

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

I declare this is my own work.

GCSE MATHEMATICS

H

Higher Tier

Paper 3 Calculator

Monday 7 November 2022

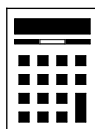
Morning

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	



N 0 V 2 2 8 3 0 0 3 H 0 1

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

Answer **all** questions in the spaces provided.

1 $2^x = 32$

Circle the value of x .

[1 mark]

4

5

6

7

Keep multiplying by 2 until 32 is reached. 2, 4, 8, 16, 32. So this must be 2^5

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

Circle your answer.

[1 mark]

-180 000

-18 000

0.000 18

0.000 018

1.8 divided by 10 4 times. This moves the decimal point 4 places to the left



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

[1 mark]

$6x^5 + 2$

$6x^6 + 2$

$6x^5 + 12x^2$

$6x^6 + 12x^2$

$$6x^2 \times x^3 = 6x^5 \text{ as } a^x \times a^y = a^{x+y}. 6x^2 \times 2 = 12x^2$$

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

Circle the correct inequality.

[1 mark]

$10 < y < 100$

$15 < y < 150$

$60 < y < 600$

$90 < y < 900$

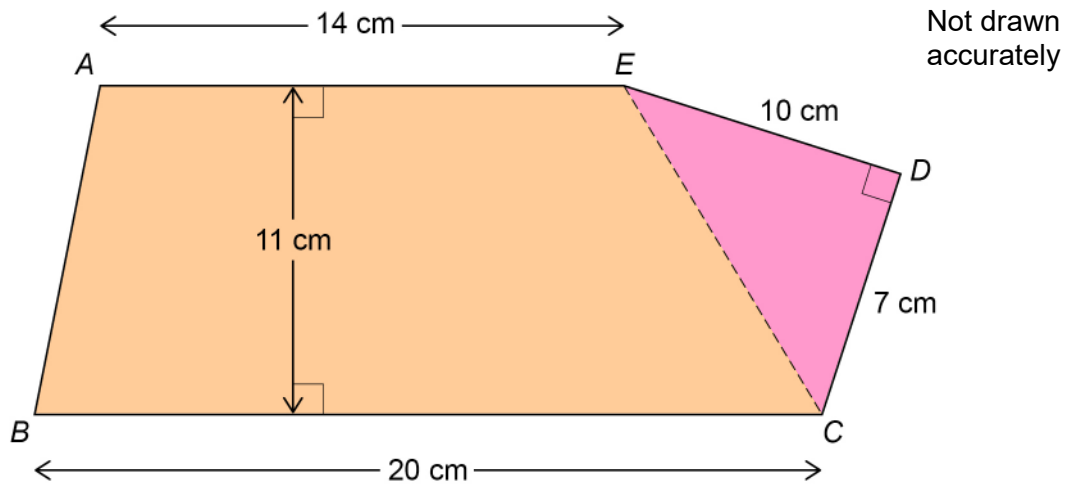
$$x \text{ is double } y \text{ so halving the } 30 \text{ and } 300 \text{ works out which one it is}$$

Turn over for the next question

Turn over ►



5

 $ABCDE$ is a pentagon.

Work out the area of the pentagon.

[3 marks]

$$\frac{1}{2}(14+20) \times 11 = 187$$

Area of the orange trapezium. Area of trapezium = $\frac{1}{2}(a+b)h$, where a and b are the parallel sides and h is the distance between them

$$\frac{1}{2} \times 7 \times 10 = 35$$

Area of the pink triangle. Area of triangle = $\frac{1}{2} \times \text{base} \times \text{height}$.
The base is 7cm and the height is 10cm

$$187 + 35$$

Adding the area of the orange trapezium and the pink triangle works out the area of the pentagon

Answer 222 cm²



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]

$$72 \div 6$$

6 parts of the ratio represent Joe's amount. So dividing the £72 Joe has by 6 works out the value of 1 part of the ratio

$$12 \times 5 = 60$$

Multiplying the value of 1 part of the ratio by the 5 parts which represent Kim works out that Kim has £60

$$1\frac{1}{2} \times 72 = 108$$

This works out that Lisa has £108

$$72 + 60 + 108 = 240$$

Adding the £72 Joe has, the £60 Kim has and the £108 Lisa has works out that they have £240 in total, which is less than £250

Turn over for the next question

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]

$$33 + x$$

This is the 3rd term. Adding the 1st and 2nd term gives the 3rd term

$$x + 33 + x$$

This is the 4th term. Adding the 2nd and 3rd term gives the 4th term

$$2x + 33 = 73$$

Simplifying the expression for the 4th term by collecting like terms.
Setting it equal to the actual value of the 4th term which is 73

$$2x = 40$$

Subtracting 33 from both sides to get the x term on its own

$$x = \frac{20}{1}$$

Dividing both sides by 2 finds x

- 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]

