SPEED-TIME

1 **(a)** Fig. 3.1 shows a skier descending a hillside. Fig. 3.2 shows the speed/time graph of his motion.

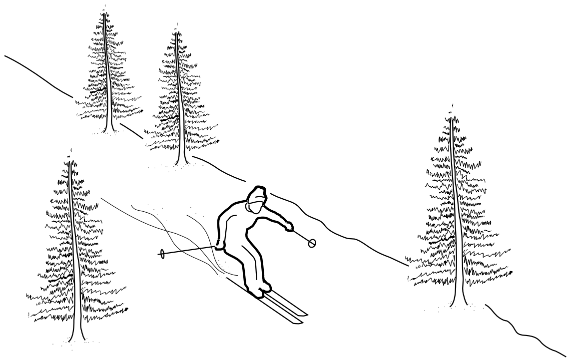

Fig. 3.1

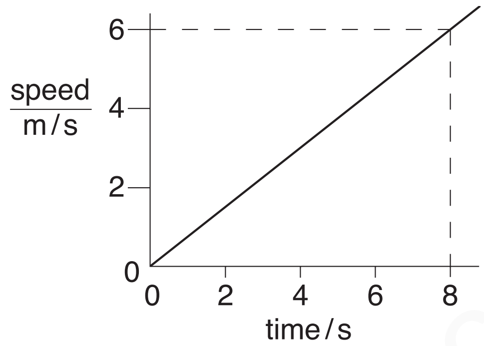

Fig. 3.2

(i) How can you tell that the acceleration of the skier is constant during the 8 s shown on the graph?

.... [1]

(ii) Calculate the acceleration of the skier.

acceleration = ... [2]

(b) Another skier starts from rest at the top of the slope. As his speed increases the friction force on the skier increases.

(i) State the effect of this increasing friction force on the acceleration.

.... [1]

(ii) Eventually the speed of the skier becomes constant.

What can be said about the friction force when the speed is constant?

.... [2]

(iii) 1. On the axes of Fig. 3.3, sketch a possible speed/time graph for the motion of the second skier.

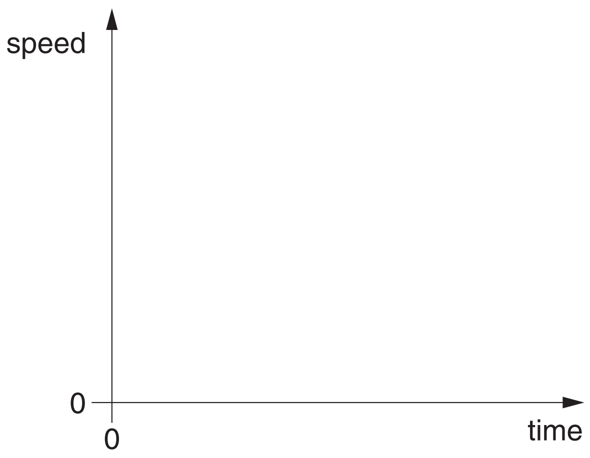

Fig. 3.3

2. On your graph, mark with the letter A a region where the acceleration is not constant. Mark with the letter B the region where the speed is constant. [4]

[Total: 10]

MARKING SCHEME:

(a)	**(i)**	straight line OR constant gradient / slope OR change in speed with time constant OR speed proportional to time	B1	
	(ii)	increase in velocity / time OR $a = v/t$, symbols, words or numbers	C1	
		0.75 m/s^2	A1	
(b)	**(i)**	decreases OR acceleration slows (down) NOT 'it slows down'	C1	
	(ii)	equal to forward / downward force / force down slope OR constant / maximum OR (giving) no resultant force	C1	
		equal to component of weight (down slope)	A1	
	(iii)	1 graph starting at origin	B1	
		curved from start AND decreasing gradient AND horizontal final part	B1	
		2 label A on any correct curved region	B1	
		label B on horizontal region	B1	[10]

2 Fig. 1.1 shows the speed/time graph for a car travelling along a straight road.

The graph shows how the speed of the car changes as the car passes through a small town.

