

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 2 Calculator

Thursday 7 June 2018

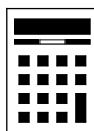
Morning

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

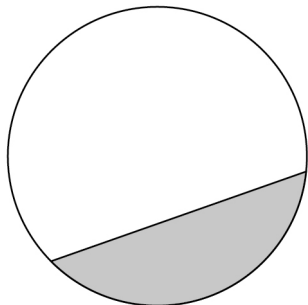
Pages	Mark
2–3	
4–5	
6–7	
8–9	
10–11	
12–13	
14–15	
16–17	
18–19	
20–21	
22–23	
24–25	
26–27	
28–29	
TOTAL	



J U N 1 8 8 3 0 0 2 H 0 1

Answer **all** questions in the spaces provided

- 1 Here is a circle.



Circle the word that describes the shaded part.

[1 mark]

segment

chord

sector

arc

- 2 Circle the number that is in standard form.

[1 mark]

$$0.25 \times 10^4$$

$$6 \times 10^7$$

$$38 \times 10^{-3}$$

$$4 \times 10^{\frac{1}{2}}$$



3

y is $1\frac{1}{2}$ times x .

Circle the ratio that is equivalent to $y : x$

[1 mark]

2 : 5

5 : 2

3 : 2

2 : 3

4

Work out 40 as a percentage of 10

Circle your answer.

[1 mark]

4%

25%

300%

400%

Turn over for the next question

Turn over ►



5

Match each sequence to its description.

One has been done for you.

[4 marks]

1 1 2 3 5 8	Arithmetic progression
1 2 4 8 16 32	Geometric progression
1 2 3 4 5 6	Fibonacci sequence
1 3 6 10 15 21	Triangular numbers
1 4 9 16 25 36	Cube numbers
1 8 27 64 125 216	Square numbers



6

The table shows information about the population of a city.

Population in 2001	Population in 2011
420 000	480 000

Liam claims,

“From 2011 to 2021 the population of the city will increase by the same percentage as from 2001 to 2011”

He works out,

$$\begin{aligned}\text{population increase from 2001 to 2011} &= 480\,000 - 420\,000 \\ &= 60\,000\end{aligned}$$

$$\begin{aligned}\text{population in 2021} &= 480\,000 + 60\,000 \\ &= 540\,000\end{aligned}$$

Does the population of 540 000 match his claim?

You **must** show your working.

[3 marks]

$$2001 \text{ to } 2011: 60\,000 \div 420\,000 \times 100 = 14.285\ldots\%$$

$$2011 \text{ to } 2021: 60\,000 \div 480\,000 \times 100 = 12.5\%$$

$14.3\% \neq 12.5\%$, so the percentage increase is not the same

(same % would be $480\,000 \times 1.142857\ldots = 548\,571$)

Answer No

Turn over for the next question



- 7 On three days, Ali throws darts at a target.
Here are his results.

	Number of throws	Number of hits	Number of misses
Monday	20	15	5
Tuesday	30	22	8
Wednesday	40	17	23
Total	90	54	36

- 7 (a) Work out **two** different estimates for the probability of Ali hitting the target.

[2 marks]

Monday: $15 \div 20 = 0.75$

All three days: $54 \div 90 = 0.6$

Answer $\frac{15}{20}$ and $\frac{54}{90}$

- 7 (b) Which of your two answers is the better estimate for the probability of Ali hitting the target?

Give a reason for your answer.

[1 mark]

Answer $54/90$ ($= 0.6$, the total for all three days)

Reason *It is based on more throws (all 90 throws, not just 20)*



8

Theo starts with savings of £18
James starts with no savings.

Each week from now,

Theo will save £4.50 and James will save £4

In how many weeks will Theo and James have savings in the ratio 15 : 8 ?

