1 A solid plastic sphere falls towards the Earth.

Fig. 1.1 is the speed-time graph of the fall up to the point where the sphere hits the Earth's surface.

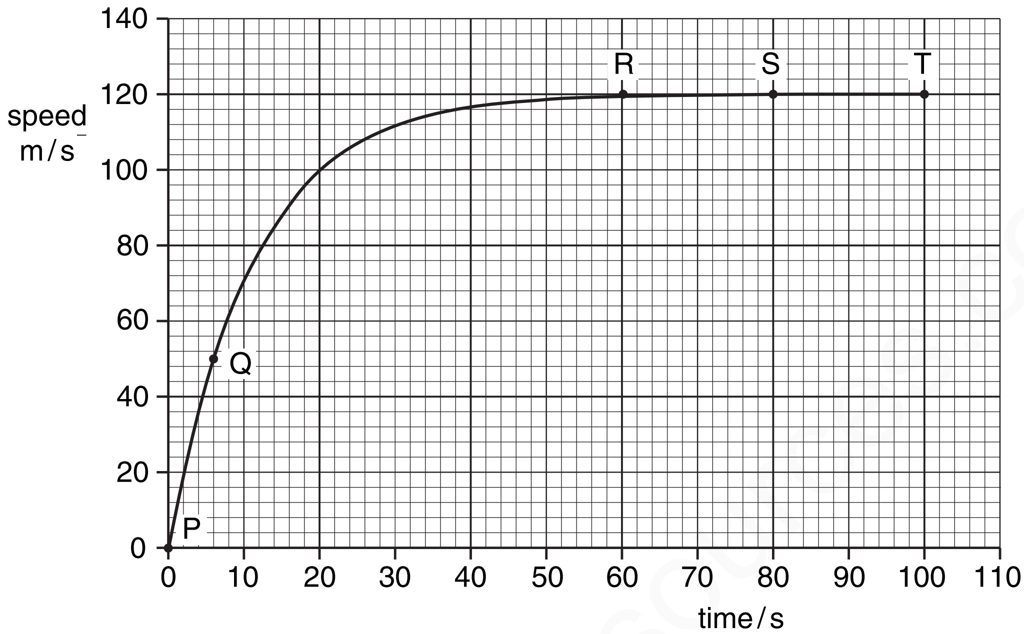

Fig. 1.1

(a) Describe in detail the motion of the sphere shown by the graph.

....

....

....

....

.... [3]

(b) On Fig. 1.2, draw arrows to show the directions of the forces acting on the sphere when it is at the position shown by point S on the graph. Label your arrows with the names of the forces. [2]

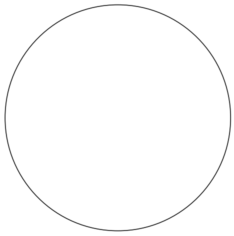

Fig. 1.2

(c) Explain why the sphere is moving with constant speed at S.

....

....

.... [2]

(d) Use the graph to calculate the approximate distance that the sphere falls

(i) between R and T,

distance = ………………. [2]

(ii) between P and Q.

distance = ………………. [2]

(a)	acceleration, speed increases acceleration getting less acc. zero/constant speed along RT or terminal velocity	B1 B1 B1	**3**
(b)	air resistance or friction (force) up (accept upthrust) weight/(force of) gravity down	B1 B1	**2**
(c)	air resistance (up) = weight (down) or two forces equal no (net) force, no acceleration	B1 B1	**2**
(d) (i) **(ii)**	distance = speed x time or 120 x 40 distance = 4800 m distance = average speed x time or 25 x 6 or area under graph distance = 150 m	C1 A1 C1 A1	**4** **[11]**

2 Fig. 1.1 shows the speed-time graph for a bus during tests.

At time $t = 0$, the driver starts to brake.

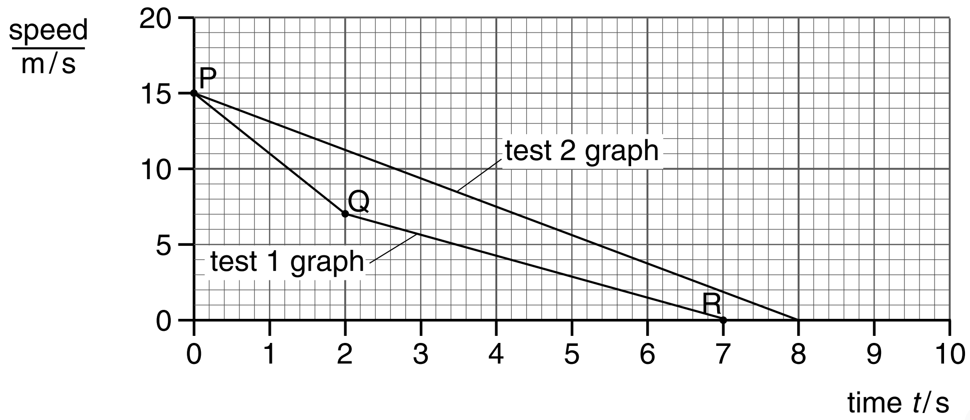

Fig. 1.1

(a) For test 1,

(i) determine how long the bus takes to stop,

....

(ii) state which part of the graph shows the greatest deceleration,

....

(iii) use the graph to determine how far the bus travels in the first 2 seconds.

distance = ...

[4]

(b) For test 2, a device was fitted to the bus. The device changed the deceleration.

(i) State two ways in which the deceleration during test 2 is different from that during test 1.

1 ....

2 ....

(ii) Calculate the value of the deceleration in test 2.

deceleration = ...

