GCSE LINKED PAIR PILOT

wjec cbac

4361/02

S16-4361-02

APPLICATIONS OF MATHEMATICS
UNIT 1: Applications 1
HIGHER TIER

A.M. THURSDAY, 9 June 2016

2 hours

4361
020001

ADDITIONAL MATERIALS

A calculator will be required for this paper.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

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

Take π as 3·14 or use the π button on your calculator.

INFORMATION FOR CANDIDATES

You should give details of your method of solution when appropriate.

Unless stated, diagrams are not drawn to scale.

Scale drawing solutions will not be acceptable where you are asked to calculate.

The number of marks is given in brackets at the end of each question or part-question.

You are reminded that assessment will take into account the quality of written communication (including mathematical communication) used in your answer to question **4**(b).

Formula List

Area of trapezium $= \frac{1}{2}(a+b)h$
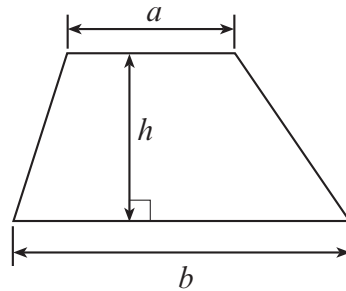
Volume of prism = area of cross-section × length
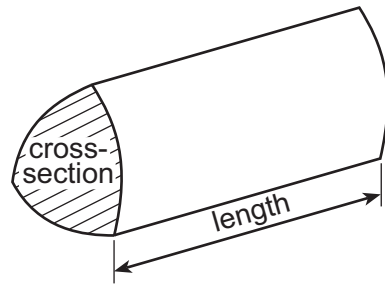
Volume of sphere $= \frac{4}{3}\pi r^3$

Surface area of sphere $= 4\pi r^2$
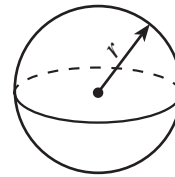
Volume of cone $= \frac{1}{3}\pi r^2 h$

Curved surface area of cone $= \pi r l$
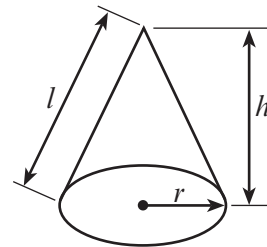
In any triangle ABC

Sine rule $\quad \dfrac{a}{\sin A} = \dfrac{b}{\sin B} = \dfrac{c}{\sin C}$

Cosine rule $\quad a^2 = b^2 + c^2 - 2bc \cos A$

Area of triangle $= \frac{1}{2}ab \sin C$
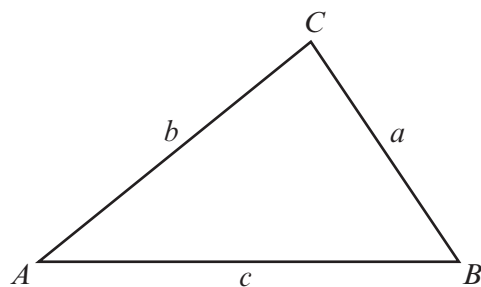
The Quadratic Equation

The solutions of $ax^2 + bx + c = 0$

where $a \neq 0$ are given by

$$x = \frac{-b \pm \sqrt{(b^2 - 4ac)}}{2a}$$

1. Trefwen, Hafon and Glenod are three castles.
The simplified map below shows the positions of the three castles.

A visitor centre is being built.

The visitor centre is on a bearing 035° from Glenod and on a bearing of 125° from Trefwen.
What is the bearing of the visitor centre from Hafon? [4]

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Bearing of the visitor centre from Hafon is .... °

2. Katie uses two mirror tiles in her bathroom.
She has one tile in the shape of an equilateral triangle, *T*, and one tile in the shape of a rhombus, *R*.
All the edges of the tiles are equal in length.
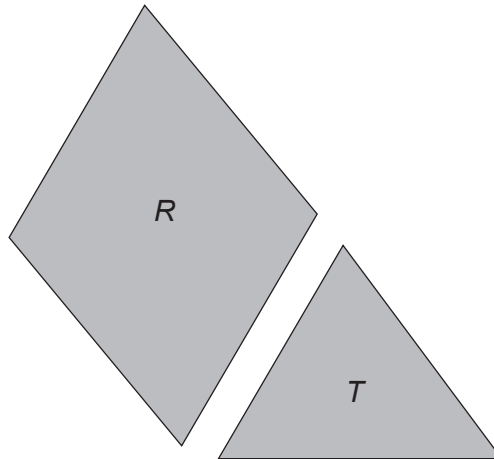
Diagram not drawn to scale

When the two tiles, *R* and *T*, are joined to form one large mirror, the shape formed is a quadrilateral.

(a) Calculate the size of each of the angles in tile *R*.
You may indicate any angles you calculate on the diagram above.
You must show your working. [4]

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Angles are .... , ... , ... , and ....