[3 marks]

$$\text{After } w \text{ weeks: Theo} = 18 + 4.5w, \text{ James} = 4w$$

$$(18 + 4.5w) : 4w = 15 : 8$$

$$8(18 + 4.5w) = 15 \times 4w$$

$$144 + 36w = 60w$$

$$144 = 24w \quad w = 6$$

$$\text{Check: Theo} = 18 + 27 = £45, \text{ James} = £24$$

$$45 : 24 = 15 : 8 \quad \checkmark$$

Answer 6 weeks



9 The length of each side of a regular pentagon is 8.4 cm to 1 decimal place.

9 (a) Complete the error interval for the length of one side.

[2 marks]

$$8.4 \pm 0.05$$

$$\underline{8.35} \text{ cm} \leq \text{length} < \underline{8.45} \text{ cm}$$

9 (b) Complete the error interval for the perimeter.

[1 mark]

$$5 \times 8.35 = 41.75 \quad 5 \times 8.45 = 42.25$$

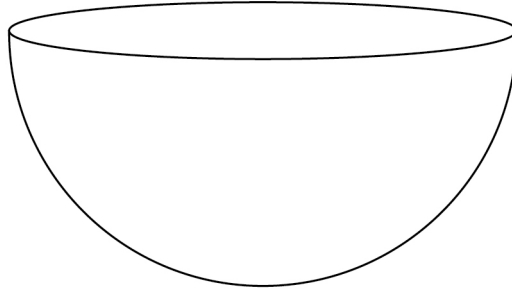
$$\underline{41.75} \text{ cm} \leq \text{perimeter} < \underline{42.25} \text{ cm}$$



10

$$\text{Volume of a sphere} = \frac{4}{3} \pi r^3 \text{ where } r \text{ is the radius}$$

A container is a hemisphere of radius 30 cm



Sand fills the container at a rate of 4000 cm^3 per minute.

Does it take **less than** a quarter of an hour to fill the container?

You **must** show your working.

[3 marks]

$$\text{Volume of hemisphere} = \frac{1}{2} \times \frac{4}{3} \times \pi \times 30^3$$

$$= 18\,000\pi = 56\,548.66... \text{ cm}^3$$

$$\text{Time} = 56\,548.66... \div 4000 = 14.137... \text{ minutes}$$

$$\frac{1}{4} \text{ hour} = 15 \text{ minutes}$$

$$14.1 \text{ minutes} < 15 \text{ minutes}$$

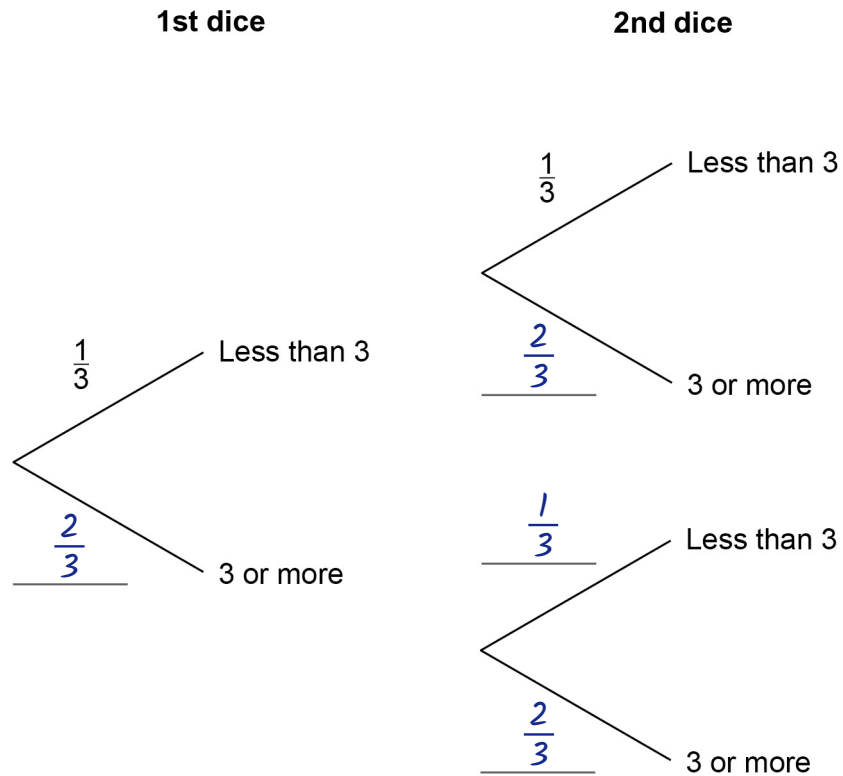
Answer Yes, it takes 14.1 minutes



11 Two ordinary fair dice are rolled.

11 (a) Complete the tree diagram.

