SPEED-TIME

1 **(a)** Fig. 1.1 shows the axes of a distance-time graph for an object moving in a straight line.

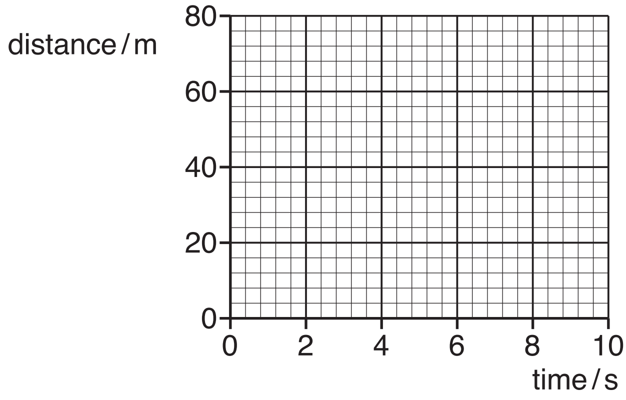

Fig. 1.1

(i) **1.** On Fig. 1.1, draw between time = 0 and time = 10 s, the graph for an object moving with a constant speed of 5.0 m / s. Start your graph at distance = 0 m.

2. State the property of the graph that represents speed.

.... [2]

(ii) Between time = 10 s and time = 20 s the object accelerates. The speed at time = 20 s is 9.0 m / s.

Calculate the average acceleration between time = 10 s and time = 20 s.

acceleration = ... [2]

(b) Fig. 1.2 shows the axes of a speed-time graph for a different object.

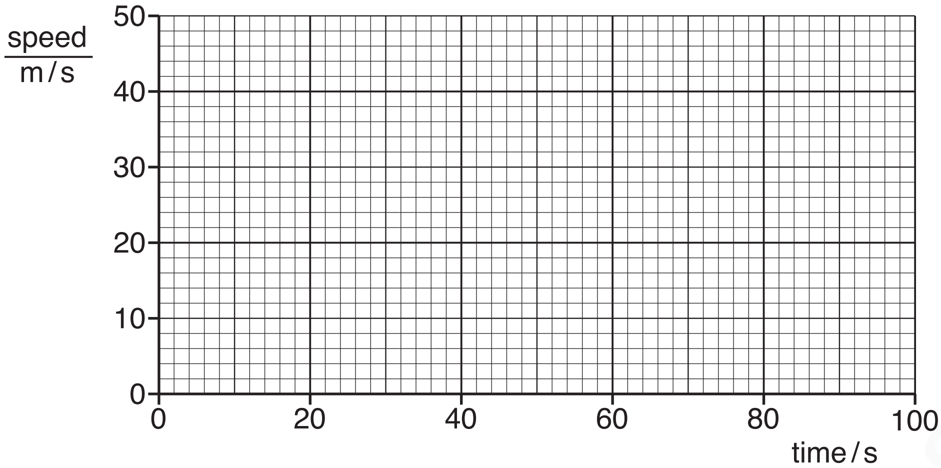

Fig. 1.2

(i) The object has an initial speed of 50 m/s and decelerates uniformly at 0.35 m/s^2 for 100 s.

On Fig. 1.2, draw the graph to represent the motion of the object. [2]

(ii) Calculate the distance travelled by the object from time = 0 to time = 100 s.

distance = ...[3]

[Total: 9]

MARKING SCHEME:

1(a)(i)	**1** straight line from (0,0) to (10,50)	**1**
	2 gradient/slope	**1**
1(a)(ii)	*a*= *Δv* ÷ *Δt* in any form **OR** (*a*=) *Δv* ÷ *Δt* **OR** (*a* =) (9–5) ÷ 10 **OR** 4 ÷ 10	**1**
	(*a* =) 0.40 m / s^2	**1**
1(b)(i)	straight line down from any point on y-axis to any speed at 100 s	**1**
	from (0,50) to (100,15)	**1**
1(b)(ii)	uses area under graph **OR** av speed × time **OR** $s=ut + ½ at^2$ **OR** $v^2=u^2 + 2as$	**1**
	100 × (50 + 15) ÷ 2 **OR** 100 × 15 + ½ (100 × 35) **OR** 5000 – ½ × 0.35 × 100^2	**1**
	3300 m	**1**

2 There is no atmosphere on the Moon.

A space probe is launched from the surface of the Moon. Fig. 1.1 shows the speed-time graph of the space probe.