(b) Give the name of the quadrilateral that Katie forms with her two tiles. [1]

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(c) How many lines of symmetry does this quadrilateral have? [1]

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3. Judy, Trefor and Wyn each time how long it takes for a coin to fall from their classroom window to the ground outside.

Judy's coin takes 1·8 seconds.
Trefor's coin takes 2·4 seconds.
Wyn's coin takes 2·2 seconds.

Their friend Abbie says:

Surely all the times should be the same!
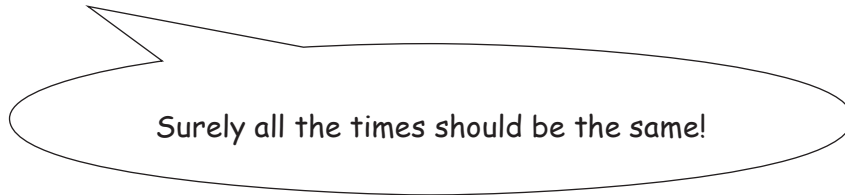
List **3** factors that could play a part in the times not being the same. [3]

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4. Alfie sells 480 raffle tickets, at 50p each, to raise money for charity.

There are 3 different raffle prizes: a bike, roller skates and a teddy bear.

The bike and the roller skates were prizes donated by a local sports shop.
Alfie paid
- £12 for the teddy bear prize,
- £14 to have the raffle tickets printed, and
- £32 to print advertising posters.
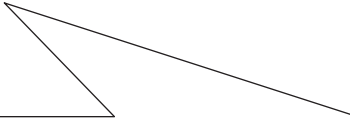
After paying the costs, Alfie donates any money raised from the raffle to charity.
He intends to give the money to a children's charity and to the local hospice in the ratio 13:17.

(a) Gary says to Alfie:

Ratios usually look like '2:3' or '5:4', I mean with small whole numbers, not larger numbers like 13 and 17.
Alfie, can't you write this in a simpler way?

How can Alfie explain to Gary that he cannot write the ratio 13:17 in a simpler way?   [1]

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(b) *You will be assessed on the quality of your written communication in this part of the question.*

Calculate how much money Alfie donates to the local hospice.
Give your answer correct to the nearest £. [6]

(c) Gary has bought 3 of the 480 raffle tickets sold.

The first ticket drawn wins the bike.
The second ticket drawn wins the roller skates.
Gary does not win either of the first two prizes.

What is the probability that Gary wins the teddy bear? [2]

5. *GoPrint* and *MyPrint* are two companies specialising in printing business cards.

The charges for the cards are shown in the table below.

GoPrint charges	*MyPrint* charges
The first 500 business cards are **free**.	The first 1000 cards cost £20.

GoPrint charges:

The first 500 business cards are **free**.

Example prices:

1500 cards	500 **free** cards + £10 for the other 1000 cards *Total cost £10*
2500 cards	500 **free** cards + £20 for the other 2000 cards *Total cost £20*
4000 cards	500 **free** cards + £35 for the other 3500 cards *Total cost £35*

Ask for a price for any other number of cards required!

MyPrint charges:

The first 1000 cards cost £20.

Buy more than 1000 cards for a small additional cost.

For example:

2000 cards	£20 for the first 1000 cards + £5 for the other 1000 cards *Total cost £25*
3200 cards	£20 for the first 1000 cards + £11 for the other 2200 cards *Total cost £31*
4400 cards	£20 for the first 1000 cards + £17 for the other 3400 cards *Total cost £37*

Ask for a price!
No orders for fewer than 1000 cards are taken.

(a) After paying £20 for the first 1000 cards, how much **extra** does *MyPrint* seem to charge for each additional 100 cards? [2]

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(b) How much do you think *GoPrint* would charge for 1800 cards? [2]

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(c) Use the information given in the tables to draw graphs to represent the *GoPrint* and *MyPrint* charges for printing up to 5000 business cards.
Label your graphs clearly. [5]

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Charge (£)