[1 mark]



11 (b) Work out the probability that **both** dice land on a number less than 3

[1 mark]

$$P(\text{both} < 3) = \frac{1}{3} \times \frac{1}{3} = \frac{1}{9}$$

Answer $\frac{1}{9}$



- 11 (c) Work out the probability that **exactly one** of the dice lands on a number less than 3

[2 marks]

$$P(\text{exactly one}) = \frac{1}{3} \times \frac{2}{3} + \frac{2}{3} \times \frac{1}{3}$$

$$= \frac{2}{9} + \frac{2}{9} = \frac{4}{9}$$

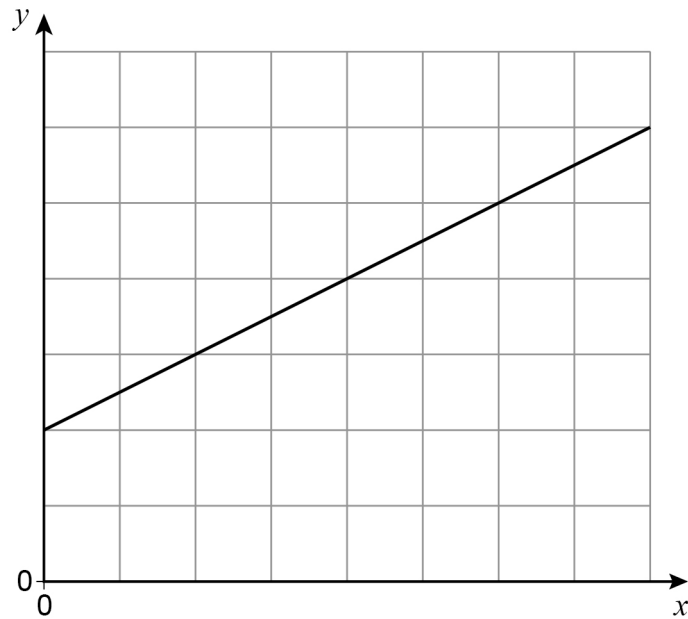
Answer $\frac{4}{9}$

Turn over for the next question

Turn over ►



- 12 A straight line is drawn on the centimetre grid.



Fay assumes that the scale is 1 cm represents 1 unit.

- 12 (a) Use her assumption to work out the gradient of the line.

[1 mark]

Line goes through (0, 2) and (8, 6)

gradient = $(6 - 2) \div (8 - 0) = 4 \div 8$

Answer $\frac{1}{2}$



12 (b) In fact, the scale is 1 cm represents 2 units.

Which statement is correct?

Tick **one** box.

[1 mark]

☐

The answer to part (a) is too big

☒

The answer to part (a) stays the same

☐

The answer to part (a) is too small

Turn over for the next question



13

Show that, for $x \neq -1$

$\frac{8x^2 - 8}{4x + 4}$ simplifies to the form $ax + b$ where a and b are integers.

[3 marks]