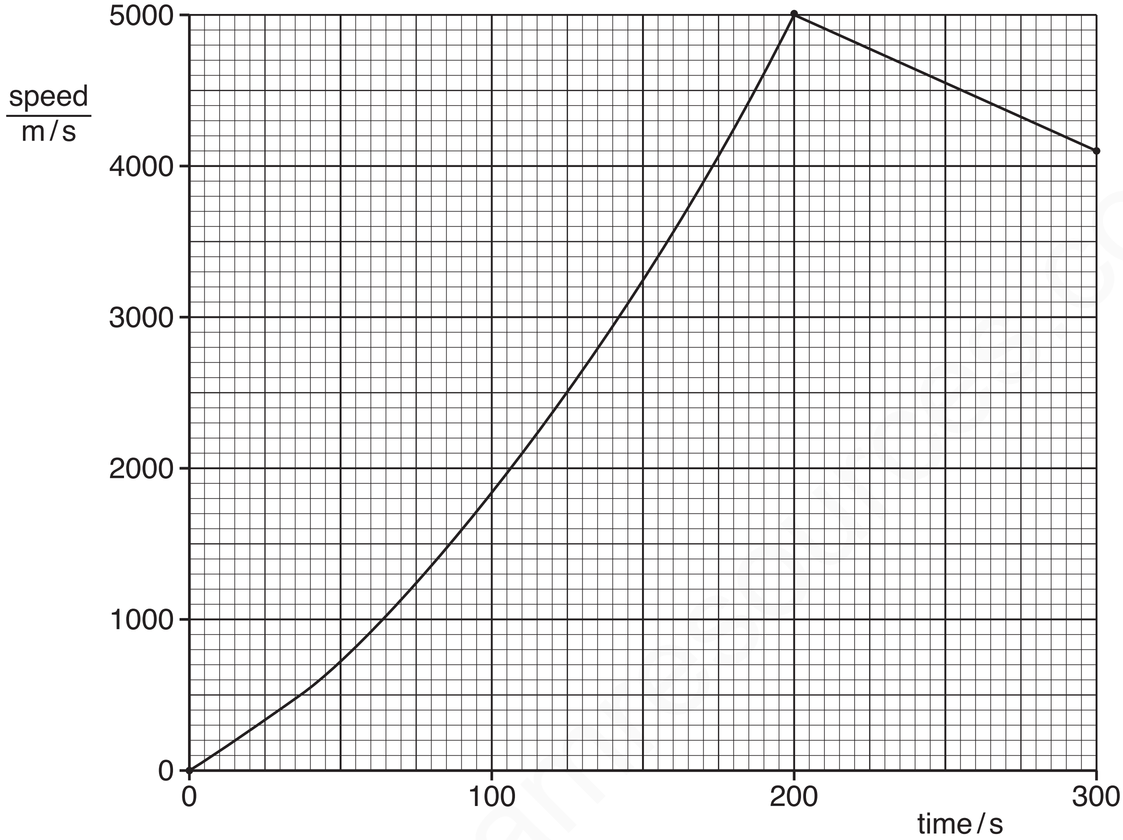

Fig. 1.1

(a) Determine the acceleration of the space probe at time = 0.

acceleration = ... [3]

(b) Between time = 0 and time = 150 s, the acceleration of the space probe changes.

(i) Without calculation, state how the graph shows this.

....

.... [1]

(ii) During this time, the thrust exerted on the space probe by the motor remains constant.

State one possible reason why the acceleration changes in the way shown by Fig. 1.1.

....

....[1]

(c) Calculate the distance travelled by the space probe from time = 200 s to time = 300 s.

distance = ...[3]

[Total: 8]

MARKING SCHEME:

(a)	tangent on graph **OR** gradient **OR** (a =) $\Delta v \div \Delta t$ or $(v - u) \div t$	**C1**
	accept gradient increases; **not** gradient decreases	**C1**
	values from tangent or line 13 to 14 m / s^2	**A1**
(b)(i)	gradient changes **OR** graph is curved	**B1**
(b)(ii)	mass of space rocket decreases **OR** gravitational field strength decreases	**B1**
(c)	area under graph **OR** (distance =) average speed × time	**C1**
	4550 × 100 **OR** (4100 + 5000) ÷ 2 × 100	**C1**
	4.5/4.55/4.6 × 10^5 m	**A1**

3 A bus is travelling between points A and D. There are bus stops at A, B, C and D but the bus does not stop at B and C. Fig. 1.1 is a speed-time graph for the bus.

