Name	Date started	Target end date

WJEC GCSE Mathematics and Numeracy (Double Award) — Question Pack

Reading rates of change from real-world graphs: gradient of a distance-time graph is speed, gradient of a speed-time graph is acceleration, and the ar

REVISE
.wales

3.10 — Rates of change, area under graph & trapezium rule

Spec 2.5.3, 2.5.4, 2.5.5 — Unit 3 (calculator allowed)

Reading rates of change from real-world graphs: gradient of a distance-time graph is speed, gradient of a speed-time graph is acceleration, and the area under a speed-time graph is distance travelled. Includes the trapezium rule for estimating areas under curves and tangents for instantaneous rates. Sourced from legacy WJEC GCSE Mathematics and Mathematics-Numeracy Higher calculator-allowed papers, organised for revision under the 2025 spec.

2025 SPECIFICATION

Estimated time for entire question pack: ~1 hours 18 minutes

*Derived from the GCSE Higher pace of **~1.5 min/mark** (52 marks across 11 questions).*

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **focused single-topic practice pack**, not a single mock paper. Questions are organised against the 2025 specification. Questions are ordered chronologically by sitting, with custom-written and SAM questions at the end.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working — method marks are awarded for clear setup.

A calculator is allowed on every question in this pack (Unit 3 is the calculator-allowed paper).

Rates of change, area under graph & trapezium rule — what the new spec asks

WJEC GCSE Mathematics (first teaching 2025) · Unit 3: calculator-allowed.

Rates of change from graphs 2.5.3

- Gradient of distance-time graph = speed.
- Gradient of speed-time graph = acceleration.
- Draw a tangent for instantaneous rate at a point.

Area under a graph 2.5.4

- Area under a speed-time graph = distance travelled.
- Estimate using the trapezium rule when the curve is not a straight line.
- Always state the units of the area in context.

Trapezium rule 2.5.5

- Use equal-width strips h across the interval.
- Apply $\frac{h}{2}[(y_0 + y_n) + 2(\text{middle ordinates})]$.
- Quote answer to the precision the data allows.

Crib sheet »

Rates of change, area under graph & trapezium rule in one page

Quick-reference notes — revisit before each question. Don't use during the questions.

Distance-time graphs

Gradient = **speed**.

Steeper ⇒ faster. Horizontal ⇒ stationary.

$\text{speed} = \dfrac{\Delta\text{distance}}{\Delta\text{time}}$ between two points.

Speed-time graphs

Gradient = **acceleration**.

Area under the curve = **distance travelled**.

Horizontal line ⇒ constant speed (zero acceleration).

Trapezium rule

$$\text{area} \approx \tfrac{h}{2}\left[(y_0 + y_n) + 2(y_1 + y_2 + \ldots + y_{n-1})\right]$$

h is the strip width.

Add first and last y, plus twice the sum of all middle y values, then multiply by $h/2$.

Worked trapezium

For 4 strips of width 1 with y values $2, 5, 8, 7, 4$:

$\text{area} \approx \tfrac{1}{2}\left[(2+4) + 2(5+8+7)\right] = \tfrac{1}{2}[6 + 40] = 23$.

Tangent for instantaneous rate

To find the rate of change *at a point*: draw a tangent to the curve there.

Pick two clear points on the tangent and compute its gradient $= \Delta y / \Delta x$.

Quote units (e.g. m/s for distance-time, m/s^2 for speed-time).

Average vs instantaneous

Average rate over $[a, b]$: $\dfrac{f(b) - f(a)}{b - a}$ — the chord gradient.

Instantaneous rate at $t = c$: gradient of the tangent at $t = c$.

Units & interpretation

Always read axis labels: m vs km, s vs hours change the units.

Speed in m/s $\times 3.6 =$ km/h.

State units with every numerical answer.

Common traps

- Forgetting to double the middle ordinates in the trapezium rule.
- Using strip count instead of strip width for h.
- Confusing speed-time and distance-time interpretations.
- Reading the tangent at the wrong point.

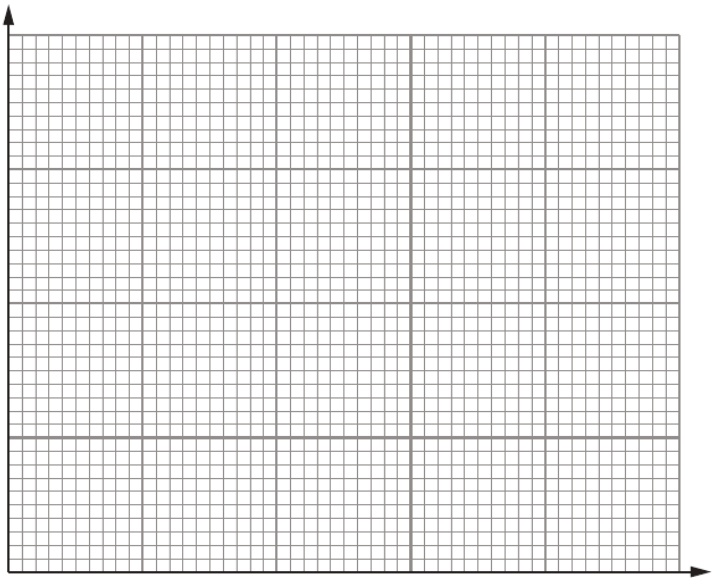
Examiner only

5. Petra is organising a prom for her year group.
The number of people attending the prom is likely to be between 20 and 80.

