

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname *StemUp Model Solution*

Forename(s)

Candidate signature

GCSE MATHEMATICS

H

Higher Tier

Paper 3 Calculator

Tuesday 12 June 2018

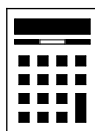
Morning

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.
- Fill in the boxes at the top of this page.
- 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	
TOTAL	



J U N 1 8 8 3 0 0 3 H 0 1

Answer **all** questions in the spaces provided

- 1 Circle the decimal that is closest in value to $\frac{11}{20}$ [1 mark]

0.56 0.6 0.525 0.5

- 2 Circle the list of **all** the integers that satisfy $-2 < x \leq 4$ [1 mark]

-2, -1, 0, 1, 2, 3 -1, 0, 1, 2, 3

-2, -1, 0, 1, 2, 3, 4 -1, 0, 1, 2, 3, 4

- 3 Circle the largest number. [1 mark]

3.2 $\dot{7}$ 3.27 3.277 3.20 $\dot{7}$



- 4 What is the size of an exterior angle of a regular decagon?
Circle your answer.

[1 mark]

18°

36°

144°

162°

- 5 a is a common factor of 72 and 120
 b is a common multiple of 6 and 9

Work out the highest possible value of $\frac{a}{b}$

[4 marks]

$$72 = 2 \times 2 \times 2 \times 3 \times 3, \quad 120 = 2 \times 2 \times 2 \times 3 \times 5$$

$$\text{Highest common factor: } a = 2 \times 2 \times 2 \times 3 = 24$$

$$\text{Multiples of 6: } 6, 12, 18, 24 \dots \quad \text{Multiples of 9: } 9, 18, 27 \dots$$

$$\text{Lowest common multiple: } b = 18$$

$$\text{Highest } a \div b \text{ uses the largest } a \text{ and the smallest } b:$$

$$a \div b = \frac{24}{18} = \frac{4}{3} = 1\frac{1}{3}$$

Answer $\frac{4}{3}$

Turn over for the next question

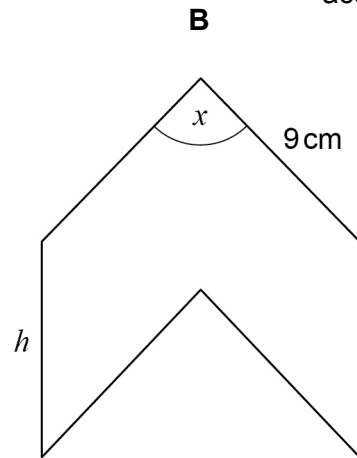
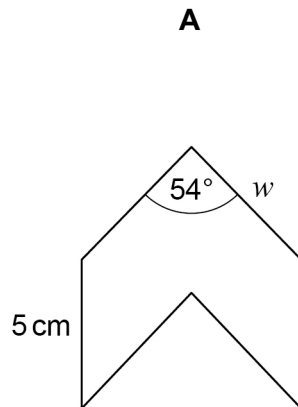
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6

A and B are similar shapes.

B is an enlargement of A with scale factor 1.5

Not drawn
accuratelyWork out the values of x , h and w .**[3 marks]***Angles do not change in an enlargement: $x = 54^\circ$* *$h = 5 \times 1.5 = 7.5 \text{ cm}$* *$w = 9 \div 1.5 = 6 \text{ cm}$* $x =$ 54 degrees $h =$ 7.5 cm $w =$ 6 cm

Investment B Invest £3500

Compound interest is added at 3% per year.

[4 marks]

Answer £ 23.15

Turn over for the next question

7

Turn over ►



- 8 (a) Show that the lines $y = 3x + 7$ and $2y - 6x = 8$ are parallel.

Do **not** use a graphical method.

[3 marks]

$$y = 3x + 7 \text{ has gradient } 3$$

$$2y - 6x = 8 \rightarrow 2y = 6x + 8 \rightarrow y = 3x + 4$$

$$y = 3x + 4 \text{ has gradient } 3$$

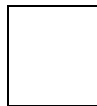
Both lines have the same gradient (3), so they are parallel.

