



Please write clearly in block capitals.

Centre number Candidate number

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE MATHEMATICS

H

Higher Tier Paper 3 Calculator

Monday 7 November 2022 Morning Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

- a calculator
- mathematical instruments
- the Formulae Sheet (enclosed).



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.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- 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

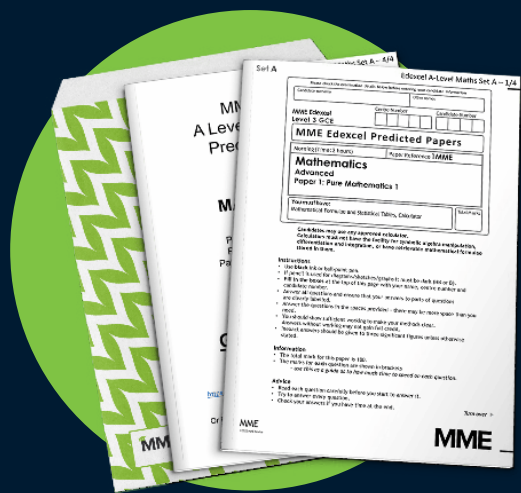
In all calculations, show clearly how you work out your answer.

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	
26-27	
28-29	
TOTAL	

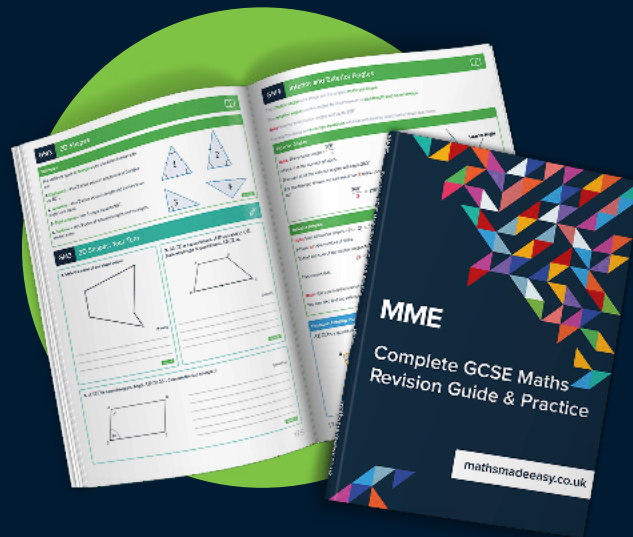


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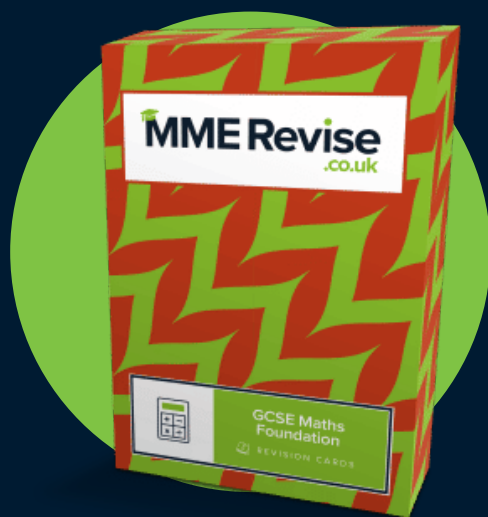
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Answer all questions in the spaces provided.

Do not write
outside the
box

1 $2^x = 32$

Circle the value of x .

[1 mark]

4

5

6

7

2 What is 1.8×10^{-4} as an ordinary number?

Circle your answer.

[1 mark]

[1 mark]

-180 000

-18 000

0.000 18

0.000 018



Do not write outside the box

3 Expand $6x^2(x^3 + 2)$
Circle your answer.

[1 mark]

$6x^5 + 2$

$6x^6 + 2$

$6x^5 + 12x^2$

$6x^6 + 12x^2$

4 $30 < x < 300$
 x is 200% of y

Circle the correct inequality.

[1 mark]

