



Please write clearly in block capitals.

Centre number Candidate number

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE MATHEMATICS



Higher Tier Paper 3 Calculator

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

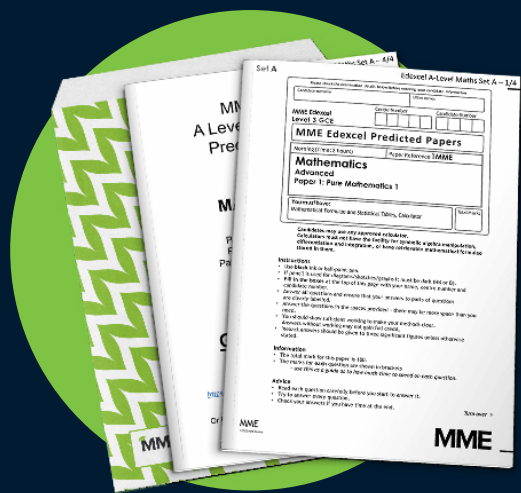
In all calculations, show clearly how you work out your answer.

| 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 | |
| TOTAL | |

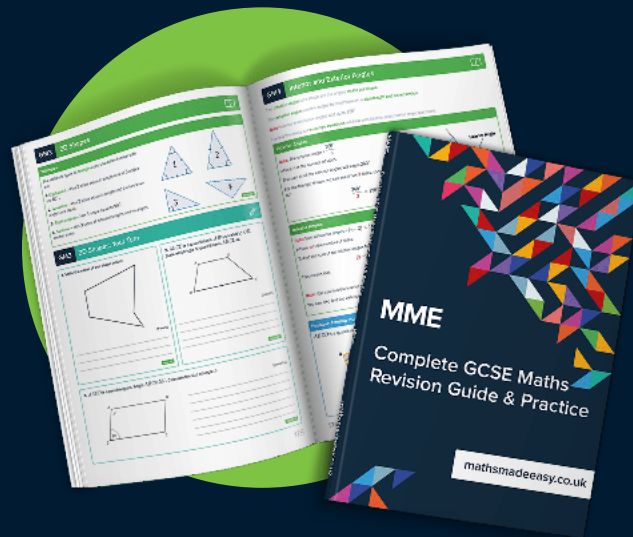


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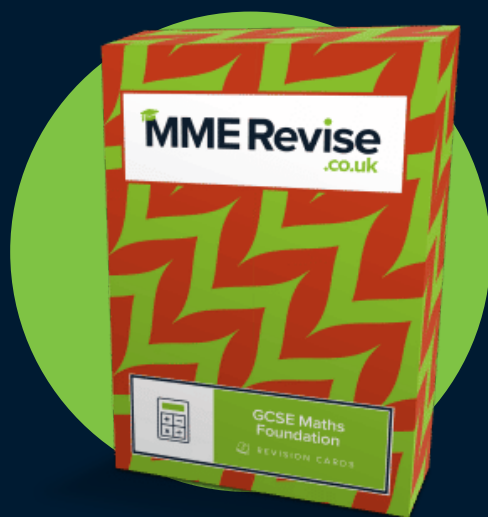
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Answer all questions in the spaces provided.

Do not write outside the box

1 Circle the smallest number.

[1 mark]

4.31

4. $\dot{3}$

4.301

4.33

2 Work out $\begin{pmatrix} -4 \\ 8 \end{pmatrix} - \begin{pmatrix} 3 \\ -2 \end{pmatrix}$
Circle your answer.

[1 mark]

$\begin{pmatrix} -7 \\ 10 \end{pmatrix}$

$\begin{pmatrix} -7 \\ 6 \end{pmatrix}$

$\begin{pmatrix} -1 \\ 10 \end{pmatrix}$

$\begin{pmatrix} -1 \\ 6 \end{pmatrix}$

3 (a) For which graph is the straight line of best fit appropriate?
Circle your answer.

[1 mark]

A

B

C

D

3 (b) Which graph has one outlier?
Circle your answer.