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

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

$$= 2(x - 1)$$

$$= 2x - 2$$

which is $ax + b$ with $a = 2$ and $b = -2$



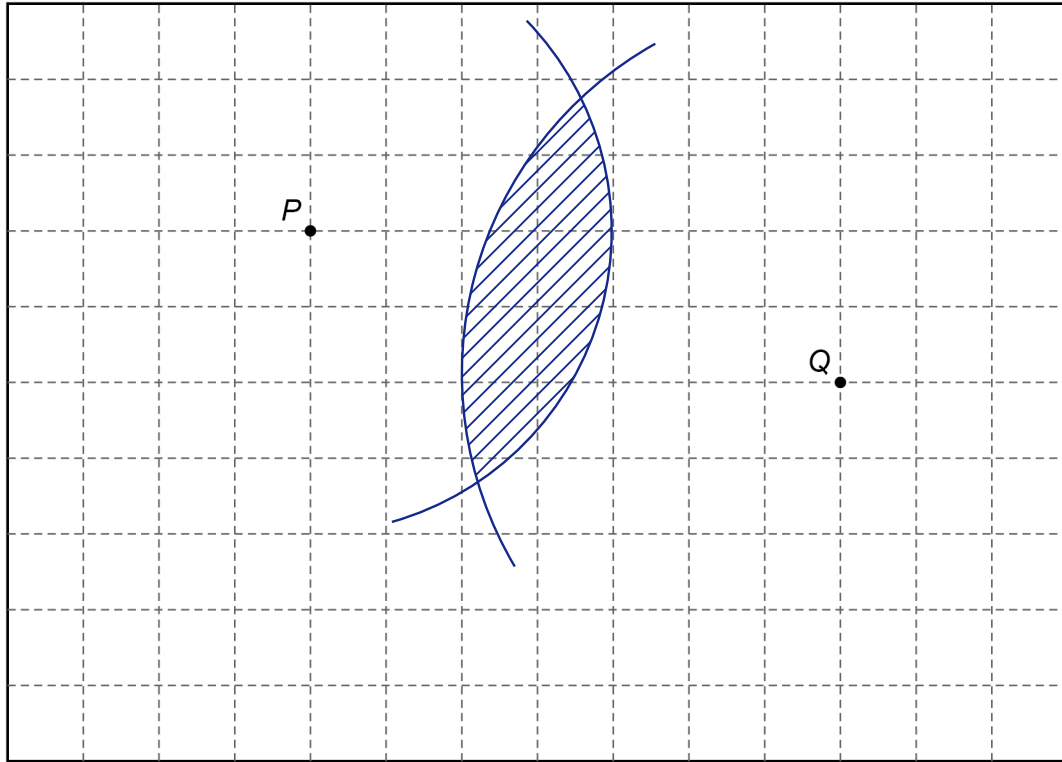
14

The scale drawing represents a garden.

Water from a sprinkler at P reaches up to 20 metres from P .

Water from a sprinkler at Q reaches up to 25 metres from Q .

Scale: 1 cm represents 5 m



Using a pair of compasses,

show the region that water from **both** sprinklers reaches.

[2 marks]

Radius from $P = 20 \div 5 = 4$ cm, radius from $Q = 25 \div 5 = 5$ cm

The shaded region is reached by both sprinklers

Turn over for the next question

Turn over ►



15 100 men and 100 women took a test.

Scores

	Median	Interquartile range	Range
Men	28	7.5	31
Women	30	9	37

Using this data, which statement **must** be true?

Tick **one** box.

[1 mark]

☐

Men had a higher average score than women

☒

Men had more consistent scores than women

☐

A woman had the highest score

☐

A man had the lowest score



16 Some concrete has volume 3.8 m^3

16 (a) The density of the concrete is 2400 kg/m^3

Work out the mass of the concrete.

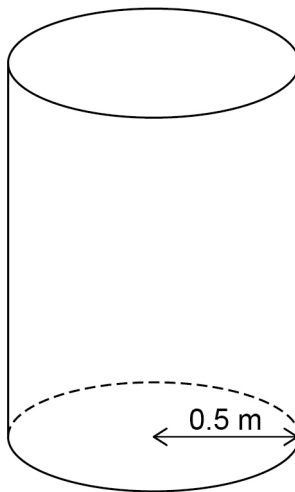
[2 marks]

$$\text{mass} = \text{density} \times \text{volume}$$

$$= 2400 \times 3.8 = 9120$$

Answer 9120 kg

16 (b) The 3.8 m^3 of concrete is made into the shape of a cylinder.
The base has radius 0.5 metres.



Work out the height of the cylinder.