The first term is 0

On the first term, $n = 1$. Substituting this into the expression for the n th term gives $1 - 1^2 = 0$. 0 is not negative



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]

$m = \frac{t}{n}$

Mean = total/number, where total is the total height of all the members and number is the number of members in the club. Writing this as a formula triangle

$$24 \times 1.8 = 43.2$$

$$20 \times 1.92 = 38.4$$

From the formula triangle, total = mean x number. So multiplying the mean height by the number of members for each club works out that the total height of the members of club A is 43.2m and the total height of the members of club B is 38.4m

$$\frac{43.2}{38.4}$$

Expressing the fraction

Answer 1.125

Turn over for the next question



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]

Answer _____ $\frac{-5}{4}$

Gradient = (change in y)/(change in x). The change in y from P to Q is -5 and the change in x from P to Q is 4



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]

$$300 \times 0.49$$

Multiplying the 300 spins by the relative frequency of heads works out that there were 147 heads out of the 300 spins

$$147 - 128 = 19$$

Subtracting the 128 heads in the first 250 spins from the 147 heads in the 300 spins works out that there were 19 heads in the extra 50 spins

$$50 - 19 = 31$$

Subtracting the 19 heads from the 50 spins works out that there were 31 tails in the extra 50 spins

Answer 19 : 31

There were 19 heads and 31 tails in the extra 50 spins. Writing this as a ratio

Turn over for the next question

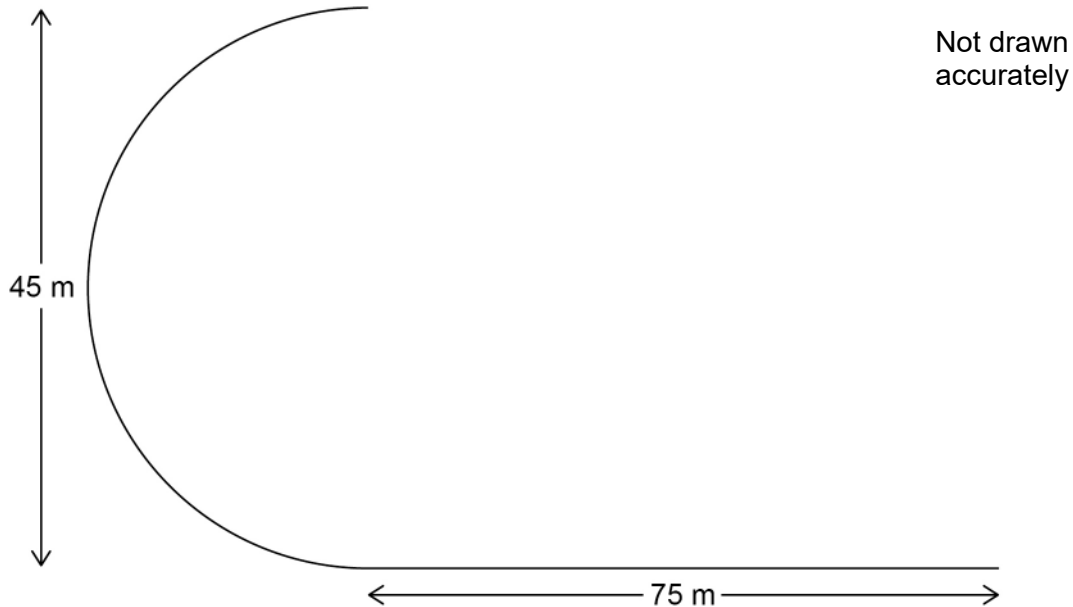


11

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]