[1 mark]

A

B

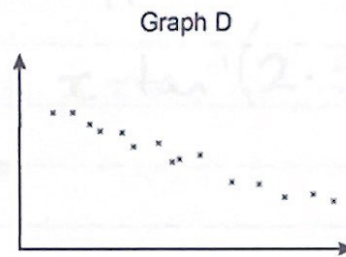
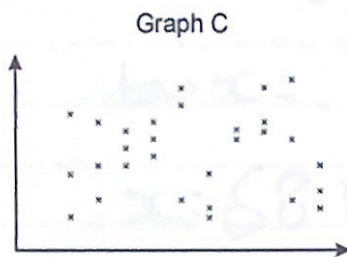
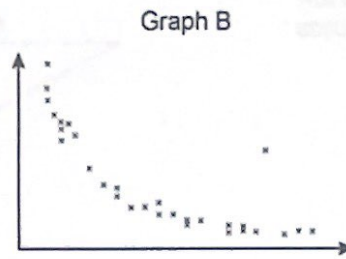
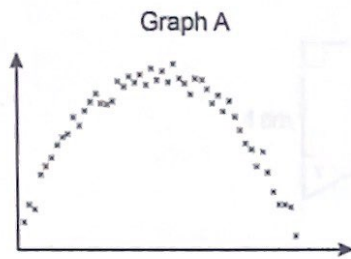
C

D



Do not write outside the box

3 Here are four scatter graphs.



3 (a) For which graph is a straight line of best fit appropriate?
Circle your answer.

[1 mark]

A

B

C

D

3 (b) Which graph has one outlier?
Circle your answer.

[1 mark]

A

B

C

D

4

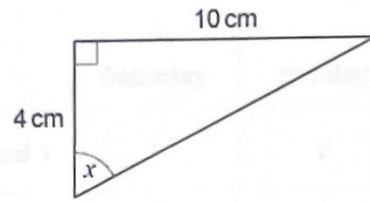
Turn over ►



4

Use trigonometry to work out the size of angle x .

The table shows the number of hours she works in each subject.

Not drawn
accurately

[3 marks]

We have adjacent and opposite. $\frac{O}{A}$

$$\tan x = \frac{10}{4}, \quad x = \tan^{-1}(2.5)$$

$$x = 68.198\dots^\circ$$

$$x = \underline{68.2^\circ}$$

Turn over for the next question

Turn over \blacktriangleright 

- 5 Laura works in a shop.
The table shows the number of hours she works on two weekends.

| | Saturday | Sunday |
|-----------|----------------|----------------|
| Weekend 1 | 3 | 2 |
| Weekend 2 | $5\frac{1}{2}$ | $3\frac{1}{2}$ |

Work out the percentage increase in her **total** hours from Weekend 1 to Weekend 2

[3 marks]

$$\text{Weekend 1: } 3 + 2 = 5 \text{ hours total.}$$

$$\text{Weekend 2: } 5\frac{1}{2} + 3\frac{1}{2} = 9 \text{ hours total.}$$

$$\frac{x}{100} \times 5 = 9, \quad x = \frac{9}{5} \times 100$$

$$x = 180\%$$

So an 80% increase.

Answer 80 %

- 6 (b) Work out the coordinates of T, the turning point of the curve

$$y = (x-2)^2 - 4 - 5 = (x-2)^2 - 9$$

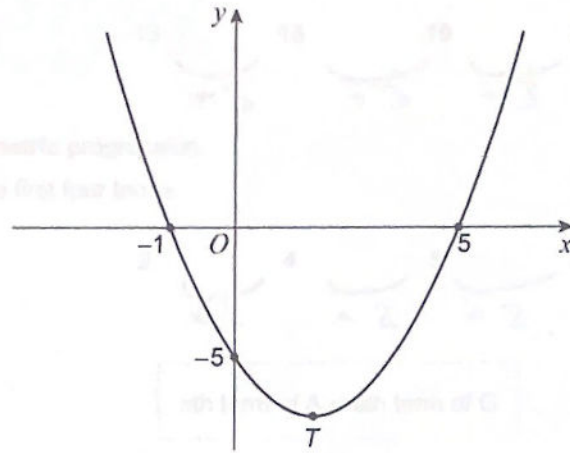
$$\text{Answer: } (2, -9)$$

Turn over for the next question

Turn over ►



- 6 Here is a sketch of the curve $y = x^2 - 4x - 5$



- 6 (a) Write down the two roots of $x^2 - 4x - 5 = 0$

$$(x-5)(x+1)$$

[1 mark]

Answer -1 and 5

- 6 (b) Work out the coordinates of T , the turning point of the curve.

