SPEED-TIME

1 A rocket, initially at rest on the ground, accelerates vertically.

It accelerates uniformly until it reaches a speed of 900 m / s after 30 s.

After this period of uniform acceleration, the rocket engine cuts out. During the next 90 s, the upward speed of the rocket decreases uniformly to zero.

(a) On Fig. 4.1, plot a speed-time graph for the rocket for the first 120 s of its flight.

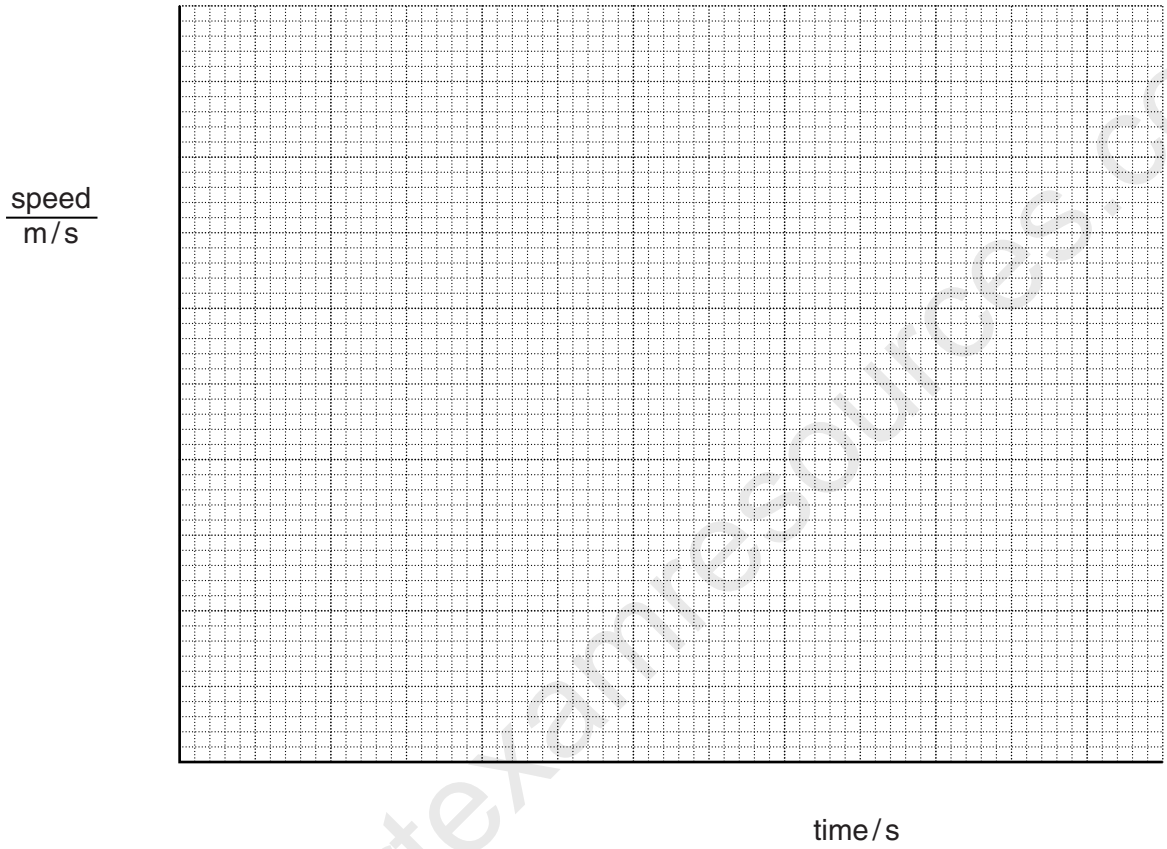

Fig. 4.1 [4]

(b) Using the graph,

(i) calculate the acceleration during the first 30 s,

acceleration = ... [2]

(ii) determine the height reached by the rocket after 120 s.

