PEARSON EDEXCEL INTERNATIONAL GCSE PHYSICS (9–1) | TOPIC 1

FREE SAMPLE

Forces and Motion

Free sample: knowledge organiser and Worksheet 1 with answers

4PH1 EDEXCEL SPEC

Speed | Distance–time graphs | Velocity–time graphs | $v^2 = u^2 + 2as$ | $F = m \times a$

Stopping distance | Terminal velocity | Hooke's law | Momentum | Moments

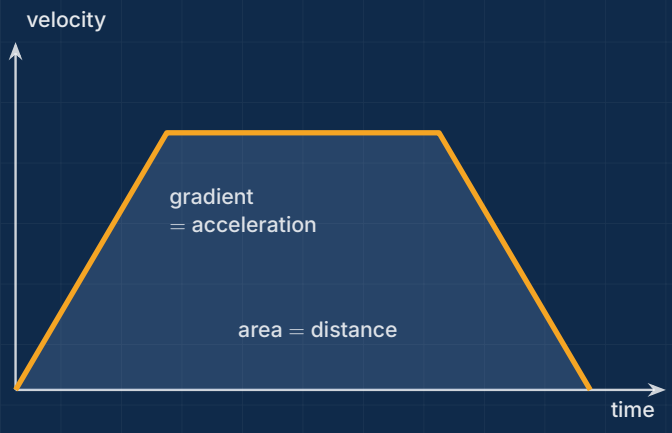
Exam-style questions

$$a = (v - u) / t$$

$$v^2 = u^2 + 2as$$

$$F = m\,a$$

$$p = m\,v$$



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Physics that finally makes sense.

Free sample
Full pack: 6 worksheets, exam paper, answers

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Knowledge organiser

Key words 1.13

Scalar – has size (magnitude) only: distance, speed, mass, time, energy.

Vector – has size **and** direction: displacement, velocity, acceleration, force, weight, momentum.

Velocity – speed in a stated direction.

Acceleration – the rate of change of velocity. A negative acceleration is a deceleration.

Equations 1.4 1.6 1.10

average speed = distance moved ÷ time taken

acceleration = change in velocity ÷ time taken

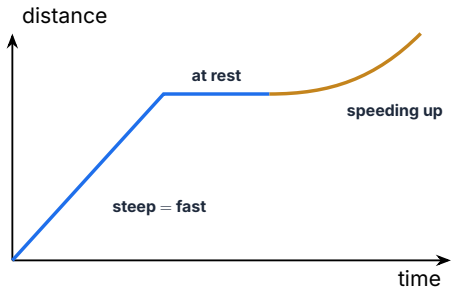
$$a = \frac{(v - u)}{t}$$

(final speed)^2 = (initial speed)^2 + (2 × acceleration × distance moved)

$$v^2 = u^2 + 2as$$

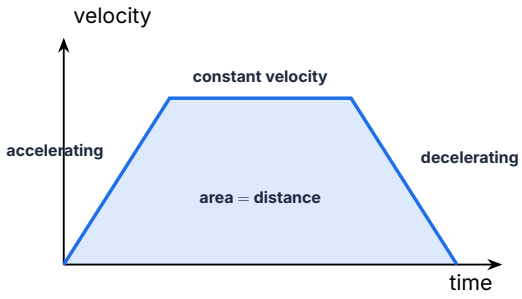
u initial velocity, v final velocity (m/s), a in m/s^2, s in m, t in s

Distance–time graphs 1.3



The **gradient** is the speed. Horizontal line: not moving. Straight sloping line: constant speed. Curve: the speed is changing.

Velocity–time graphs 1.7–1.9



The **gradient** is the acceleration. The **area** between the line and the time axis is the distance travelled.