[2 marks]

$$y = (x-2)^2 - 4 - 5 = (x-2)^2 - 9$$

Answer (2 , -9)



7

A is an arithmetic progression.

Here are the first four terms.

$$13 \quad 16 \quad 19 \quad 22$$

$\underbrace{\hspace{1.5cm}}_{+3}$ $\underbrace{\hspace{1.5cm}}_{+3}$ $\underbrace{\hspace{1.5cm}}_{+3}$

G is a geometric progression.

Here are the first four terms.

$$2 \quad 4 \quad 8 \quad 16$$

$\underbrace{\hspace{1.5cm}}_{\times 2}$ $\underbrace{\hspace{1.5cm}}_{\times 2}$ $\underbrace{\hspace{1.5cm}}_{\times 2}$

n th term of A = 8 th term of G

Work out the value of n .

[4 marks]

~~n th term = 2^n .~~

$A \text{ } n\text{th term} = 3n + 10.$

$$3n + 10 = 2^8 = 256.$$

$$3n = 246$$

$$n = 82.$$

$$n = \underline{82}$$



Do not write outside the box

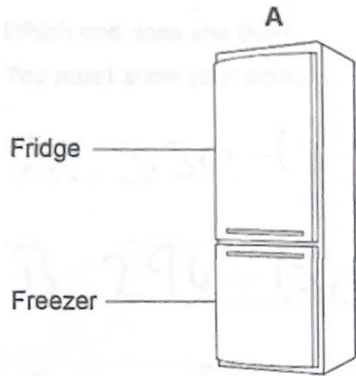
8

Information about two fridge-freezers, A and B, is shown.

One buys the one with the smaller freezer capacity.

Which one does she buy?

You must show your work.

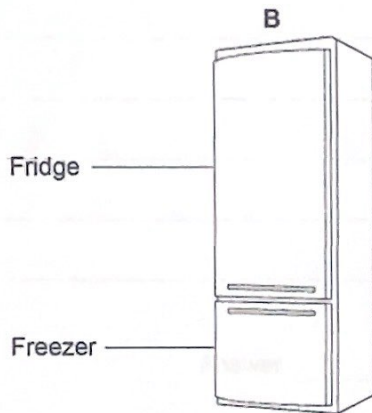


Total capacity is 330 litres

fridge capacity : freezer capacity = 3 : 2

$330 \div (2+3) \times 2 = 126L$

So Grace bought Fridge-Freezer A



Fridge capacity is 294 litres

fridge capacity : freezer capacity = 7 : 3

Turn over for the next question



Grace buys one of these fridge-freezers.

She buys the one with the greater freezer capacity.

Which one does she buy?

You **must** show your working.

[4 marks]

$$A: 330 \div (3-2) \times 2 = 132 \text{ L.}$$

$$B: 294 \div (7+3) \times 3 = 126 \text{ L.}$$

So Grace bought Fridge-Freezer A.

Answer

A.

Turn over for the next question

4

Turn over ►



- 9 Tom and Adil are the two runners in a 200-metre race.
- Tom completes the race in 24 seconds.
 - Adil completes the race at an average speed of 28.8 kilometres per hour.

Who wins the race?

You must show your working.

[3 marks]

$$200 \div 24 = 8.3 \text{ m/s, for Tom.}$$

~~Adil:~~
$$28.8 \times 1000 = 28800 \text{ m/hour} \begin{matrix} \downarrow \div 60 \\ = 480 \text{ m/minute.} \\ = 8 \text{ m/s.} \leftarrow \div 60. \end{matrix}$$

So Adil is going slower and
Tom wins the race.

Answer

Tom.



Do not write outside the box

10 The mass of a baby is 3.6 kilograms to 1 decimal place.

What is the error interval for the mass in kilograms?

Tick **one** box.