height reached = ... [2]

[Total: 8]

(a)	suitable scales (more than half each scale used, no products of 3 s, 7 s etc.)		B1	
	2 straight line sections, continuous 0 to 120 s, 1st section positive gradient,			
	2nd section negative gradient		B1	
	section 1 straight line, from(0, 0) to (30, 900)		B1	
	section 2 straight line from end of section 1 to (120, 0)		B1	[4]
(b)	**(i)**	use of $a = \Delta v / t$ or $\Delta v / t$ in any form words, symbols or numbers	C1	
		(a = 900 / 30 =) 30 m / s^2	A1	[2]
		e.c.f. from graph		
	(ii)	use of s = area under graph (accept valid equation(s))	C1	
		(distance = 0.5 × 900 × 120 =) 54 000 m	A1	[2]
		e.c.f. from continuous graph, if curves working must be clear		
		no e.c.f. from graph if it's a single rectangle		

[Total: 8]

2 Fig. 3.1 shows the speed-time graph of a firework rocket as it rises and then falls to the ground.

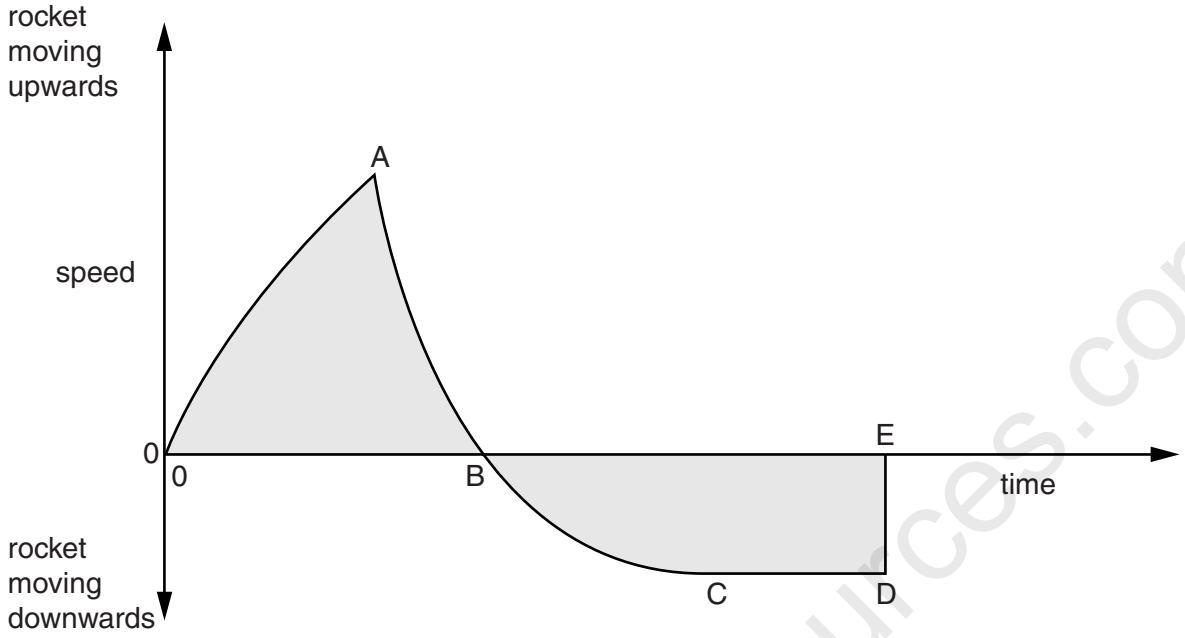

Fig. 3.1

The rocket runs out of fuel at A. It reaches its maximum height at B. At E it returns to the ground.

(a) (i) State the gradient of the graph at B. gradient = ... [1]

(ii) State why the gradient has this value at B.

.....

..... [1]

(b) State and explain the relationship between the shaded areas above and below the time axis.

.....

.....

.....

