SMART EXAM RESOURCES
SUBJECT: PHYSICS
TOPIC: SPEED-TIME GRAPH
SET-6-QP-MS

1 An aeroplane accelerates along a horizontal runway before take-off.
The aeroplane accelerates for 35 s. The speed of the aeroplane when it takes off is 72 m / s.

Fig. 1.1 shows how the speed of the aeroplane varies between time t = 0 and t = 35 s.

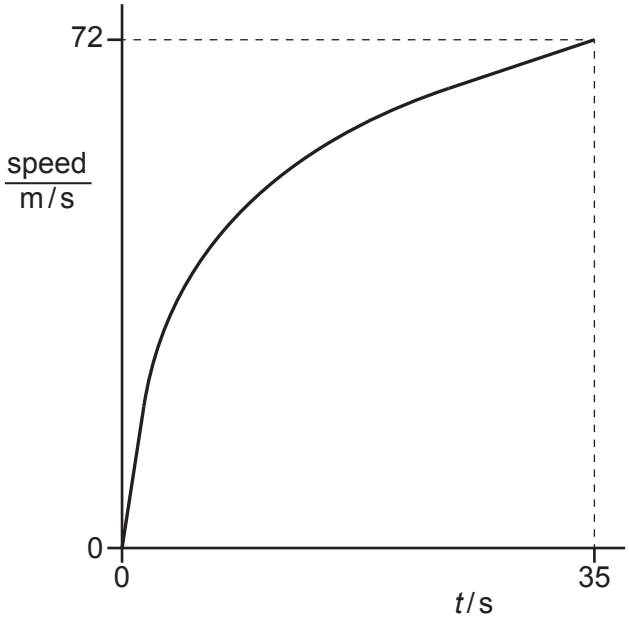

Fig. 1.1

(a) Define acceleration.

.....

..... [1]

(b) **(i)** Calculate the average acceleration of the aeroplane between t = 0 and t = 35 s.

acceleration = ... [1]

(ii) The combined mass of the aeroplane, its passengers and its fuel on take-off is 1.1×10^5 kg.

Calculate the average resultant force on the aeroplane between t = 0 and t = 35 s.

force = ... [2]

(iii) The force provided by the engines of the aeroplane is constant.

Give **one** possible explanation for the change in acceleration of the aeroplane between $t = 0$ and $t = 35$ s.

.....

..... [1]

(iv) On Fig. 1.2, sketch a graph to show how the acceleration of the aircraft varies between $t = 0$ and $t = 35$ s.

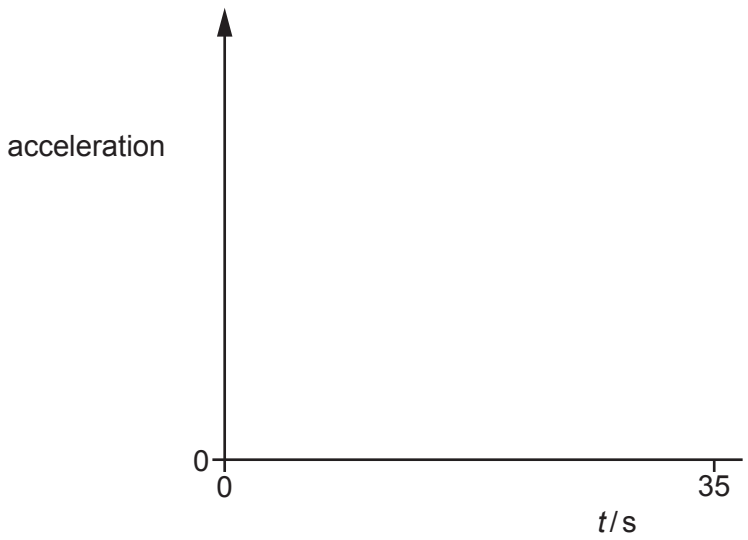

Fig. 1.2

[3]

[Total: 8]

MARK SCHEME:

(a)	change of velocity per unit time or $\frac{v-u}{t}$	**B1**
(b)(i)	(72 / 35 =) 2.1 m / s^2	**A1**
(b)(ii)	230 000 N OR 230 kN	**A2**
	$F = ma$ **OR** (F =) ma **OR** 110 000 × 2.1	C1
(b)(iii)	any **one** from: • (increase / change in) air resistance • (increase / change in) wind	**B1**
(b)(iv)	any **three** from: • initial acceleration highest value **AND** horizontal line • curved or straight line downwards • curved or straight line downwards **AND** line not reaching zero by 35 s • horizontal line before and up to 35 s.	**B3**

2 A ball rolls down a ramp and onto a horizontal surface. The first section of the horizontal surface is smooth. The second section of the horizontal surface is rough. Fig. 1.1 shows a speed–time graph for the ball.

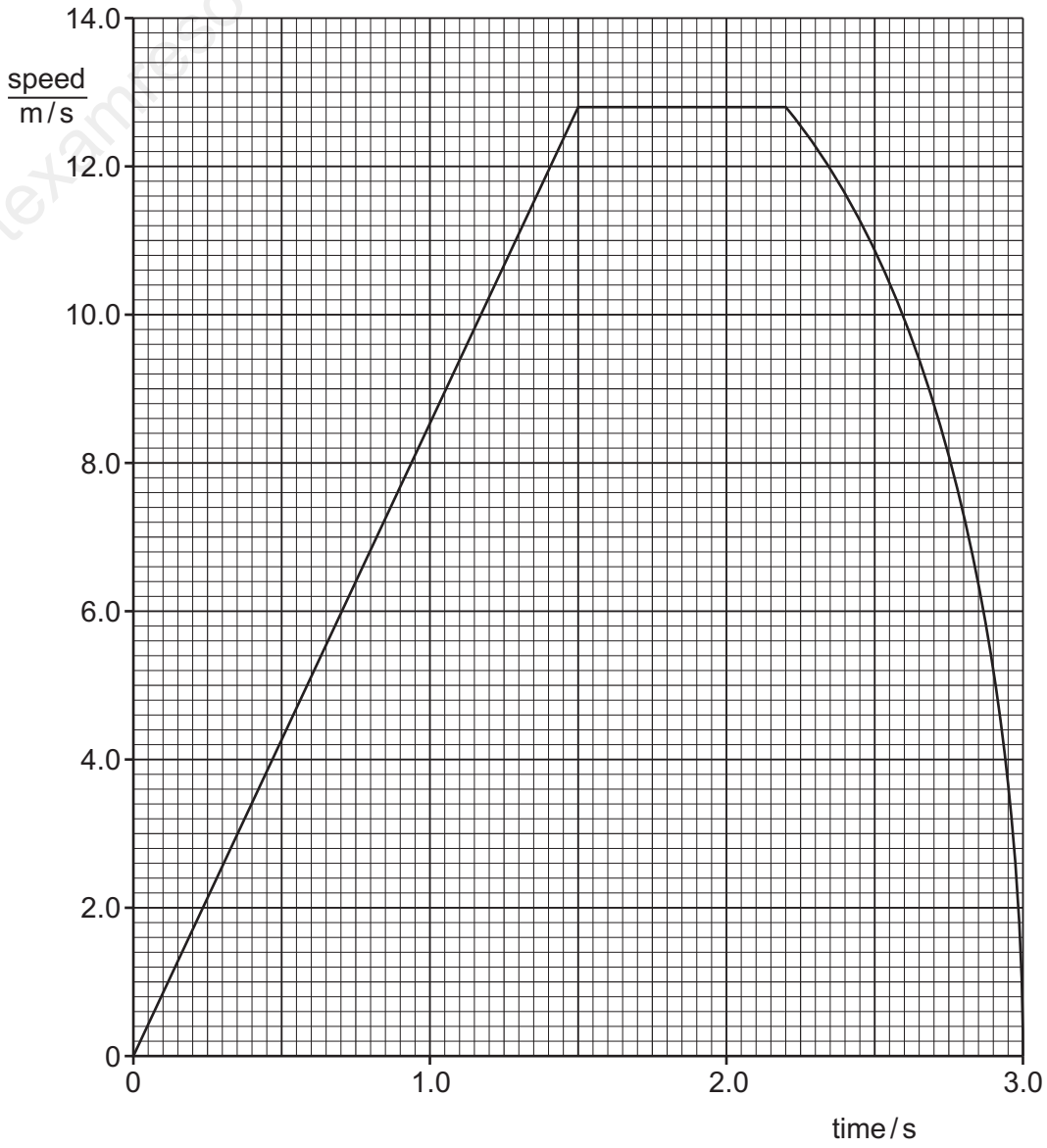

Fig. 1.1

(a) State the time when the ball reaches the start of the rough section of the horizontal surface.

time = ... [1]

(b) Explain how Fig. 1.1 shows that there is **no** resultant force on the ball when it rolls along the smooth section of the horizontal surface.

.....

..... [2]

(c) Using Fig. 1.1, determine the acceleration of the ball as it rolls down the ramp.

acceleration = ... [3]

(d) The ball starts from rest at the top of the ramp.