$10 < y < 100$

$15 < y < 150$

$60 < y < 600$

$90 < y < 900$

Turn over for the next question

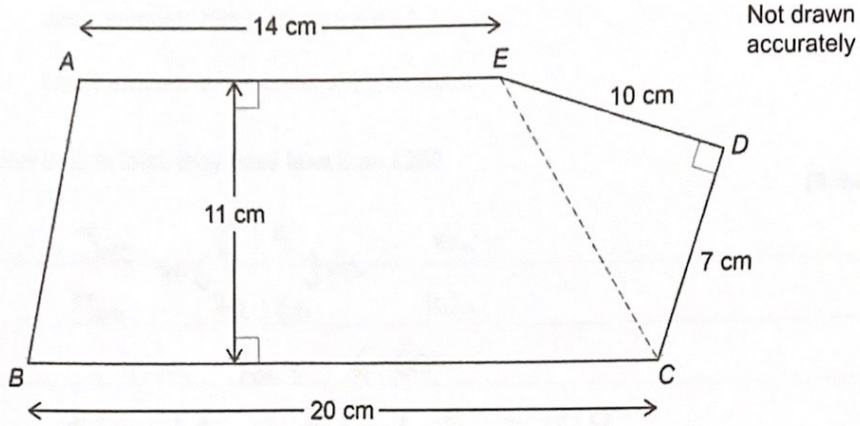
4

Turn over ►



Do not write outside the box

5 ABCDE is a pentagon.



Work out the area of the pentagon.

[3 marks]

$$\begin{aligned}
 \text{Area} &= \text{ABCE} + \text{CDE} \\
 &= \frac{1}{2} \times (14 + 20) \times 11 + \frac{1}{2} \times 10 \times 7 \\
 &= \frac{1}{2} \times 34 \times 11 + \frac{1}{2} \times 10 \times 7 \\
 &= 187 + 35 \\
 &= 222 \text{ cm}^2
 \end{aligned}$$

Answer 222 cm²



Do not write
outside the
box

6 Joe, Kim and Lisa each have an amount of money.

Joe has £72

Joe's amount : Kim's amount = 6 : 5

Lisa's amount is $1\frac{1}{2}$ times Joe's amount.

Show that, in total, they have **less** than £250

[3 marks]

Joe $\times 12$ $6:5$ $\downarrow \times 12$ Kim
 Joe 72:60 Kim
 Kim has £60
 $72 \times 1\frac{1}{2} = 72 \times 1.5 = 108$
 Lisa has £108
 Total = $72 + 60 + 108 = £240 < £250$

Turn over for the next question

6

Turn over ►



- 7 (a) Here is the rule for a sequence.

After the first two terms, each term is the sum of the previous two terms

The 1st term is 33

The 2nd term is x

The 4th term is 73

Work out the value of x .

[3 marks]

$$\begin{array}{ccccccc}
 33 & & x & & 33+x & & 73 \\
 \hline
 & & x+33+x & = & 73 & & \\
 \hline
 & & 33+2x & = & 73 & & \\
 \hline
 & & 2x & = & 40 & & \\
 \hline
 & & x & = & 20 & & \\
 \hline
 \end{array}$$

$$x = \underline{\quad 20 \quad}$$

- 7 (b) An expression for the n th term of a different sequence is $n - n^2$

Ruth says,

"All the terms will be negative because n^2 is always greater than n ."

Is she correct?

Tick a box.

Yes

No

Give a reason for your answer.

[1 mark]

First term is 0 ie.
 $1 - 1^2 = 1 - 1 = 0$



8 Here is some information about the members of clubs A and B.

	Number of members	Mean height of members
Club A	24	1.8 m
Club B	20	1.92 m

Work out $\frac{\text{total height of the members of club A}}{\text{total height of the members of club B}}$

Give your answer as a decimal.

[2 marks]

$$\frac{24 \times 1.8}{20 \times 1.92} = \frac{43.2}{38.4} = \frac{9}{8} = 1.125$$

Answer 1.125

Turn over for the next question

Turn over ►



9

P and Q are points.

The x -coordinate of Q is 4 **more** than the x -coordinate of P .

The y -coordinate of Q is 5 **less** than the y -coordinate of P .

Work out the gradient of the straight line through P and Q .

[2 marks]

$$\text{Gradient} = \frac{-5}{4} = -1.25$$

Answer -1.25



10 Here are the results after 250 spins of a coin.

Heads	128
Tails	122

The coin is spun an extra 50 times.

After all 300 spins, the relative frequency of Heads is 0.49

For the extra 50 spins, work out number of Heads : number of Tails

[3 marks]