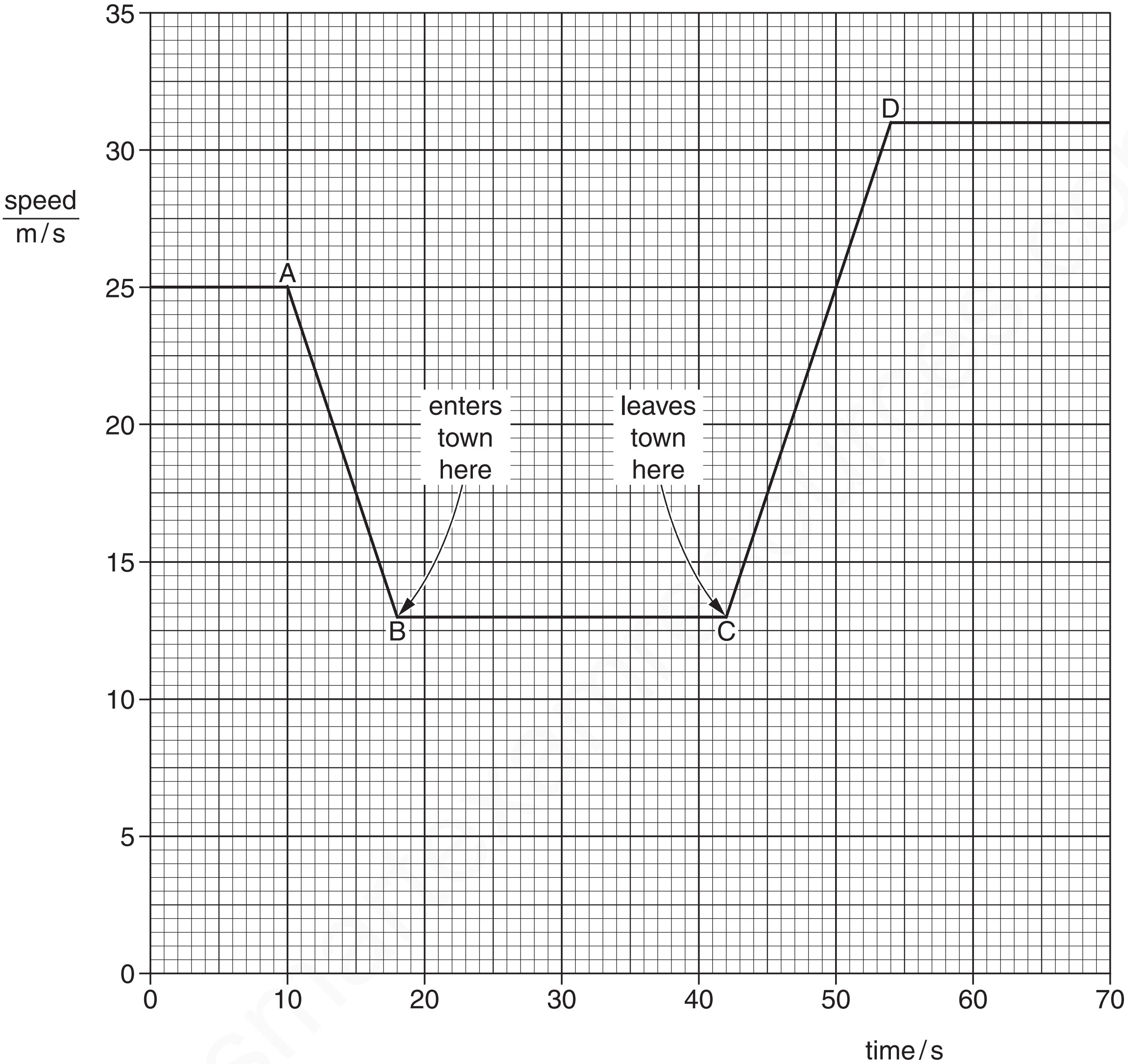

Fig. 1.1

(a) Describe what happens to the speed of the car

(i) between A and B, ...