Show that the length of the ramp is 9.6 m.

[2]

MARK SCHEME:

Question	Answer	Marks
(a)	2.2 s	**B1**
(b)	*Any two from:* • Line on graph is horizontal / gradient is zero • (therefore) no acceleration / speed is constant • (resultant) force causes / is proportional to acceleration	**B2**
(c)	8.5 ms^{-2}	**A3**
	(a =) $\Delta v / t$ in any form OR gradient of graph OR 12.8 / 1.5 OR other suitable values from graph	**(C1)**
	(1.5, 12.8) both seen OR alternative suitable points on the line identified	**(C1)**
(d)	$0.5 \times 12.8 \times 1.5$ (= 9.56 / 9.6 m) OR 6.4×1.5 (= 9.6)	**A2**
	(length of ramp) = area under graph (between 0–1.5 s) OR average velocity × time	**(C1)**

3 Fig. 1.2 shows a vertical speed–time graph for a parachutist who jumps from a stationary hot-air balloon.

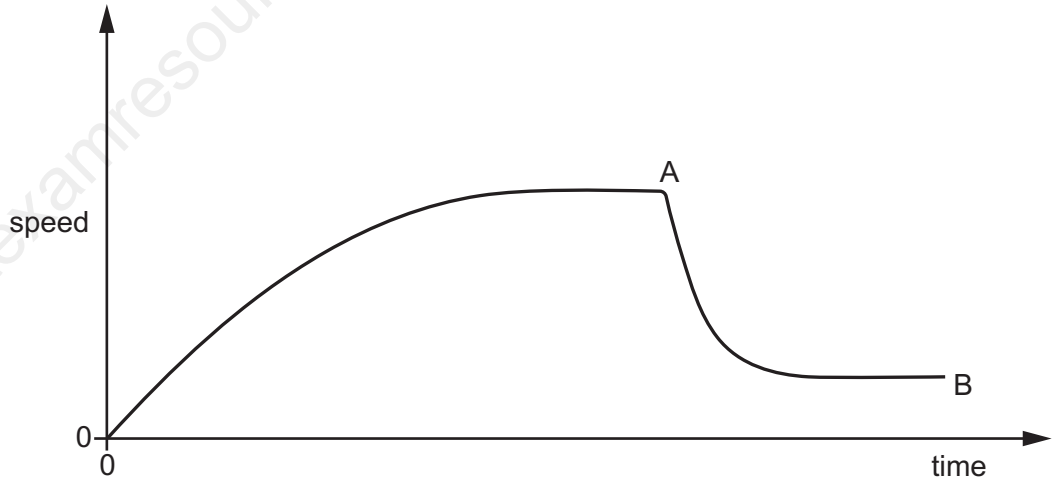

Fig. 1.2

The parachutist jumps from the balloon at time = 0 and reaches the ground at B. The point A indicates when the parachute opens.

(i) On Fig. 1.2, label a point on the graph where the acceleration is:
- zero with '1'
- negative with '2'
- decreasing with '3'. [3]

(ii) Explain, in terms of forces, the changes in motion which occur from when the parachutist leaves the hot-air balloon until point A.

