

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

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.

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	
TOTAL	

Advice

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



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

[1 mark]

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

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

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

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

$$2 \times \begin{pmatrix} -4 \\ -1 \end{pmatrix} + \begin{pmatrix} 3 \\ -1 \end{pmatrix}$$

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

2 Which of these values of n makes 2.7×10^n a cube number?

Circle your answer.

[1 mark]

0

1

2

3

$$n=0 \rightarrow 2.7$$

$$n=1 \rightarrow 2.7 \times 10 = 27 \text{ cube}$$

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

Circle your answer.

[1 mark]

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

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

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

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

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

 $\times w$

$$2xw = y$$

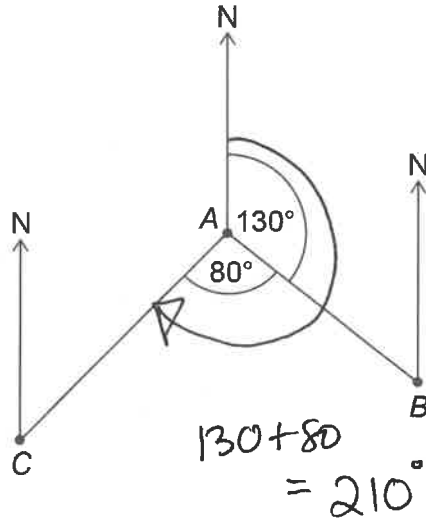
 $\div 2x$

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



4

Not drawn accurately



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

[1 mark]

030°

130°

150°

210°

Turn over for the next question

4

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.

$$\frac{\text{estimated tails}}{200} = 0.4 \times \text{total n}^{\circ} \text{ of times thrown.}$$

[2 marks]

$$\frac{200}{0.4} = 500$$

$$\text{OR } 0.4 = 40\% \text{ of the time tails} = 200 \text{ times}$$

$$\text{so } 100\% = 500 \text{ times.}$$

Build up to

Answer 500

- 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]

$$A: 3 \leq 3x < 18$$

$$B: 3 < 3x \leq 18$$

$$(\div 3) 1 \leq x < 6$$

$$1 < x \leq 6$$

possible values of x 1, 2, 3, 4, 5

Possible values of x 2, 3, 4, 5, 6



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]

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,

"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]

$3.5_m \leq \text{Length} < 4.5_m$

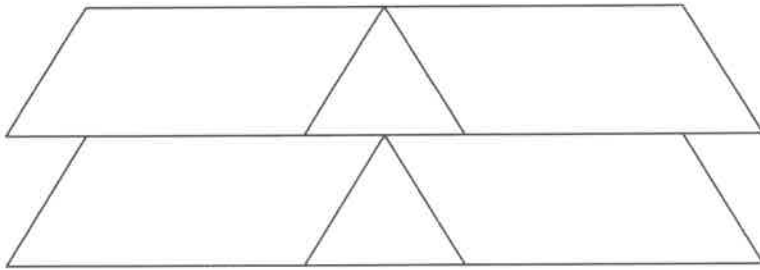
Turn over for the next question

Try a pair of numbers within each range
that when they add, the total is
greater than or equal to 10.5m.

eg. $6.45 + 4.3 = 10.75 = 11m$ to nearest metre



- 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

Must be false

- 8 (b) The triangles are congruent.

[1 mark]

Must be true

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]

$$\frac{2}{3} \times 720 = 480 \qquad \frac{3}{5} \times 700 = 420$$

$$480 + 420$$

Answer 900

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

[2 marks]