$$\text{Heads} = 0.49 \times 300 = 147$$

$$147 - 128 = 19$$

$$\text{Tails} : 50 - 19 = 31$$

$$19 : 31$$

Answer 19 : 31

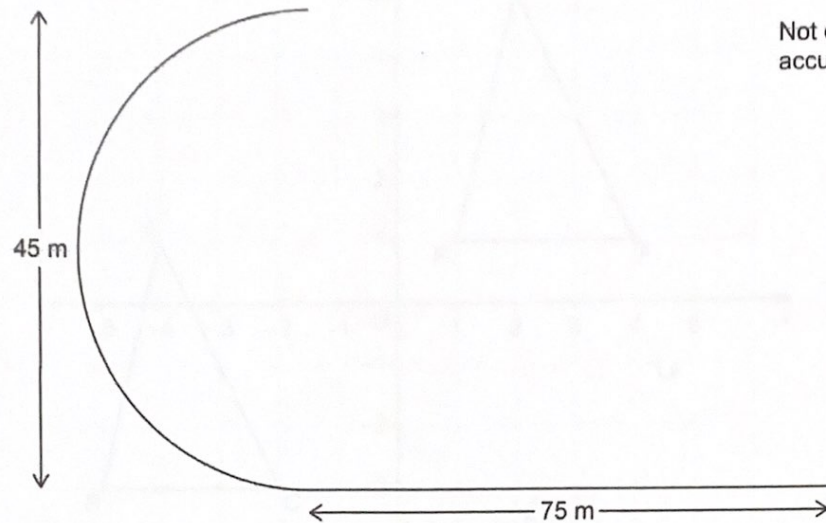
Turn over for the next question

5

Turn over ►



- 11 Part of a running track is the arc of a semicircle joined to a straight line.
The semicircle has diameter 45 metres.
The straight line has length 75 metres.



Abby runs once along this part of the track in 18 seconds.

Work out her average speed.

Give your answer to 2 significant figures.

[4 marks]

$$\text{Semicircle } ~~area~~ = \frac{1}{2} \times \pi \times 45$$

$$\text{Total} = 75 + \frac{45\pi}{2}$$

$$\text{Speed} = \frac{75 + \frac{45\pi}{2}}{18} = \frac{25}{6} + \frac{5\pi}{4}$$

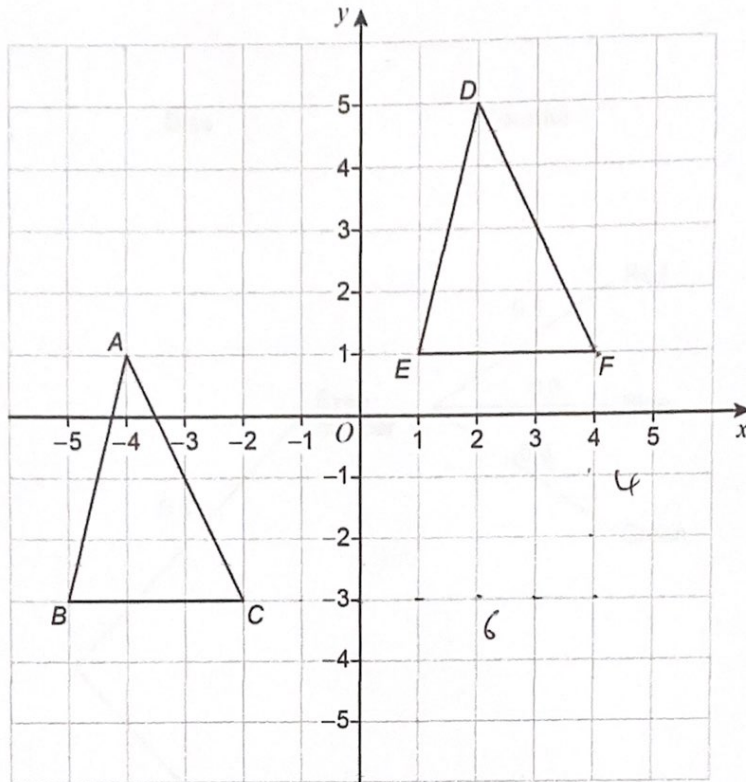
$$\text{Speed} = 8.1 \text{ m/s}$$

Answer 8.1 m/s



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outside the
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12 Triangles ABC and DEF are shown on a grid.



Describe a single transformation that shows the triangles are congruent.

[2 marks]