- 8 (b) Is the point $(-5, -6)$ above, below or on the line $y = 3x + 7$?

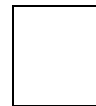
Tick **one** box.



Above



Below



On the line

You **must** show your working.

Do **not** use a graphical method.

[2 marks]

$$\text{When } x = -5: y = 3 \times (-5) + 7 = -15 + 7 = -8$$

So the point on the line is $(-5, -8)$

$-6 > -8$, so $(-5, -6)$ is above the line.



- 9 The cost of a ticket increases by 10% to £19.25

Work out the original cost.

[3 marks]

$$110\% = £19.25$$

$$1\% = 19.25 \div 110 = 0.175$$

$$100\% = 19.25 \div 1.1 = 17.5$$

Answer £ 17.50

- 10 The n th term of a sequence is $12n - 5$

Work out the numbers in the sequence that

have two digits

and

are **not** prime.

[3 marks]

$$n = 1, 2, 3, \dots: 7, 19, 31, 43, 55, 67, 79, 91, 103$$

$$\text{Two-digit numbers: } 19, 31, 43, 55, 67, 79, 91$$

$$19, 31, 43, 67, 79 \text{ are prime}$$

$$55 = 5 \times 11 \text{ (not prime), } 91 = 7 \times 13 \text{ (not prime)}$$

Answer 55 and 91



11 $\mathbf{a} = \begin{pmatrix} 6 \\ -10 \end{pmatrix}$ $\mathbf{b} = \begin{pmatrix} -1 \\ 2 \end{pmatrix}$ $\mathbf{c} = \begin{pmatrix} -4 \\ 7 \end{pmatrix}$

11 (a) Work out $\mathbf{a} + \mathbf{b} + \mathbf{c}$

[2 marks]

$$\mathbf{a} + \mathbf{b} + \mathbf{c} = \begin{pmatrix} 6 \\ -10 \end{pmatrix} + \begin{pmatrix} -1 \\ 2 \end{pmatrix} + \begin{pmatrix} -4 \\ 7 \end{pmatrix} = \begin{pmatrix} 6 - 1 - 4 \\ -10 + 2 + 7 \end{pmatrix} = \begin{pmatrix} 1 \\ -1 \end{pmatrix}$$

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

11 (b) Show that $\mathbf{a} + 2\mathbf{c}$ is parallel to $\mathbf{b}$

[2 marks]

$$\mathbf{a} + 2\mathbf{c} = \begin{pmatrix} 6 \\ -10 \end{pmatrix} + 2 \begin{pmatrix} -4 \\ 7 \end{pmatrix} = \begin{pmatrix} 6 \\ -10 \end{pmatrix} + \begin{pmatrix} -8 \\ 14 \end{pmatrix} = \begin{pmatrix} -2 \\ 4 \end{pmatrix}$$

$$2\mathbf{b} = 2 \begin{pmatrix} -1 \\ 2 \end{pmatrix} = \begin{pmatrix} -2 \\ 4 \end{pmatrix}$$

So $\mathbf{a} + 2\mathbf{c} = 2\mathbf{b}$, a multiple of $\mathbf{b}$,

so $\mathbf{a} + 2\mathbf{c}$ is parallel to $\mathbf{b}$.



12

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

A force of 40 Newtons is applied to an area of 3.2 square metres.

Work out the pressure.

Give the units of your answer.

[2 marks]

$$\text{pressure} = 40 \div 3.2 = 12.5$$

Answer 12.5 N/m²

13

Tick **all** the statements that are true for any rhombus.