[4]

(c) Fig. 1.2 shows a sketch graph of the magnitude of the acceleration for the bus when it is travelling around a circular track at constant speed.

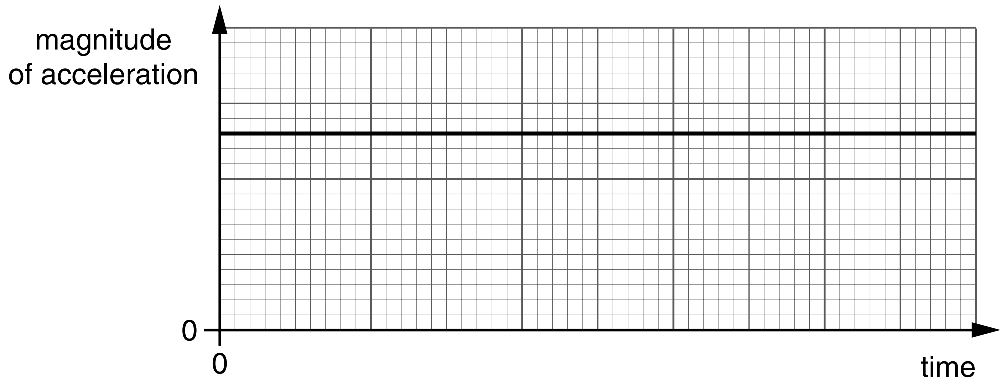

Fig. 1.2

(i) Use the graph to show that there is a force of constant magnitude acting on the bus.

....

....

(ii) State the direction of this force.

.... [3]

(a) (i)	7(.0 s)	**A1**	
(ii)	PQ or 0 – 2s or other correct description	**A1**	
	distance = av. speed x time or area under graph	**C1**	
	distance 11 x 2 m= 22 m	**A1**	**4**
(b) (i)	deceleration (now) uniform (test 2)	**B1**	
	slower/lower (average) value/value between that of PQ and QR/takes longer (or values) time to come to rest.	**B1**	
(ii)	deceleration = change in speed/time or 15/8	**C1**	
	value = 1.9 m/s^2	**A1**	**4**
(c) (i)	graph shows constant acceleration	**B1**	
	force = ma (and m is also constant) so force is constant	**B1**	
(ii)	towards the centre of the motion/circle	**A1**	**3**
			[11]

3 A rocket is stationary on the launchpad. At time t = 0, the rocket engines are switched on and exhaust gases are ejected from the nozzles of the engines. The rocket accelerates upwards.

Fig. 1.1 shows how the acceleration of the rocket varies between time t = 0 and time $t = t_f$.

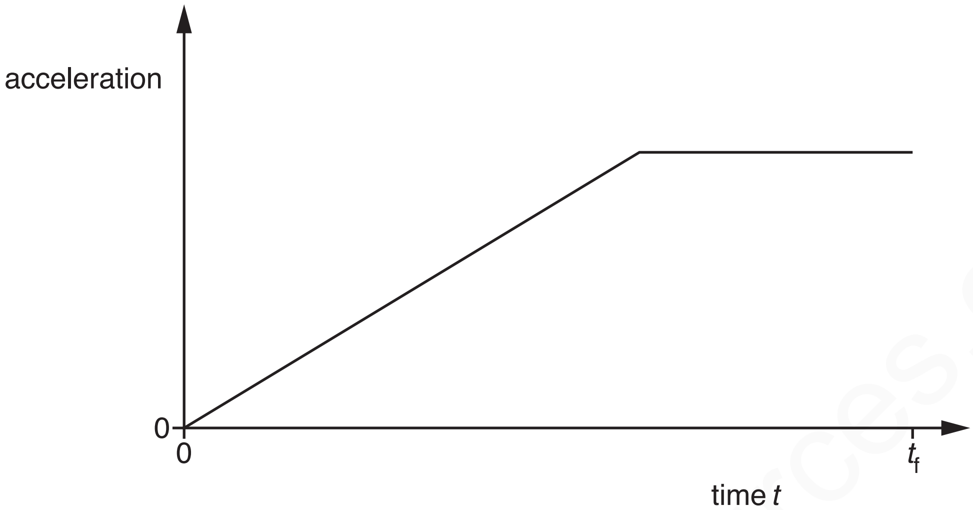

Fig. 1.1

(a) Define *acceleration*.

....

.... [1]

(b) On Fig. 1.2, sketch a graph to show how the speed of the rocket varies between time t = 0 and time $t = t_f$.

Fig. 1.2

[3]

(c) Some time later, the rocket is far from the Earth. The effect of the Earth's gravity on the motion of the rocket is insignificant. As the rocket accelerates, its momentum increases.

(i) State the principle of the conservation of momentum.

....

....

.... [2]

(ii) Explain how the principle of the conservation of momentum applies to the accelerating rocket and the exhaust gases.

....

....

....

.... [2]

[Total: 8]

MARKING SCHEME:

(a)	change of velocity per unit time **OR** $\frac{v-u}{t}$	**B1**
(b)	line starts at origin **and** is asymptotic to *x*-axis	**B1**
	increasing gradient initially **and** no decrease	**B1**
	constant **and** clearly positive gradient finally	**B1**
(c)(i)	no external forces **OR** isolated system	**B1**
	sum of momenta / (total) momentum remains constant	**B1**
(c)(ii)	rocket <u>gains</u> (upward) momentum	**B1**
	(ejected) gas <u>gains</u> equal (quantity of) momentum in opposite direction **OR** momentum of gas <u>decreases</u> by equal amount	**B1**