Translation by vector $\begin{pmatrix} 6 \\ 4 \end{pmatrix}$

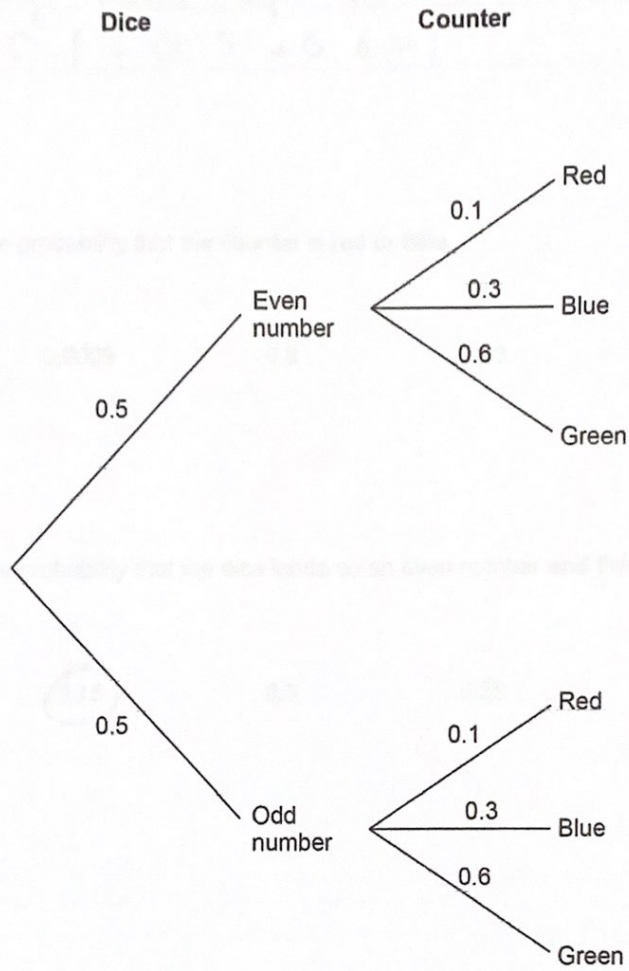
6

Turn over ►



Do not write
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- 13 A fair, ordinary dice is rolled and a counter is taken at random from a bag.
The tree diagram shows the probabilities.



Turn over for the next question



Do not write
outside the
box

- 13 (a) How do the probabilities show that **all** the counters in the bag are red, blue or green? [1 mark]

They add up to 1
 $0.1 + 0.3 + 0.6 = 1$

- 13 (b) Circle the probability that the counter is red or blue. [1 mark]

0.0009

0.8

0.03

0.4

- 13 (c) Circle the probability that the dice lands on an even number **and** the counter is blue. [1 mark]

0.15

0.3

0.35

0.8

Turn over for the next question

3

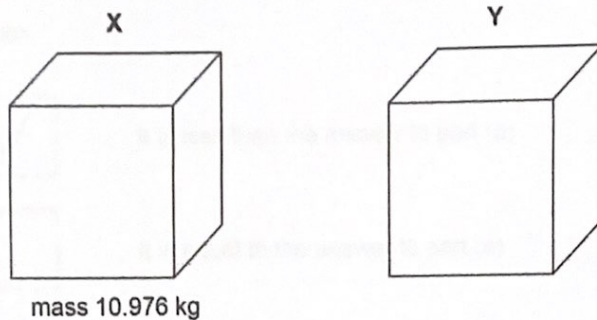
Turn over ►



14 Here are two solid cubes, X and Y.

The mass of X is 10.976 kg

The area of **each face** of X is 784 cm²



14 (a) Zayan wants to know the density of Y.

He assumes that Y is identical to X.

What density should he get for Y?

Give your answer in **grams per cubic centimetre**.

[4 marks]

$$\begin{aligned} \text{Side length} &= \sqrt{784} = 28 \text{ cm.} \\ \text{Volume} &= 28 \times 28 \times 28 = 21952 \text{ cm}^3 \\ \text{Mass} &= 10.976 \times 1000 = 10976 \text{ g} \\ \text{Density} &= \frac{10976}{21952} = 0.5 \text{ g/cm}^3 \end{aligned}$$

Answer 0.5 g/cm³



14 (b)

In fact,

the mass of Y is less than the mass of X

the area of each face of Y is greater than the area of each face of X.

What does this mean about the actual density of Y?

Tick **one** box.

[1 mark]

It is less than the answer to part (a)

It is equal to the answer to part (a)

It is greater than the answer to part (a)