Number of business cards printed
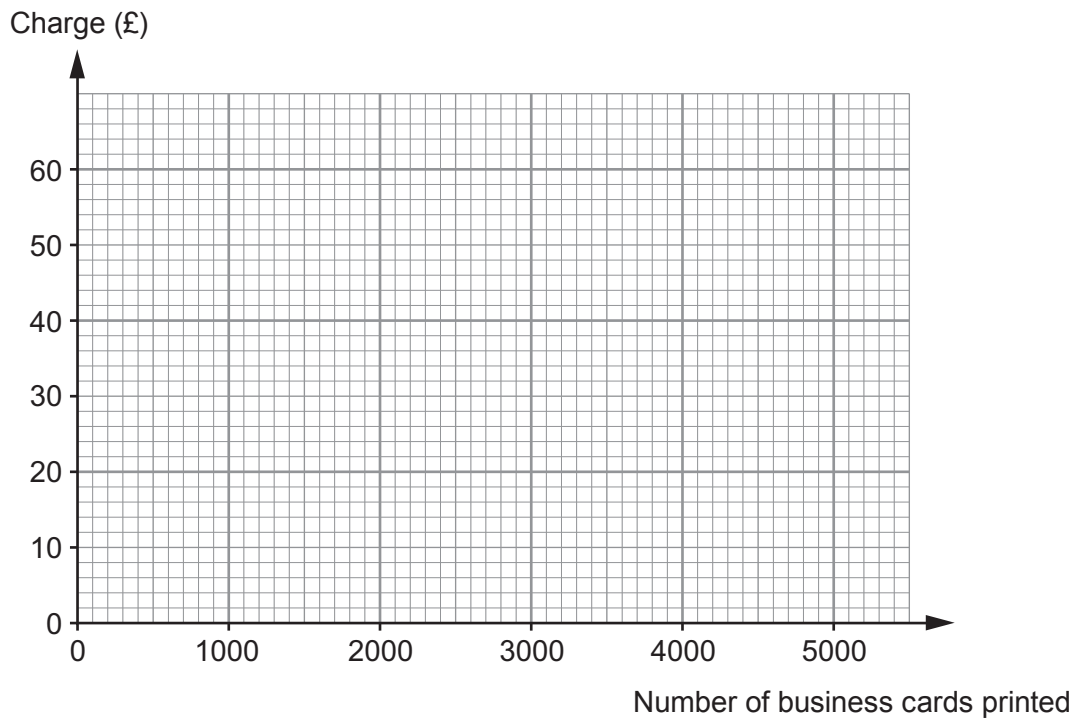
(d) Rhian decides to order a number of business cards.
She finds that both of the companies, *GoPrint* and *MyPrint*, would charge the same for her order.
How many cards is Rhian intending to order? [2]

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(e) *MyPrint* uses the following formula for working out the charges for business cards,

$$C = 20 + \frac{5(n - 1000)}{1000}$$

where
- C is the charge in £, and
- n is the number of business cards printed.

(i) Use this formula to calculate the charge for 56 500 business cards. [2]

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(ii) A trainee in the offices of *MyPrint* takes a telephone call from a customer requesting 800 business cards.
Explain why the formula cannot be used. [1]

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(f) Use your graph or the *GoPrint* charges shown below, to derive a formula that *GoPrint* could use to calculate charges for numbers of business cards.
You must define any variables you use. [3]

GoPrint charges	
The first 500 business cards are **free**. Example prices:	

1500 cards	500 **free** cards + £10 for the other 1000 cards *Total cost £10*
2500 cards	500 **free** cards + £20 for the other 2000 cards *Total cost £20*
4000 cards	500 **free** cards + £35 for the other 3500 cards *Total cost £35*

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6. A sports therapist measures the angle at a knee joint using a goniometer.

Measurements of the distance from the hip to the knee and the distance from the knee to the ankle are also recorded.

Knee

Angle at the
knee joint

Hip
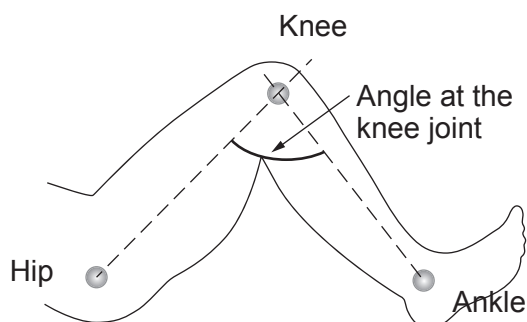
Ankle

(a) Ewan has a knee injury.
The measurement between Ewan's hip and his knee is 45 cm.
The measurement between Ewan's knee and his ankle is 40 cm.
A sports therapist records the angle at Ewan's knee joint as 105°.

Complete the scale diagram opposite to show the position of Ewan's ankle.
Use a scale of 1 cm to represent 5 cm.

The line representing the distance from the hip to the knee has been drawn for you.   [2]

Knee

Hip
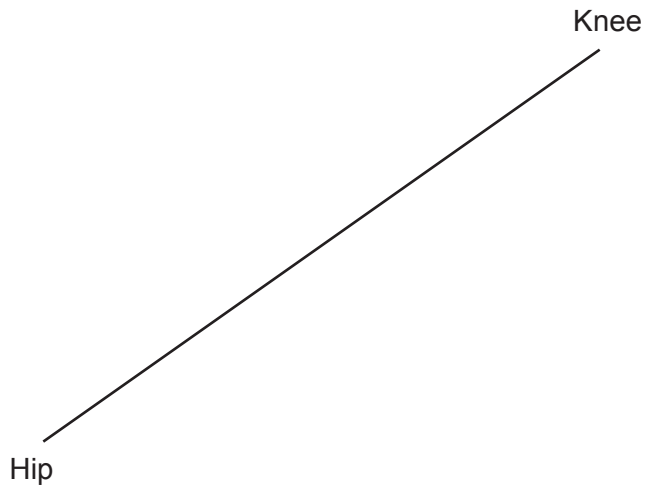
(b) Write down the actual distance between Ewan's hip and ankle when his leg is in this
position. [2]

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7. *(a)* A gardener plants water lilies in a circular pond.