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.....

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.....

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.....

.....

..... [4]

[Total: 11]

MARK SCHEME:

(i)	point, labelled 1, on either of the horizontal sections of the graph (to the left of A or to the left of B)	**B1**
	point, labelled 2, on the graph between A and the start of the horizontal section of the graph to the left of B	**B1**
	point, labelled 3, on the graph between the start of the curved section to the right of the origin and the start of the horizontal section of the graph to the left of A	**B1**
(ii)	(initially there is acceleration due to) weight **OR** gravitational force **OR** unbalanced force / resultant force / downward force	**B1**
	(then) air resistance increases as speed or velocity increases	**B1**
	(as air resistance increases) resultant force downwards decreases **OR** acceleration decreases	**B1**
	constant speed when air resistance = weight / gravitational force	**B1**

4 A skydiver of mass 76 kg is falling vertically in still air. At time $t = 0$, the skydiver opens his parachute.

Fig. 1.1 is the speed–time graph for the skydiver from $t = 0$.

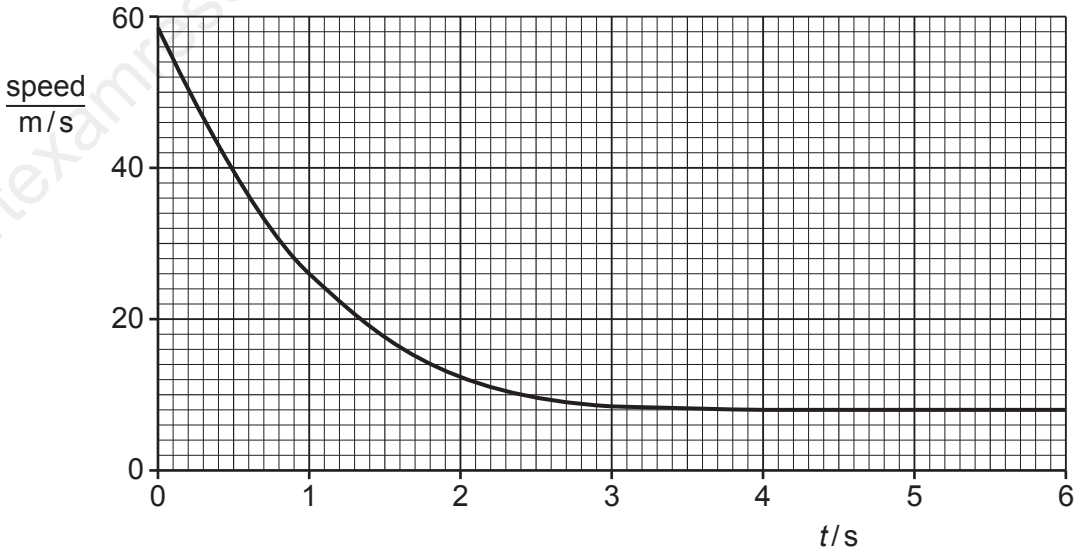

Fig. 1.1

(a) Using Fig. 1.1, determine:

(i) the deceleration of the skydiver immediately after the parachute opens

deceleration = ... [2]

(ii) the force due to air resistance acting on the skydiver immediately after the parachute opens.

force = ... [3]

(b) Explain, in terms of the forces acting on the skydiver, his motion between $t = 0$ and $t = 6.0$ s.

.....

.....

.....

..... [3]

(c) Explain why opening the parachute cannot reduce the speed of the skydiver to zero.

.....

.....