It is not possible to tell

Turn over for the next question

5

Turn over ►



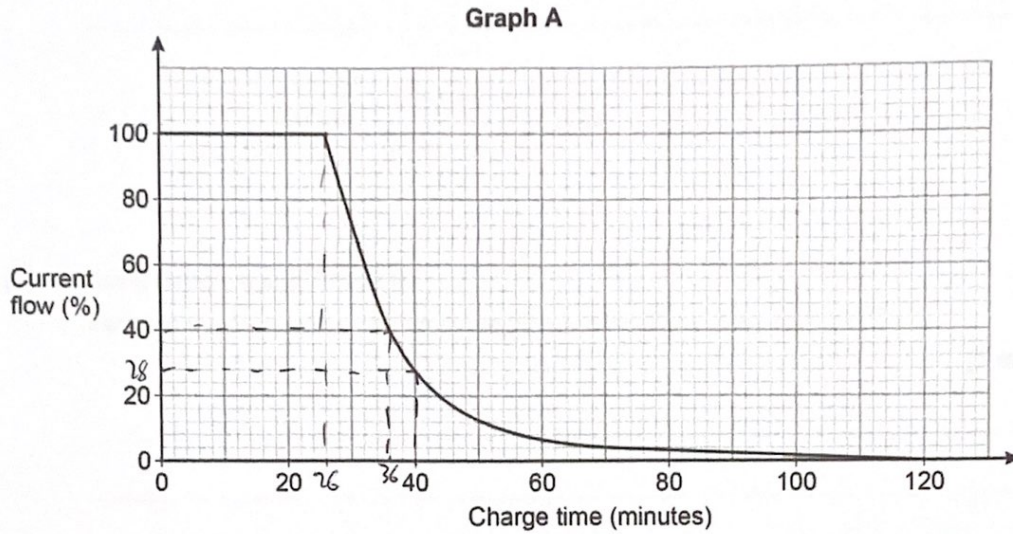
15

A mobile phone takes 2 hours to charge from empty.

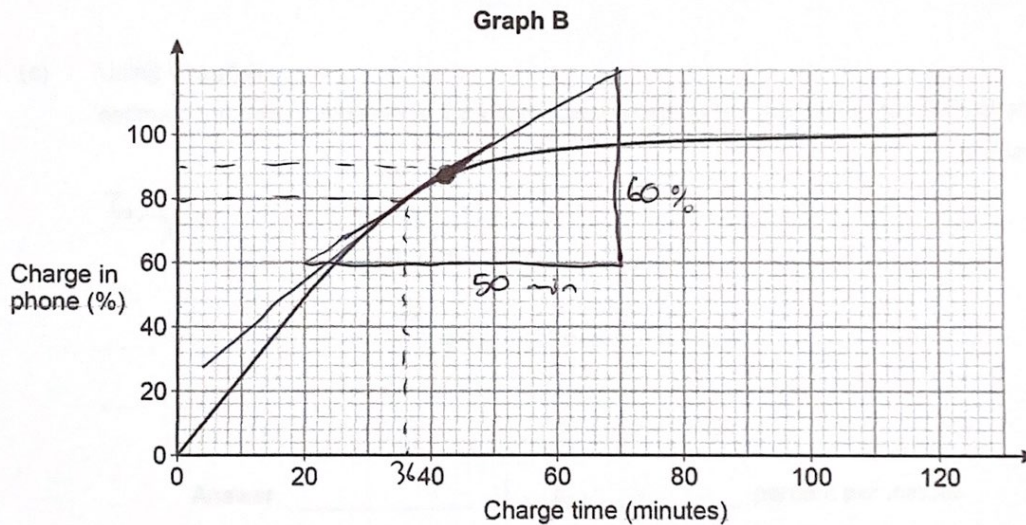
When the phone is being charged, the current flow into the phone

- starts at full current flow (100%)
- continues at full current flow for a period of time
- gradually decreases until the phone is fully charged.

This is shown on **Graph A** below.



Graph B shows the percentage charge in the phone when charging from empty.



Megan's phone is empty of charge.
She starts to charge her phone at 10.00 am

- 15 (a) Using Graph A,
estimate the time when the current flow starts to decrease.

[2 marks]

26 mins

Answer 10:26 am

- 15 (b) Using Graph A and Graph B,
estimate the percentage charge in the phone when the current flow is 40%

[1 mark]

Answer 80 %

- 15 (c) Using Graph B,
estimate the rate of increase in the percentage charge when the phone has 90% charge.

[2 marks]

$$\begin{aligned} \text{Tangent} &= 60\% \text{ in } 50 \text{ min} \\ &= \frac{60}{50} \\ &= 1.2\% \text{ per min} \end{aligned}$$

Answer 1.2 percent per minute

5

Turn over ►



16 H is inversely proportional to the cube root of L .

$$H = 7 \quad \text{when} \quad L = 64$$

16 (a) Work out an equation connecting H and L .

[3 marks]

$$H \propto \frac{1}{\sqrt[3]{L}}$$

$$H = \frac{k}{\sqrt[3]{L}}$$

$$7 = \frac{k}{\sqrt[3]{64}}$$

$$7 = \frac{k}{4}$$

$$k = 28$$

Answer $H = \frac{28}{\sqrt[3]{L}}$

16 (b) Work out the value of H when $L = 2744$

[2 marks]

$$H = \frac{28}{\sqrt[3]{2744}}$$

$$H = \frac{28}{14}$$

$$H = 2$$

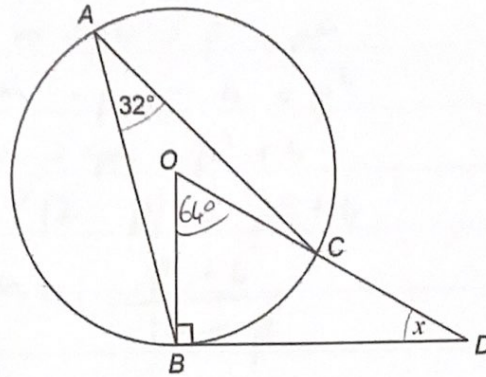
$$H = \underline{\hspace{2cm}}$$



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- 17 A, B and C are points on a circle, centre O.
 BD is a tangent to the circle.
 OCD is a straight line.