When looking at the surface of the pond, the ratio of the surface covered by water lilies to clear water is 2:3.

The area of the surface covered by water lilies is $3 \cdot 8 \, m^2$.

Calculate
• the surface area of the pond, and
• the diameter of the pond.

Give your answers correct to 2 significant figures.
You must show all your working. [7]

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The surface area of the pond is .... m^2

The diameter of the pond is .... m

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QUESTION 7 continues on page 16

(b) The diameters of water lilies in the pond were measured by the gardener.
The results are summarised in the grouped frequency distribution below.

Diameter, d (cm)	$0 < d \leqslant 2$	$2 < d \leqslant 4$	$4 < d \leqslant 6$	$6 < d \leqslant 8$	$8 < d \leqslant 10$	$10 < d \leqslant 12$	$12 < d \leqslant 14$	$14 < d \leqslant 16$	$16 < d \leqslant 18$
Frequency	1	0	4	10	16	14	4	1	1

When reviewing the results, the gardener decides that the groups $0 < d \leqslant 2$ and $2 < d \leqslant 4$ should be combined, and so should the groups $14 < d \leqslant 16$ and $16 < d \leqslant 18$.

(i) Do you think this decision is sensible?
Give a reason for your answer. [1]

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(ii) Complete the table below and draw a histogram to display the results for the water lilies measured. [4]

Diameter, d (cm)	$0 < d \leqslant 4$	$4 < d \leqslant 6$	$6 < d \leqslant 8$	$8 < d \leqslant 10$	$10 < d \leqslant 12$	$12 < d \leqslant 14$	$14 < d \leqslant 18$
Frequency Density							

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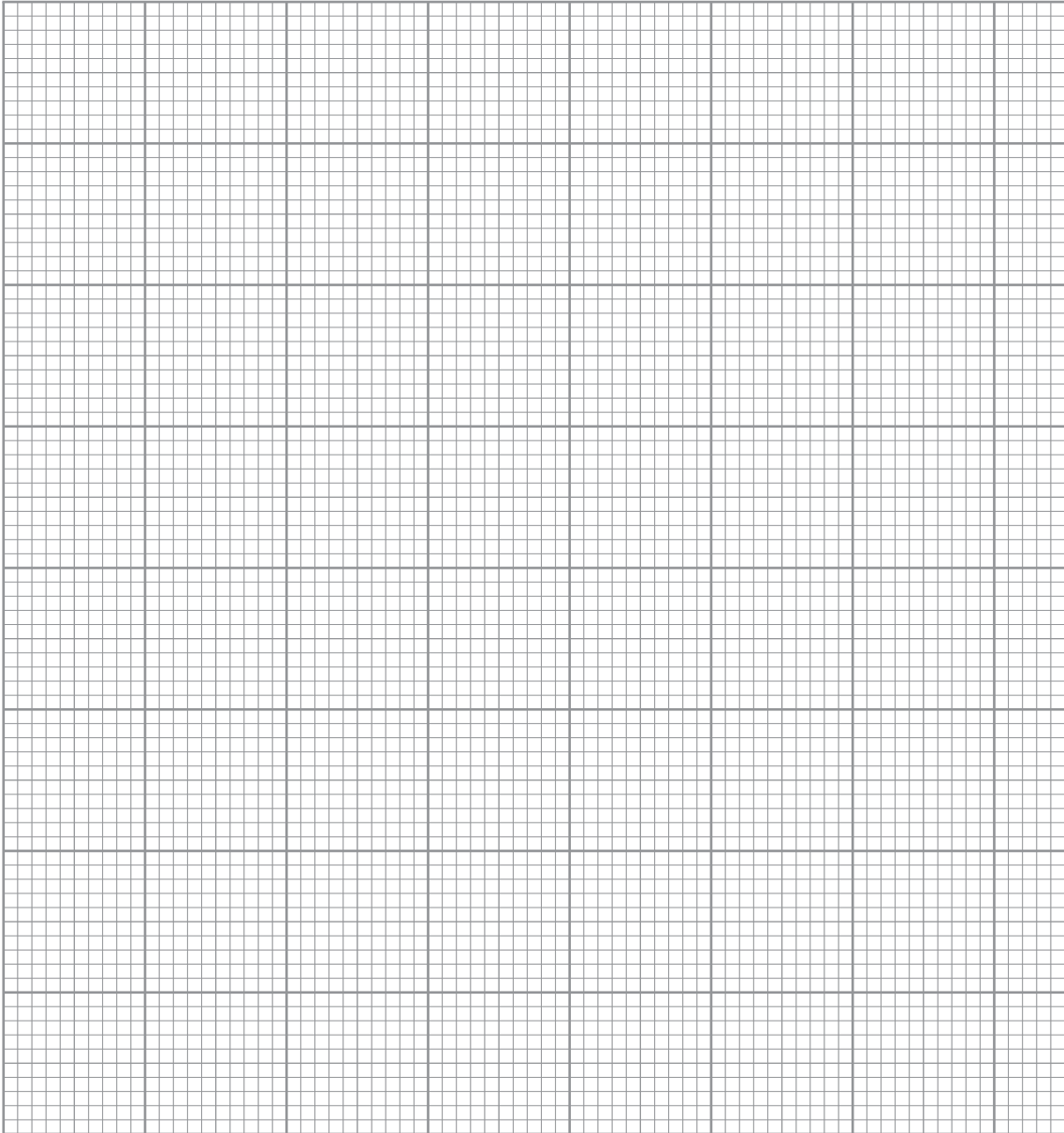
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8. Luca bought a sandwich van to start selling sandwiches from 1st April.