The cost of holding the prom at *Hotel Afonwen* would be as follows.

- Hire of the room: £100
- Food: £15 per person
- Welcome drink on arrival: £3 per person
- Decorations: £2 per person

(a) Draw a graph to illustrate the total cost of holding the prom for between 20 and 80 people.
Use the graph paper below. [4]



Examiner only

(b) Petra decides to share all the costs equally between the people attending.

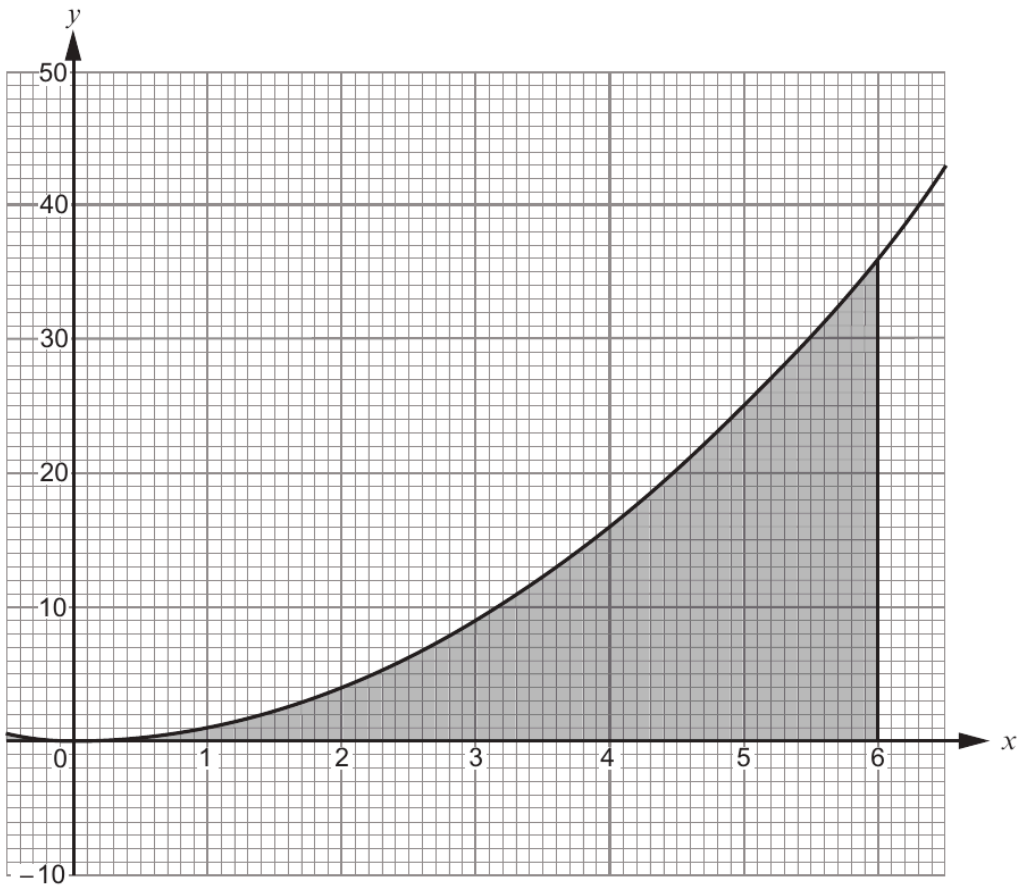
- Let £P be the price paid per person.
- Let N be the number of people attending the prom.