$$\frac{45\pi \div 2 + 75}{18}$$

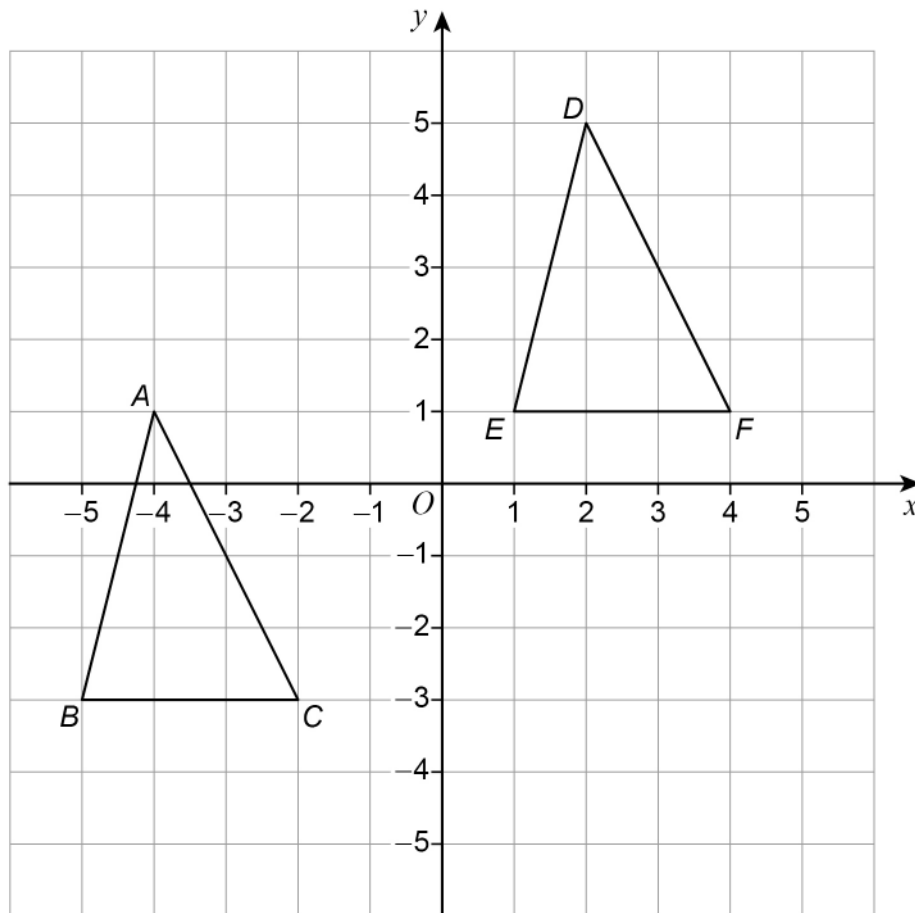
Circumference is the distance around the outside of a circle and is found by multiplying the diameter by π . So 45π is the circumference of the whole circle. Dividing this by 2 expresses the length of the semi-circle. Adding the 75m to this expresses the distance of the whole track in metres. m/s is metres per second, which means to divide the distance in metres by the time in seconds. So dividing the distance of the whole track in metres by the time taken in seconds

The answer of 8.09... is rounded to 2 significant figures

Answer 8.1 m/s



12 Triangles ABC and DEF are shown on a grid.



Describe a single transformation that shows the triangles are congruent.

[2 marks]

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

ABC can be translated to DEF so they must be congruent,
which means they are the same size and shape



- 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

$0.1 + 0.3 + 0.6 = 1$, which is the probability of something which is certain. Therefore it is certain to either get red, blue or green

- 13 (b) Circle the probability that the counter is red **or** blue.

[1 mark]

0.0009

0.8

0.03

0.4

$$0.1 + 0.3 = 0.4$$

Whether the dice is even or odd has no impact on the counter and both are equally as likely so the first event can be ignored. Red **OR** blue, **OR** means to add the probabilities

- 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

$$0.5 \times 0.3 = 0.15$$

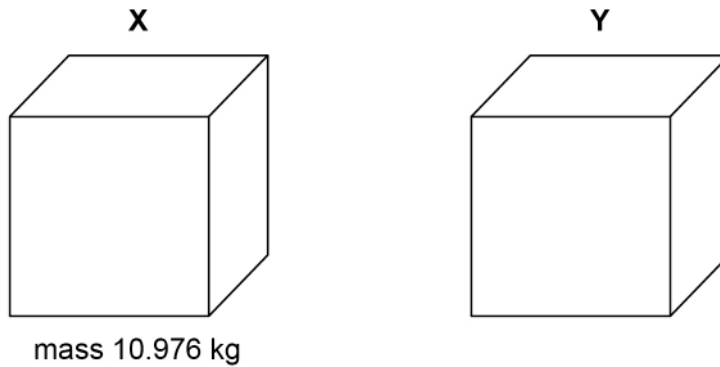
Even **AND** blue. **AND** means to multiply the probabilities

Turn over for the next question

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 cm^2



- 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]

The density is in grams per cubic centimetre, which means to divide the mass in grams by the volume in cubic centimetres

$$10.976 \times 1000 = 10976$$

Converting the mass in kilograms to grams. There are 1000g in 1kg

$$\sqrt{784}$$

Each of the faces on the cube are squares. Area of square = length². So square rooting the area of each face works out that the length is 28cm

$$28^3$$

Volume of cube = length³. So this works out that the volume of the cube is 21952cm³

$$10976 \div 21952$$

Dividing the mass in grams by the volume in cubic centimetres works out the density in grams per cubic centimetre