$$720 + 700 = 1420$$

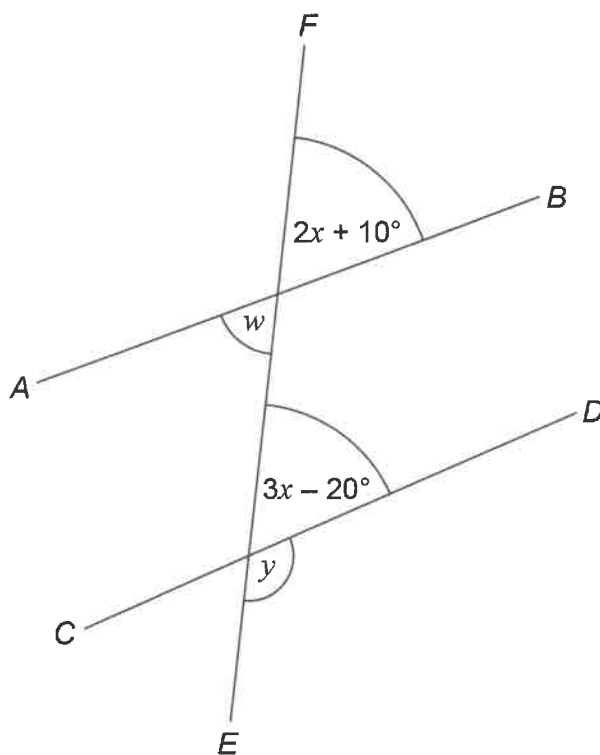
$$- 900 = 520 \text{ who don't study french}$$

Answer $\frac{520}{1420}$

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]

$$\text{If Parallel then } 2x + 10 = 3x - 20$$

$$\begin{array}{r} (-2x) \\ 10 = x - 20 \\ (+20) \end{array} \quad 30 = x$$

$$\text{Then } 3x - 20$$

$$= 3 \times 30 - 20 =$$

$$90 - 20 = 70$$

$$3x - 20 \text{ only equal to } 180^\circ$$

$$180 - 70 = 110$$

Answer 110 degrees



- 10 (b)** In fact,
 AB and CD are **not** parallel
 angle w is 60°

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]

$$\begin{aligned} \text{When } w=60 \quad 2x+10 &= 60 \\ 2x &= 50 \\ x &= 25 \end{aligned}$$

$$\begin{aligned} \text{angle at the bottom} \quad 3x-20 \\ 3 \times 25 - 20 = 55 \end{aligned}$$

$$\text{so } y = 180 - 55 = 125^\circ$$

y was 110 before, now is 125°

so bigger

Turn over for the next question



- 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]

if uses all red $\times 6$

$$R : B$$

$$5 : 2$$

$$30 : 12$$

$$\text{total} = 30 + 12$$

BUT ~~is~~ not enough

Blue to use all
30 litres of red.

try using 9 litres of Blue.

R : B

$$\times 4.5$$

$$5 : 2$$

$$22.5 : 9$$

total.

$$22.5 + 9 =$$

Answer 31.5 litres

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

Work out a and b

$$a^4 r^{4b} = 16 r^{20}$$

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

$$4b = 20$$

$$b = 5$$

[2 marks]

$$a^4 = 16$$

$$a = 2$$

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



- 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]

$$\text{mean} = \frac{\text{total height}}{n}$$

12 Boys 28 students

$$\text{mean} = \frac{\text{total height of 12 Boys}}{12} \qquad 1.52 = \frac{\text{total height of 28 students}}{28}$$

$$12 \times 1.58 = \text{total height of 12 Boys} \qquad 28 \times 1.52 = \text{total height of 28 students}$$

$$18.96 = \text{total height of 12 Boys} \qquad 42.56 = \text{total height of 28 students}$$