Not drawn accurately



Work out the size of angle x .

[3 marks]

$OB \perp BD = 90^\circ$ tangent and radius meet at right angle
 $BOC = 32 \times 2 = 64^\circ$ angle at centre is twice angle at circumference
 $x = 90 - 64 = 26^\circ$ angles in a triangle add to 180°

$x = 26$ degrees

8

Turn over ►



18

Rearrange $9m + 4(2m - 1) = p^2 + pm$ to make m the subject.

[4 marks]

$$9m + 4(2m - 1) = p^2 + pm$$

$$9m + 8m - 4 = p^2 + pm$$

$$17m - 4 = p^2 + pm$$

$$17m - pm - 4 = p^2$$

$$17m - pm = p^2 + 4$$

$$m(17 - p) = p^2 + 4$$

$$m = \frac{p^2 + 4}{17 - p}$$

Answer $m = \frac{p^2 + 4}{17 - p}$

19

A circle has centre $(0, 0)$ and passes through $(0, 11)$

Write down the equation of the circle.

[1 mark]

Answer $x^2 + y^2 = 121$



- 20 There should be a train leaving a station every hour from 7 am
No trains leave early.

$P(\text{the first train leaves on time}) = 0.9$

For all the **other** trains,

if the previous train did leave on time, $P(\text{this train leaves on time}) = 0.8$

if the previous train did **not** leave on time, $P(\text{this train leaves on time}) = 0.65$

- 20 (a) Work out $P(\text{the first three trains leave on time})$

[2 marks]

$$0.9 \times 0.8 \times 0.8 = 0.576$$

Answer 0.576

- 20 (b) The 2pm train does **not** leave on time.

Work out $P(\text{exactly one of the next two trains does not leave on time})$

[3 marks]