[1 mark]



The diagonals are lines of symmetry



The diagonals bisect each other



The diagonals are perpendicular



The diagonals are equal in length

Turn over for the next question

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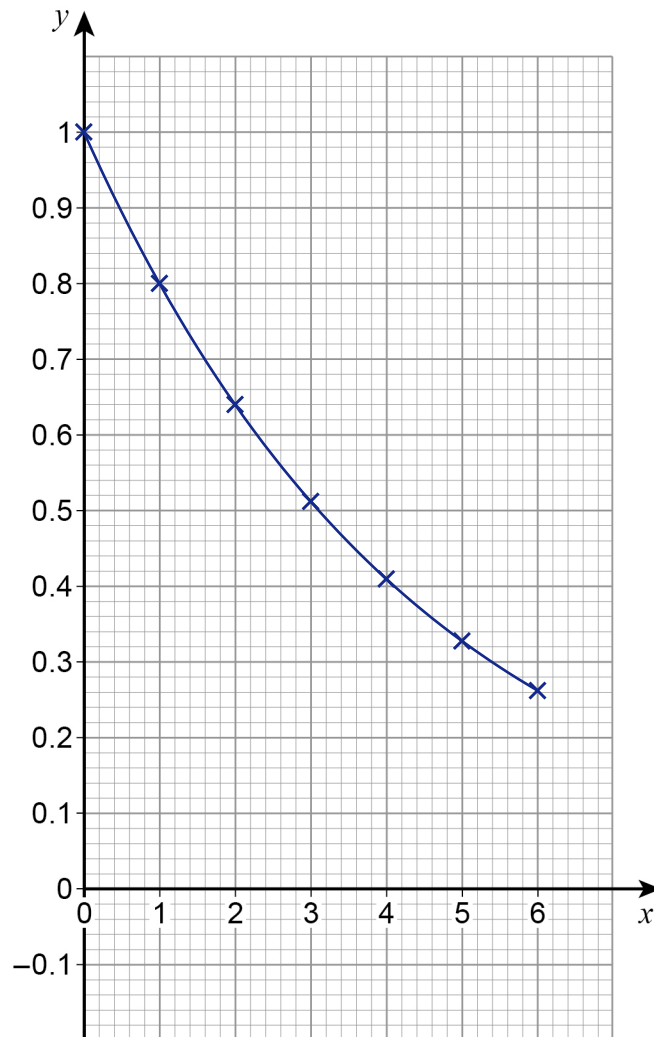


14

Draw the graph of $y = 0.8^x$ for values of x from 0 to 6

[3 marks]

x	0	1	2	3	4	5	6
y	1	0.8	0.64	0.51	0.41	0.33	0.26



- 15** Amy has x beads.
 Billy has three more beads than Amy.
 Carly has four times as many beads as Billy.
 Circle the expression for the number of beads that Carly has.
- [1 mark]**

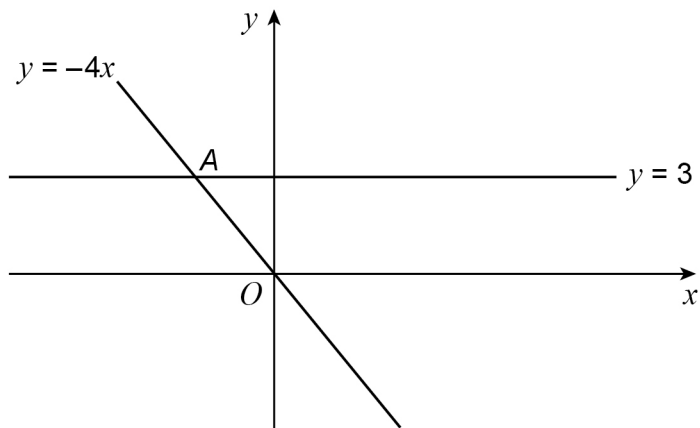
$4x + 3$

$3x + 4$

$4(x + 3)$

$x + 12$

- 16** Two straight lines intersect at point A.



Circle the coordinates of A.

[1 mark]

$(-\frac{3}{4}, 3)$

$(-4, 3)$

$(-12, 3)$

$(-\frac{4}{3}, 3)$



17

Here are two methods to make a 4-digit code.

