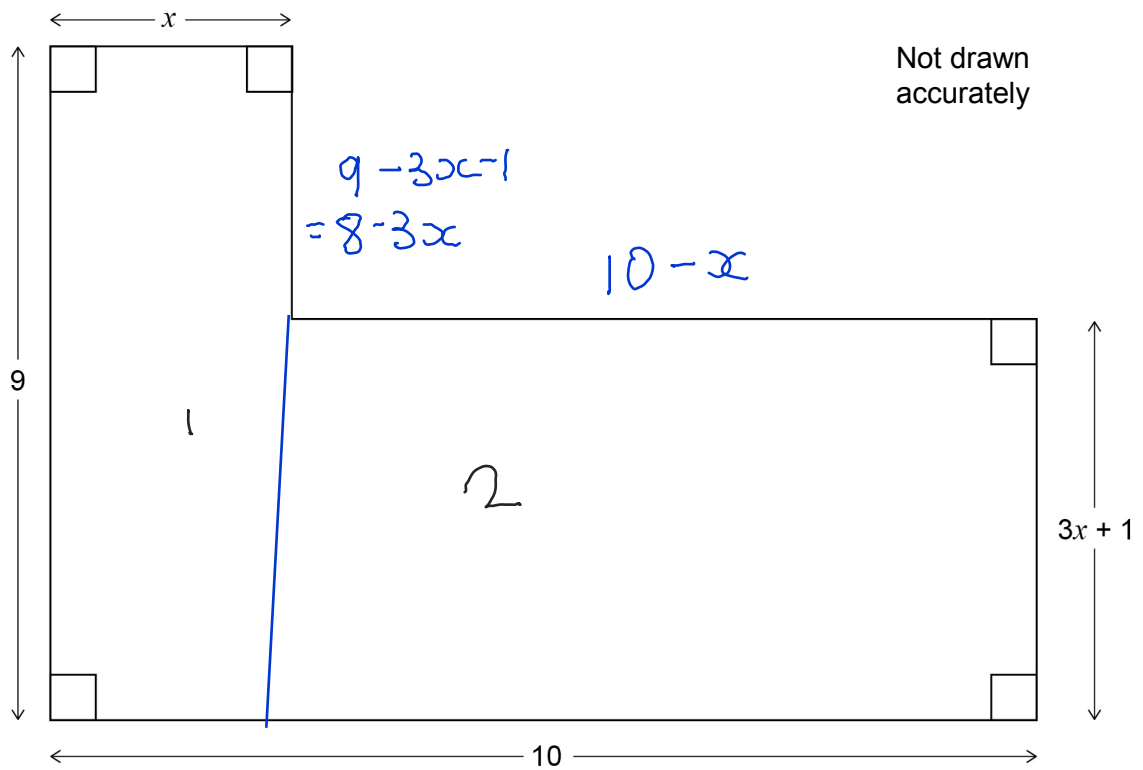
Turn over ►



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]

$$\text{Area of 1} = 9 \times x = 9x$$

$$\text{Area of 2} = (10-x)(3x+1) = -3x^2 + 29x + 10$$

$$\text{Total Area: } -3x^2 + 29x + 10 + 9x$$

$$65 = -3x^2 + 38x + 10$$

$$3x^2 - 38x + 55 = 0$$

$\begin{matrix} a & & b & & c \\ \underbrace{\hspace{1cm}} & & \underbrace{\hspace{1cm}} & & \underbrace{\hspace{1cm}} \\ & +32 & & -38x & & -10 \end{matrix}$

Quadratic Formula:

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$x = \frac{38 \pm \sqrt{38^2 - 4 \times 55 \times 3}}{2 \times 3}$$

$$= \frac{38 \pm \sqrt{784}}{6}$$

$$\text{Adding } x = \frac{38 + 28}{6} = 11$$

$$\text{subtracting } x = \frac{38 - 28}{6} = \frac{10}{6} = \frac{5}{3}$$

$x < 10$  as  $10 - x$  is a length

$$\text{so } x \neq 11$$

Answer  $\frac{5}{3}$

Turn over for the next question

Turn over ►



27

Prove that  $x^2 + x + 1$  is always positive.

[3 marks]

To prove a quadratic is positive  
complete the square

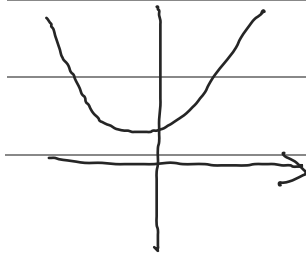
$$\begin{aligned} x^2 + x + 1 &= (x + 0.5)^2 - 0.5^2 + 1 \\ &= (x + 0.5)^2 + 0.75 \end{aligned}$$

Turning point is  $(-0.5, 0.75)$

which is above  $x$  axis and

the coefficient of  $x^2$  is positive.

Therefore  $x^2 + x + 1$  will always  
be positive



**END OF QUESTIONS**



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