[2 marks]

$$\pi \times 0.5^2 \times h = 3.8$$

$$h = 3.8 \div (\pi \times 0.25) = 3.8 \div 0.7853...$$

$$= 4.8381... = 4.84$$

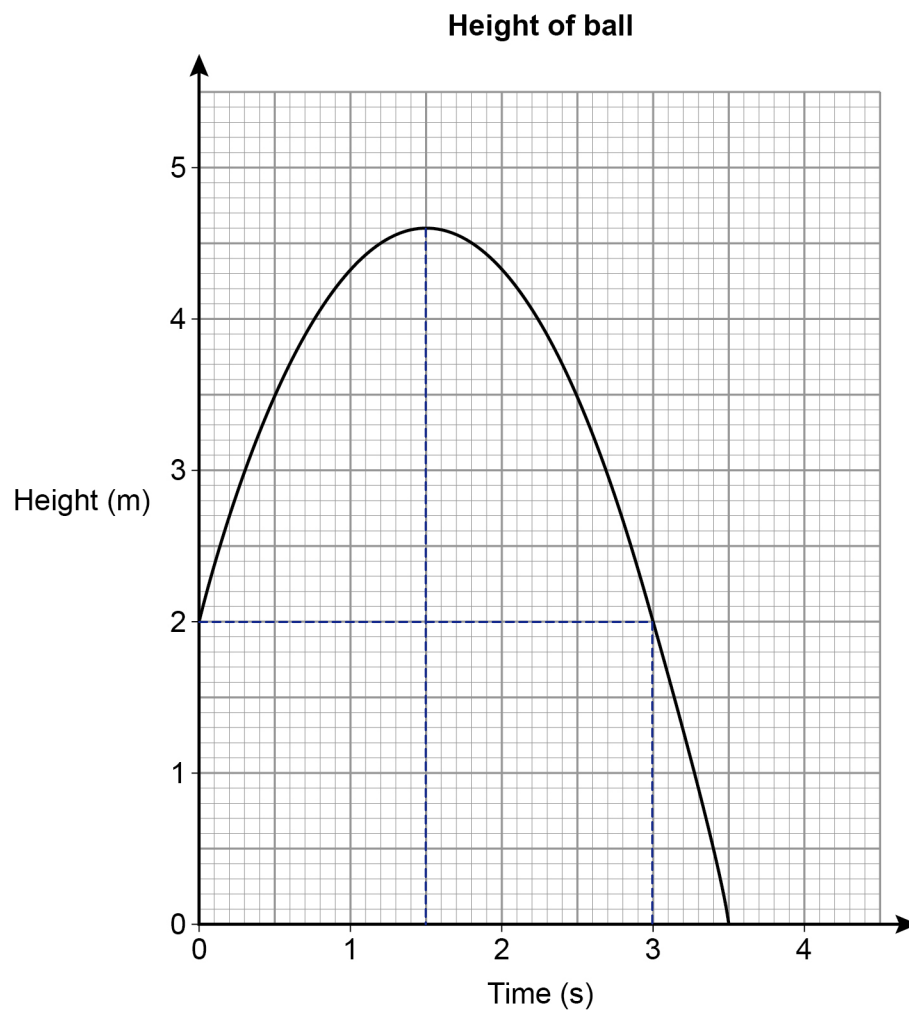
Answer 4.84 m



17

A ball is thrown vertically upwards.

The graph shows the height of the ball above the ground after it is thrown.

17 (a) For how many seconds is the ball at a height of **more than** 2 metres?

[1 mark]

Answer 3 s

17 (b) After how many seconds is the ball at instantaneous rest when it is in the air?

[1 mark]

Answer 1.5 s

- 17 (c) Work out the average speed of the ball when it is moving downwards.

[2 marks]

Moving down from $t = 1.5 \text{ s}$ (4.6 m) to $t = 3.5 \text{ s}$ (0 m)

$$\text{speed} = \text{distance} \div \text{time} = 4.6 \div (3.5 - 1.5)$$

$$= 4.6 \div 2 = 2.3$$

Answer 2.3 m/s

- 18 The solution of $3^x = 300$ lies between two consecutive integers.
Work out the two integers.