He records his weekly sales to the nearest pound during his first six weeks.

Week	1	2	3	4	5	6
Sales (£)	70	95	111	100	41	84

The time series graph for the sales of sandwiches for each week has been plotted on the graph paper opposite.

(a) Calculate the 3-point moving averages correct to the nearest £ and complete the table below. [4]

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3-point period	Week 1 to week 3	Week 2 to week 4	.... to	.... to ....
3-point moving average (£)				

(b) On the graph below, plot the 3-point moving averages and draw a trend line. [2]

Sales (£)

Time (weeks)
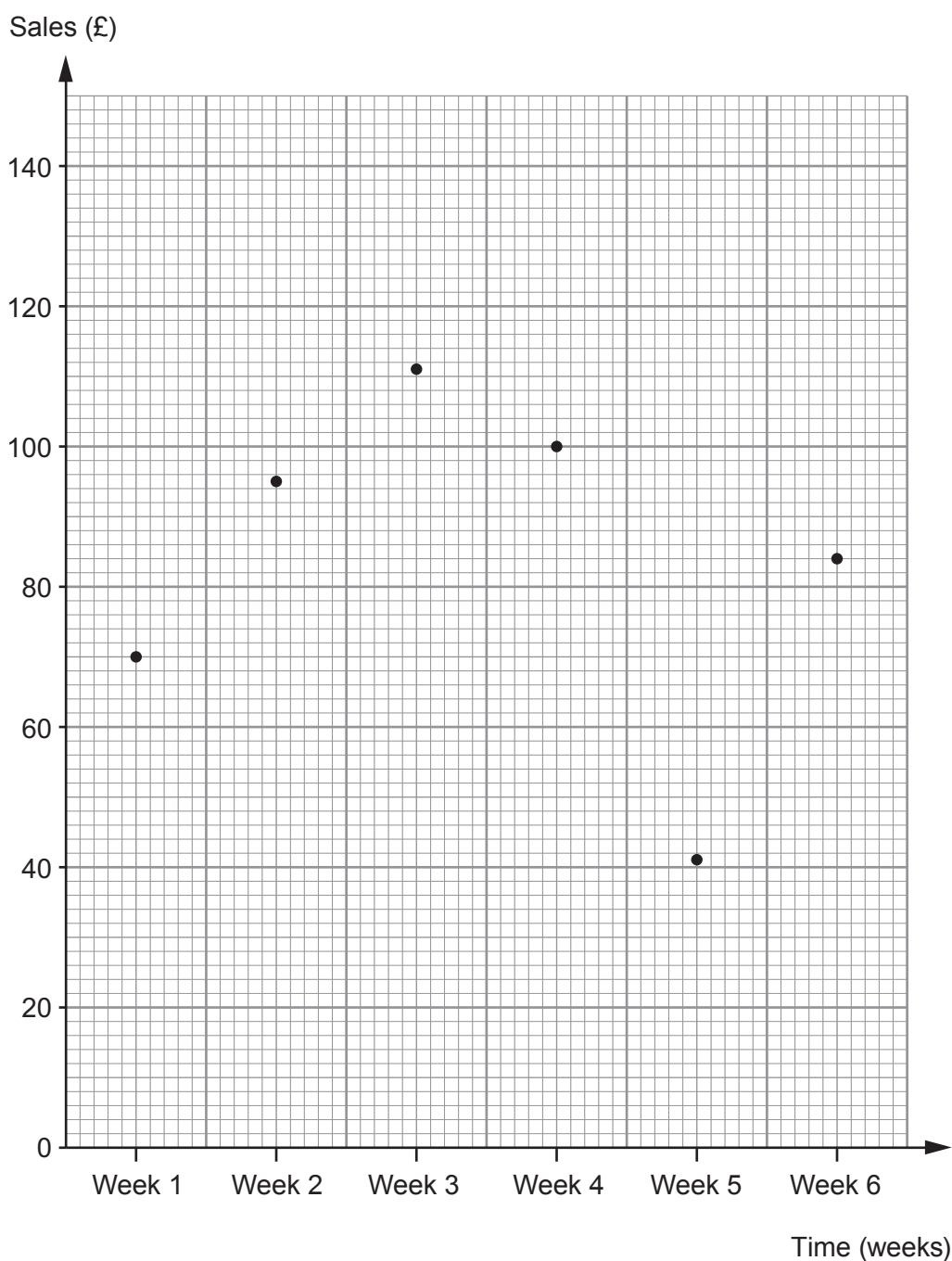
(c) Luca looks at the trend line and says his sales are falling.