[1 mark]

$3.5 \leq \text{mass} < 3.6$

$3.55 \leq \text{mass} < 3.65$

$3.5 \leq \text{mass} < 3.6$

$3.55 \leq \text{mass} < 3.65$

11 A quadrilateral has angles 70° , 110° , 130° and 50°

Circle the possible type of quadrilateral.

[1 mark]

kite

parallelogram

rhombus

trapezium

Turn over for the next question

5

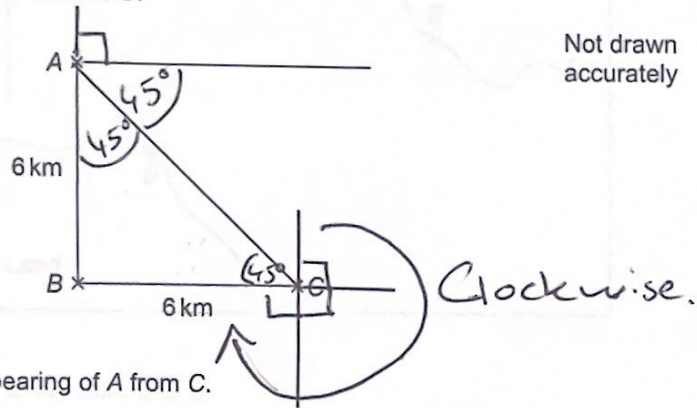
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Do not write outside the box

12 (a) B is

6 km due South of A
and
6 km due West of C.



Not drawn accurately

Work out the bearing of A from C.

[2 marks]

$$90 \times 3 + 45 = 315^\circ$$

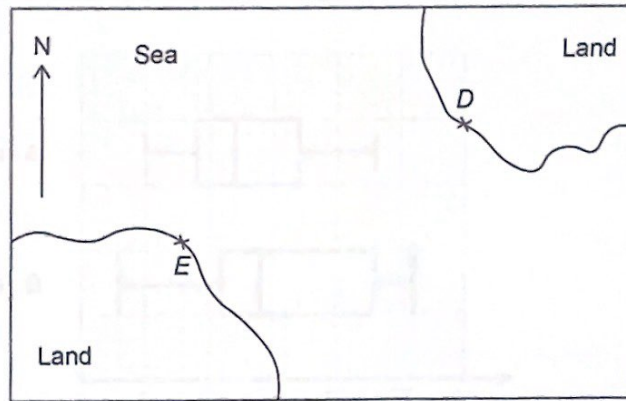
A bearing of 68 from D would face a
load of 68. The bearing back to
D.

Answer 315°



Do not write outside the box

12 (b) Here is a scale drawing.



A ship is going to sail from D to E.

Mia works out that the ship needs to sail on a bearing of 068°

Why must Mia be wrong?

[1 mark]

A bearing of 68° from D would face in land. 68° is the bearing from E to D.

13

Simplify $\sqrt{5}a + \sqrt{5}a$

Circle your answer.

[1 mark]

$5a$

$5a^2$

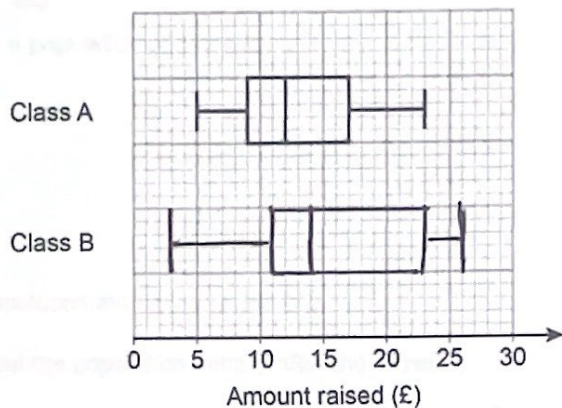
$2\sqrt{5}a$

$\sqrt{10}a$

Turn over ►



14 Students in two classes, A and B, raised money for charity.
The box plot for class A is shown on the grid.



For class B,

- the lowest amount was £3 and the highest amount was £26
- the lower quartile was £11
- the median was £2 greater than the class A median
- the interquartile range was $1\frac{1}{2}$ times greater than the class A interquartile range.

Draw the box plot for class B on the grid.