[1 mark]

$$3^5 = 243 \text{ (less than 300)}$$

$$3^6 = 729 \text{ (more than 300)}$$

so x is between 5 and 6

Answer 5 and 6

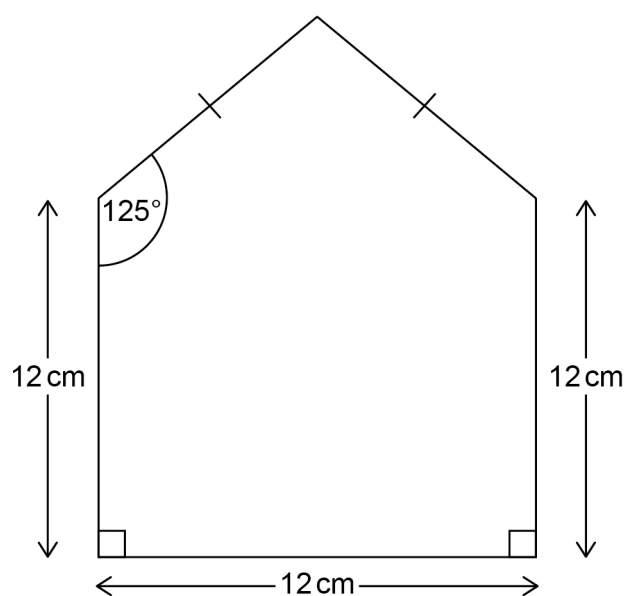
Turn over for the next question

Turn over ►



19

A pentagon is made from a square and an isosceles triangle.

Not drawn
accurately

Work out the perimeter of the pentagon.

[4 marks]

$$\text{Base angle of triangle} = 125 - 90 = 35^\circ$$

$$\text{Split triangle in half: adjacent} = 12 \div 2 = 6 \text{ cm}$$

$$\cos 35 = 6 \div s$$

$$s = 6 \div \cos 35 = 7.3246... \text{ cm}$$

$$\text{Perimeter} = 12 + 12 + 12 + 2 \times 7.3246...$$

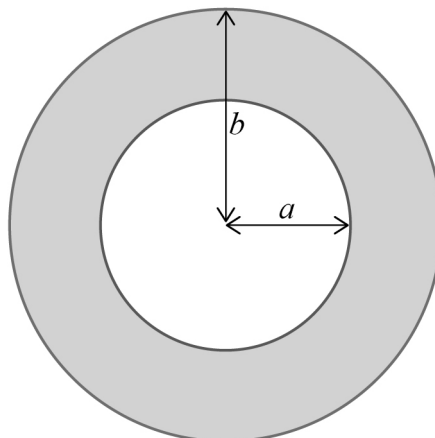
$$= 36 + 14.6493... = 50.6493...$$

$$= 50.6 \text{ cm (3 sf)}$$

Answer 50.6 cm

20

Here is an inflated swimming ring with dimensions in centimetres.



The volume of the ring, $V \text{ cm}^3$, is given by

$$V = 0.25\pi^2(b - a)^2(b + a)$$

Work out the volume when $a = 20$ and $b = 30$

Give your answer to 3 significant figures.

[3 marks]

$$V = 0.25 \times \pi^2 \times (30 - 20)^2 \times (30 + 20)$$

$$= 0.25 \times \pi^2 \times 100 \times 50$$

$$= 1250\pi^2 = 12\,337.005\dots$$

$$= 12\,300 \text{ (3 sf)}$$

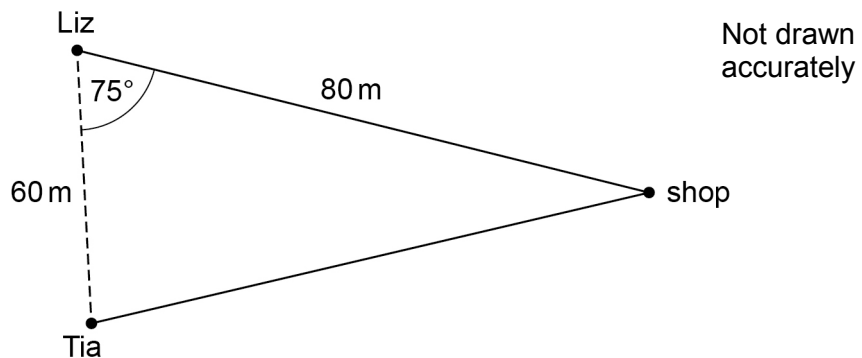
Answer 12 300 cm^3

Turn over for the next question

Turn over ►



- 21** Liz and Tia are walking towards a shop along different straight paths.
The diagram shows their positions at 2 pm