What can you say to reassure Luca that his business is not on the decline? [1]

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9. Freya visits the gym on 60 occasions.
She records the length of time she spends on the treadmill on each of these 60 occasions.

Freya has grouped her data in 5 minute intervals.
Her first interval is $0 < \text{time} \leqslant 5$ minutes.
Her final interval is $35 < \text{time} \leqslant 40$ minutes.
Freya drew a cumulative frequency diagram.

From her results she gives you the following information:

- The shortest time she spent on the treadmill was 5 minutes and this happened only once.
- The range of her times is 35 minutes.
- Her median time is 18 minutes.
- Her lower quartile is 10 minutes.
- Her interquartile range is 14 minutes.
- There were only 5 occasions when Freya spent more than 30 minutes on the treadmill.

(a) Use this information to complete a possible cumulative frequency diagram on the axes given below. [7]

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Cumulative frequency

Time (minutes)
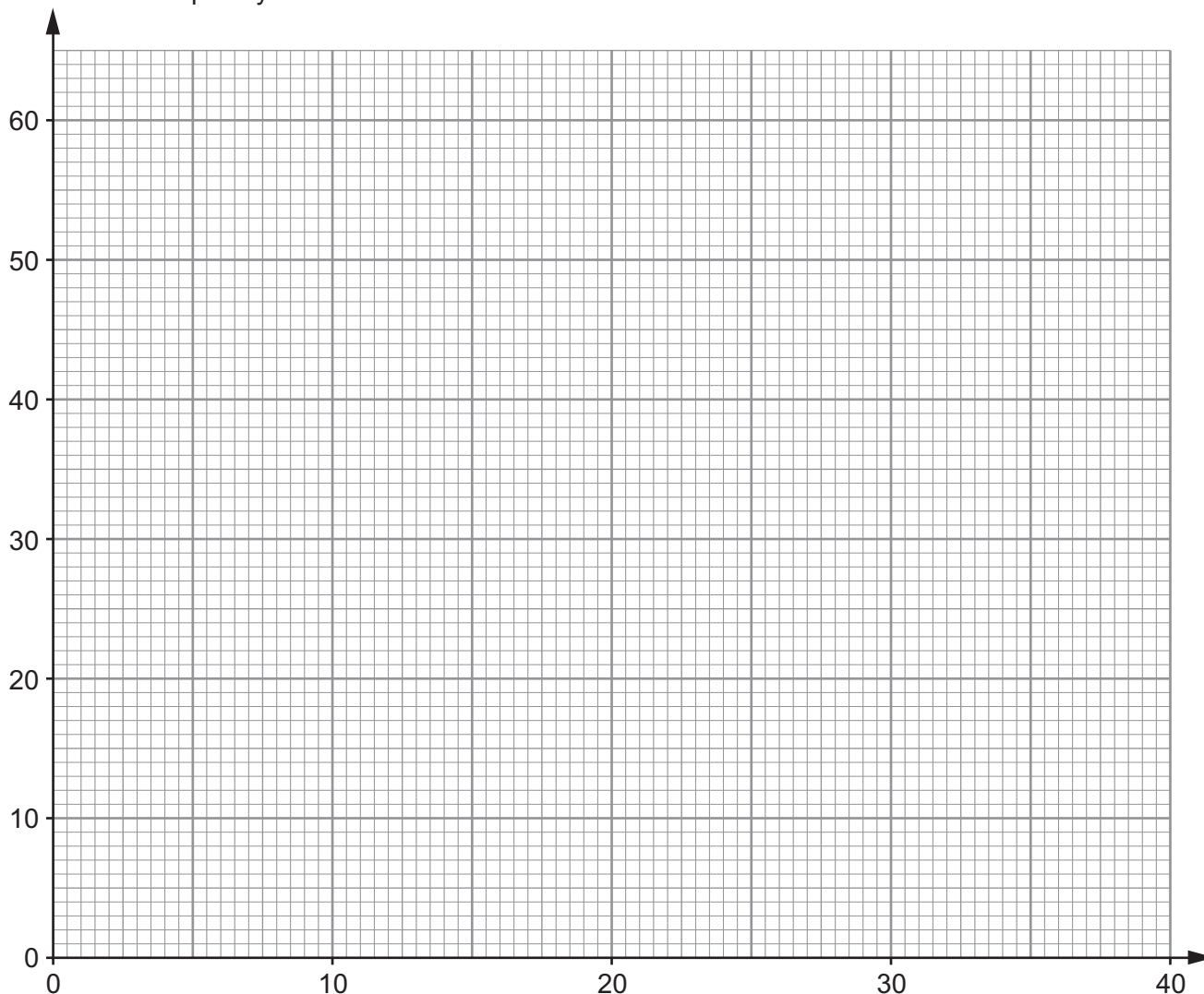
(b) The cumulative frequency diagram you have drawn is not exactly the same as the one Freya had drawn.
Explain why your cumulative frequency diagram is different from Freya's cumulative frequency diagram. [1]