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

As the mass was divided by the volume to find the density. Decreasing the mass decreases the density. Increasing the area of each face increases the length, which increases the volume, which decreases the density

Turn over for the next question

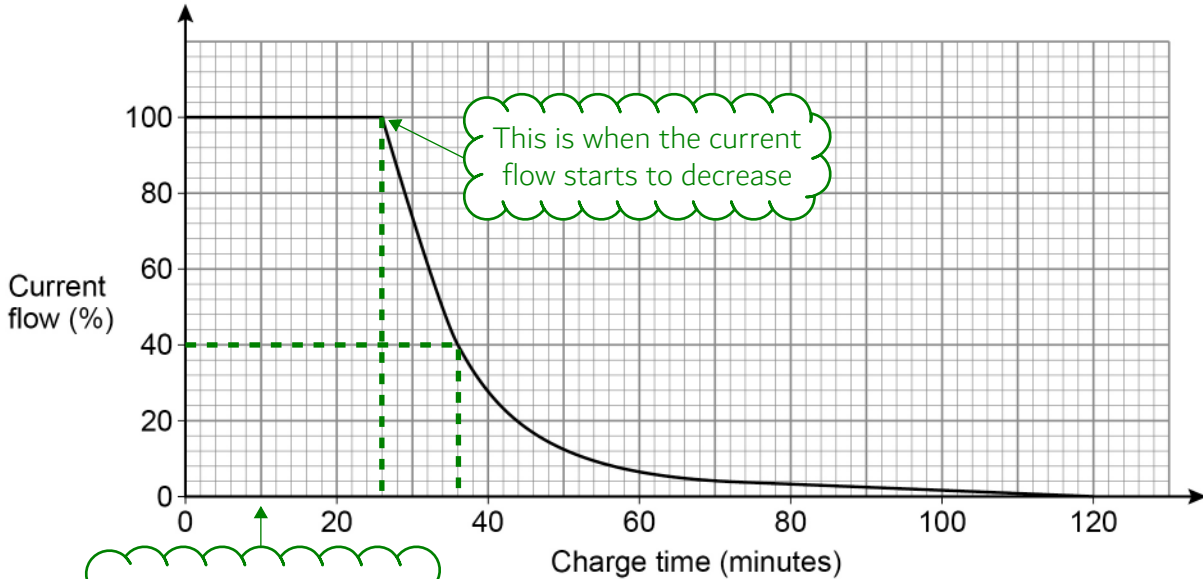
5

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.

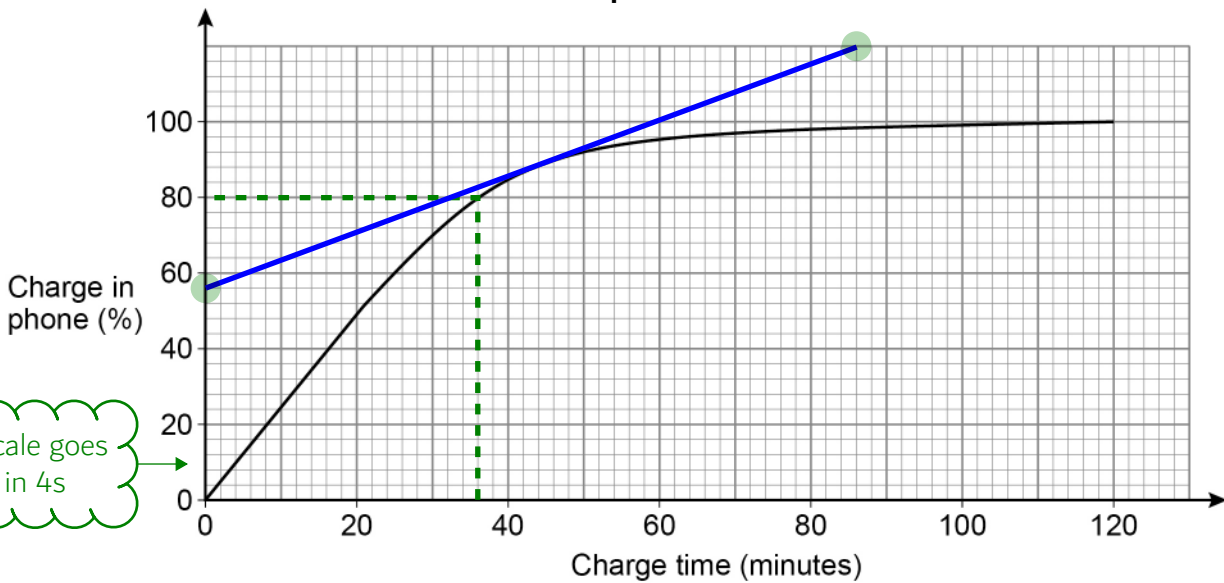
This is shown on **Graph A** below.

