SPEED-TIME-FALLING OBJECTS

1 **(a)** A large stone, initially at rest, falls from the top of a building. The stone takes 3.2 s to fall to the ground. For this stone, air resistance can be ignored.

(i) Stating the formula that you use, show that the speed of the stone when it hits the ground is 32 m/s.

[1]

(ii) On Fig. 1.1, draw the speed-time graph for the fall of the stone. Label with an X the line on the graph. [1]

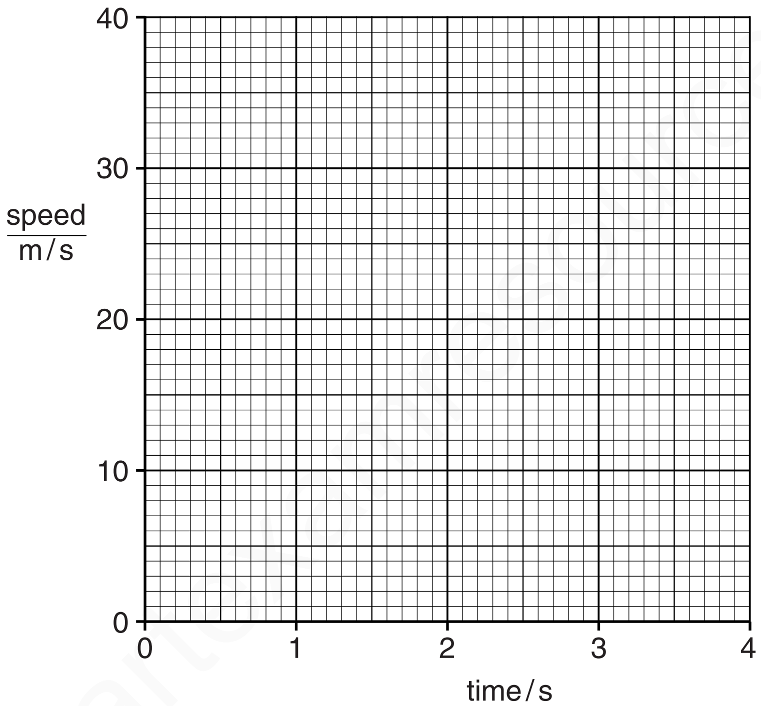

Fig. 1.1

(iii) Use the graph in **(ii)** to determine the height of the building.

height = ... [2]

(b) A smaller stone than the stone in **(a)** falls from the same building. This stone is affected by air resistance.

(i) What happens to the air resistance as the stone falls? Underline your choice of answer.

Air resistance decreases. Air resistance is constant. Air resistance increases. [1]

(ii) On Fig. 1.1, draw a possible speed-time graph for the fall of this stone. Label with a Y this line on the graph. [3]

[Total: 8]

(a)	(i)	$a = (v - u) \div t$ OR $a = \Delta v \div t$ in any form OR in words in any form AND with correct numbers substituted	B1
	(ii)	Straight line from origin to point (3.2 s, 32 m/s)	B1
	(iii)	Area under graph OR $\frac{1}{2} \times 3.2 \times 32$ OR $s = \frac{1}{2} at^2$ OR $\frac{1}{2} \times 10 \times 3.2^2$ 51 m	 C1 A1
(b)	(i)	Air resistance increases	B1
	(ii)	Graph line Y under graph line X Graph has decreasing gradient Graph extends to value of *t* greater than 3.5 s and greater than X	B1 B1 B1

[Total: 8]

2 **(a)** A stone falls from the top of a building and hits the ground at a speed of 32 m/s. The air resistance-force on the stone is very small and may be neglected.

(i) Calculate the time of fall.

time = ...

(ii) On Fig. 1.1, draw the speed-time graph for the falling stone.