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(c) Use the information given and your cumulative frequency diagram to draw a box-and-whisker diagram on the graph paper below. [3]

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| 0 | 10 | 20 | 30 | 40 |

Time (minutes)
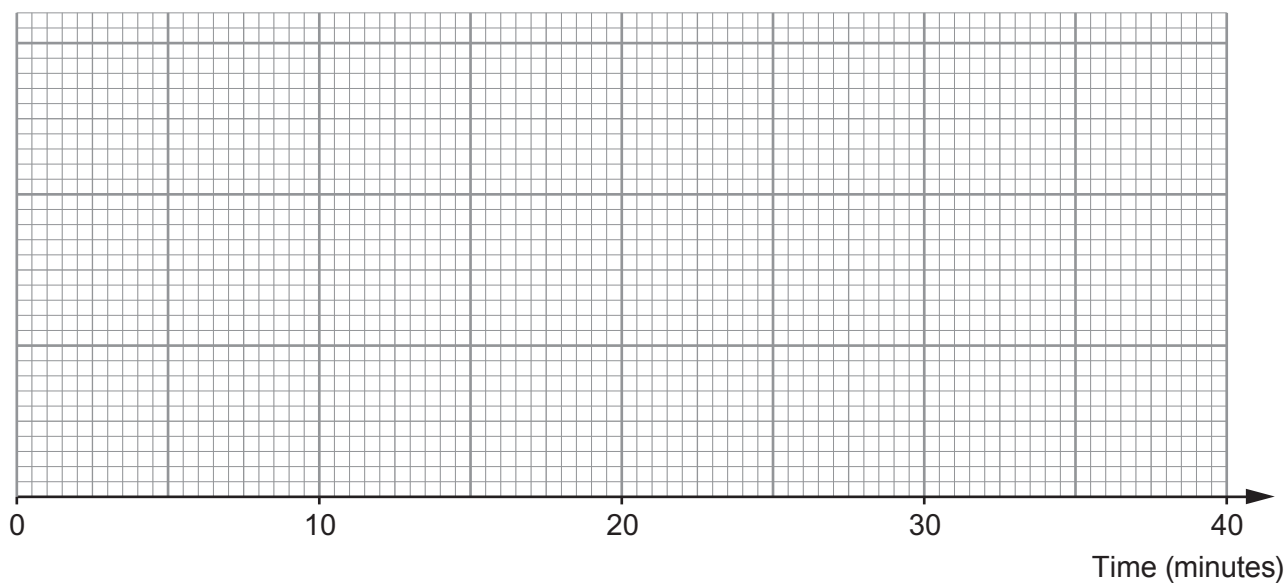
11

10. Over a period of 30 days it snowed every day.

In her notepad, Rita recorded the snowfall, correct to the nearest centimetre, in a grouped frequency table.

She then calculated an **estimate of the mean** snowfall for these 30 days as 27 cm.

Unfortunately Rita has torn the page containing the table from her notepad and lost some of the original data.

Snowfall, s (cm)	Number of days
$1 \leqslant s \leqslant 9$	2
$10 \leqslant s \leqslant 18$	8
$19 \leqslant s \leqslant 27$	4
$28 \leqslant s \leqslant 36$	
$37 \leqslant s \leqslant 41$	

Find the values of the frequencies missing in Rita's table. [4]

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$28 \leqslant s \leqslant 36$	....
$37 \leqslant s \leqslant 41$	....

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11. *(a)* There are typically 3×10^4 grains of rice in 600 g.
Calculate how many grains of rice there would typically be in 5 g.
Give your answer in standard form. [2]

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(b) A grain of sugar weighs 2×10^{-5} g.
Calculate how many grains of this sugar would be in a 1 kg bag of sugar.
Give your answer in standard form. [3]

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12. Daniel has found a relationship between two variables, x and y.
Daniel states that

$$y = \frac{8}{x^2}$$

Daniel is trying to find the value of x that meets the above relationship and the following rule:

> This value of x has a y-value that is half the value of y when $x = \frac{1}{2}$.