$$\text{total height of 16 girls} = 42.56 - 18.96$$

$$= 23.6 \rightarrow \text{mean}_{16 \text{ girls}} = \frac{23.6}{16} = 1.475$$

Answer 1.48 metres

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

$$xy = c$$

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

is inverse
proportion
equation

[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

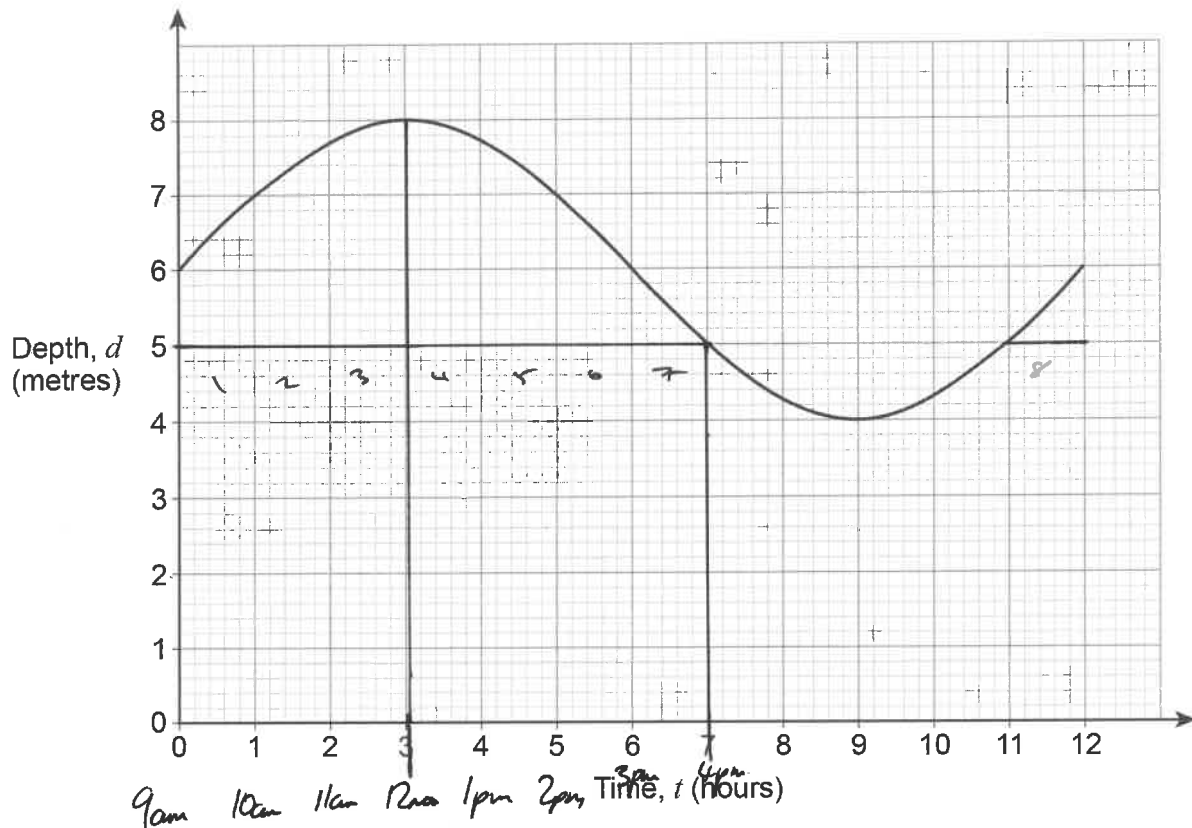
Turn over for the next question



- 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 8 Hours.

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

[1 mark]

$$8 - 5$$

Answer 3 metres



17

Liam drives his car.

He drives the first 9 miles in 9 minutes.

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.

1st stage

$$9 \text{ miles} = 9 \text{ mins}$$

$$1 \text{ miles} = 1 \text{ min}$$

$$60 \text{ miles} = 60 \text{ mins}$$

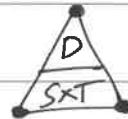
i.e. 60mph

$$\begin{array}{l} \text{so } \left(\begin{array}{l} 50 \text{ miles} = 1 \text{ gallon} \\ 1 \text{ mile} = 0.02 \text{ gallons} \end{array} \right) \div 50 \\ \times 9 \left(\begin{array}{l} 9 \text{ miles} = 0.18 \text{ gallons} \end{array} \right) \times 9 \end{array}$$

2nd stage

$$1 \text{ HR } 36 \text{ mins} \quad \frac{36}{60} = \frac{3}{5} = 0.6 \text{ HRS}$$

$$1.6 \text{ Hours}$$



$$\begin{array}{l} \text{Dist} = 70 \times 1.6 \\ = 112 \text{ miles} \end{array}$$

$$\begin{array}{l} \div 40 \left(\begin{array}{l} 40 \text{ miles} = 1 \text{ gallons} \\ 1 \text{ mile} = 0.025 \text{ gallons} \end{array} \right) \div 40 \\ \times 112 \left(\begin{array}{l} 112 \text{ miles} = 2.8 \text{ gallons} \end{array} \right) \times 112 \end{array}$$

$$0.18 + 2.8 = 2.98 \text{ gallon}$$

in total.

which is less than 3 gallons



- 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]

