**Question 2** (Answer: **B**)

- Average speed is *total distance* divided by *total time* – never the average of the two speeds.
- Distance $= (8 \times 10) + (6 \times 12)$.
- Total time $= 10 + 12 = 22$ s, so divide that distance by 22.

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**Question 2** (Answer: **B**)

- A speed–time graph's *gradient* is the rate at which speed changes – the acceleration.
- A negative gradient is a deceleration.
- The *area* under the graph gives the distance travelled instead.

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**Question 2** (Answer: **C**)

- The car comes to rest, so the final speed is zero.
- Its initial speed was $at = 4.0 \times 8.0 = 32$ m/s.
- With constant deceleration the average speed is $(32 + 0)/2 = 16$ m/s.

**Question 3** (Answer: **D**)

- Released from rest, the object speeds up, so its velocity increases.
- As it speeds up the air resistance grows, so the resultant force – and the acceleration – falls.
- At terminal velocity the forces balance: the velocity is constant and the acceleration is zero.

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| | |
|---|---|
| 1(a)(i) | constant acceleration |
| 1(a)(ii) | area under the graph **OR** ½ *bh* **OR** <u>average</u> speed × time |
| | 0.5 × 5.9 × 0.6 **OR** 1.77 (to ⩾ 3 sf) |
| 1(a)(iii) | 9.5 J |
| | ($\Delta E$p =) $mg(\Delta)h$ **OR** 0.54 × 9.8 × 1.8 |
| 1(a)(iv) | candidate's **1(a)(iii)** value × 0.5 (2sf) |
| 1(b) | any **three** from:<br>• (initially there is acceleration due to) an unbalanced force **OR** resultant force **OR** downward force **OR** weight **OR** gravitational force acting on the ball<br>• as speed increases the <u>air</u> resistance increases<br>• (as air resistance increases) resultant force downwards decreases **OR** acceleration decreases<br>• (eventually) ball falls with constant speed when air resistance = weight **OR** ball falls with terminal velocity when air resistance = weight |
| 1(c) | (some of the) energy is:<br><br>transferred to the thermal energy (store) of the ground (when ball hits ground)<br>**OR** converted / transferred to thermal energy (store) of the air<br>**OR** used to deform ball / transferred to the elastic energy (store) of the ball (as it contacts the ground) |
| | gravitational potential energy (in the store at C) will be less (than at A)<br>**OR**<br>(ball has) less kinetic energy (in its store just after B) |

**Question 1** (Answer: **C**)

- On a speed–time graph a rising line is acceleration and a falling line is deceleration.
- A horizontal line is constant speed, and the graph touching zero means at rest.
- A crash shows as a very steep fall to zero, so look for the steepest downward section.

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**Question 7** (Answer: **B**)

- Use $v^2 = 2gh$; the mass is irrelevant for a falling object.
- $v^2 = 2 \times 9.8 \times 50 = 980$.
- $v = 31$ m/s.

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| | |
|---|---|
| 1(a) | (acceleration is) rate of change in velocity **OR** change in velocity per unit time **OR** ($a$ =) $\Delta v / \Delta t$ |
| 1(b) | 0.021 N |
| | $F$ = $ma$ **OR** ($F$ =) $ma$ **OR** 0.0075 × 2.8 |
| 1(c)(i) | any **four** from:<br>• (acceleration) decreases<br>• (acceleration decreases) to zero (at approximately 0.03 s)<br>• resistive force increases / resistance increases (as speed / velocity increases)<br>• resultant force (downwards) decreases<br>• (until) terminal velocity / constant speed (is reached)<br>• (when) resistive force = weight **OR** resultant force is zero **OR** forces are balanced |
| 1(c)(ii) | tangent drawn at $t$ = 0.010 s |
| | 1.2 m / s² ⩽ acceleration ⩽ 1.8 m / s² |
| | ($a$ =) gradient of tangent **OR** ($a$ =) {$\Delta y / \Delta x$} |

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**Question 2** (Answer: **D**)

- Deceleration means the speed is falling.
- On a speed–time graph that is a section sloping *downwards*.
- A horizontal section is constant speed and an upward slope is acceleration.

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**Question 3** (Answer: **C**)

- Distance travelled is the *area* under a speed–time graph.
- The line rises from rest to 20 m/s over 400 s, so that area is a triangle.
- $\frac{1}{2} \times 400 \times 20 = 4000$ m; 8000 m would be the area if the speed had been 20 m/s throughout.

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| | |
|---|---|
| 2(a)(i) | (speed =) 38 m / s |
| | $a = \Delta v / \Delta t$ **OR** ($\Delta v$ =) $a\Delta t$ **OR** ($\Delta v$ =) 7.2 × 5.3 |
| 2(a)(ii) | (resultant force = ) 1 700 N |
| | $F$ = $ma$ **OR** ($F$ =) $ma$ **OR** ($F$ =) 240 × 7.2 |
| 2(b)(i) | (vector) has direction (as well as magnitude) **OR** scalar does not have direction |

| | |
|---|---|
| 2(b)(ii) | (velocity) changes (as direction of motion changes) **OR** direction (of velocity) changes |
| 2(b)(iii) | any **two** from:<br>• because there is an acceleration / change in velocity / change in direction / change in momentum (which needs a resultant force)<br>• motorcyclist accelerates / changes momentum (because velocity / direction changes)<br>• (resultant) force is perpendicular to the motion (of the motorcycle) **OR** $a \propto F$ |