SPEED-TIME-PARACHUTIST

1 A free-fall parachutist jumps out of an aeroplane, but doesn't open his parachute until after some time has elapsed.

Fig. 3.1 shows the graph of his speed during the fall.

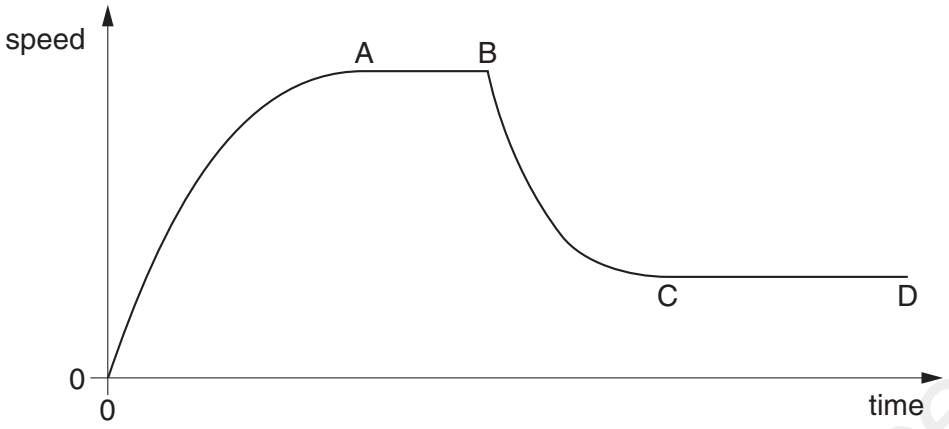

Fig. 3.1

(a) What is the value of the acceleration of the parachutist immediately after he has jumped from the aeroplane?

..... [1]

(b) How can you tell that the acceleration decreases until point A on the graph is reached?

.....

..... [1]

(c) State why the acceleration of the parachutist decreases until point A on the graph.

.....

.....

.....

..... [2]

(d) Consider section AB of the graph.

(i) State what is happening to the parachutist's speed in this section.

..... [1]

(ii) What can be said about the forces on the parachutist during this section?

.....

..... [1]

(e) At which point did the parachutist open his parachute?

..... [1]

(f) Explain why the speed decreases from B to C.

.....

.....

..... [2]

[Total: 9]

(a) 10 m/s^2 OR 9.8 m/s^2 OR 9.81 m/s^2 OR 9.80 m/s^2 B1

(b) gradient / slope decreased OR graph becomes less steep / flatter B1

(c) air resistance / drag was increasing M1
as speed was increasing A1

(d) **(i)** constant B1

(ii) no resultant force / force up = force down / weight = air resistance / forces (up and down) balance / opposite forces equal B1

(e) B B1

(f) larger air resistance / air resistance bigger than weight B1
(upward force not acceptable)
larger area (due to open parachute) B1 [9]

2 A free-fall parachutist jumps from a helium balloon, but does not open his parachute for some time.

Fig. 1.1 shows the speed-time graph for his fall. Point B indicates when he opens his parachute.

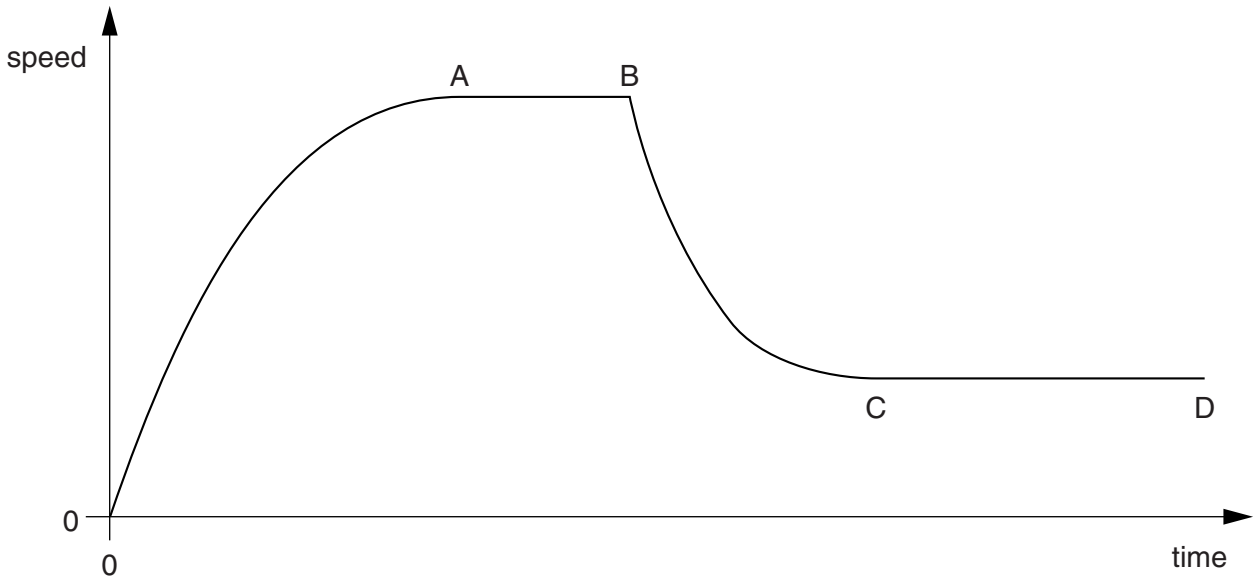

Fig. 1.1

(a) **(i)** State the value of the gradient of the graph immediately after time $t = 0$.

gradient = ... [1]

(ii) Explain why the gradient has this value.

.....

.....[1]

(b) State how Fig. 1.1 shows that the acceleration decreased between time $t = 0$ and the time to A.

.....

.....[1]

(c) Explain, in terms of forces, what is happening in section AB of the graph in Fig. 1.1.

.....

.....

.....[2]

(d) A second parachutist of the same size and mass jumps from the balloon with a larger parachute. He also opens his parachute at point B.

On Fig. 1.1, sketch a possible speed-time graph for his fall after he opens his parachute. [3]

[Total: 8]

MARKING SCHEME:

(a) **(i)** (gradient =) 10 (m/s^2) B1

(ii) any linking of gradient to acceleration of freefall **OR** gravitational field strength B1

(b) gradient decreases B1

(c) speed / velocity stays constant **OR** terminal velocity / speed B1
no resultant force **OR** forces cancel / balance B1

(d) initially gradient steeper B1
graph lower in second half of BC B1
horizontal final section **and** lower than CD B1

[Total: 8]