- 21 (a)** Assume they walk at the same speed.

Who will arrive at the shop first?

You **must** show your working.

[3 marks]

$$\text{Tia to shop: } d^2 = 80^2 + 60^2 - 2 \times 80 \times 60 \times \cos 75$$

$$d^2 = 6400 + 3600 - 9600 \cos 75$$

$$d^2 = 7515.33...$$

$$d = \sqrt{7515.33...} = 86.69... \text{ m}$$

Liz walks 80 m, Tia walks 86.7 m

80 < 86.7 so Liz has the shorter distance

Answer Liz

- 21 (b)** In fact, Liz walks at a faster speed than Tia.

How does this affect the answer to part (a)?

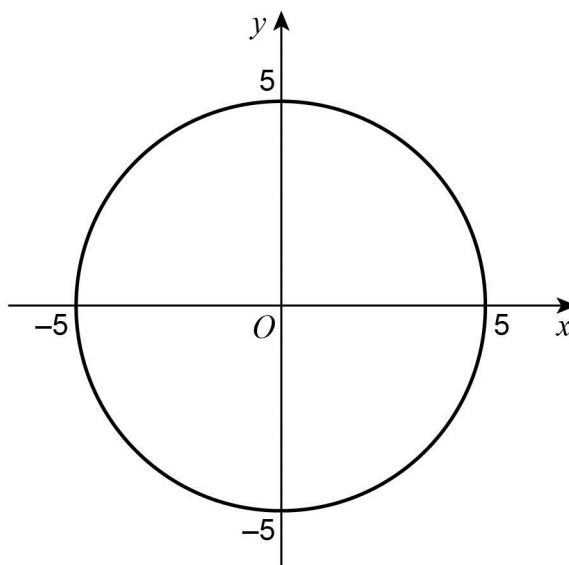
[1 mark]

No change. Liz will still arrive first

(she will arrive even earlier than Tia).



- 22 A circle, centre O , passes through $(5, 0)$.



What is the equation of the circle?

Circle your answer.

[1 mark]

$x^2 + y^2 = 25$

$x^2 + y^2 = 5$

$x^2 + y^2 = 10$

$x^2 + y^2 = 100$

Turn over for the next question

Turn over ►



23

Solids X and Y are similar.

X has volume 64 cm^3 Y has volume 343 cm^3 The surface area of X is 176 cm^2

Work out the surface area of Y.

[3 marks]

$$\text{Volume scale factor} = 343 \div 64$$

$$\text{Length scale factor} = \sqrt[3]{343} \div \sqrt[3]{64} = 7 \div 4$$

$$\text{Area scale factor} = (7 \div 4)^2 = 49 \div 16$$

$$\text{Surface area of Y} = 176 \times 49 \div 16 = 11 \times 49 = 539$$

Answer 539 cm^2



24

A tank is a cuboid measuring 50 cm by 35 cm by 20 cm

All lengths are to the **nearest centimetre**.

A container has a capacity of **exactly** 34 litres.

1 litre = 1000 cm^3

Which has the greater capacity?

Tick **one** box.

☐

Tank

☐

Container

☒

Cannot tell

Show working to support your answer.

[4 marks]

Lower bounds 49.5, 34.5, 19.5 Upper bounds 50.5, 35.5, 20.5

Min volume = $49.5 \times 34.5 \times 19.5 = 33\,301.125 \text{ cm}^3$

Max volume = $50.5 \times 35.5 \times 20.5 = 36\,751.375 \text{ cm}^3$

Container = $34 \times 1000 = 34\,000 \text{ cm}^3$

$33\,301.125 < 34\,000 < 36\,751.375$

The tank could be smaller or larger than the container,

so you cannot tell.