25% decrease means dec multiplier of 0.75

$$18000 \times 0.75 = 13500 \text{ after 1st year.}$$

12% decrease = 0.88 dec multiplier

$$13500 \times 0.88^4 = 8095.88$$

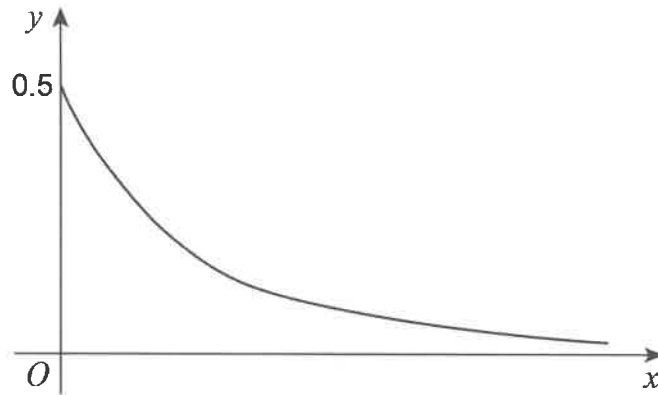
$$\approx \pounds 8096$$

Answer £ £8096

Turn over for the next question



- 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 y value on
the graph is ~~1~~ NOT 1 it is 0.5

Turn over for the next question

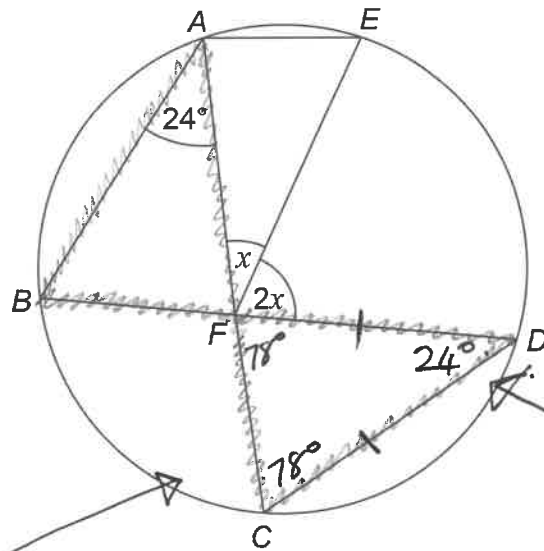


19

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

BFD and AFC are straight lines.

DC = DF

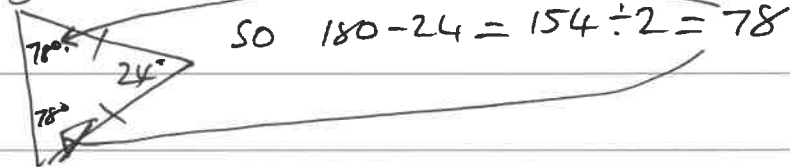
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accurately

umm is circle theorem
angles on the
same arc
are equal.

Work out the size of angle x .You **must** show your working which may be on the diagram.

[4 marks]

triangle CDF is isosceles.



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

$$3x + 78 = 180$$

$$(-78) \quad 3x = 102$$

$$(\div 3) \quad x = 34^\circ$$

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

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.

nearest 5 kg

[4 marks]

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

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

Total cannot be greater than 450 kg

$$\begin{aligned} \text{Biggest mass} &\rightarrow \text{assume total mass is max value} - \text{Ben's smallest weight} \\ &= 527.5 - 77.5 \\ &= 450 \text{ kg} \end{aligned}$$

Answer Yes

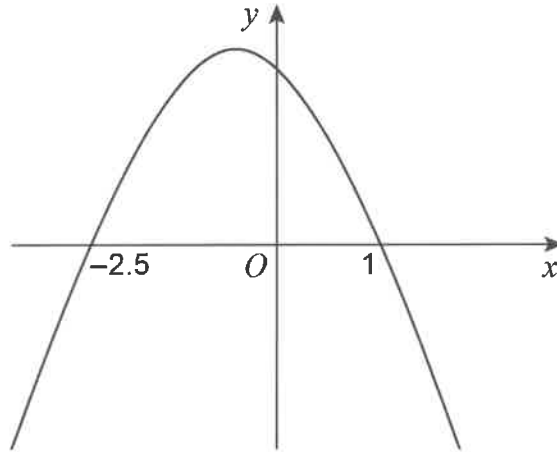
Turn over for the next question



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 $f(x) > 0$

*means graph is above x axis
is values of x between
-2.5 and 1*

[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

$$\begin{array}{cccc}
 2 & 17 & 40 & 71 & \dots \\
 \underbrace{\quad} & \underbrace{\quad} & \underbrace{\quad} & & \\
 15 & 23 & 31 & & \\
 \underbrace{\quad} & \underbrace{\quad} & & & \\
 8 & 8 & & &
 \end{array}$$