Graph A



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

Graph B



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]

Reading down from where the current flow starts to decrease to the time. It is 3 boxes after 20 and each box is worth 2, so this must be after 26 minutes

Answer _____ 10.26 _____ am

The current flow starts to decrease after 26 minutes

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

[1 mark]

Reading across from 40% on graph A to the line then down works out that the current flow is 40% at 36 minutes. Reading up from 36 minutes on graph B to the line then across works out that the percentage charge is at 80%

Answer _____ 80 _____ %

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

[2 marks]

$$\frac{120-56}{86-0}$$

Drawing a tangent at the point on the curve where the charge is 90% then working out the gradient of the tangent. Gradient = (change in y)/(change in x). The two end points of the line are used, which are highlighted in green. Change in y = 120 - 56 and change in x = 86 - 0

Answer _____ 0.74 _____ percent per minute



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]

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

Writing out the proportion. Inversely means '1 over'

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

Converting the proportion into an equation by multiplying the right side by k , which represents a constant value

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

Multiplying both sides by $\sqrt[3]{L}$ to make k the subject

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

$$= 28$$

Substituting in the values given for H and L finds that $k = 28$

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

Going back to the second step and replacing k with 28

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

[2 marks]

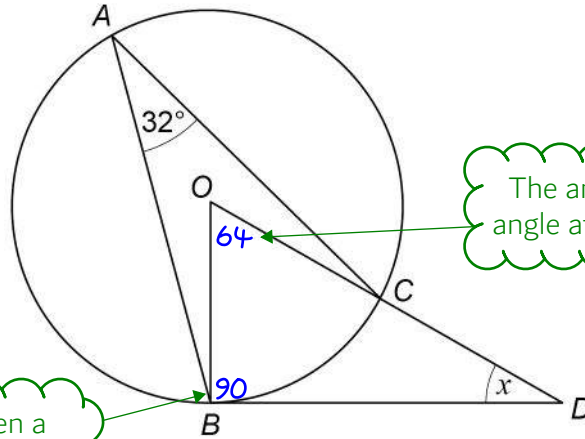
$$\frac{28}{\sqrt[3]{2744}}$$

Substituting the value of L into right side of the equation. H is equal to this

$H =$ 2



- 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

The angle at the centre is double the angle at the circumference. $32 \times 2 = 64$

The angle between a tangent and radius is 90°

Work out the size of angle x .

$$180 - 90 - 54$$

There are 180° in total in a triangle. Subtracting the other angles from 180 leaves x

[3 marks]

$$x = \underline{\quad 26 \quad} \text{ degrees}$$

Turn over ►



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

[4 marks]

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

Expanding the bracket

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

Getting all the terms involving m on the same side and all the other terms on the other side by subtracting pm and adding 4 to both sides. Collecting the $9m$ and $8m$ to make $17m$

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

Factorising the left side to get m out of all the terms on the left

Answer _____

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

Dividing both sides by $17 - p$

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

Write down the equation of the circle.

[1 mark]

Answer _____

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

The general equation of a circle with its centre at the origin is $x^2 + y^2 = \text{radius}^2$. The radius must be 11 as the point $(0, 11)$ is 11 vertically above the centre. $11^2 = 121$



- 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**,

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

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

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

[2 marks]

$$0.9 \times 0.8 \times 0.8$$

On time AND on time AND on time.
AND means to multiply the probabilities

Answer 0.576

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

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

[3 marks]

$$1 - 0.8 = 0.2$$

$$1 - 0.65 = 0.35$$

It is certain to either be on time or not on time so the probabilities of the two events must add up to 1. Subtracting the probabilities of being on time from 1 works out the probabilities of not being on time

NO ON

Listing out the outcomes for the next two trains where one of them is not on time. N stands for not on time and O stands for on time