Worked example: speed and acceleration

A horse gallops 1500 m in 125 s.
speed = 1500 ÷ 125 = 12 m/s

A lorry speeds up from 6.0 m/s to 18 m/s in 8.0 s.
$a = (18 - 6.0) \div 8.0 = 1.5$ m/s^2

Worked example: $v^2 = u^2 + 2as$

A trolley moving at 4.0 m/s accelerates at 3.0 m/s^2 for 14 m.
$v^2 = 4.0^2 + (2 \times 3.0 \times 14) = 16 + 84 = 100$
$v = \sqrt{100} = 10$ m/s
Remember to take the square root at the end.

Investigating motion 1.5

Measure a distance with a metre rule or tape measure. Time the object with a stopwatch, or use **light gates** and a data logger for short times.

Repeat each timing and find a mean. Then average speed = distance ÷ mean time.

Light gates remove human reaction time.

Units and common mistakes 1.1

SI units: mass kg, distance m, time s, speed m/s, acceleration m/s^2, force N, g N/kg

1 km = 1000 m; 1 minute = 60 s; 1 hour = 3600 s

- Average speed uses the **total** distance and the **total** time, including stops.
- In $a = (v - u)/t$ use the **change** in velocity, not the final velocity alone.
- A slowing object has a negative acceleration.

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Forces 1.11–1.16

Forces can change the **speed**, **direction** or **shape** of an object. Types: gravitational (weight), electrostatic, friction, air resistance, tension, normal reaction.

Force is a **vector**. Forces along a line: add those in the same direction, subtract those in opposite directions.



resultant = 6 N to the right

Friction always opposes motion.

Force, mass and weight 1.17 1.18

unbalanced force = mass × acceleration

$$F = m \times a$$

weight = mass × gravitational field strength

$$W = m \times g$$

F, W in N; m in kg; a in m/s^2; g = 10 N/kg on the Earth

Example: a 1200 kg car accelerates at 2.5 m/s^2: $F = 1200 \times 2.5 = 3000$ N. A 65 kg person weighs $65 \times 10 = 650$ N.

Stopping distance 1.19 1.20

stopping distance = thinking distance + braking distance

Thinking distance increases with speed and with a longer reaction time (tiredness, alcohol, drugs, distraction).

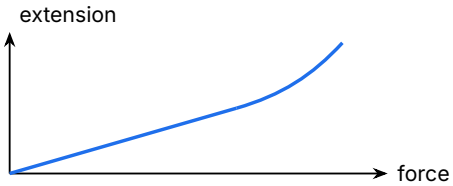
Braking distance increases with speed, greater mass, and a wet or icy road or worn tyres and brakes.

Falling objects 1.21



At first weight > air resistance, so the object accelerates. As it speeds up, air resistance increases, so the resultant force and acceleration decrease. When air resistance = weight, the resultant force is zero: it falls at **terminal velocity**.

Hooke's law 1.22–1.24



straight line through the origin: Hooke's law

Hooke's law: extension is directly proportional to force, in the initial straight-line region. **Elastic:** returns to its original shape when the force is removed.

extension = new length − original length

Momentum PAPER 2 ONLY 1.25P–1.29P

momentum = mass × velocity

$$p = m \times v \quad \text{(kg m/s)}$$

force = change in momentum ÷ time taken

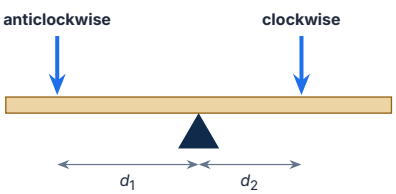
$$F = (mv - mu) \div t$$

In a collision or explosion, total momentum is **conserved**. Crumple zones, airbags and seat belts increase the time taken, so the force is smaller.

Newton's third law: if A exerts a force on B, B exerts an equal and opposite force on A.

Example: 0.15 kg at 30 m/s: $p = 4.5$ kg m/s

Moments and centre of gravity PAPER 2 ONLY 1.30P–1.33P



moment = force × perpendicular distance from the pivot (N m)

Principle of moments: for an object in equilibrium, the sum of clockwise moments = the sum of anticlockwise moments. Example: 25 N at 0.40 m gives 10 N m.

The weight acts through the **centre of gravity**. On a light beam supported at both ends, the support nearer a heavy object pushes up with the larger force.