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

$$\text{2nd difference} = 8$$

$$\text{so } 4n^2$$

[3 marks]

	2	17	40	71	
$4n^2$	4	16	36	64	
difference	-2	1	4	7	nth term is $3n-5$

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

Answer _____

Turn over for the next question

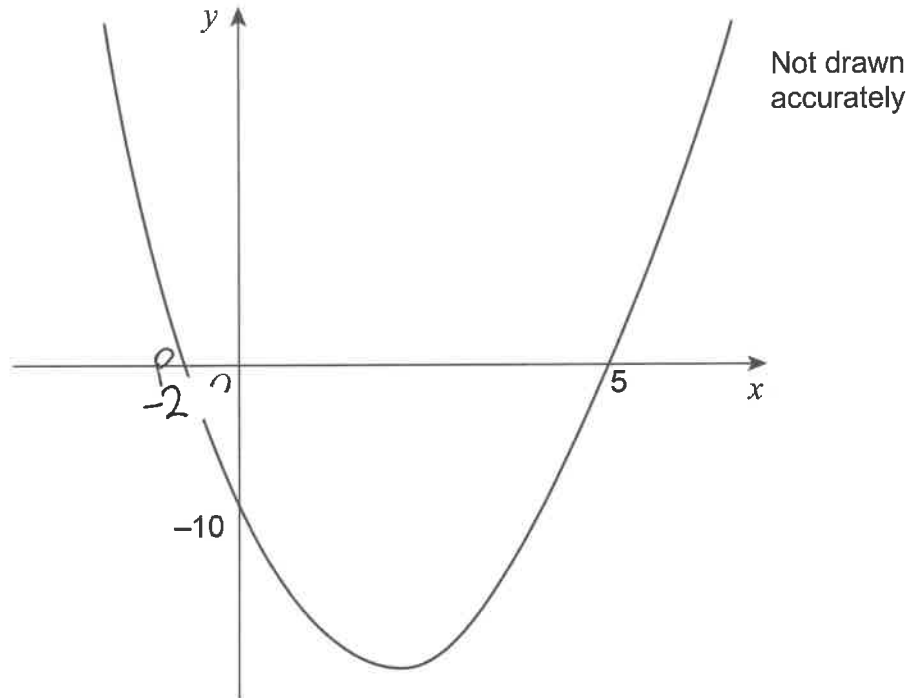
Turn over ►



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]

Crosses y axis at -10 means $y = x^2 + bx - 10$ Crosses ~~at~~ x axis at 5 ie $x = 5$ $y = 0$

$$0 = 5^2 + 5b - 10$$

$$-15 = 5b$$

$$b = -3 \quad \text{so}$$

midpoint of -2 & 5 is 1.5

$$\begin{aligned} x^2 + bx + c &= 0 \\ x^2 - 3x - 10 &= 0 \\ (x - 5)(x + 2) &= 0 \\ x = 5 \quad x = -2 \end{aligned}$$