Write a formula for P, in terms of N. [3]

(c) Hiring a larger room at *Hotel Afonwen* costs £200.
The cost per person for food, welcome drinks and decorations remains the same.
If the total cost is £2240, how many people attend? [2]

Examiner only

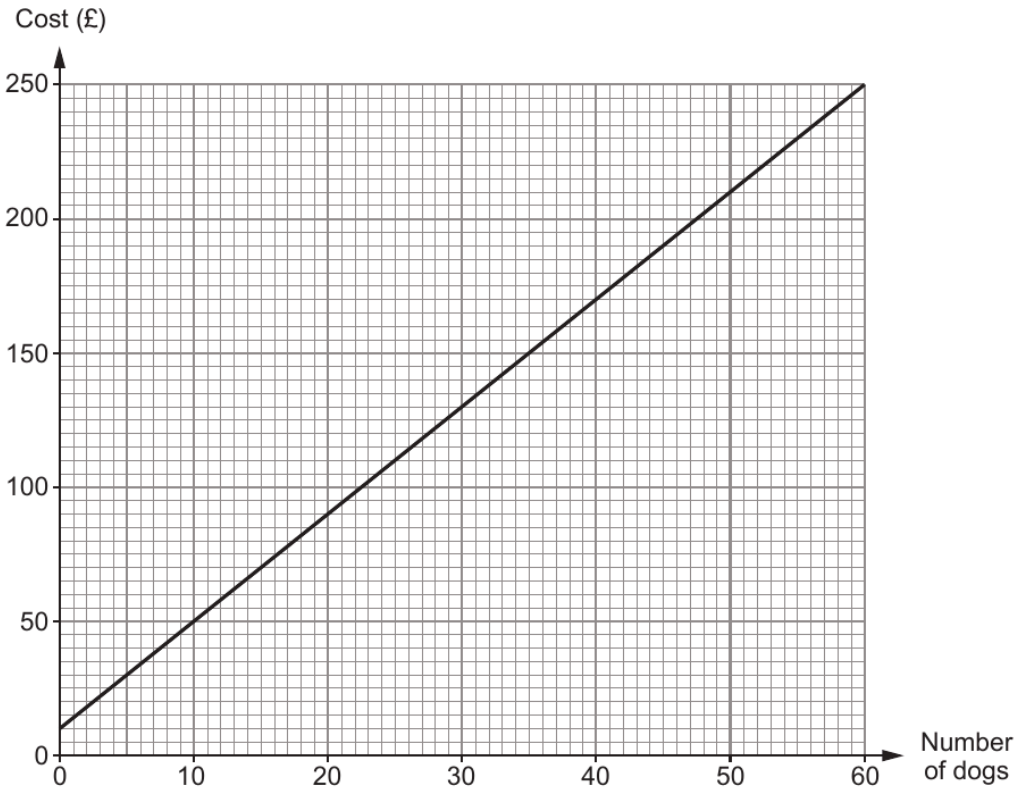
18. The graph of $y = x^2$ has been drawn below, for values of x from $x = 0$ to $x = 6$.



Use the trapezium rule, with the ordinates $x = 0$, $x = 1$, $x = 2$, $x = 3$, $x = 4$, $x = 5$ and $x = 6$, to estimate the area of the shaded region shown above. [4]

Examiner only

2. William owns and runs dog kennels.
His costs depend on the number of dogs in the kennels.
The running costs for one day are shown on the graph below.



(a) Why does the graph not pass through (0, 0)? [1]

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Examiner only

(b) What is the increase in the daily running costs for each additional dog that is kept in the kennels? [2]

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(c) (i) Freda also runs a dog kennels.
The cost of keeping 20 dogs in her kennels for one day is £130.
She knows that as the number of dogs increases, the overall cost increases at the same rate as in William's kennels.

Display this information on the graph paper opposite. [2]

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(ii) Find the cost of keeping 30 dogs for one day in Freda's kennels. [1]

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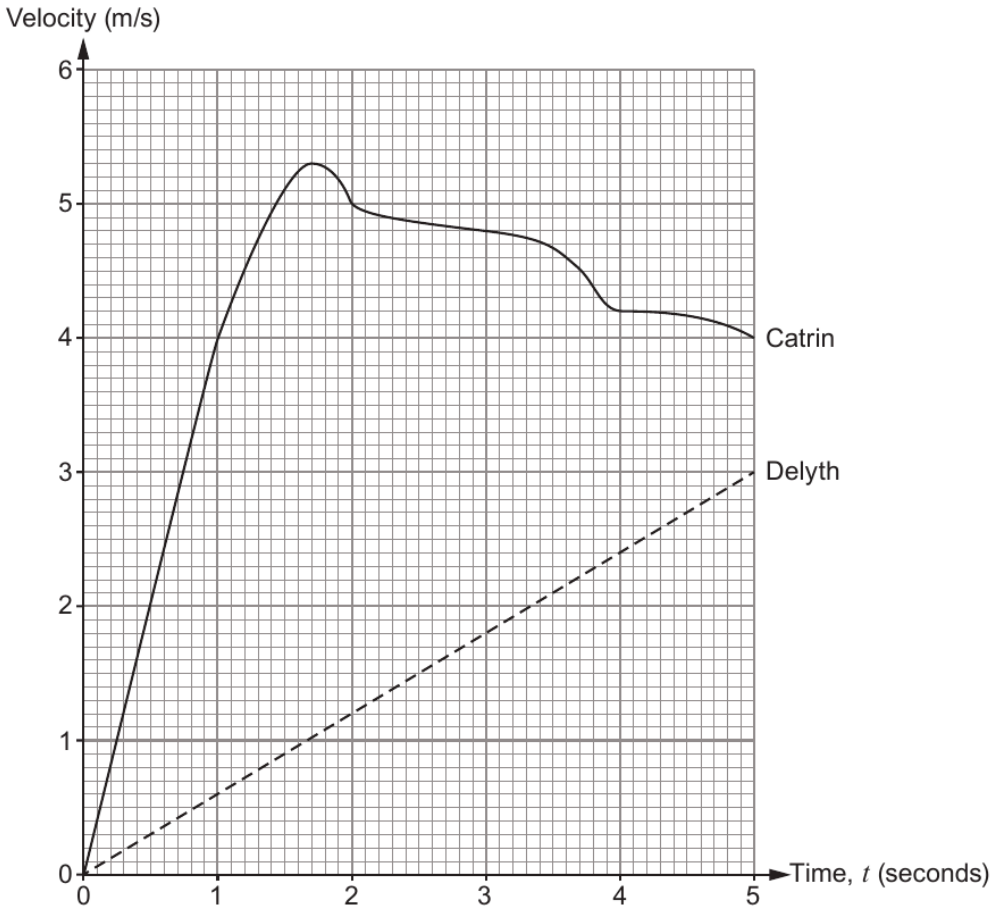
Examiner only