(ii) between B and C, ...

(iii) between C and D. ....

[1]

(b) Calculate the distance between the start of the town and the end of the town.

distance = ... [3]

(c) Calculate the acceleration of the car between C and D.

acceleration = ... [3]

(d) State how the graph shows that the deceleration of the car has the same numerical value as its acceleration.

....

.... [1]

[Total: 8]

MARKING SCHEME:

(a)	decreases / braking / decelerating) constant / steady / nothing) all 3 increases / accelerate)	B1	
(b)	speed x time in any form, symbols, numbers or words OR any area under graph used or stated	C1	
	13 (m/s) OR 24 (s) seen or used in correct context	C1	
	312 m	A1	
(c)	rate of change of speed OR gradient of graph OR 18/12	C1	
	18 (m/s) OR 12 (s) seen or used in correct context	C1	
	1.5 m/s^2	A1	
(d)	same gradient / slope OR equal speed changes in equal times OR allow graph symmetrical	B1	[8]

3 A train is at rest in a railway station. At time $t = 0$, the train starts to move forwards with an increasing speed until it reaches its maximum speed at time $t = 48$ s.

Fig. 1.1 is the speed-time graph for the first 48 s of the journey.

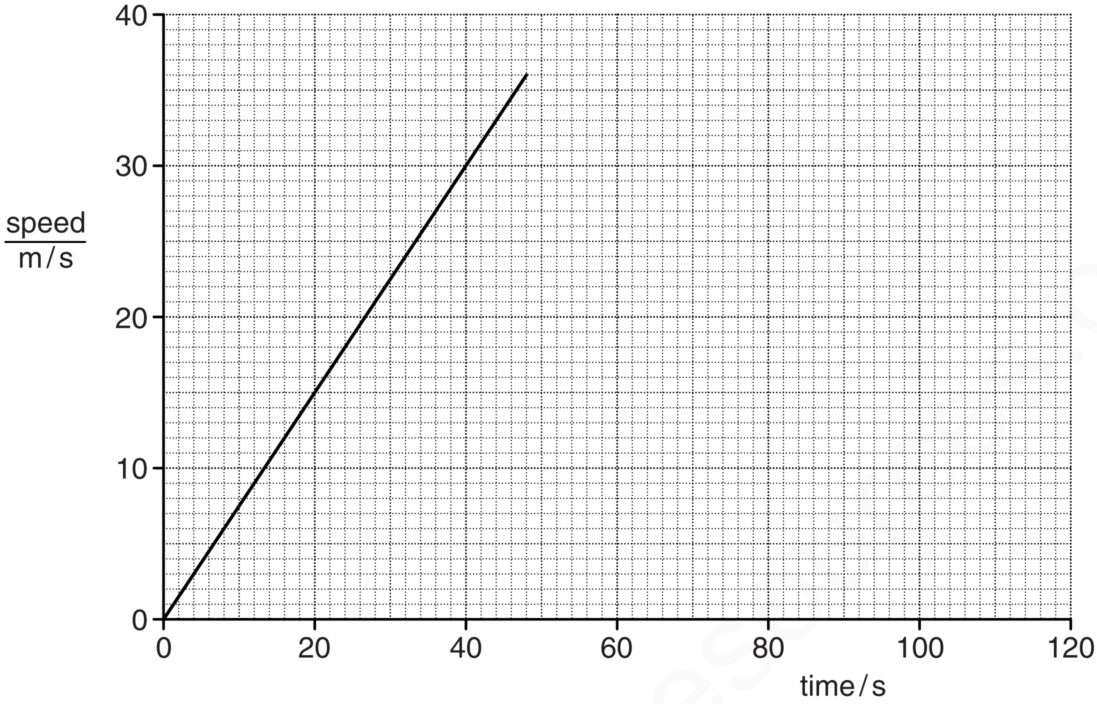

Fig. 1.1

(a) (i) State how the graph shows that, during the first 48 s of the journey, the acceleration of the train is constant.