..... [2]

[Total: 10]

MARK SCHEME:

Question	Answer	Marks
(a)(i)	any value from 35 to 43 m / s^2	**A2**
	(a =) (v – u) / t in any form **or** gradient (of line) **or** (58 – 50) / 0.20 **or** equivalent values from the graph	**C1**
(a)(ii)	3800 N	**A3**
	(F =) ma in any form **or** Δp / Δt in any form **or** 76 × candidate's **1(a)(i)** **or** 760 seen	**C1**
	76 × candidate's **1(a)(i)** evaluated **or** 76 × (candidate's **1(a)(i)** + 10) **or** 76 × (candidate's **1(a)(i)**)+ 760	**C1**
(b)	(deceleration because) upward force greater than weight **or** upward resultant force	**B1**
	air resistance decreases (with decreasing speed / with time) **or** deceleration decreases **or** resultant (upward) force decreases	**B1**
	(until / finally) weight equals air resistance **or** forces balance **or** at terminal / constant velocity / speed	**B1**
(c)	at zero speed there is no air resistance	**B1**
	weight / downwards force is (still) acting **or** there is (now) a resultant force (downwards at zero speed)	**B1**
	OR forces balance at a speed greater than zero	**(B1)**
	speed cannot decrease / no deceleration once forces balance	**(B1)**

5 A ship sails in a straight line between two ports.

Fig. 1.1 shows the speed–time graph of the ship for the first 100 minutes of its journey between the two ports.

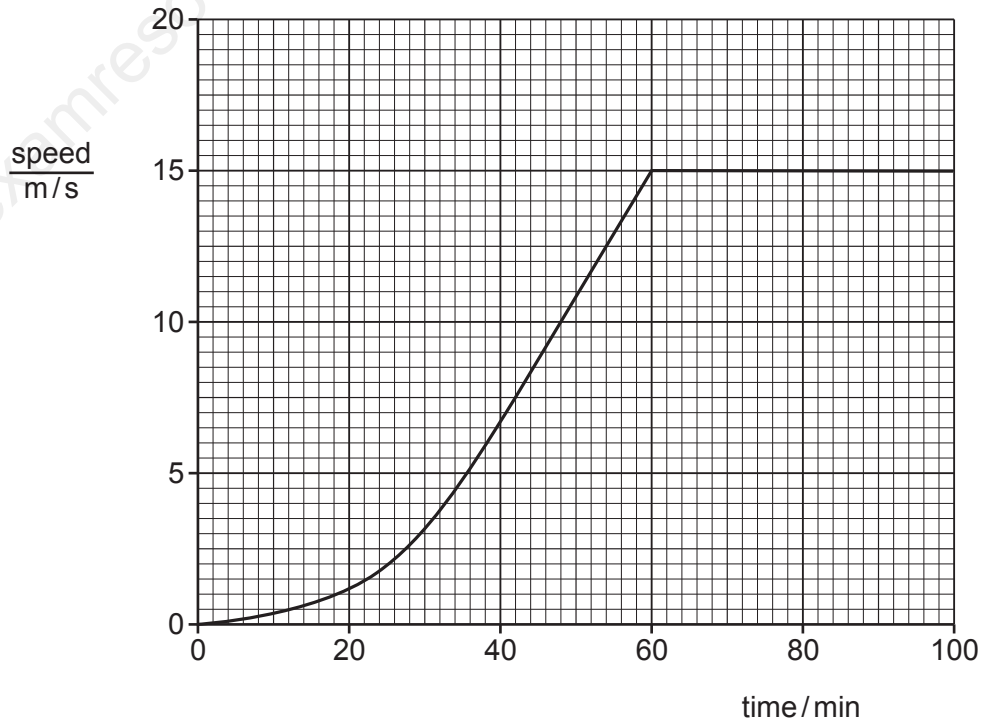

Fig. 1.1

(a) Calculate the maximum acceleration during the first 100 minutes of the ship's journey.

maximum acceleration = ... [2]

(b) Calculate the total distance travelled by the ship between time = 42 min and time = 100 min.

distance travelled = ... [3]

MARK SCHEME:

(a)	$0.0069\ m/s^2$	**A2**
	(acceleration =) gradient of graph or $\Delta v / \Delta t$ in any form OR $\frac{15-7.5}{(60-42)60}$	C1
(b)	48 000 m or 48 km	**A3**
	area under graph	C1
	$\frac{1}{2}(18\times7.5\times60)+(7.5\times18\times60)+(15\times40\times60)$	C1