[4 marks]

$$\text{IQR of A: } 17 - 9 = 8.$$

$$1.5 \times 8 = 12 = \text{IQR of B.}$$

$$\text{Upper Q of B} = 11 + 12 = 23.$$



15

A town has
a population density of 278 people per km²
and
a population of 158 460

$$\text{population density} = \frac{\text{population}}{\text{area}}$$

The population increases to 168 720

Work out the population density after the increase.

[3 marks]

$$\text{Area} = \frac{\text{Population}}{\text{Population density}}$$

$$\text{Area} = 158460 \div 278 = 570 \text{ km}^2$$

after increase:

$$\text{P.D.} = \frac{168720}{570} = 296$$

Answer 296 people per km²

7

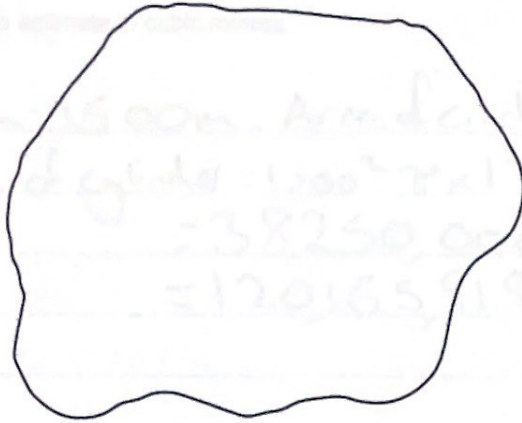
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Do not write outside the box

16 Here is a scale drawing of a reservoir.

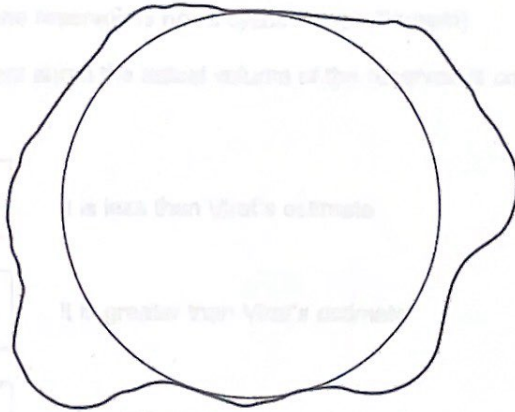
Scale: 1 cm represents 500 m



3cm x 5cm Area = 1500 m²
 Volume of cylinder = 1500 m² x 1
 = 38250,000 m³
 = 120,165,919 m³

Virat wants to estimate the volume of water in the reservoir.

He draws on the scale drawing a circle with radius 3 cm



- is less than Virat's estimate
- is similar to Virat's estimate
- should be less than or greater than Virat's estimate

Give a reason for your answer.

Could be larger as the depth surface area is larger, but the depth is smaller, so the volume could be too.



16 (a) Virat estimates the volume of the reservoir by assuming that

- the reservoir is a cylinder whose cross section is the circle
- the depth of the reservoir is 17 metres.

Work out Virat's estimate in cubic metres.

[3 marks]

$$3\text{cm} = 1500\text{m}. \text{ Area of circle} = 1500^2 \times \pi$$

$$\text{Volume of cylinder} = 1500^2 \pi \times 17$$

$$= 38,250,000\pi$$

$$= 120,165,919\text{m}^3$$

Answer 120,165,919 m³

16 (b) In fact,

- the depth of the reservoir is 13.8 metres
- the reservoir is **not** a cylinder (see diagram).

Which statement about the actual volume of the reservoir is correct?

Tick **one** box.

It is less than Virat's estimate

It is greater than Virat's estimate

It could be less than or greater than Virat's estimate

Give a reason for your answer.

[2 marks]

Could be larger as the ~~depth's~~ surface area is larger, but the depth is smaller, so the volume could be too.

5

Turn over ►



- 17 In a video game, players make their own character.
They choose one of each from
- 8 faces
 - 4 bodies
 - 5 hairstyles.

- 17 (a) How many different characters can be made?

[2 marks]

$$8 \times 4 \times 5 = 160$$

Answer 160 characters.

- 17 (b) Two characters are made at random.

What is the probability that they are exactly the same?