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Speed and distance–time graphs

WORKSHEET 1
1.1 1.3 1.4 1.5

You will: use average speed = distance moved ÷ time taken with the correct units, plot and explain distance–time graphs, and describe how to investigate the motion of everyday objects.

1.4 specification statement | PAPER 2 ONLY Paper 2 only (bold P statements) | CHALLENGE stretch question

1 1.1 Complete the table by giving the SI unit of each quantity. [3]

Quantity	SI unit
mass	
distance	
time	
speed	
acceleration	
force	
gravitational field strength	

2 1.4 Complete the calculations. Show your working.

(a) A cyclist travels 1800 m in 360 s. Calculate her average speed. [1]

average speed = _____

(b) A train moves at an average speed of 45 m/s for 120 s. Calculate the distance it travels. [1]

distance = _____

(c) A runner has an average speed of 4.0 m/s. Calculate the time she takes to run 1000 m. [1]

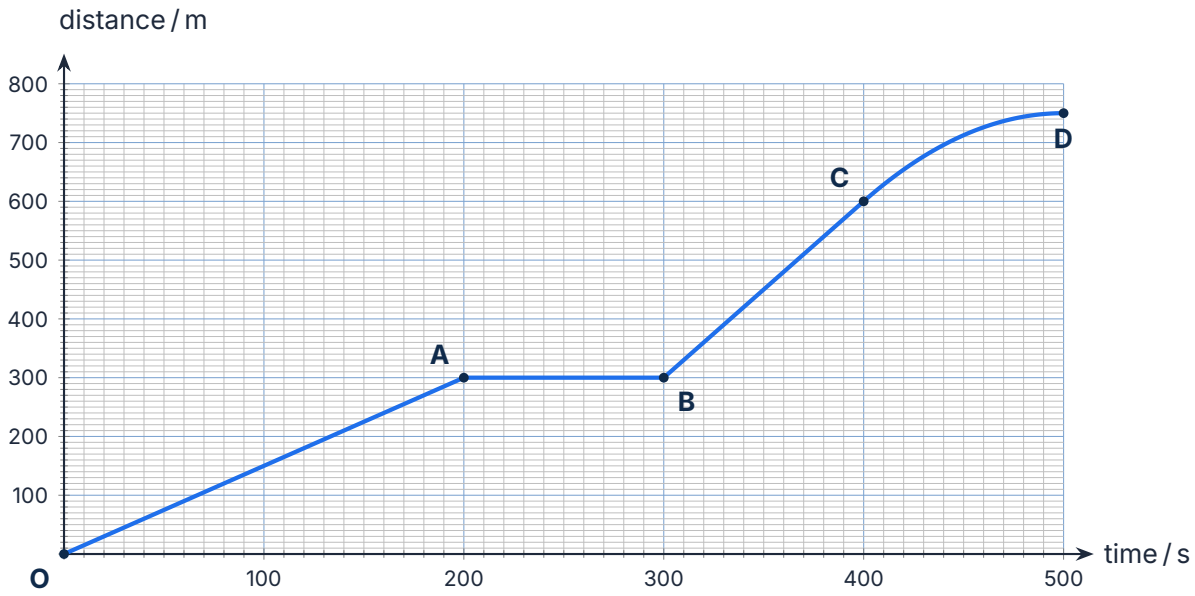
time = _____

(d) A car travels 54 km in 45 minutes. Calculate its average speed in m/s. [2]

average speed = _____

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3 1.3 1.4 The graph shows a student's journey to school along a straight road.



(a) State the section of the journey in which the student is not moving. [1]

.....

(b) Calculate the speed of the student between O and A. [2]

.....

speed = _____

(c) Calculate the speed of the student between B and C. [2]

.....

speed = _____

(d) Describe the motion of the student between C and D. Give a reason for your answer. [2]

.....

.....

(e) Calculate the average speed of the student for the whole journey, O to D. [2]

.....