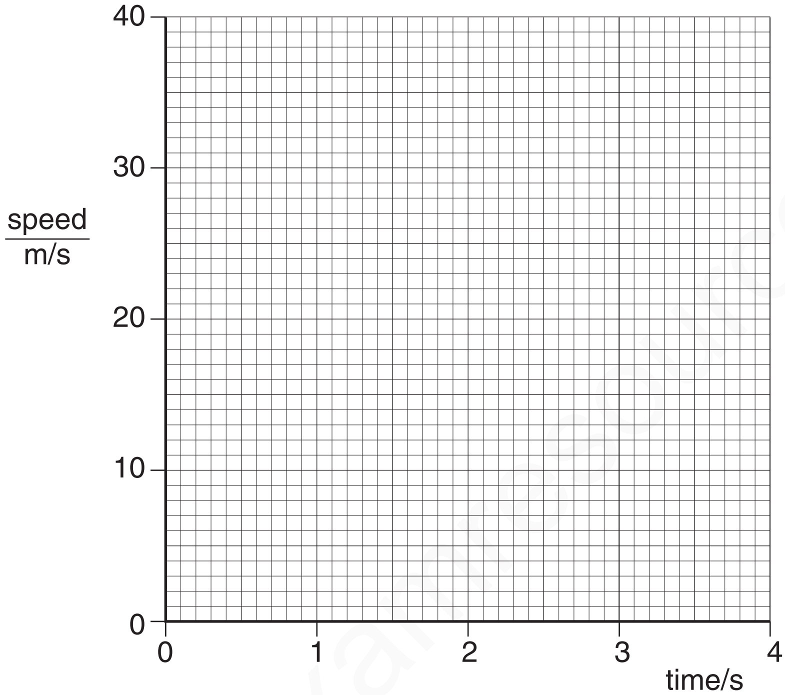

Fig. 1.1

(iii) The weight of the stone is 24 N.
Calculate the mass of the stone.

mass = ...
[5]

(b) A student used a suitable measuring cylinder and a spring balance to find the density of a sample of the stone.

(i) Describe how the measuring cylinder is used, and state the readings that are taken.

....

....

....

....

(ii) Describe how the spring balance is used, and state the reading that is taken.

....

....

(iii) Write down an equation from which the density of the stone is calculated.

....

(iv) The student then wishes to find the density of cork. Suggest how the apparatus and the method would need to be changed.

....

....

....

[6]

(a)	**(i)**	t = v/g or 32/10 = 3.2 s	C1 A1	
	(ii)	straight line starting at zero, inclined line joining 0,0 and 3.2, 32, accept c.f. from time **(i)**	C1 A1	
	(iii)	2.4 kg	A1	[5]
(b)	**(i)**	take volume of water before use (totally) immerse stone and take new volume (Not clearly measured before and after C1)	B1 B1	
	(ii)	hang rock from balance and take reading	B1	
	(iii)	density = mass/volume	B1	
	(iv)	need to tie "sinker" or cork or press cork down need volume with sinker then volume with sinker and cork or just completely submerge cork	B1 B1	[6]

[Total: 11]

3 A large plastic ball is dropped from the top of a tall building.

Fig. 1.1 shows the speed-time graph for the falling ball until it hits the ground.

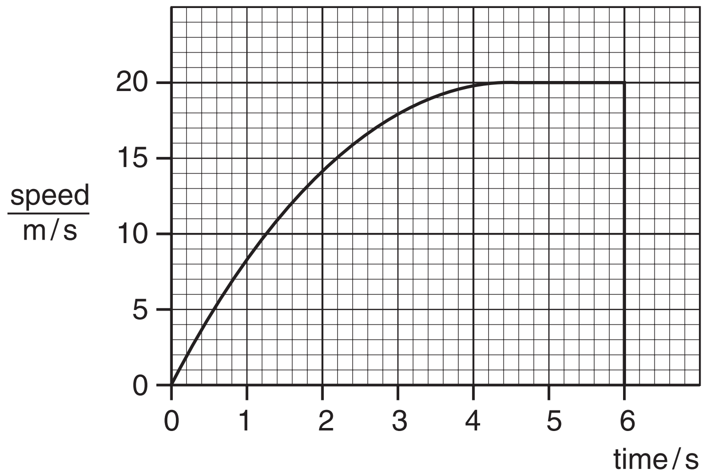

Fig. 1.1

(a) From the graph estimate,

(i) the time during which the ball is travelling with terminal velocity,

time = ... [1]

(ii) the time during which the ball is accelerating,

time = ... [1]

(iii) the distance fallen while the ball is travelling with terminal velocity,

distance = ... [2]

(iv) the height of the building.

height = ... [2]

(b) Explain, in terms of the forces acting on the ball, why

(i) the acceleration of the ball decreases,

....

....

....

.... [3]

(ii) the ball reaches terminal velocity.

....

.... [2]

[Total: 11]

(a)	**(i)**	1.6s to 1.8s ALLOW 4.2 – 6s ALLOW 4.4 – 6s NOT 2s NOT 4.0 – 6s	B1
	(ii)	6 – his **(i)**, evaluated ALLOW 0 – 4.2s ALLOW 0 – 4.4s NOT 0 – 4s e.c.f.	B1
	(iii)	his **(i)** × 20 32 – 36m or his **(i)** × 20 evaluated allow B1 only for 40m with no working	C1 A1
	(iv)	area under whole graph or ½vt + his**(iii)** 70 – 95m	C1 A1
(b)	**(i)**	weight of ball down and (air) resistance up OR friction opposes weight) upward/resistance/friction force increases with time/distance/speed/as ball falls) any 3 net force reduces) less force, so less acceleration)	B1×3
	(ii)	up force = down force OR no resultant force OR air res. = weight no net force, no acceleration/constant speed	B1 B1

[Total: 11]