ie x coord is 1.5

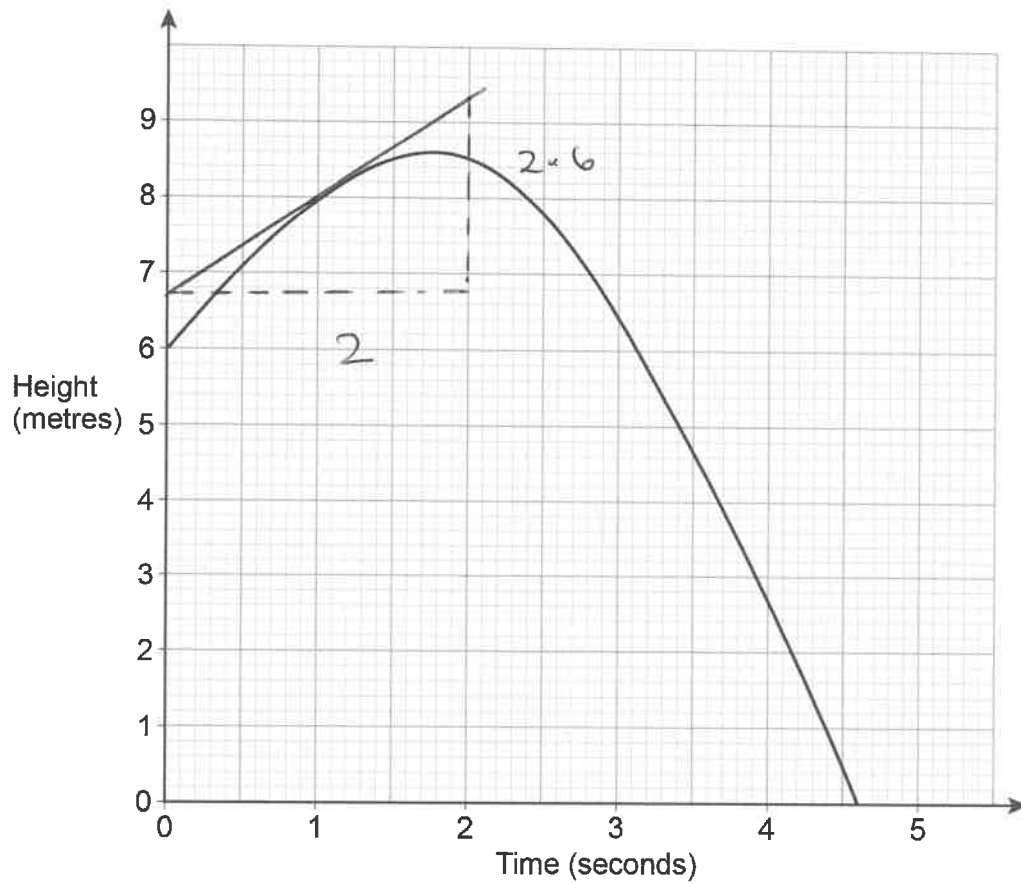
Answer _____



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]

$$\text{speed is gradient at } t=1$$

$$\text{speed} \approx \frac{2.6}{2} \approx 1.3 \text{ m s}^{-1}$$

Answer 1.3 approx m/s



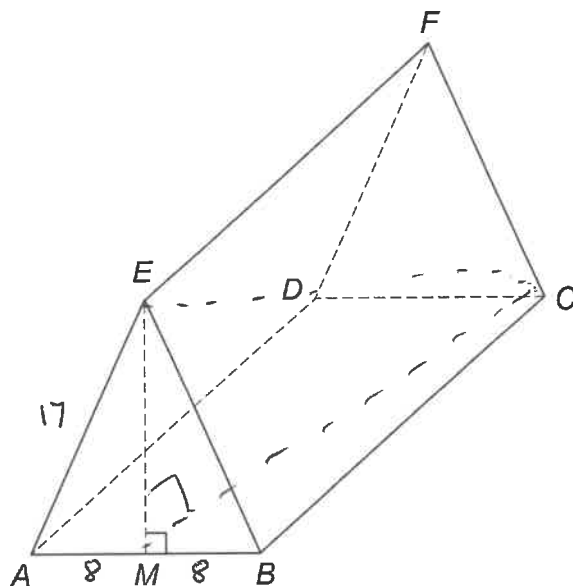
25

Rectangle $ABCD$ is the horizontal base of a triangular prism $ABCDEF$.

$$AE = BE$$

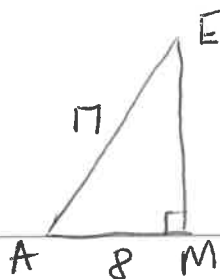
E is vertically above M , the midpoint of AB .