[1 mark]

$$\frac{1}{160}$$

Answer $\frac{1}{160}$

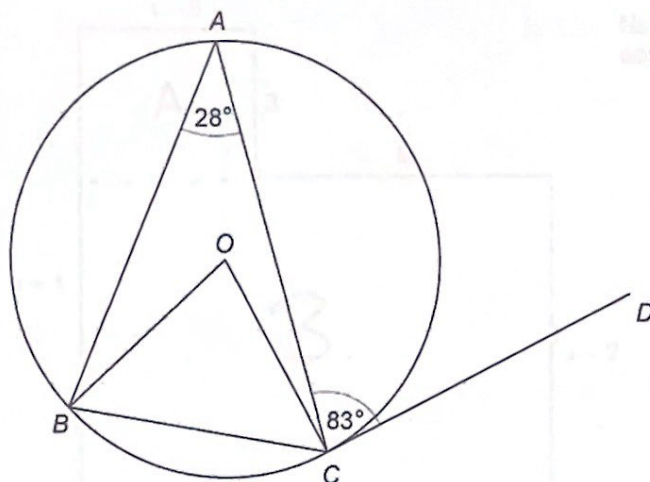


18

A, B and C are points on a circle, centre O .

DC is a tangent to the circle.

Do not write
outside the
box



Not drawn
accurately

Show that $\text{angle } ABO : \text{angle } ACO = 3 : 1$

[5 marks]

$$\begin{aligned} \angle OCD &= 90^\circ \text{ as radii meet tangents at } 90^\circ. \\ \text{So } \angle ACO &= 90 - 83 = 7^\circ. \end{aligned}$$

$$\text{(Acute) } \angle BOC = 2 \times 28 = 56^\circ$$

$$\text{(Reflex) } \angle BOC = 360 - 56 = 304^\circ$$

$ABOC$ form a quadrilateral, so inside angles add to 360° .

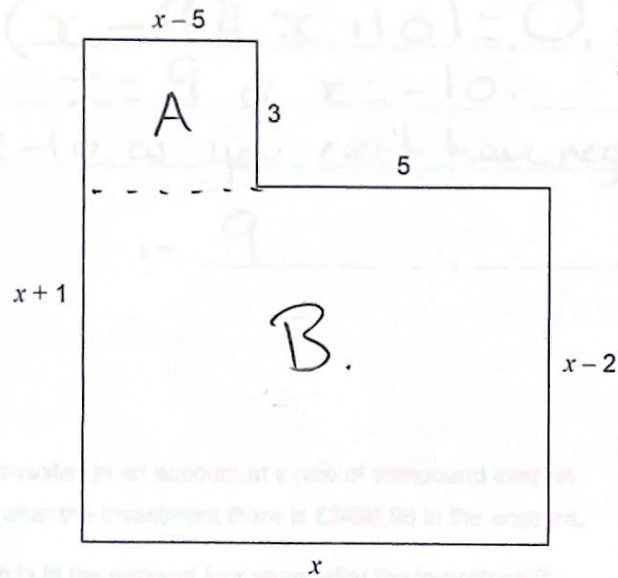
$$\text{So } 28^\circ + 7^\circ + 304^\circ + \angle ABO = 360^\circ$$

$$\angle ABO = 21^\circ$$

$$\angle ABO : \angle ACO = 21^\circ : 7^\circ = 3 : 1.$$



- 19 Here is the plan of the floor of an L-shaped room.
All lengths are in metres.



- 19 (a) The area of the floor is 75m^2

Show that $x^2 + x - 90 = 0$

[3 marks]

$$\text{Area A} = 3 \times (x - 5) = 3x - 15.$$

$$\text{Area B} = x \times (x - 2) = x^2 - 2x$$

$$\text{Area A} + \text{Area B} = 75\text{m}^2.$$

$$3x - 15 + x^2 - 2x = 75.$$

$$x^2 + x - 15 = 75$$

$$x^2 + x - 90 = 0 \quad \square$$



- 19 (b) By factorising $x^2 + x - 90$ work out the value of x .

You must show your working

[2 marks]

$$(x-9)(x+10) = 0.$$

$$x = 9 \text{ or } x = -10.$$

$x \neq -10$ as you can't have negative length.

$$x = 9$$

- 20 £2448 is invested in an account at a rate of compound interest.