.....

.....

..... [3]

(c) Another rocket, of the same size and mass, opens a parachute at point B.

On Fig. 3.1, sketch a possible graph of its speed from B until it reaches the ground. [3]

[Total: 8]

(a) **(i)** $10\,m/s^2$ ignore sign B1

(ii) (same as) acceleration (of rocket at B) **OR** gravitational acceleration B1

(b) same area B1
area represents distance travelled B1

distance up = distance down
OR overall displacement = 0
OR area above = distance up **AND** area below = distance below B1

(c) any three from:
- all of graph below *x*-axis after B
- final section horizontal and above CD **AND** gradient always $\leqslant 0$
- continuous graph from B until time > at DE
- new area not clearly different from old B3

[Total: 8]

3 The speed of a cyclist reduces uniformly from 2.5 m/s to 1.0 m/s in 12 s.

(a) Calculate the deceleration of the cyclist.

deceleration = ...[3]

(b) Calculate the distance travelled by the cyclist in this time.

distance = ...[2]

(a)	change in speed is 1.5 m/s	**C1**	
	deceleration = decrease in speed/time or 1.5/12	**C1**	
	a = (-/+) 0.125 m/s	**A1**	**3**
(b)	average speed = 1.75 m/s	**C1**	
	distance = 21 m	**A1**	**2**
			[5]

4 A plastic ball is dropped from the balcony of a tall building and falls towards the ground in a straight line.

Fig. 1.1 is the speed-time graph for the falling ball.

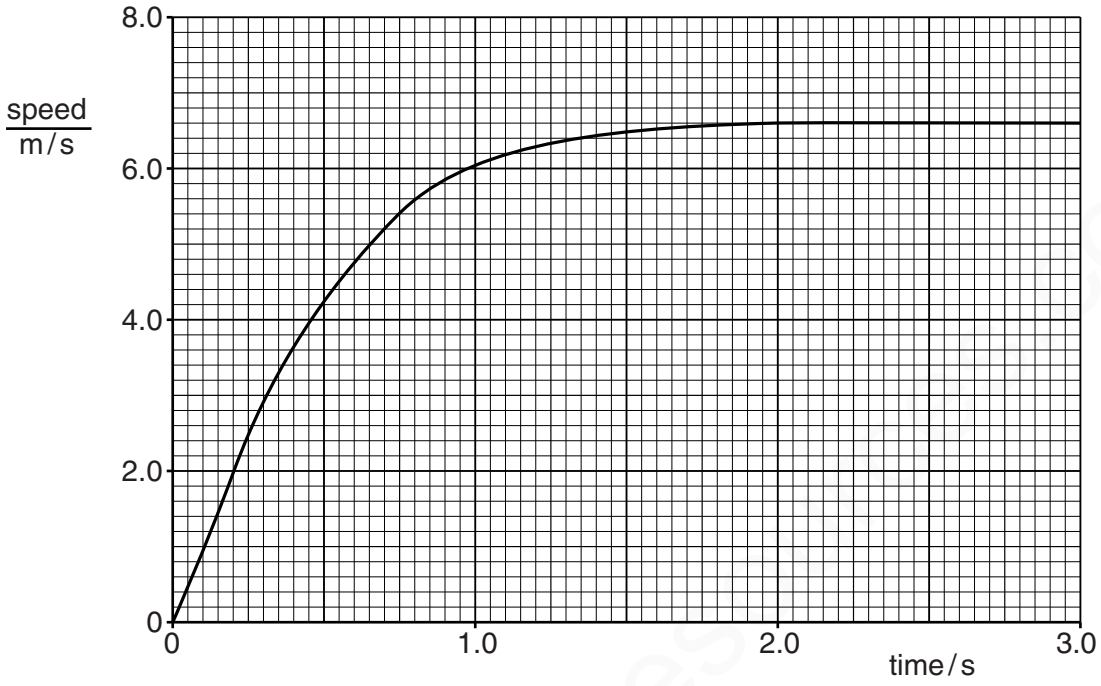

Fig. 1.1

(a) State and explain, in terms of forces, what is happening to the speed of the ball between time $t = 2.0\,s$ and $t = 3.0\,s$.