9. Two runners, Catrin and Delyth, start a race at the same time.
The velocity-time graph shows their velocities over the first 5 seconds of the race.



(a) After the start of the race, what was the earliest time that Catrin's acceleration was $0\,m/s^2$? [1]

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Examiner only

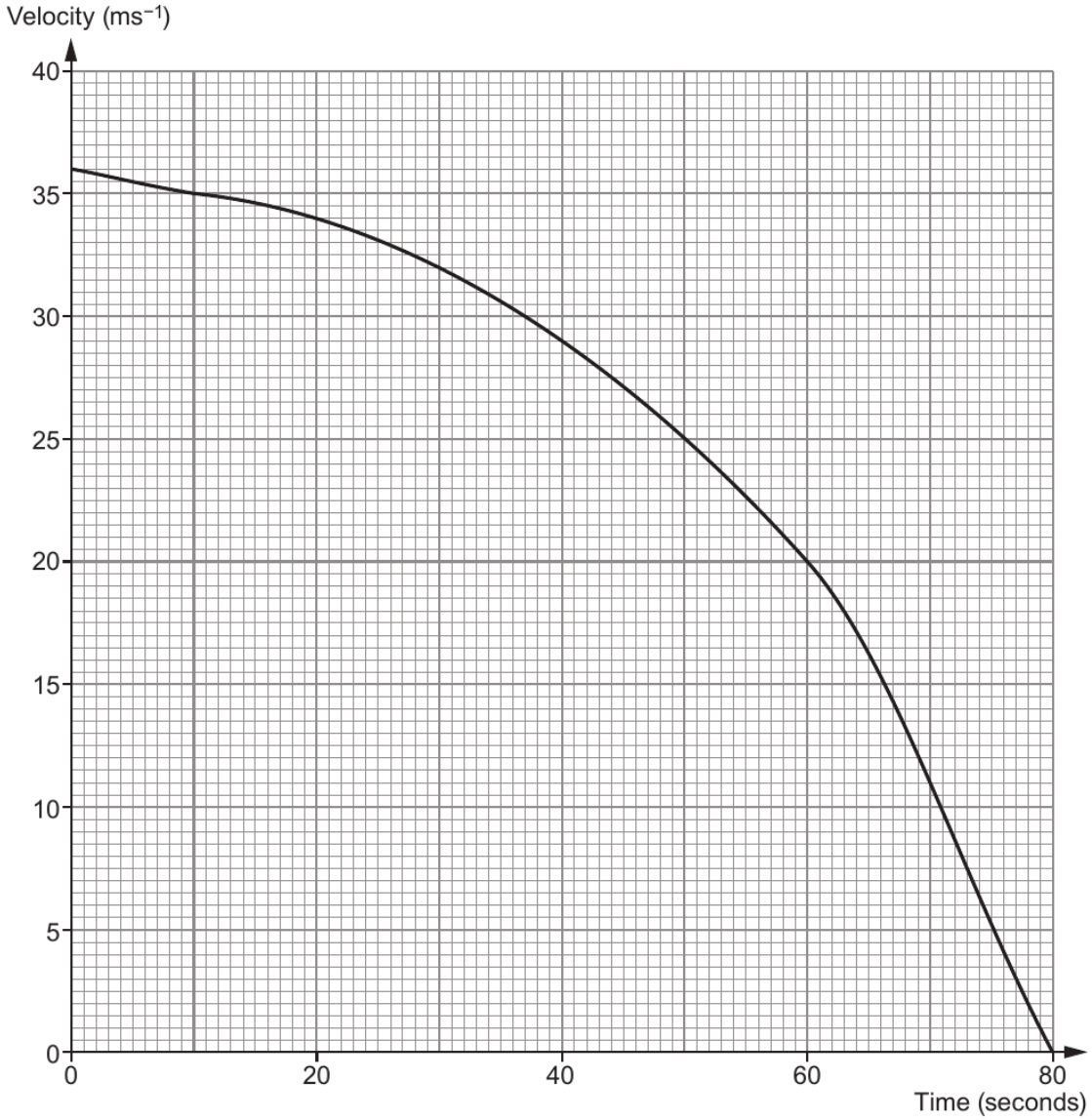
(b) Use the trapezium rule to calculate an estimate of the distance Catrin travelled in the first 5 seconds of the race.
Use Catrin's velocities at times $t = 0$, $t = 1$, $t = 2$, $t = 3$, $t = 4$ and $t = 5$.
You must show all your working. [3]