One year after the investment there is £2496.96 in the account.

How much is in the account four years after the investment?

[3 marks]

$x = \% \text{ multiplier.}$

$$2448 \times x = 2496.96.$$

$$\frac{2496.96}{2448}$$

$$x = \frac{2496.96}{2448} = 1.02.$$

$$2448 \times 1.02^4 = 2649.793 \dots$$

$$\pounds 2649.79.$$

Answer £ 2649.79



21

Here are two simultaneous equations

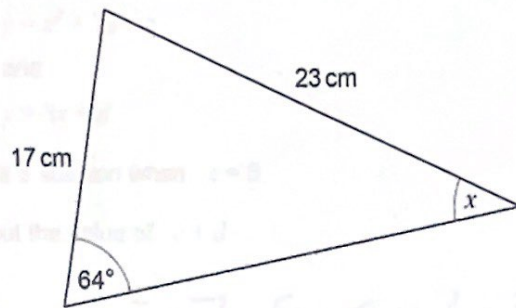
Solve

and

There is a question when $x=0$

Mark out the correct answer

(3 marks)

Not drawn
accuratelyUse the sine rule to work out the size of angle x .

[3 marks]

$$\frac{\sin x}{17} = \frac{\sin(64)}{23}$$

$$\sin x = 17 \sin(64) \div 23$$

$$x = \sin^{-1}(17 \sin(64) \div 23)$$

$$x = 41.63 \dots^\circ$$

$$x = 41.6^\circ$$

22

$$f(x) = 3x \quad \text{and} \quad g(x) = x^2$$

Circle the expression for $fg(x)$

[1 mark]

$$3x^2$$

$$9x^2$$

$$3x^3$$

$$9x^4$$

Turn over for the next question



2 2

23

Here are two simultaneous equations.

$$y = x^2 + 7x - c$$

and

$$y = 3x + d$$

There is a solution when $x = 5$

Work out the value of $c + d$

[3 marks]

$$y = 5^2 + 7 \times 5 - c = 3 \times 5 + d$$

$$y = 60 - c = 15 + d.$$

$$60 - 15 = c + d$$

$$c + d = 45.$$

Answer $c + d = 45.$

Turn over for the next question

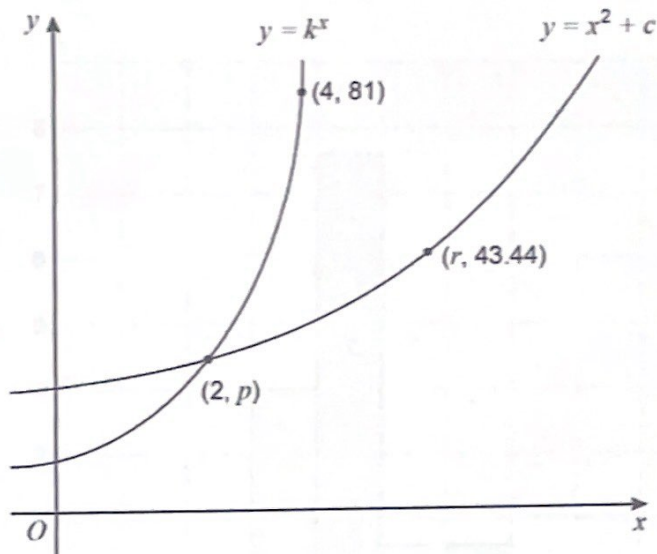
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Turn over ►



24

Here is a sketch of the graphs of $y = k^x$ and $y = x^2 + c$
 k and c are positive constants.



Work out the value of r .