Codes can have repeated digits.

Method A

For the first two digits use an odd number between 30 and 100

For the last two digits use a multiple of 11

Method B

Use four digits in the order even odd even odd

Do **not** use the digit zero

Which method gives the **greater** number of possible codes?

You **must** show your working.

[3 marks]

Method A: odd numbers 31, 33, ..., 99: $(99 - 31) \div 2 + 1 = 35$

two-digit multiples of 11: 11, 22, ..., 99 = $99 \div 11 = 9$

Method A codes = $35 \times 9 = 315$

Method B: even digits 2, 4, 6, 8 (4 choices)

odd digits 1, 3, 5, 7, 9 (5 choices)

Method B codes = $4 \times 5 \times 4 \times 5 = 400$

$400 > 315$

Answer Method B



18 Show that, for $x \neq 0$

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

can be written in the form $\frac{ax+b}{cx}$ where a , b and c are integers.

[3 marks]

$$\frac{x+4}{3x} - \frac{5}{2x} = \frac{2(x+4)}{6x} - \frac{15}{6x}$$

$$= \frac{2(x+4) - 15}{6x} = \frac{2x + 8 - 15}{6x} = \frac{2x - 7}{6x}$$

$$a = 2, b = -7, c = 6$$

Answer $\frac{2x - 7}{6x}$

19 The equation of a straight line is $3x + 2y = 24$

Circle the point where the line crosses the x -axis.

[1 mark]

(0, 8)

(12, 0)

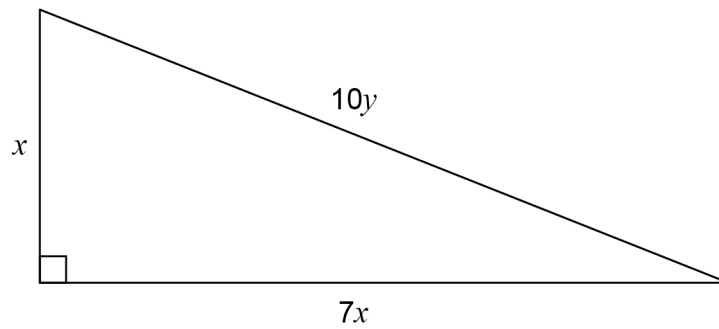
(0, 12)

(8, 0)



20

All dimensions are in centimetres.

Not drawn
accuratelyUse Pythagoras' theorem to work out the exact value of $\frac{x}{y}$ **[3 marks]**

$$x^2 + (7x)^2 = (10y)^2$$

$$x^2 + 49x^2 = 100y^2$$

$$50x^2 = 100y^2$$

$$x^2 = 2y^2$$

$$x^2 \div y^2 = 2$$

$$x \div y = \sqrt{2}$$

Answer $\sqrt{2}$ 

- 21** The mass of an ornament is m grams.
The height of the ornament is h centimetres.
 m is directly proportional to the cube of h .
 $m = 1600$ when $h = 8$

- 21 (a)** Work out an equation connecting m and h .

[3 marks]

$$m = kh^3$$

$$1600 = k \times 8^3 = 512k$$

$$k = 1600 \div 512 = 3.125$$

Answer $m = 3.125h^3$

- 21 (b)** Work out the mass of an ornament of height 12 centimetres.

[2 marks]