(c) (i) Calculate an estimate of how far Catrin was ahead of Delyth after 5 seconds. [2]

(ii) Explain why your answer to *(c)* (i) is an underestimate. [1]

Examiner only

9. A train manufacturer has developed a new braking system.
The velocity-time graph shows the velocity of a train from when the new brakes are applied until it comes to rest.



(a) Estimate the train's deceleration at time 60 seconds. [3]

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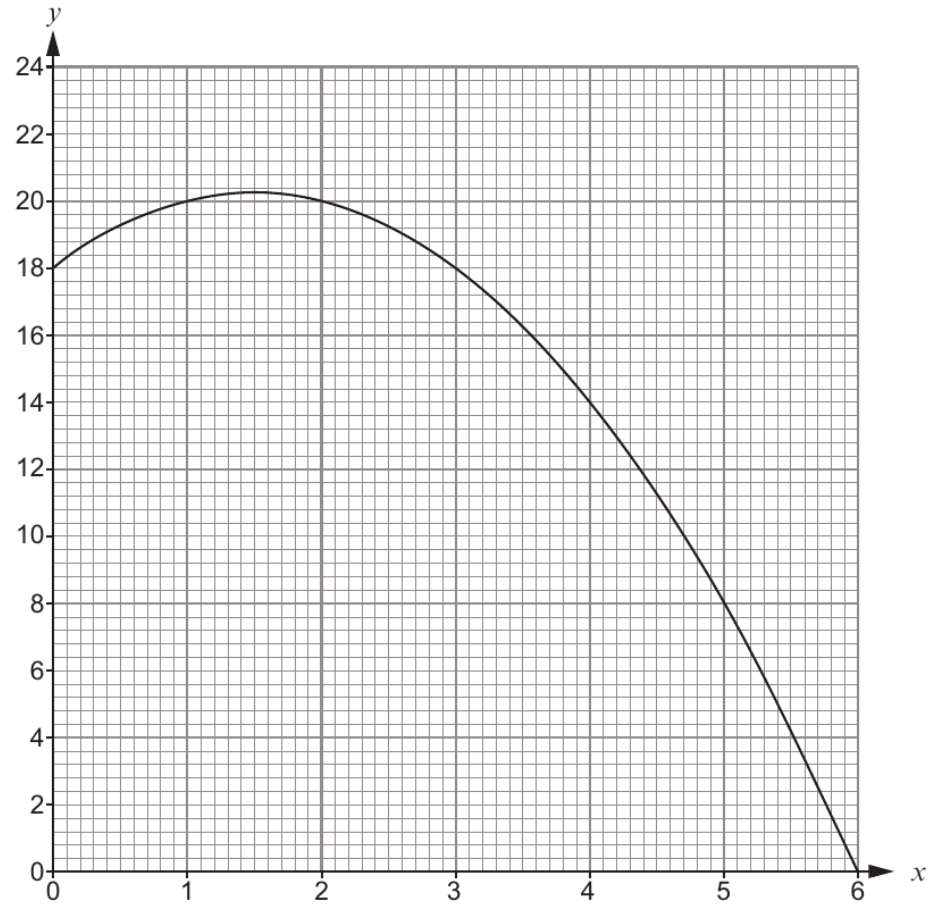
Examiner only

(b) (i) Calculate an estimate of the distance travelled by the train from the instant the brakes are applied until it comes to rest.
You must use exactly 4 strips of equal width. [3]

(ii) Explain how you could use the graph to gain a more accurate estimate of the distance travelled. [1]