$$AB = 16 \text{ cm} \quad AE = 17 \text{ cm} \quad BC = 30 \text{ cm}$$



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

[2 marks]



$$EM = \sqrt{17^2 - 8^2}$$

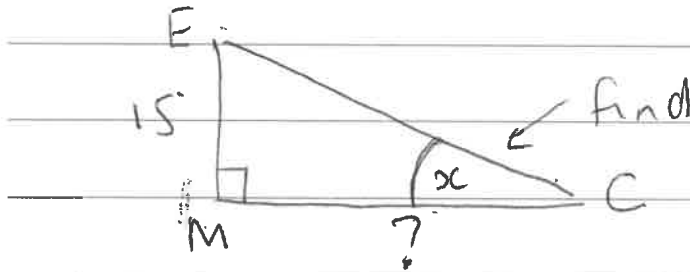
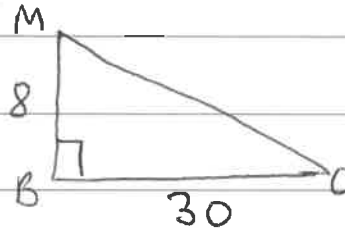
$$EM = \sqrt{289 - 64}$$

$$EM = \sqrt{225} = 15 \text{ cm}$$



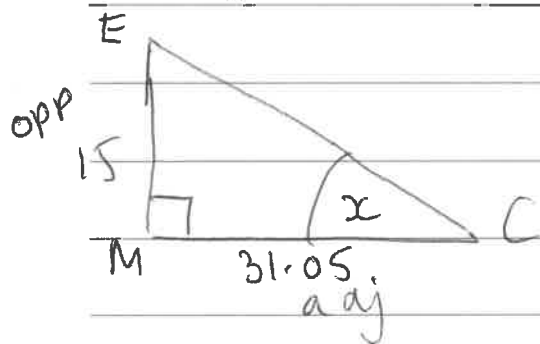
25 (b) Work out the size of angle ECM .

[4 marks]

(i) Find MC . MC is diagonal of base

$$MC = \sqrt{30^2 + 8^2}$$

$$MC = 31.05$$



$$\tan x = \frac{15}{31.05}$$

$$x = \text{shift tan} \left(\frac{15}{31.05} \right)$$

$$x = 25.8$$

Answer 25.8 degrees

Turn over for the next question

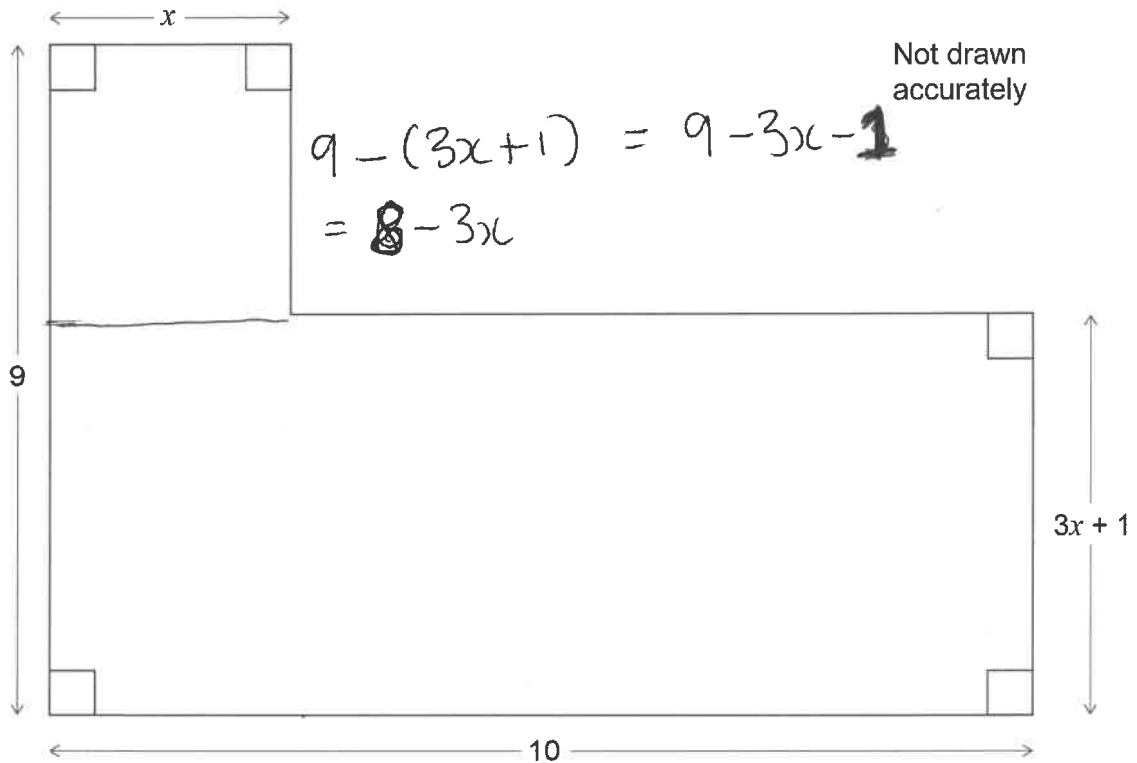
SOM CAH (TOA)