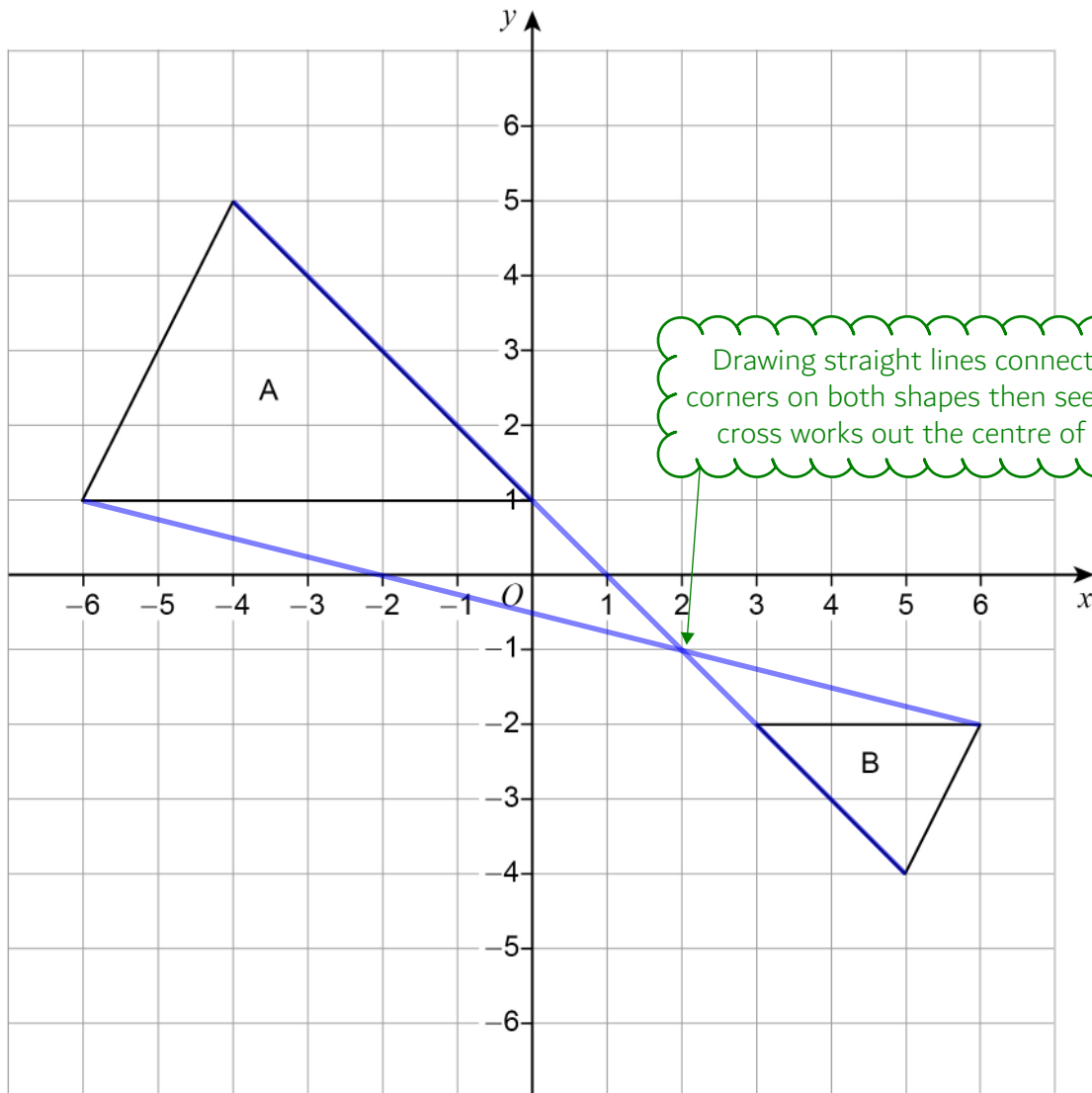
$$0.35 \times 0.65 + 0.65 \times 0.2$$

Not on time AND on time OR on time AND not on time. OR means to add the probabilities, AND means to multiply the probabilities

Answer 0.3575



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

It is half the size and inverted

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]

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

Making all the denominators the same so that the fractions can be added. Whatever the denominator is multiplied by, the numerator has to be multiplied by the same. For the first fraction, the denominator is multiplied by 3 so the numerator is also multiplied by 3. For the second fraction, the denominator is multiplied by $(x + 1)$ so the numerator is also multiplied by $(x + 1)$. For the third fraction, the denominator was basically 1 and is multiplied by both 3 and $(x + 1)$ so the numerator is multiplied by both 3 and $(x + 1)$

$$\frac{6+7x+7-5x^2-5x+12x^2+12x}{3x+3}$$

Expanding all the brackets and adding the fractions. The numerators are added and the denominator is shared

Answer _____

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

Simplifying by collecting the like terms on the numerator. The numerator cannot be factorised so there is no way of simplifying this any further