Examiner only

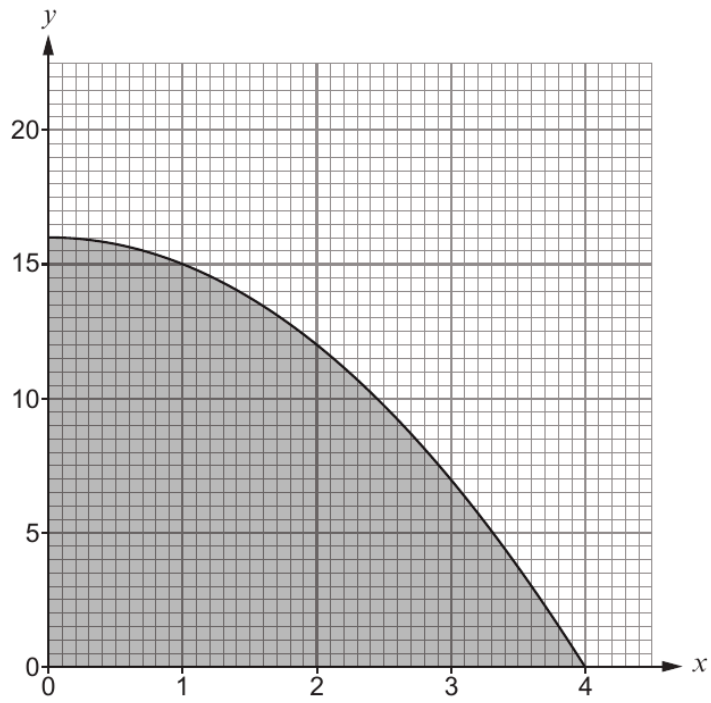
16. The graph of $y = 18 + 3x - x^2$, for values of x from $x = 0$ to $x = 6$, is drawn below.



Use the trapezium rule, with the ordinates $x = 0$, $x = 1$, $x = 2$, $x = 3$, $x = 4$, $x = 5$ and $x = 6$, to estimate the area of the region bounded by the curve, the positive x-axis and the positive y-axis. [3]

Examiner only

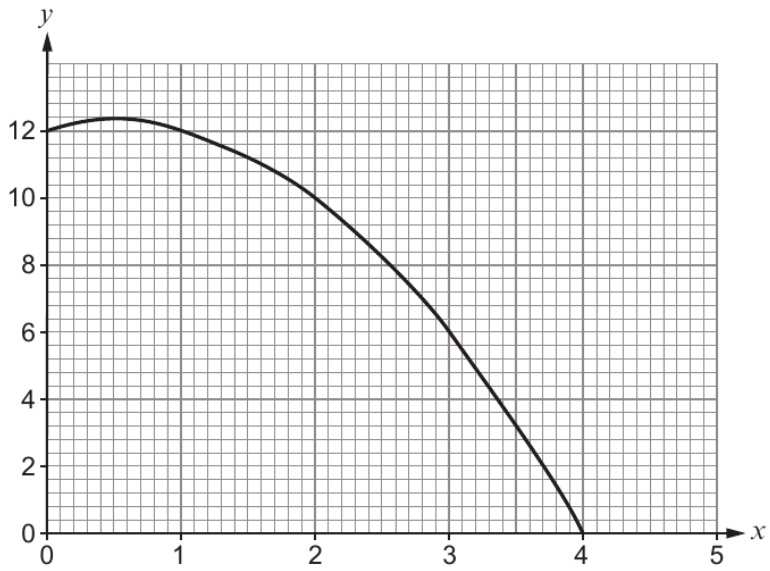
16. The graph of $y = 16 - x^2$ has been drawn below, for values of x from $x = 0$ to $x = 4$.



(a) Use the trapezium rule, with the ordinates $x = 0$, $x = 1$, $x = 2$, $x = 3$ and $x = 4$, to estimate the area of the shaded region shown above. [3]

Examiner only

14. The graph of $y = 12 + x - x^2$, for values of x from $x = 0$ to $x = 4$, is drawn below.



Use the trapezium rule, with the ordinates $x = 0$, $x = 1$, $x = 2$, $x = 3$ and $x = 4$, to estimate the area of the region bounded by the curve, the positive x-axis and the positive y-axis. [3]

Examiner only

8. Emma wants to know how much water is in a pond near her house.
She has taken width measurements of the pond every 3 m along its length.
These width measurements are shown on the plan view of the pond below.

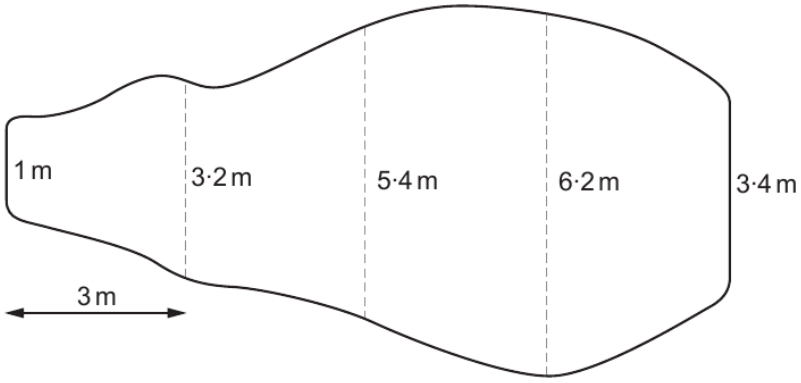


Diagram not drawn to scale

Emma has used these width measurements to sketch the following graph.