....

.... [1]

(ii) Calculate the acceleration of the train during the first 48 s of the journey.

acceleration = ... [2]

(b) After time $t = 48$ s, the train continues at its maximum speed for another 72 s.

(i) On Fig. 1.1, sketch the speed-time graph for the next 72 s of the journey. [1]

(ii) Determine the total distance travelled by the train in the 120 s after it starts moving.

distance = ... [3]

MARKING SCHEME:

(a)	**(i)**	constant/uniform gradient/slope OR straight line	B1	
	(ii)	(*a* = Δ) *v* ÷ *t* OR 36 ÷ 48	C1	
		0.75 m / s^2 (NOT 0.76)	A1	
(b)	**(i)**	horizontal line from (48, 36) to (120, 36)	B1	
	(ii)	area under graph (mentioned **or** implied)	B1	
		864 OR 2592	C1	
		3500/3460/3456 m	A1	[7]

4 Parachutes are used to slow down a certain racing car.

Fig. 1.1 shows the racing car, of total mass 750 kg, slowing down by using parachutes.

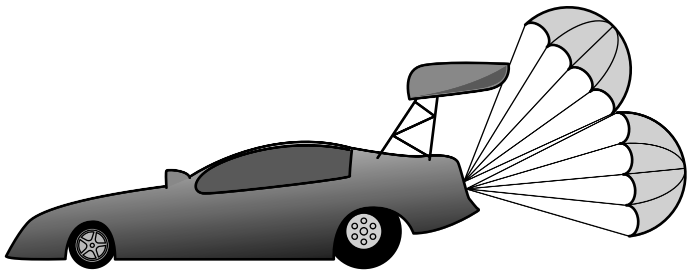

Fig. 1.1

Fig. 1.2 is the speed-time graph for 20 s after the car reaches full speed.

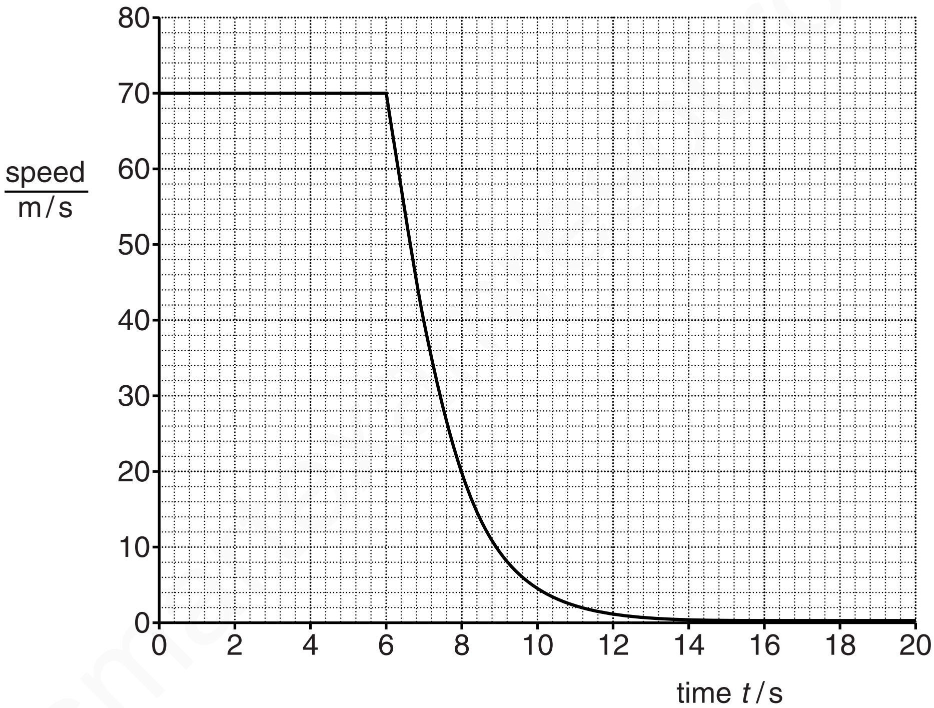

Fig. 1.2

At time t = 6.0 s, the parachutes open.