$$m = 3.125 \times 12^3$$

$$= 3.125 \times 1728 = 5400$$

Answer 5400 grams

Turn over for the next question

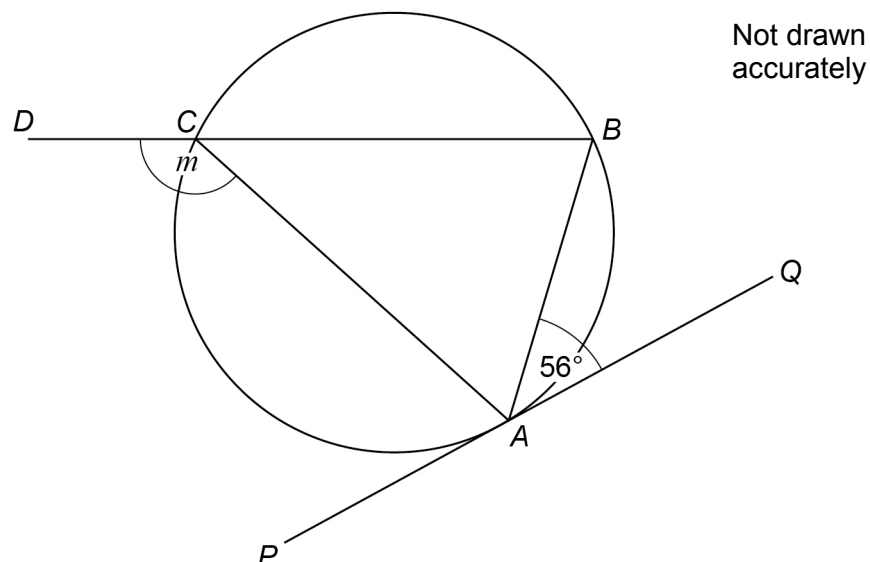


22

A , B and C are points on a circle.

DCB is a straight line.

PAQ is a tangent to the circle.



Sam is trying to work out the size of angle m .

Here is his working.

$$\text{angle } ACB = 56^\circ$$

angles in the same segment are equal

$$m = 180^\circ - 56^\circ$$

angles at a point on a straight line add up to 180°

$$m = 124^\circ$$

Make a criticism of his working.

[1 mark]

Angle $ACB = 56^\circ$ is right, but the reason is wrong. It is the alternate segment theorem, not angles in the same segment.



23

A sequence of numbers is formed by the iterative process

$$u_{n+1} = \frac{3}{u_n + 1}, \quad u_1 = 4$$

Work out the values of u_2 and u_3 **[2 marks]**

$$u_2 = 3 \div (4 + 1) = 3 \div 5 = 0.6$$

$$u_3 = 3 \div (0.6 + 1) = 3 \div 1.6 = 1.875$$

$$u_2 = \underline{\hspace{10em} 0.6 \hspace{10em}}$$

$$u_3 = \underline{\hspace{10em} 1.875 \hspace{10em}}$$

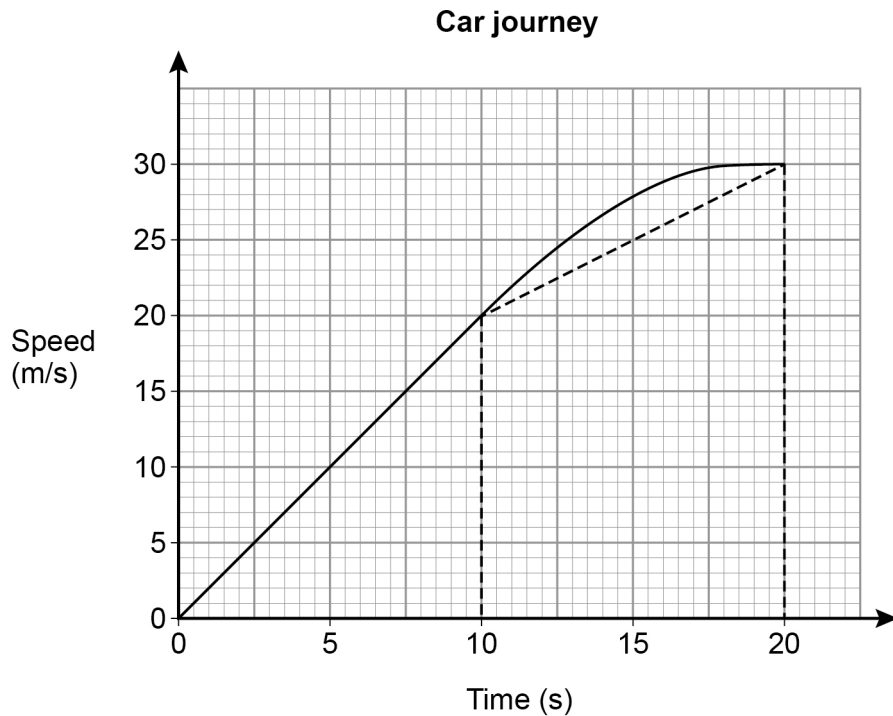
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24