.....

.....

.....[2]

(b) On Fig. 1.1, mark a point P on the line where the acceleration of the ball is not constant. [1]

(c) Using Fig. 1.1,

(i) calculate the acceleration of the ball between $t = 0\,s$ and $t = 0.25\,s$,

acceleration = ...[2]

(ii) estimate the distance that the ball falls in the first 3.0 s.

distance = ...[2]

[Total: 7]

MARKING SCHEME:

(a)	speed is constant / uniform / unchanging OR terminal velocity / speed		B1
	no net / resultant force OR air resistance cancels / equals weight		B1
(b)	P between 0.25 s and 1.90 s (inclusive)		B1
(c)	**(i)**	(a =) $\Delta v / t$ OR 2.5 / 0.25 OR other point on correct section of line	B1
		9.6 to 10 m / s^2 (inclusive)	B1
	(ii)	area under graph OR attempt at counting squares OR between 16.2 and 17.5 m (inclusive)	C1
		between 16.5 and 17.1 m (inclusive)	A1

5 Fig. 1.1 shows the speed-time graph for a vehicle accelerating from rest.

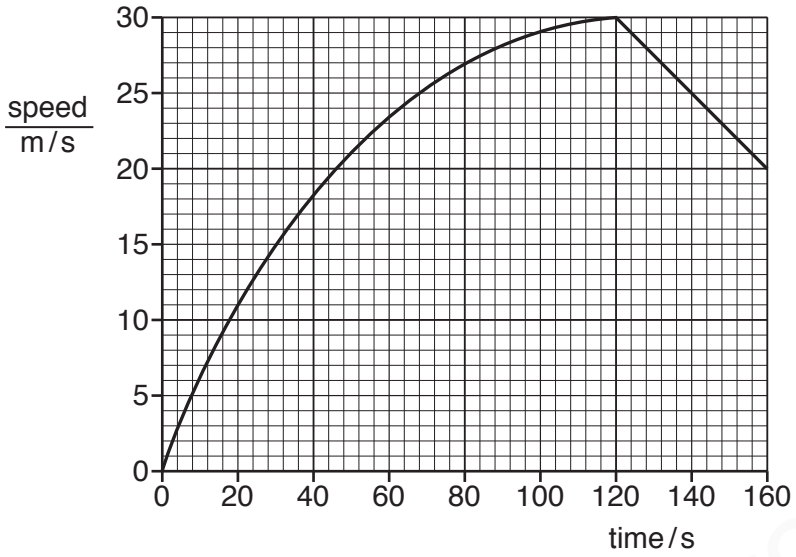

Fig. 1.1

(a) Calculate the acceleration of the vehicle at time = 30 s.

acceleration = ...[2]

(b) Without further calculation, state how the acceleration at time = 100 s compares to the acceleration at time = 10 s. Suggest, in terms of force, a reason why any change has taken place.

.....

.....

.....[3]

(c) Determine the distance travelled by the vehicle between time = 120 s and time = 160 s.

distance = ...[3]

[Total: 8]

MARKING SCHEME:

1(a)	Mention of gradient of graph at t = 30 s **OR** tangent drawn at t = 30 s and triangle drawn	**1**
	Acceleration in range 0.30 to 0.45 m / s^2	**1**
1(b)	Acceleration less/at a slower rate	**1**
	Less driving force **OR** greater resistive force/friction/air resistance/drag	**1**
	Resultant force less	**1**
1(c)	Area under graph	**1**
	Distance = (20 × 40) + (½ × 40 × 10) **OR** ½ × (30 + 20) × 40	**1**
	1000 m	**1**