~~$$0.65 \times 0.35 + 0.8 \times 0$$~~

$$\text{On time then late} = 0.65 \times 0.2 = 0.13$$

$$\text{Late then on time} = 0.35 \times 0.65 = 0.2275$$

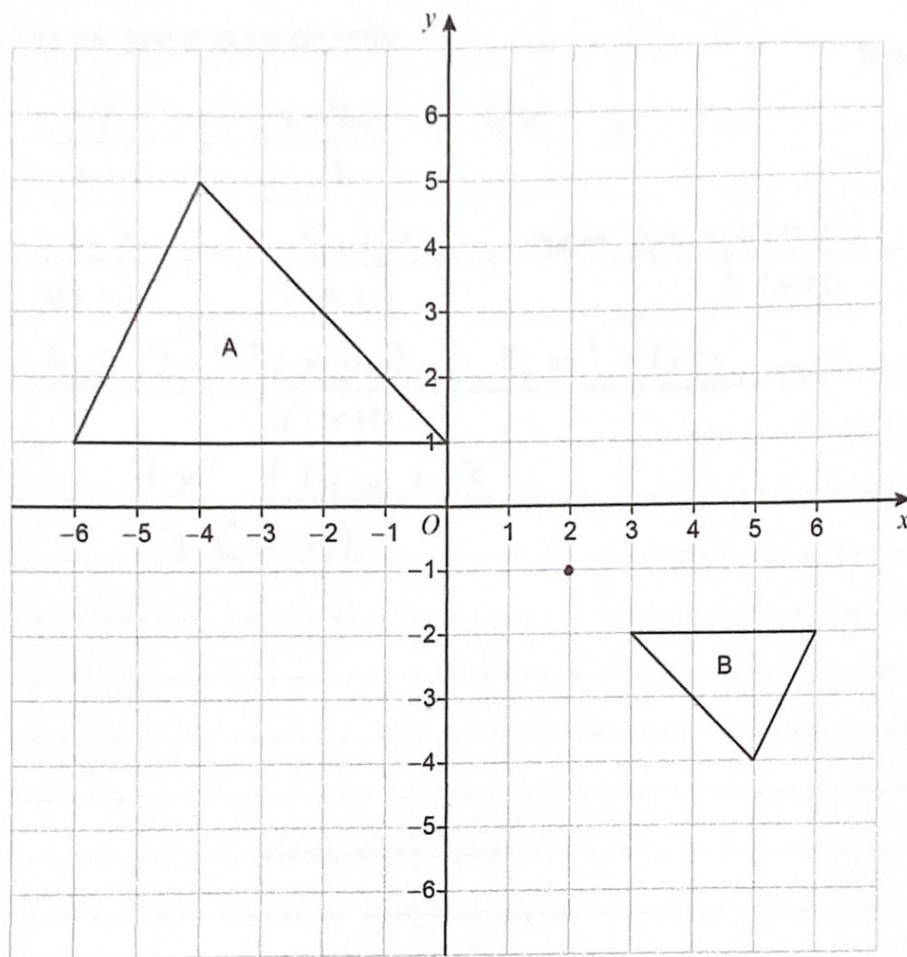
$$0.13 + 0.2275 = 0.3575$$

Answer 0.3575



Do not write outside the box

21 Shape A is enlarged to shape B.



21 (a) Circle the scale factor of the enlargement.

[1 mark]

$\frac{1}{2}$

-2

$\frac{1}{2}$

2

21 (b) Write down the coordinates of the centre of enlargement.

[1 mark]

Answer (2 , -1)



22

Simplify fully $\frac{2}{x+1} + \frac{7-5x}{3} + 4x$

Give your answer as a single fraction.

[4 marks]

$$\frac{2}{x+1} + \frac{7-5x}{3} + 4x =$$

$$\frac{2 \times 3}{3(x+1)} + \frac{(7-5x)(x+1)}{3(x+1)} + \frac{4x \times 3(x+1)}{3(x+1)} =$$

$$\frac{6 - 5x^2 + 2x + 7 + 12x^2 + 12x}{3(x+1)} =$$

$$\frac{7x^2 + 14x + 13}{3(x+1)}$$

Answer $\frac{7x^2 + 14x + 13}{3(x+1)}$

6

Turn over ►



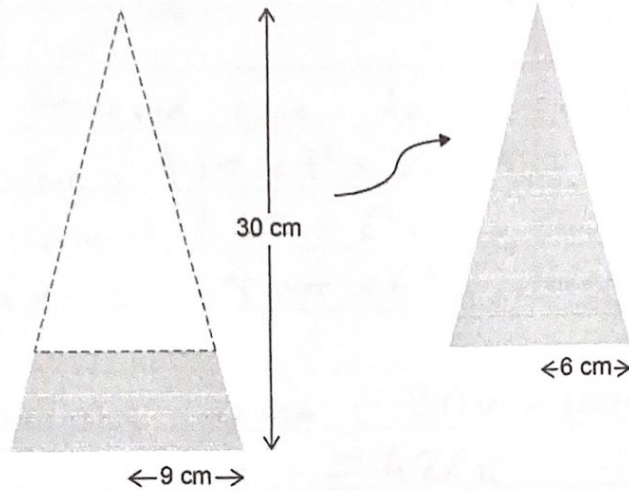
23

Alec makes a bowl for dog food from a solid wooden cone.

The sketches show how the bowl is made.

The cone has radius 9 cm and perpendicular height 30 cm

A smaller cone, with radius 6 cm, is removed.

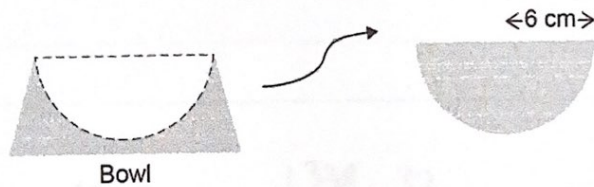


Not drawn
accurately

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

where r is the radius and h is the perpendicular height

A hemisphere with radius 6 cm is then removed.



Not drawn
accurately

$$\text{Volume of a hemisphere} = \frac{2}{3} \pi r^3 \text{ where } r \text{ is the radius}$$



Work out the volume of the remaining wood that forms the bowl.

[5 marks]

Cones are similar so side ratios are
same.

$$\begin{array}{l} \times \frac{10}{3} \left(\begin{array}{l} 9 : 6 \\ 30 : 20 \end{array} \right) \times \frac{10}{3} \end{array}$$

Removed cone height = 20 cm.

$$\text{Big cone} = \frac{1}{3} \times \pi \times 9^2 \times 30 = 810\pi$$

$$\text{Small cone} = \frac{1}{3} \times \pi \times 6^2 \times 20 = 240\pi$$

$$\text{Hemisphere} = \frac{2}{3} \times \pi \times 6^3 = 144\pi$$

$$\begin{aligned} \text{Remaining area} &= 810\pi - 240\pi - 144\pi \\ &= 426\pi \\ &= 1338.32 \text{ cm}^3 \end{aligned}$$

Answer 1338.32 cm³

5

Turn over ►



2 5

- 24 On the same day, Kate buys
a car for £14 000
and
a painting for £5000

The value of the car decreases by 35% in the first year, and then by 10% each year.
The value of the painting increases by 4% each year.