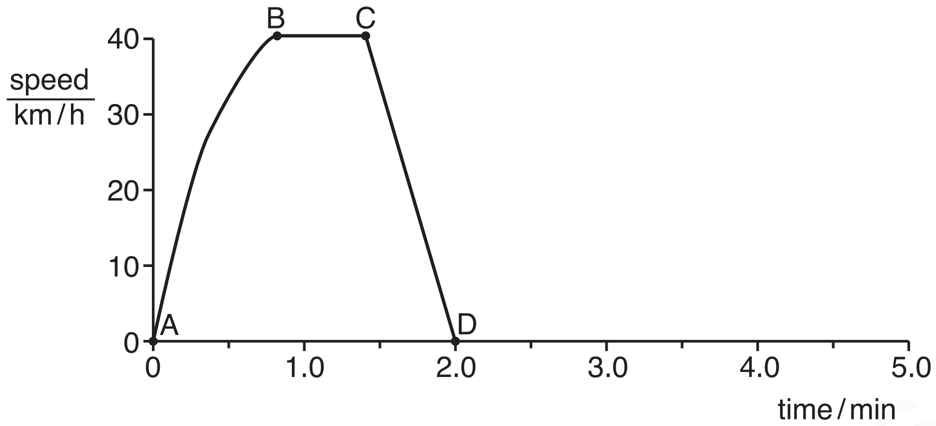

Fig. 1.1

(a) Describe the motion of the bus between each of the bus stops. Select the appropriate description from the list below.

constant acceleration **decreasing acceleration**

increasing acceleration **moving backwards at constant speed**

moving forwards at constant speed **stationary**

1. between A and B ....

2. between B and C ....

3. between C and D ....

[3]

(b) The average speed of the bus between A and D is 23 km / h.

Calculate the distance between A and D.

distance = ... [3]

(c) The bus stops at D for 1 min and then travels at a constant acceleration for 30 seconds.

On Fig. 1.1, sketch a possible graph for this additional motion. Label X when the bus starts to accelerate and label Y for 30 seconds later. [3]

[Total: 9]

Question	Answer	Marks
1(a)	(A and B) decreasing acceleration	**B1**
	(B and C) moving forwards at constant speed	**B1**
	(C and D) constant acceleration	**B1**
1(b)	(average) speed = distance/time OR $v = s/t$ in any form OR (s =) (average) speed × time OR $v \times t$ OR area under graph stated or used	**C1**
	(s =) 23 × 2/60	**C1**
	0.77 km round candidates response to 2 sfs	**A1**
1(c)	horizontal line starting at t = 2.0 min AND at speed = 0 for 1 minute	**B1**
	line of constant positive gradient starting at t >= 2.0 min NOT wrong labels X OR Y	**B1**
	for 30 seconds line continuously rising	**B1**

4 A car accelerates from rest at time $t = 0$ to its maximum speed.

Fig. 1.1 is the speed-time graph for the first 25 s of its motion.

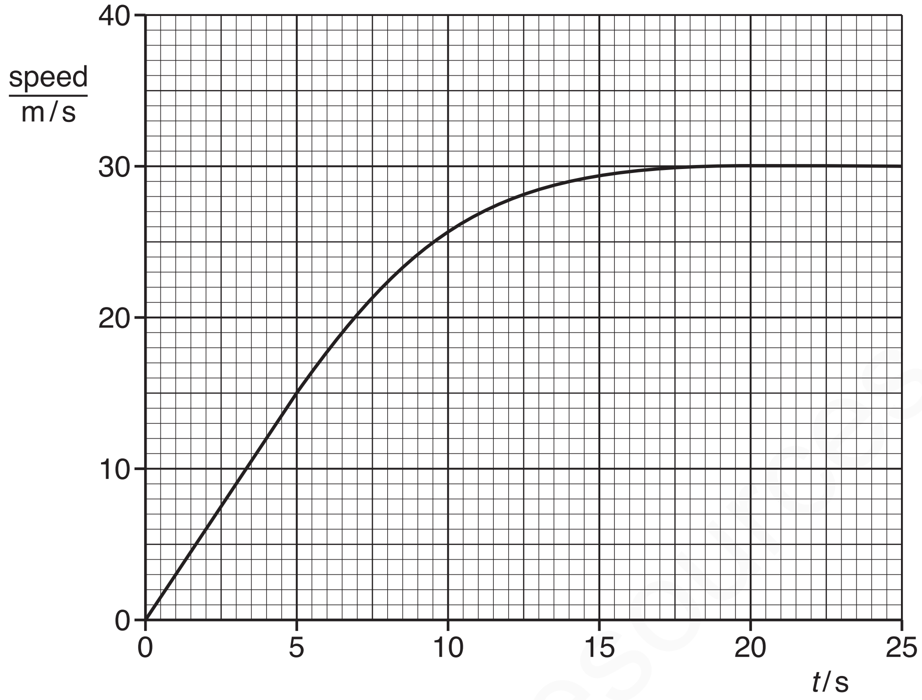

Fig. 1.1

(a) The mass of the car is 2300 kg.

For the time between $t = 0$ and $t = 5.0$ s, determine:

(i) the acceleration of the car

acceleration = ... [2]

(ii) the resultant force acting on the car.

resultant force = ... [2]

(b) Describe the motion of the car between $t = 10\,s$ and $t = 15\,s$. Explain how Fig. 1.1 shows this.