Find the positive value of x that meets this rule. [4]

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**TURN OVER FOR
QUESTION 13**

13. In an experiment, it was found that the velocity, v in m/s, of a particle at time t seconds after the start of the experiment, was given by the equation $v = 7t - t^2$.

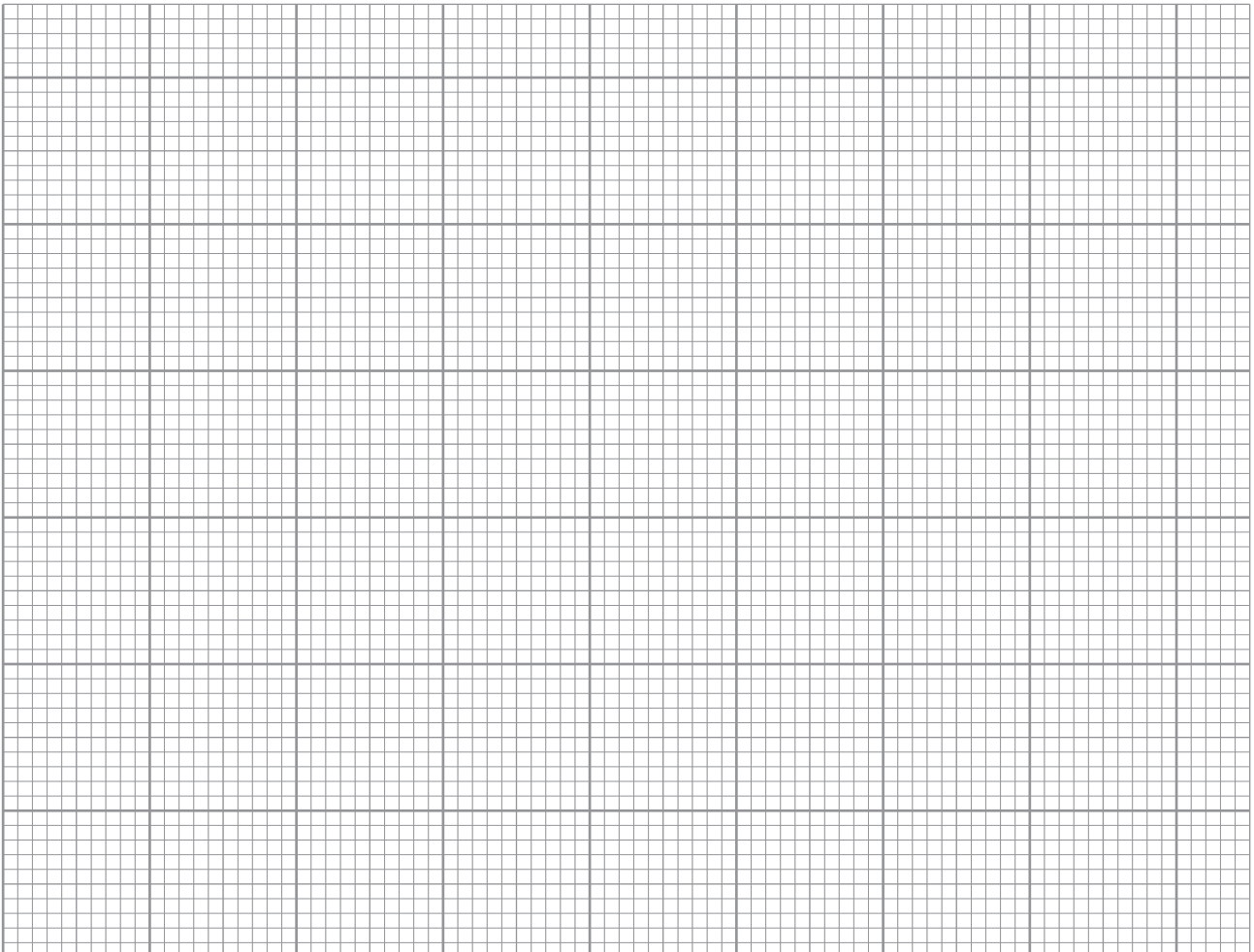   *(a)*   Draw the curved graph of $v = 7t - t^2$ for values of t from 0 to 7.   **[5]**

(b) The acceleration of the particle is the rate of change of the velocity.

(i) Find the value of t when the acceleration of the particle is zero. [1]

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(ii) Find an approximation for the acceleration when $t = 5 \cdot 2$.
State the units of your answer. [4]

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(c) Use the graph to find an approximation for the distance travelled by the particle between the times $t = 1$ and $t = 5$. [4]

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END OF PAPER