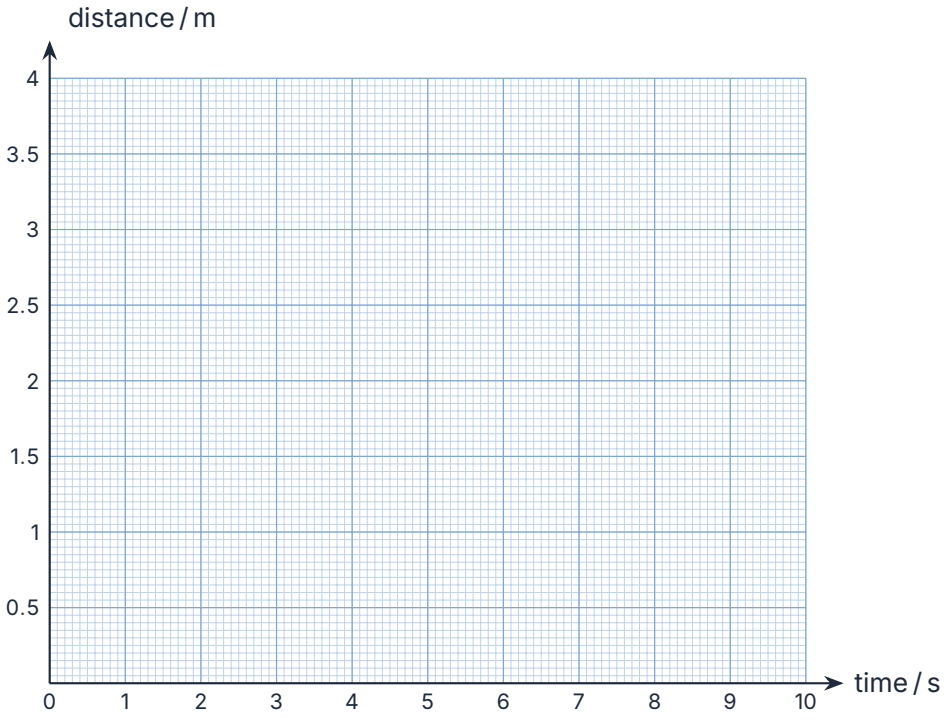
average speed = _____

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4 1.3 A toy car moves along a straight track. The table shows how far it has travelled.

time / s	0	1	2	3	4	5	6	7	8
distance / m	0	0.5	1.0	1.5	2.0	2.0	2.0	2.8	3.6

(a) On the grid, plot the points and draw the distance–time graph. [3]



Scales: *x*-axis 1 s per large square · *y*-axis 0.5 m per large square

(b) State the time interval during which the car is not moving. [1]

.....

(c) Use the gradient of your graph to find the speed of the car between $t = 0$ s and $t = 4$ s, and between $t = 6$ s and $t = 8$ s. [3]

.....

.....

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5 1.5 A student investigates the motion of a tennis ball rolling across a playground. She measures the time the ball takes to roll 2.00 m between two chalk lines.

(a) Name the measuring instruments she uses. [2]

.....

.....

(b) She repeats the timing three times. Her times are 1.62 s, 1.58 s and 1.60 s. Calculate the mean time and the average speed of the ball. [3]

.....

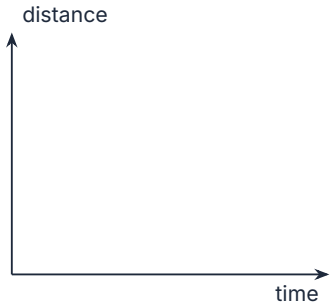
.....

average speed = _____

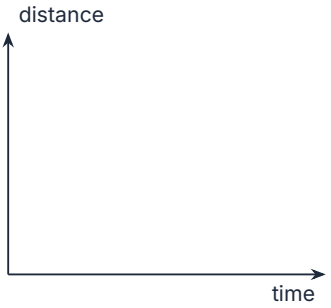
(c) Suggest how she could make her timings more accurate. [1]

.....