[4 marks]

$$k^4 = 81, \quad k = \sqrt[4]{81} = 3.$$

$$y = 3^x, \quad y = 3^2 = p = 9.$$

$$(2, 9) \text{ lies on } y = x^2 + c.$$

$$y = 2^2 + c = 9$$

$$4 + c = 9, \quad c = 5.$$

$$y = r^2 + 5 = 43.44.$$

$$r^2 = 38.44$$

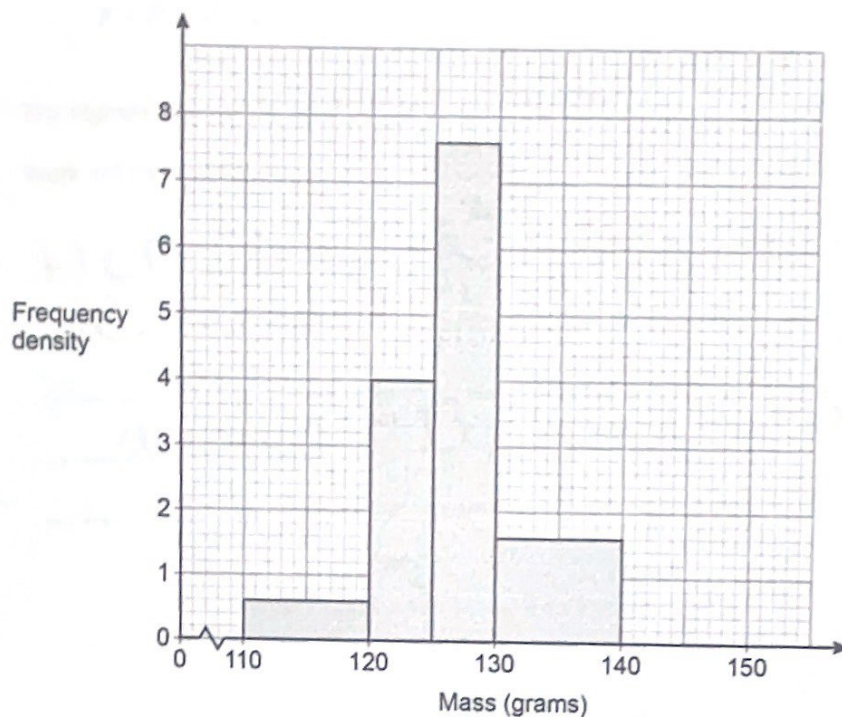
$$r = \sqrt{38.44} = 6.2$$

$$r = 6.2$$



25

A company makes tubes of toothpaste.
The masses of 80 tubes are checked.
A histogram is drawn to represent the data.

Do not write
outside the
box

The company makes 28 000 tubes each day.

Estimate how many tubes each day have a mass less than 122 grams.

[4 marks]

We will estimate $\frac{2}{5}$ of tubes between
120 and 125 gram will be less than 122.
So $4 \times 5 \times \frac{2}{5} = 8$ tubes.
 $10 \times 0.6 = 6$ tubes,
 $6 + 8 = 14$ tubes out of 80.
 $\frac{14}{80} \times 28000 = 4900$ tubes each day.

Answer 4900

8

Turn over ►



2 5

26 Q and R are two numbers.

As a product of prime factors,

$$Q = 2^3 \times 3 \times a^3$$

$$R = 2^4 \times 3^2 \times a^2$$

26 (a) The highest common factor (HCF) of Q and R is 4056

Work out the value of a .

[2 marks]

$$\text{HCF} = 2^3 \times 3 \times a^2 = 24a^2 = 4056.$$

$$a^2 = 4056 \div 24 = 169.$$

$$a = \sqrt{169} = 13, \text{ (cannot be } -13 \text{ as it's prime)}$$

$$a = 13.$$

26 (b) Work out the lowest common multiple (LCM) of Q and R .

[2 marks]

The highest power of their shared prime factors.

$$2^4 \times 3^2 \times a^3 = 16 \times 9 \times 13^3$$

$$= 144 \times 2197$$

$$= 316368$$

Answer 316368.



27

Expand and simplify fully $(x-3)(x-4)(x+8)$

[3 marks]

Do not write
outside the
box

$$\begin{aligned} & (x-3)(x-4)(x+8) \\ &= (x^2-3x-4x+12)(x+8) \\ &= (x^2-7x+12)(x+8) \\ &= x(x^2-7x+12) + 8(x^2-7x+12) \\ &= x^3-7x^2+12x+8x^2-56x+96 \\ &= x^3+x^2-44x+96 \end{aligned}$$

Answer $x^3+x^2-44x+96.$

END OF QUESTIONS

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| 7 |
|---|