26

Here is an L-shape.

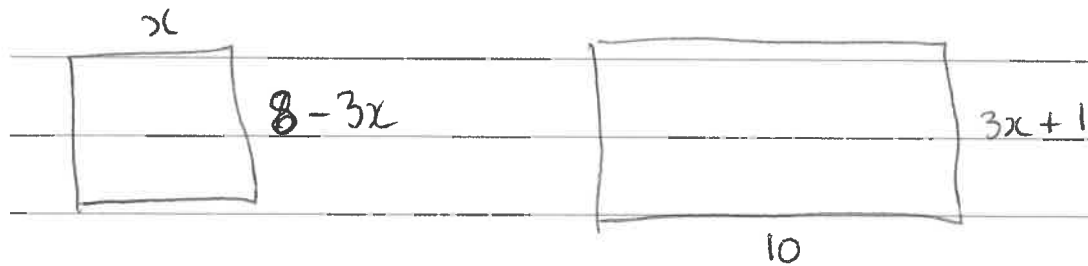
All dimensions are in centimetres.



The area of the L-shape is 65 cm^2

Work out the value of x .

[6 marks]



$$\text{Total area } x(8-3x) + 10(3x+1)$$

$$\Rightarrow 8x - 3x^2 + 30x + 10 = 65$$

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

factorise

$$(3x - 5)(x - 11) = 0$$

$$\begin{matrix} x=5 \\ 3 \end{matrix} \quad \begin{matrix} x=11 \end{matrix} \quad \text{Think}$$

can x be 11? $8-33 = -25$ can't be.

$$x = \frac{5}{3}$$

$$\text{formula } \frac{38 \pm \sqrt{38^2 - 4 \times 3 \times 55}}{2 \times 3} \Rightarrow 11, \frac{5}{3}$$

Answer

$$\frac{5}{3}$$

Turn over for the next question

Discount 11



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

[3 marks]

complete the square

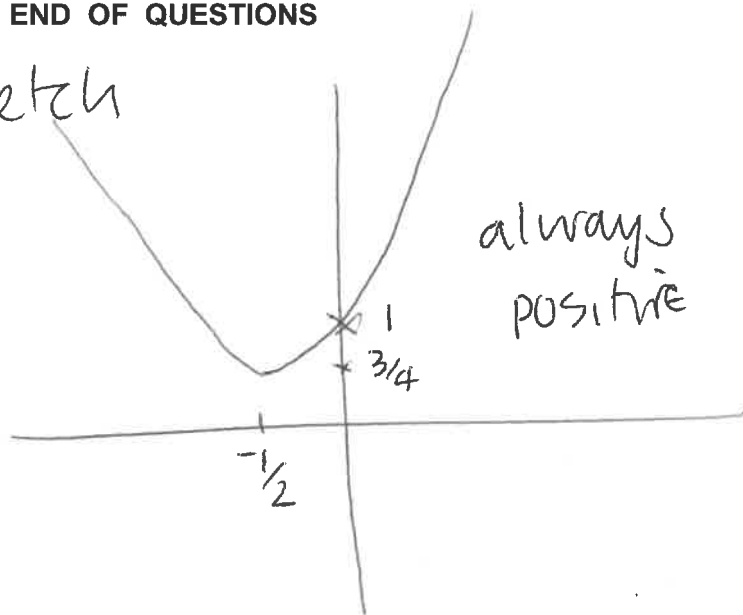
$$\left(x + \frac{1}{2}\right)^2 - \frac{1}{4} + 1$$

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

$(\quad)^2$ always positive
positive $+\frac{3}{4}$ is always positive.

END OF QUESTIONS

Could do a sketch



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