Show that the painting becomes worth more than the car during the fifth year.

[5 marks]

Year	Car	Painting
0	14000	5000
1	$14000 \times 0.65 = 9100$	$5000 \times 1.04 = 5200$
2	$14000 \times 0.65 \times 0.9 = 8190$	$5000 \times 1.04^2 = 5408$
3	$14000 \times 0.65 \times 0.9^2 = 7371$	$5000 \times 1.04^3 = 5624.32$
4	$14000 \times 0.65 \times 0.9^3 = 6633.9$	$5000 \times 1.04^4 = 5849.29$
5	$14000 \times 0.65 \times 0.9^4 = 5970.51$	$5000 \times 1.04^5 = 6083.26$

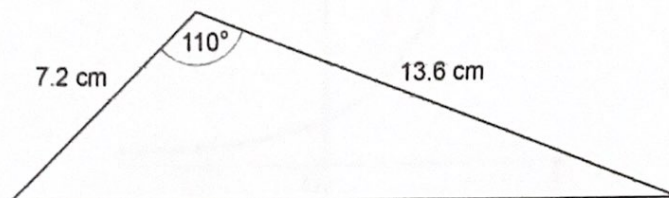
As per the table, the fifth year is the first in which the painting is worth more than the car.



25

Two sides of a triangle are measured to 1 decimal place.
The angle between the sides is measured to the nearest degree.

Not drawn
accurately



Work out the upper bound for the area of the triangle.

You **must** show your working.

[4 marks]

$$\text{Area} = \frac{1}{2} ab \sin(C)$$

Upper side lengths are 7.25 and 13.65

~~Upper angle is 110~~

$\sin(109.5) > \sin(110.5)$ so use

109.5 for angle

$$\text{Area} = \frac{1}{2} \times 7.25 \times 13.65 \times \sin(109.5)$$

$$\text{Area} = 46.64 \text{ cm}^2$$

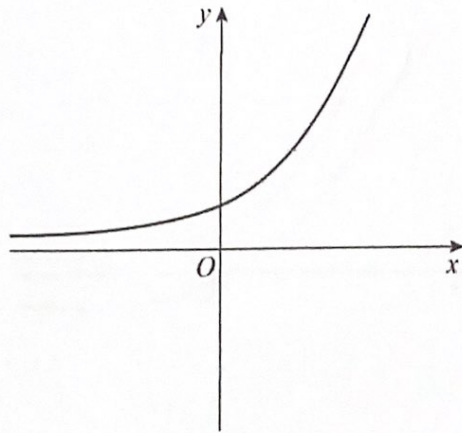
Answer 46.64 cm²

Turn over for the next question



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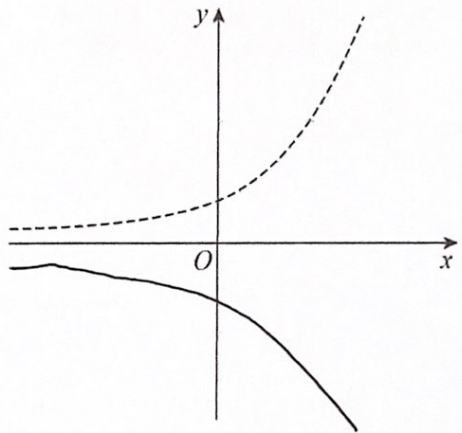
- 26 Here is a sketch of the graph of $y = 5^x$



In parts (a) and (b) the sketch of $y = 5^x$ is shown as a dashed line.

- 26 (a) On the axes below, sketch the graph of $y = -5^x$

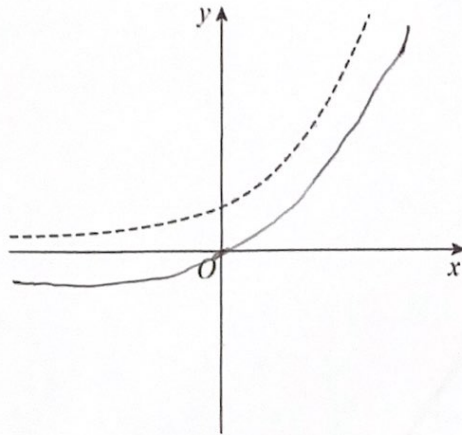
[1 mark]



26 (b) On the axes below, sketch the graph of $y = 5^x - 1$

[1 mark]

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ANSWER IN THE SPACES PROVIDED

END OF QUESTIONS

2



2 9