1.1 Movement and position

Name: _____ Class: _____ Date: _____ **Total: 30 marks**

Objective

Build the skills to answer exam questions on **movement and position** : average speed, distance–time and velocity–time graphs, acceleration, and the equation $v^2 = u^2 + 2as$.

You must be able to:

- calculate average speed and acceleration
- read speed from a distance–time graph and acceleration and distance from a velocity–time graph
- use $v^2 = u^2 + 2as$
- plan an investigation into the motion of a trolley

1 Key knowledge and worked examples

Speed and acceleration

idea	equation or rule
average speed	distance moved ÷ time taken
acceleration	$a = (v - u) \div t$ (unit m/s^2)
uniform acceleration	$v^2 = u^2 + 2as$
distance–time graph	gradient = speed
velocity–time graph	gradient = acceleration; area under the line = distance travelled

Worked example 1: acceleration. A car speeds up from rest to 24 m/s in 8.0 s. Find its acceleration.

1. Known: $u = 0$; $v = 24$ m/s; $t = 8.0$ s.
2. Rule: $a = (v - u) \div t$.
3. Numbers: $(24 - 0) \div 8.0$.
4. Result: 3.0 $\mathbf{m/s^2}$.

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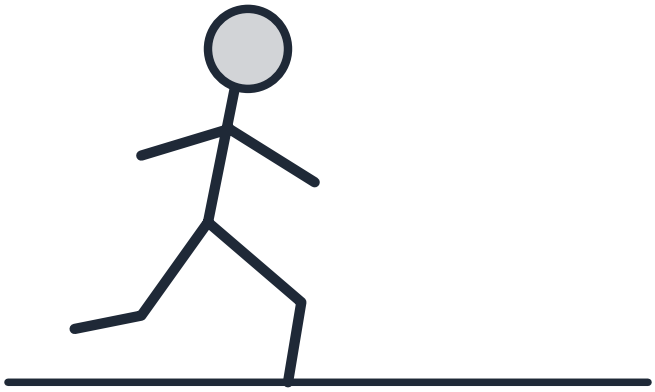
Worked example 2: $v^2 = u^2 + 2as$. A trolley starts from rest and accelerates at 2.0 m/s^2 for 25 m. Find its final speed.

1. Known: $u = 0$; $a = 2.0$; $s = 25$.
2. Rule: $v^2 = u^2 + 2as$.
3. Numbers: $v^2 = 0 + 2 \times 2.0 \times 25 = 100$.
4. Result: $v = 10$ **m/s**.

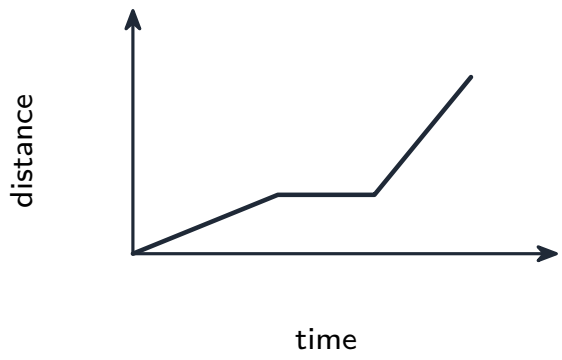
Answer shapes: write the equation, put in the numbers with units, then give the answer with its unit.

2 Practice

2.1 A runner covers 1200 m in 150 s. Calculate her average speed. [2]

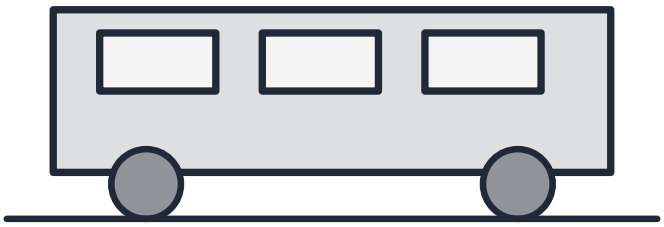


2.2 On a distance–time graph, what does a horizontal line show, and what does a steeper straight line show? [2]

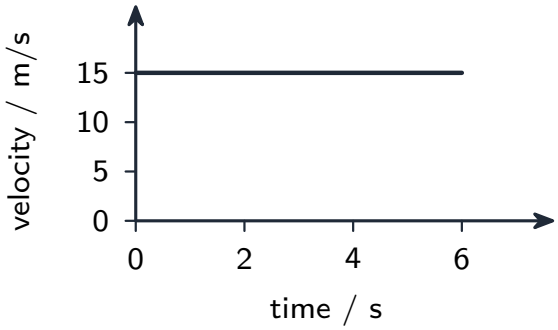


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2.3 A train speeds up from 12 m/s to 30 m/s in 9.0 s. Calculate its acceleration. [2]