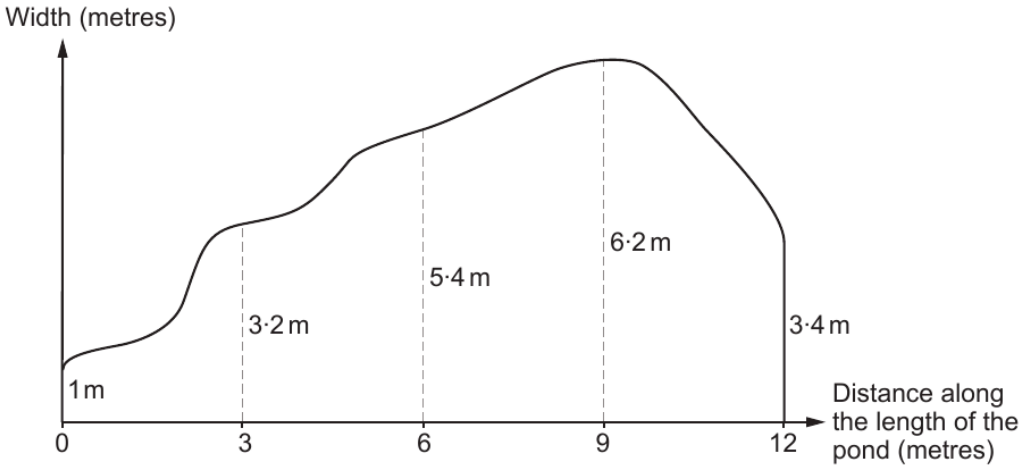
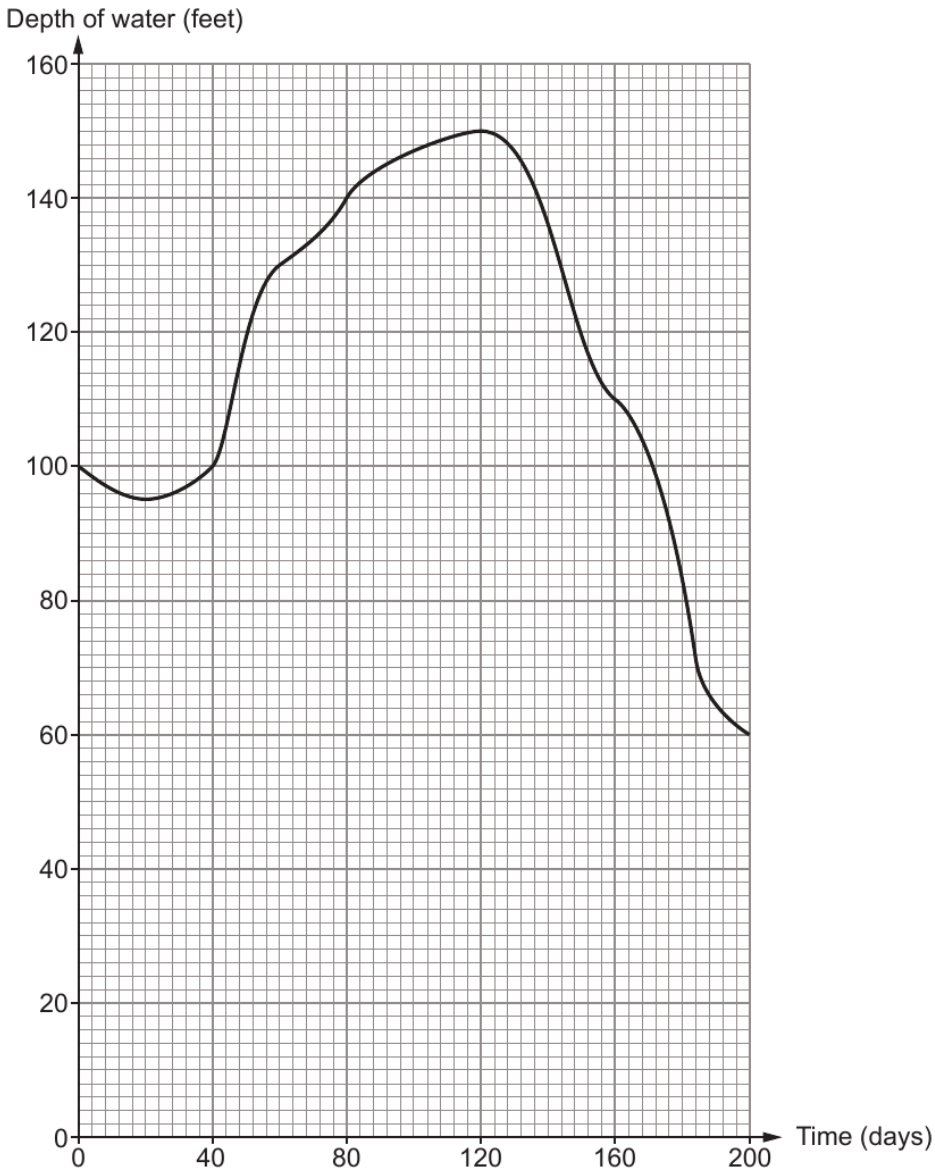