Turn over for the next question



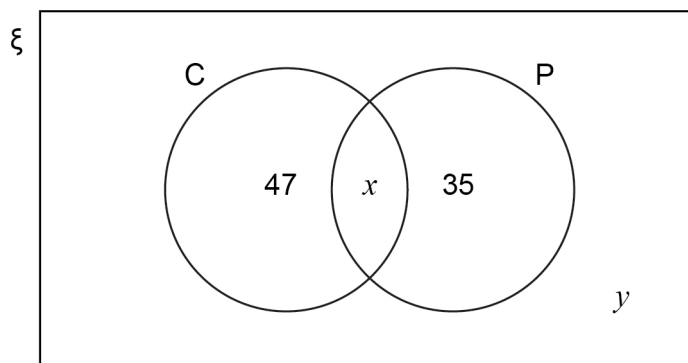
25

The Venn diagram shows some information about 150 students.

ξ = 150 students

C = students who study Chemistry

P = students who study Physics



The probability that a Physics student, chosen at random, also studies Chemistry is $\frac{5}{12}$

One of the 150 students is chosen at random.

Work out the probability that the student does **not** study either Chemistry or Physics.

[4 marks]

$$P(C \text{ given } P) = \frac{x}{x + 35} = \frac{5}{12}$$

$$12x = 5(x + 35)$$

$$12x = 5x + 175$$

$$7x = 175 \quad x = 25$$

$$y = 150 - 47 - 25 - 35 = 43$$

$$P(\text{neither}) = 43 \div 150$$

Answer $\frac{43}{150}$



26

A curve has equation $y = 4x^2 + 5x + 3$ A line has equation $y = x + 2$ Show that the curve and the line have **exactly** one point of intersection.Do **not** use a graphical method.**[4 marks]**

$$4x^2 + 5x + 3 = x + 2$$

$$4x^2 + 5x - x + 3 - 2 = 0$$

$$4x^2 + 4x + 1 = 0$$

$$(2x + 1)(2x + 1) = 0$$

$$x = -\frac{1}{2} \text{ only (repeated root, both brackets the same)}$$

$$\text{Discriminant: } b^2 - 4ac = 4^2 - 4 \times 4 \times 1 = 16 - 16 = 0$$

$$b^2 - 4ac = 0 \text{ so there is only one solution}$$

so the curve and the line have exactly one point

of intersection, at $(-\frac{1}{2}, \frac{1}{2})$

Turn over for the next question

Turn over ►



27

Prove algebraically that $2.7\dot{5}$ converts to the fraction $\frac{124}{45}$

[3 marks]

$$\text{Let } x = 2.7555\ldots$$

$$10x = 27.555\ldots$$

$$100x = 275.555\ldots$$

$$100x - 10x = 275.555\ldots - 27.555\ldots$$

$$90x = 248$$

$$x = \frac{248}{90} = \frac{124}{45}$$



28 $f(x) = 5 - x$ and $g(x) = 3x + 7$

28 (a) Simplify $f(2x) + g(x - 1)$

[3 marks]

$$f(2x) = 5 - 2x$$

$$g(x - 1) = 3(x - 1) + 7 = 3x - 3 + 7 = 3x + 4$$

$$f(2x) + g(x - 1) = 5 - 2x + 3x + 4$$

$$= x + 9$$

Answer $x + 9$

28 (b) Solve $g^{-1}(x) = 2x$

[3 marks]

$$y = 3x + 7 \quad \text{swap: } x = 3y + 7$$

$$x - 7 = 3y \quad y = (x - 7) \div 3$$

$$g^{-1}(x) = (x - 7) \div 3$$

$$(x - 7) \div 3 = 2x$$

$$x - 7 = 6x$$

$$-7 = 5x$$

$$x = -7 \div 5 = -1.4$$

$x = -1.4$

END OF QUESTIONS



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