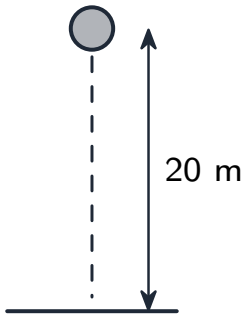
2.4 A velocity–time graph shows a car moving at a steady 15 m/s for 6.0 s. Calculate the distance travelled. [2]



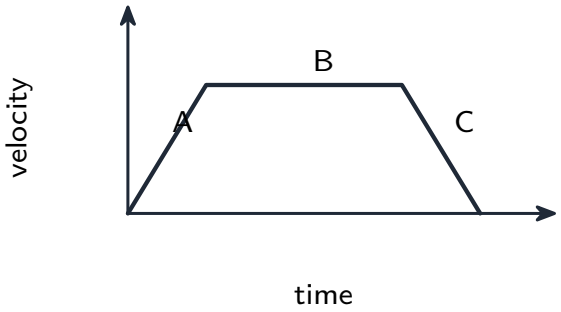
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3 Exam-style questions

3.1 A ball is dropped from rest and falls 20 m. Its acceleration is 10 m/s^2. Calculate its speed when it hits the ground. Ignore air resistance. [3]

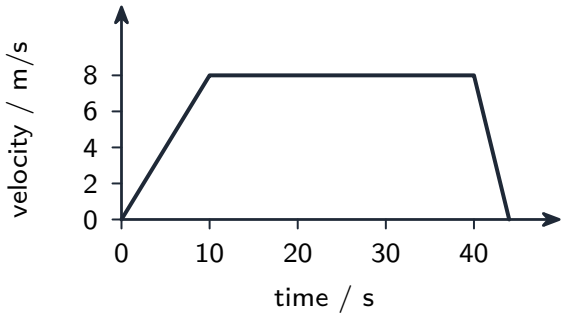


3.2 The velocity–time graph shows a lift moving upwards. Describe its motion in parts A, B and C. [3]



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3.3 A cyclist rides along a straight road. The velocity–time graph of her journey is shown.



(a) Calculate her acceleration in the first 10 s. [3]

(b) Calculate the total distance she travels. [4]

(c) Calculate her average speed for the whole journey. [3]

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(d) Describe an investigation to find how the height of a ramp affects the speed of a trolley at the bottom. [6]

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Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

- $1200 \div 150$
- **8.0** m/s

2.2

- horizontal: the object is stationary
- steeper: a greater (constant) speed

2.3

- $(30 - 12) \div 9.0$
- **2.0** m/s^2

2.4

- area $= 15 \times 6.0$
- **90** m

3.1

- $v^2 = u^2 + 2as = 0 + 2 \times 10 \times 20$
- $v^2 = 400$
- $v =$ **20** m/s

3.2

- A: constant acceleration from rest
- B: constant velocity
- C: constant deceleration to rest

3.3

(a) $(8 - 0) \div 10 = 0.8$ m/s^2

(b) first part $\frac{1}{2} \times 10 \times 8 = 40$ m; middle $30 \times 8 = 240$ m; last part $\frac{1}{2} \times 4 \times 8 = 16$ m; total **296** m

(c) total time 44 s; $296 \div 44 =$ **6.7** m/s

(d) points to include:

- set up a ramp and measure its height with a metre rule (K)
- release the trolley from the same point each time, without pushing it (App)
- measure the speed at the bottom with a light gate and data logger, or time it over a measured distance with a stopwatch (K)
- speed = length of card ÷ time to pass the light gate (or distance ÷ time) (K)

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- change the height in steps, e.g. 10, 20, 30, 40, 50 cm, using the same trolley and ramp surface (App)
- repeat each height three times and find the mean; plot speed against height (An)

Levels: **5–6** a full, logical answer with correct physics and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.

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