The speed-time graph shows 20 seconds of a car journey.

Harry wants to estimate the distance the car travels in this time.

He uses a triangle and a trapezium, as shown, to estimate the area under the graph.



24 (a) Complete Harry's method to estimate the distance the car travels.

[3 marks]

Triangle (0 to 10 s): $\frac{1}{2} \times 10 \times 20 = 100$

Trapezium (10 to 20 s): $\frac{1}{2} \times (20 + 30) \times 10 = 250$

Distance $\approx 100 + 250 = 350$ m

Answer 350 m



24 (b) For this journey, which of these is true for Harry's method?

Tick **one** box.

[1 mark]

☐

It works out an overestimate of the distance

☒

It works out an underestimate of the distance

☐

It could work out an overestimate or an underestimate of the distance

Turn over for the next question

Turn over ►

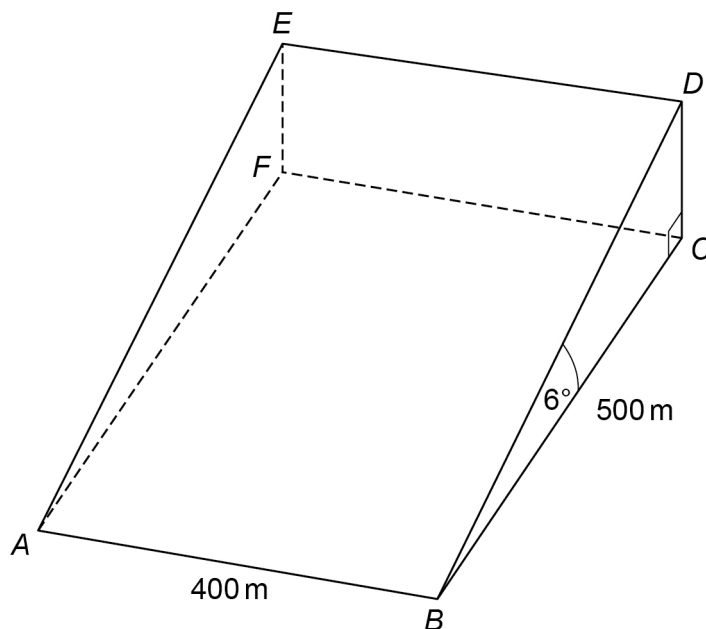


25

$ABCDEF$ is a triangular prism which represents part of a hill.

$ABCF$ is the horizontal rectangular base.

D is vertically above C .



25 (a) Work out the height CD .

[2 marks]