....

....

....

.... [3]

(c) Between $t = 10\,s$ and $t = 15\,s$, the force exerted on the car due to the engine remains constant.

Suggest and explain why the car moves in the way shown by Fig. 1.1.

....

....

.... [2]

[Total: 9]

MARKING SCHEME:

(a)(i)	$a = \Delta v / \Delta t$ **or** $a = (v - u) / t$ in any form words, symbols or numbers **or** (a =) $\Delta v / \Delta t$ **or** (a =) $(v - u) / t$ **or** 15 (– 0) / 5.0 **or** (a =) gradient 3.0 m / s^2	**C1** **A1**
(a)(ii)	(F =) ma in any form words, symbols or numbers **or** (F =) ma **or** 2300 × 3.0 6900 N	**C1** **A1**
(b)	accelerating **or** speed / velocity increasing at a decreasing rate **or** acceleration decreasing gradient (of graph is positive and) decreasing	**B1** **B1** **B1**
(c)	air resistance **or** friction mentioned **or** resistive force air resistance **or** friction **or** resistive force increases (with speed)	**B1** **B1**

5 Fig. 1.1 shows the speed-time graphs for two falling balls.

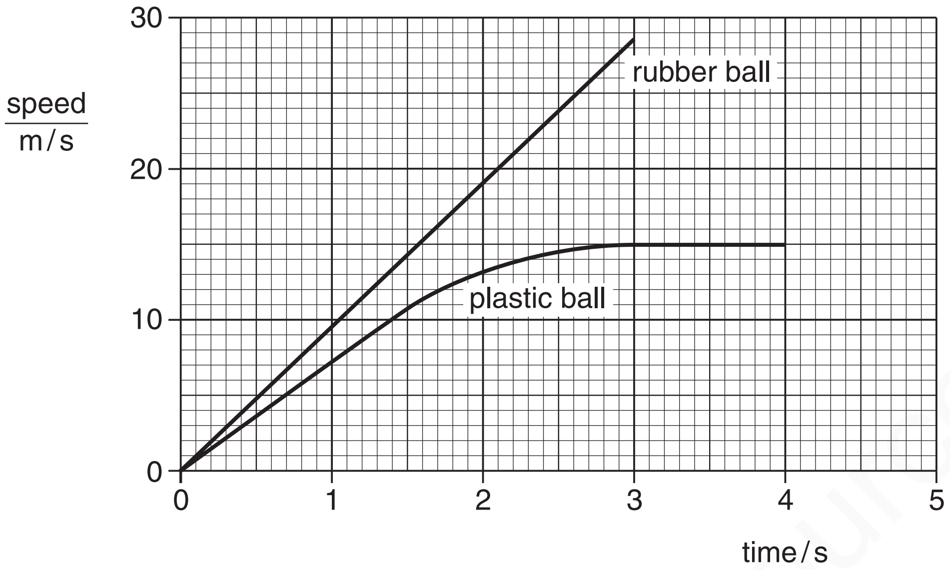

Fig. 1.1

Both balls fall from the same height above the ground.

(a) Use the graphs to find

(i) the average acceleration of the falling rubber ball during the first 3.0 s,

acceleration = ... [2]

(ii) the distance fallen by the rubber ball during the first 3.0 s,

distance = ... [2]

(iii) the terminal velocity of the plastic ball.

terminal velocity = ... [1]

(b) Both balls have the same mass but the volume of the plastic ball is much greater than that of the rubber ball. Explain, in terms of the forces acting on each ball, why the plastic ball reaches a terminal velocity but the rubber ball does not.

....

....

....

....

....

.... [3]

(c) The rubber ball has a mass of 50 g. Calculate the gravitational force acting on the rubber ball.

force = ... [2]

[Total: 10]

MARKING SCHEME:

(a)	**(i)**	v/t or (v-u)/t or 28.5/3 or his correct ratio	C1
		9.3 to 9.5 m/s^2	A1
	(ii)	area under graph or 0.5 × 3 × 28.5 or ½b×h	C1
		42 to 44 m (allow reasonable e.c.f.)	A1
	(iii)	15 m/s	B1

(b) (plastic ball larger so) upward force/air resistance/drag more (or vice versa for rubber ball) IGNORE wind resistance — B1

rubber ball, this force not big enough to balance weight/gravity (force) — B1

plastic ball, upward force/air resistance big enough to balance/equal weight/gravity (force) — B1

(c) mg or 0.05 × 10 or 50 x 10 accept 9.8 or 9.81 instead of 10 — C1

0.5 N or 0.49N or 0.4905N nothing else — A1

[10]