Turn over ►



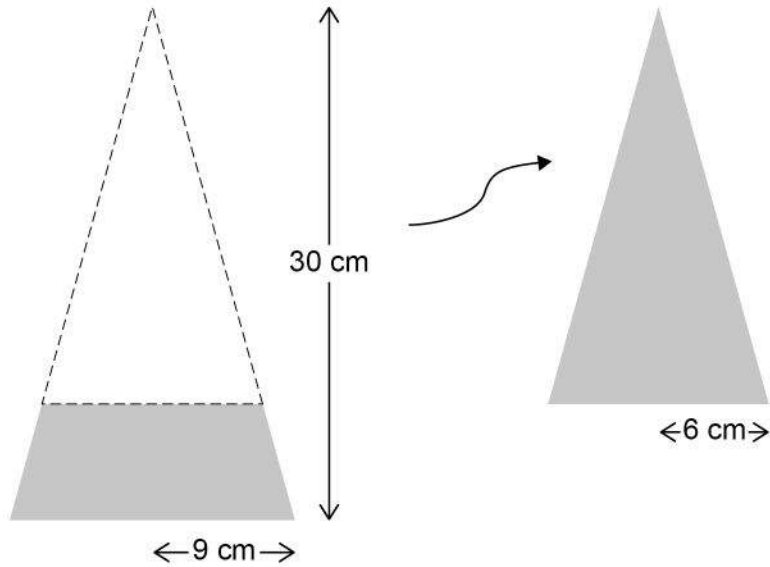
23

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.

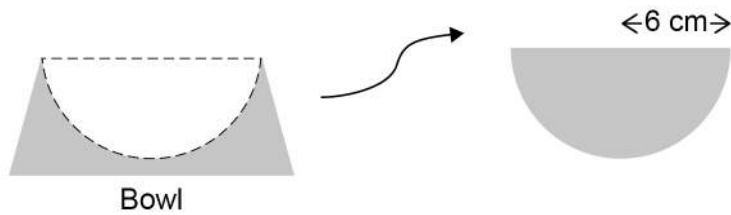


Not drawn
accurately

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

where r is the radius and h is the perpendicular height

A hemisphere with radius 6 cm is then removed.



Not drawn
accurately

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



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

[5 marks]

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

The volume of the solid wooden cone

$$\frac{6}{9} \times 30 = 20$$

The two cones are similar as they have the same angle at the top. $\frac{6}{9}$ is the fraction of the solid wooden cone the smaller cone is as this is the fraction of their radii. Doing this fraction of the height works out that the height of the smaller cone is 20cm

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

The volume of the smaller cone

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

The volume of the hemisphere

$$810\pi - 240\pi - 144\pi$$

Subtracting the volume of the smaller cone and hemisphere from the solid wooden cone leaves the volume of the bowl

Answer 426 π cm³



- 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]

Subtracting the percentage decrease or adding the percentage increase to 100 expresses the percentage it changes to. Putting this over 100 converts it into a fraction, which does the percentage change when multiplied by

$$14000 \times \frac{100-35}{100} \times \left(\frac{100-10}{100}\right)^3 = 6633.90$$

Decreasing the £14000 by 35% and 10% three times (so raising the multiplier to the power of 3) works out that the value of the car after 4 years was £6633.90

$$5000 \times \left(\frac{100+4}{100}\right)^4 = 5849.29$$

Increasing the £5000 by 4% four times (so raising the multiplier to the power of 4) works out that the value of the painting after 4 years was £5849.29, to the nearest penny

This shows that at the end of the fourth year the car is worth more than the painting

$$6633.90 \times \frac{100-10}{100} = 5970.51$$

Decreasing the value of the car after 4 years by another 10% works out that the value of the car after 5 years was £5970.51

$$5849.29 \times \frac{100+4}{100} = 6083.26$$

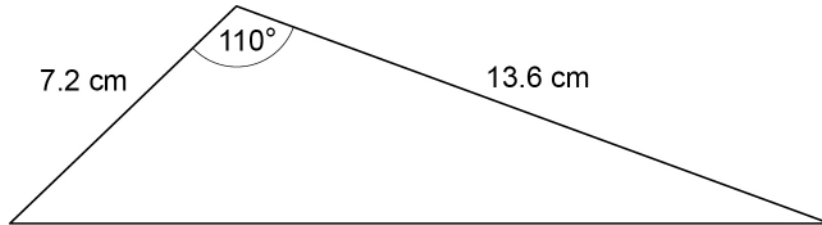
Increasing the value of the painting after 4 years by another 4% works out that the value of the painting after 5 years was £6083.26, to the nearest penny

This shows that at the end of the fifth year the painting is worth more than the car.
Therefore the painting becomes worth more than the car during the fifth year



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

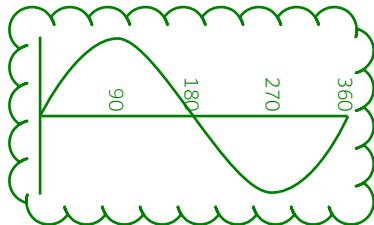
Work out the upper bound for the area of the triangle.