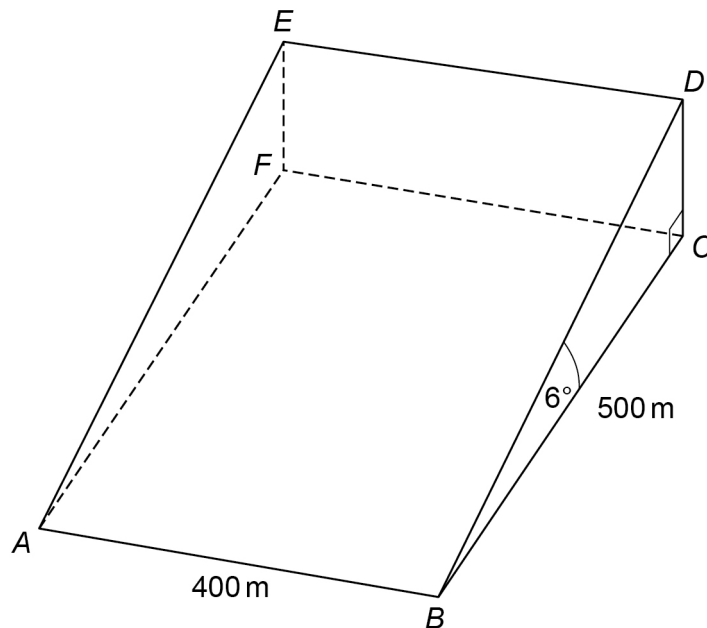
$$\tan 6^\circ = \frac{CD}{500}$$

$$CD = 500 \times \tan 6^\circ = 52.552\dots$$

Answer 52.6 m



- 25 (b) Jamil walks in a straight line from A to D.



Work out the size of angle DAC .

You **must** show your working.

[4 marks]

$$AC^2 = 500^2 + 400^2 = 250\,000 + 160\,000 = 410\,000$$

$$AC = \sqrt{410\,000} = 640.312\dots$$

$$\text{Triangle } ACD \text{ has a right angle at } C, CD = 52.552\dots$$

$$\tan DAC = \frac{CD}{AC} = \frac{52.552\dots}{640.312\dots} = 0.08207\dots$$

$$\text{angle } DAC = \tan^{-1}(0.08207\dots) = 4.6918\dots$$

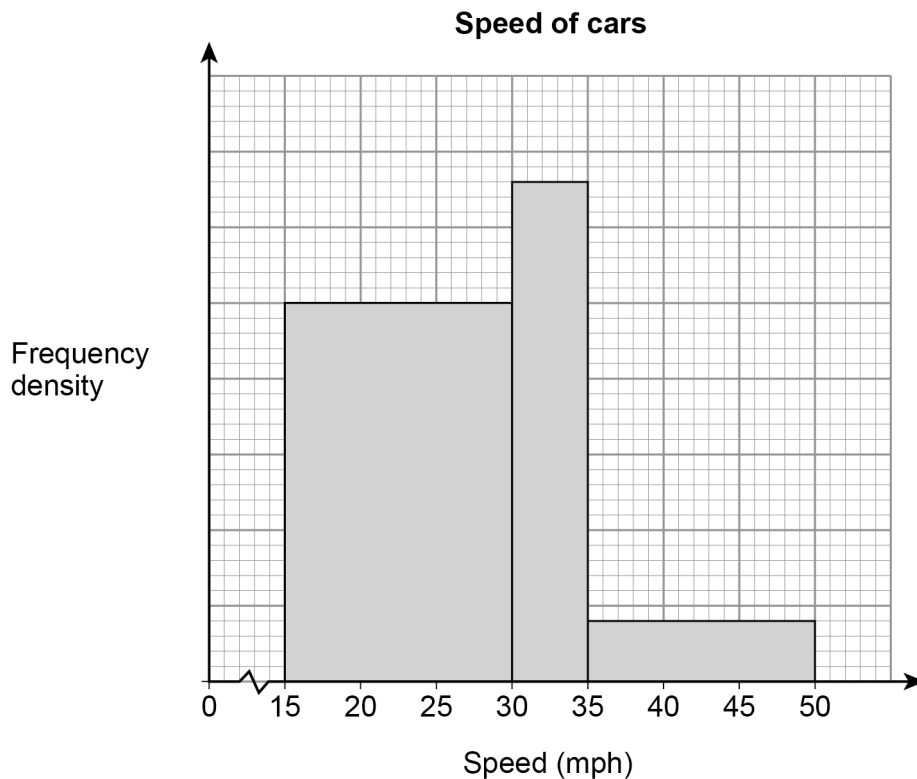
$$= 4.69^\circ \text{ (3 s.f.)}$$

Answer 4.69 degrees



26

The histogram shows information about the speed of cars as they pass a checkpoint.
The scale on the frequency density axis is missing.