Diagram not drawn to scale

Emma knows that the pond has a uniform depth of 1·2 m.
Use the trapezium rule with 4 strips to calculate an estimate for the volume of water in the pond. [5]

Examiner only

11. The graph below shows the depth of water in a reservoir during a 200-day period.



(a) For approximately how many of the 200 days was the depth of water in the reservoir decreasing?
Circle your answer. [1]

120 days 200 days 80 days 100 days 40 days

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Examiner only

(b) Use 5 strips of width 40 days to estimate the area under the curve.
Hence, calculate an estimate of the average depth of the water during this 200-day period. [5]

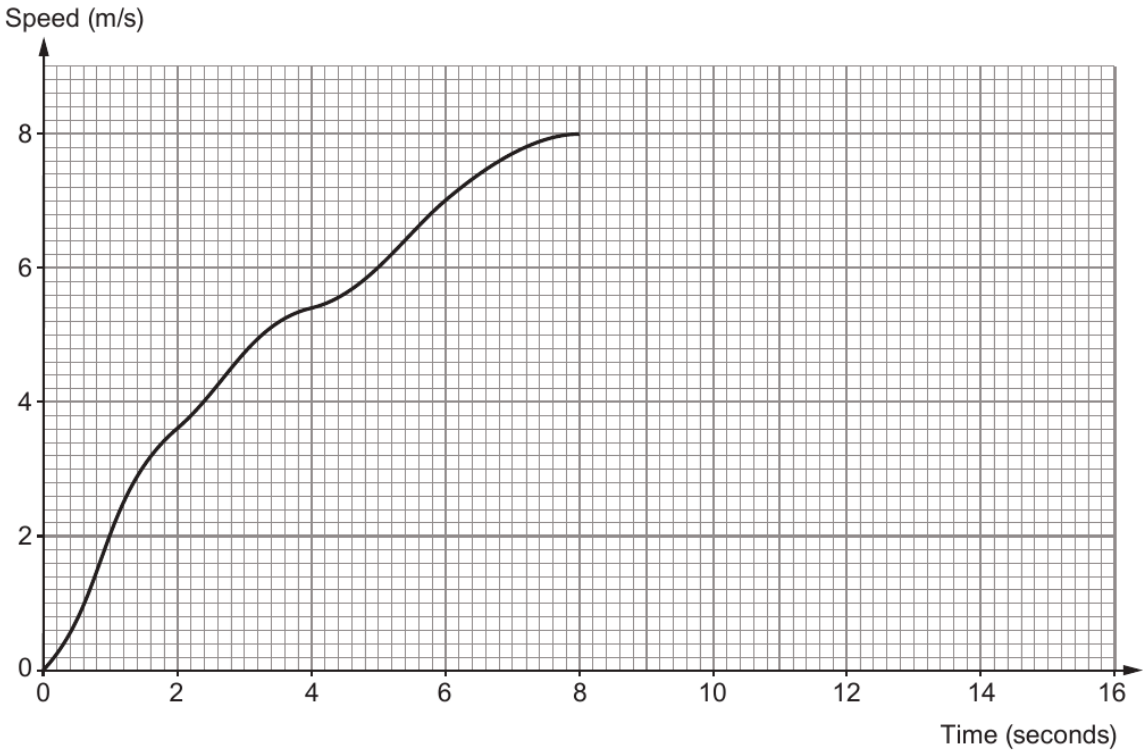
Average depth of water = ... feet

(c) Estimate the rate of increase in the depth of the water on the 60th day of this period.
Give your answer in its simplest form. [3]

Examiner only

8. Sian ran a 100-metre race.

The graph below shows Sian's speed over the **first** 8 seconds of the race.
Sian then ran the rest of the race at a constant speed of 8 m/s.



By first using the trapezium rule with 4 strips of equal width for the first 8 seconds, estimate the total time it took Sian to run the 100-metre race.
You must show all your working. [5]

Sian's total time to run the 100-metre race = ... seconds