(a) On Fig. 1.2,

(i) mark a point, labelled A, where the car is moving at constant speed,

(ii) mark a point, labelled B, where the car is decelerating at a uniform rate,

(iii) mark a point, labelled C, where the car is decelerating at non-uniform rate.

[3]

(b) Calculate

(i) the deceleration of the car at time $t = 6.5\,s$,

deceleration = ... [2]

(ii) the resultant force acting on the car at this time.

resultant force = ... [2]

(c) Explain why there is no resultant force acting on the car at time $t = 4.0\,s$.

....

.... [1]

[Total: 8]

MARKING SCHEME:

(a)	**(i)**	A marked between $t = 0$ and $t = 6.0$ s	B1
	(ii)	B marked between t 6.0 s and $t = 7.0$ s	B1
	(iii)	C marked on clearly curved section before $t = 14$ s	B1
(b)	**(i)**	(a =)$\Delta v / t$ **OR** 30 / 1 **OR** 15 / 0.5 etc. **OR** triangle on graph / tangent	C1
		(**ignore** – sign) 25 m / s^2 < a < 35 m / s^2	A1
	(ii)	(F =)ma **OR** 750 × 30 e.c.f. from **(b)(i)**	C1
		2.2 / 2.25 / 2.3 × 10^4 N e.c.f. from **(b)(i)**	A1
(c)		acceleration / rate of change of speed is zero **OR** speed is constant **OR** air resistance / backwards force equal and opposite to driving / forwards force	B1

[Total: 8]

5 A young athlete has a mass of 42 kg. On a day when there is no wind, she runs a 100 m race in 14.2 s. A sketch graph (not to scale) showing her speed during the race is given in Fig. 1.1.

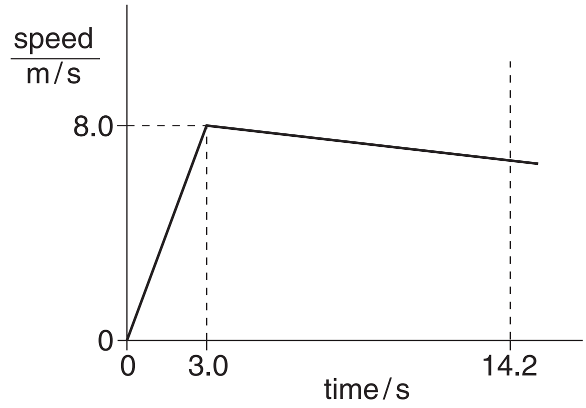

Fig. 1.1

(a) Calculate

(i) the acceleration of the athlete during the first 3.0 s of the race,

acceleration = ... [2]

(ii) the accelerating force on the athlete during the first 3.0 s of the race,

force = ... [2]

(iii) the speed with which she crosses the finishing line.

speed = ... [3]

(b) Suggest two differences that might be seen in the graph if there had been a strong wind opposing the runners in the race.

1. ....

....

2. ....

.... [2]

[Total: 9]

MARKING SCHEME:

(a) (i)	$(v - u)/t$ OR v/t OR 8/3	C1
	2.7 m/s^2	A1
(ii)	*ma* OR 42 × answer from **(i)** OR 42 × 8/3	C1
	110/112 N e.c.f.	A1
(iii)	(distance in 1st 3 secs =) 12 m OR (dist in last 3 secs =) 88 m	C1
	use of area of trapezium OR area of "top" triangle	C1
	7.7 m/s	A1

(b) longer time to top speed)
longer total time)
lower top speed)
lower finishing speed) any 2 B1+B1
specific/all speeds lower (**not** speed decreases))
less slope/less acceleration (in first section))
greater slope/greater deceleration in 2nd section)

[Total: 9]