You **must** show your working.

[4 marks]

$$\frac{1}{2}(7.2 + \frac{0.1}{2})(13.6 + \frac{0.1}{2})\sin(110 - \frac{1}{2})$$

Area of triangle = $\frac{1}{2} ab \sin C$, where a and b are sides and C is the angle between them. Using the upper bounds of the sides a and b and the lower bound of the angle C (as \sin values get less as the angle increases between 90° and 270° , as shown on the \sin graph below). To work out the bounds, adding half of the resolution for the upper bounds and subtracting half of the resolution for the lower bounds. The resolution of the sides is 0.1 as they are to 1 decimal place and the first decimal place goes up in 0.1 s. The resolution of the angle is 1 as it is measured to the nearest degree

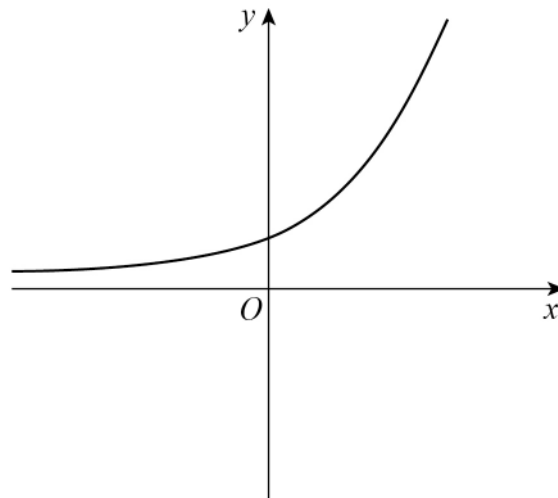


Answer 46.6 cm²

Turn over for the next question



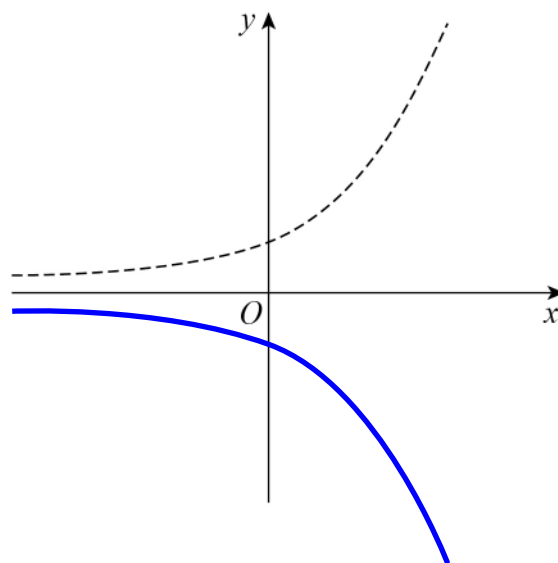
26 Here is a sketch of the graph of $y = 5^x$



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]



It is a reflection on the x-axis as the whole right side has become negative

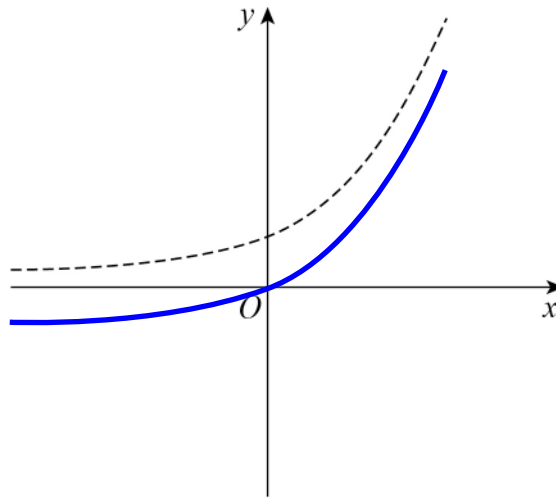
Table mode could be used. $f(x) = 5^x$. $g(x) = -5^x$. Start: -5. End: 5. Step 1

This gives a table of values of both equations so that they can be compared and it gives a rough idea of what the second graph should look like



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

[1 mark]



The graph is translated 1 downward as 1 is subtracted from the whole of the right side. It must go through (0, 0) as the y-intercept of $y = 5^x$ is (0, 1) because $5^0 = 1$

Table mode could be used. $f(x) = 5^x$. $g(x) = 5^x - 1$. Start: -5. End: 5. Step 1

This gives a table of values of both equations so that they can be compared and it gives a rough idea of what the second graph should look like

END OF QUESTIONS