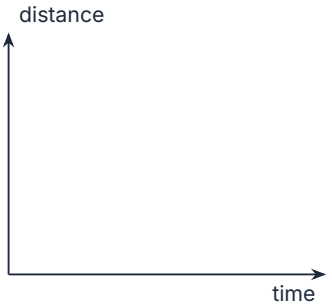
6 1.3 Sketch a distance–time graph on each pair of axes. [3]



(a) an object at rest 20 m from the start



(b) an object moving at a constant speed



(c) an object speeding up

7 1.4 CHALLENGE A bus travels 6.0 km at a steady 12 m/s. It then stops for 5.0 minutes. It then travels a further 3.0 km at a steady 15 m/s. Calculate the average speed of the bus for the whole journey. [4]

.....

.....

.....

average speed = _____

Exam tip On a distance–time graph, **steeper means faster** and the gradient is the speed. A horizontal line means the object is not moving. A curve means the speed is changing.

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Answers: Worksheet 1

Each **(1)** is one mark. Accept answers that round correctly and allow error carried forward from earlier parts. $g = 10$ N/kg throughout. Graph readings: accept answers within half a small square.

Worksheet 1 – Speed and distance–time graphs

1 mass **kg**; distance **m**; time **s**; speed **m/s**; acceleration **m/s²**; force **N**; gravitational field strength **N/kg**: all seven **(3)**; five or six **(2)**; three or four **(1)**

2 **(a)** $1800 \div 360 = \mathbf{5.0\ m/s}$ **(1)**
(b) $45 \times 120 = \mathbf{5400\ m}$ **(1)**
(c) $1000 \div 4.0 = \mathbf{250\ s}$ **(1)**
(d) 54 000 m and $45 \times 60 = 2700$ s **(1)**; $54\,000 \div 2700 = \mathbf{20\ m/s}$ **(1)**

3 **(a)** **A to B** **(1)**
(b) $300 \div 200$ **(1)** $= \mathbf{1.5\ m/s}$ **(1)**
(c) $(600 - 300) \div (400 - 300)$ **(1)** $=$ **3.0 m/s** **(1)**
(d) slowing down (until it stops at D) **(1)**; the gradient decreases **(1)**
(e) $750 \div 500$ **(1)** $= \mathbf{1.5\ m/s}$ **(1)**

4 **(a)** all 9 points plotted correctly **(2)**; 7–8 correct **(1)**; straight lines joining the points **(1)**
(b) **4 s to 6 s** **(1)**
(c) 0–4 s: $2.0 \div 4 = \mathbf{0.50\ m/s}$ **(1)**; 6–8 s: $(3.6 - 2.0) \div 2$ **(1)** $= \mathbf{0.80\ m/s}$ **(1)**

5 **(a)** metre rule or tape measure **(1)**; stopwatch **(1)**
(b) mean $= (1.62 + 1.58 + 1.60) \div 3 =$ 1.60 s **(1)**; $2.00 \div 1.60$ **(1)** $= \mathbf{1.25\ m/s}$ **(1)**
(c) use light gates (and a data logger) to remove reaction time, or time over a longer distance **(1)**

6 **(a)** horizontal line starting above the origin **(1)**
(b) straight line sloping upwards **(1)**
(c) curve getting steeper **(1)**

7 times: $6000 \div 12 = 500$ s and $3000 \div 15 =$ 200 s **(1)**; total time $= 500 + 300 + 200 =$ 1000 s **(1)**; total distance $= 9000$ m **(1)**; $9000 \div 1000 = \mathbf{9.0\ m/s}$ **(1)**

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Get the full pack

You have just used Worksheet 1. The full Topic 1 pack contains:

- **Worksheet 1:** Speed and distance–time graphs
- **Worksheet 2:** Acceleration, velocity–time graphs and $v^2 = u^2 + 2as$
- **Worksheet 3:** Forces, $F = m \times a$, weight, stopping distance and terminal velocity
- **Worksheet 4:** Hooke's law practical and elastic behaviour
- **Worksheet 5:** Momentum and Newton's third law (Paper 2)
- **Worksheet 6:** Moments and centre of gravity (Paper 2)
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