The histogram shows information about 480 cars.

26 (a) How many cars does the first bar represent?

[4 marks]

Area of bars in cm squares (1 cm by 1 cm):

Bar 1: $3 \times 5 = 15$, Bar 2: $1 \times 6.6 = 6.6$, Bar 3: $3 \times 0.8 = 2.4$

Total area = $15 + 6.6 + 2.4 = 24$ cm squares

$480 \div 24 = 20$ cars per cm square

First bar = $15 \times 20 = 300$ cars

Answer 300



26 (b) Cars with a speed greater than 40 mph are over the speed limit.

Use the histogram to estimate the number of cars that are over the speed limit.

[2 marks]

40 to 50 mph is 2 cm of the 3 cm wide last bar:

area = $2 \times 0.8 = 1.6$ cm squares (or $\frac{2}{3} \times 2.4 = 1.6$)

$1.6 \times 20 = 32$ cars

Answer 32

Turn over for the next question



27

A bag contains 30 discs.

10 are red and 20 are blue.

One disc is taken out at random and replaced by **two** of the other colour.

Another disc is then taken out at random and replaced by **two** of the other colour.

Another disc is then taken out at random.

Work out the probability that all three discs taken out are **red**.

[3 marks]

1st red: 10 red out of 30. Then 9 red, 22 blue (31 discs)

2nd red: 9 red out of 31. Then 8 red, 24 blue (32 discs)

3rd red: 8 red out of 32

$$P(R, R, R) = \frac{10}{30} \times \frac{9}{31} \times \frac{8}{32} = \frac{720}{29\,760} = \frac{3}{124}$$

Answer $\frac{3}{124}$

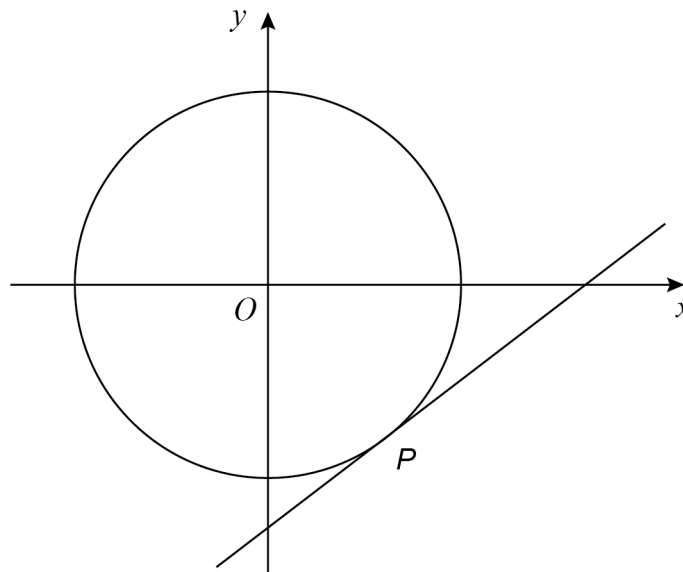


28

P is a point on the circle with equation $x^2 + y^2 = 80$

P has x -coordinate 4 and is below the x -axis.

Not drawn
accurately



Work out the equation of the tangent to the circle at P .

[5 marks]

$$\text{At } P: 4^2 + y^2 = 80$$

$$y^2 = 80 - 16 = 64, \quad y = -8 \quad (P \text{ is below the } x\text{-axis})$$

$$P = (4, -8)$$

$$\text{Gradient of radius } OP = -8 \div 4 = -2$$

Tangent is perpendicular to the radius OP :

$$\text{gradient of tangent} = -1 \div (-2) = \frac{1}{2}$$

$$y - (-8) = \frac{1}{2}(x - 4)$$

$$y + 8 = \frac{1}{2}x - 2$$

$$y = \frac{1}{2}x - 10$$

Answer $y = \frac{1}{2}x - 10$

END OF QUESTIONS



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