6 The ends of a metal resistance wire are connected to a battery of electromotive force (e.m.f.) 8.0 V and negligible internal resistance, as shown in Fig. 6.1.

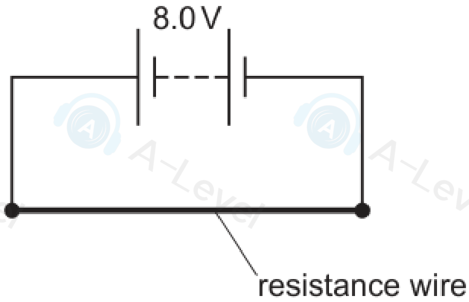

Fig. 6.1

The power dissipated by the resistance wire is 36 W.

(a) Calculate:

(i) the current in the resistance wire

current = ...A [2]

(ii) the number of free electrons that pass through the resistance wire in a time of 50 s

number = ... [2]

(iii) the resistance of the wire.

resistance = ... Ω [2]

(b) The metal of the resistance wire in the circuit has a resistivity of $1.4 \times 10^{-6}\,\Omega\,m$. The cross-sectional area of the wire is $0.25\,mm^2$.

5 **(a)** Two progressive sound waves meet to form a stationary wave. The two waves have the same amplitude, wavelength, frequency and speed.

State the other condition that must be fulfilled by the two waves in order for them to produce the stationary wave.

.... [1]

(b) A stationary wave is formed on a string that is stretched between two fixed points A and B. Fig. 5.1 shows the string at time $t = 0$ when each point is at its maximum displacement.

Fig. 5.1

Distance AB is 0.80 m. The period of the stationary wave is 0.016 s.

(i) On Fig. 5.1, sketch a solid line to show the position of the string:

- at time $t = 0.004$ s (label this line P)
- at time $t = 0.024$ s (label this line Q).

[2]

(ii) Determine the speed of a progressive wave along the string.

speed = ... m s^{-1} [3]

(c) A beam of vertically polarised light of intensity I_0 is incident normally on a polarising filter that has its transmission axis at 30° to the vertical, as shown in Fig. 5.2.

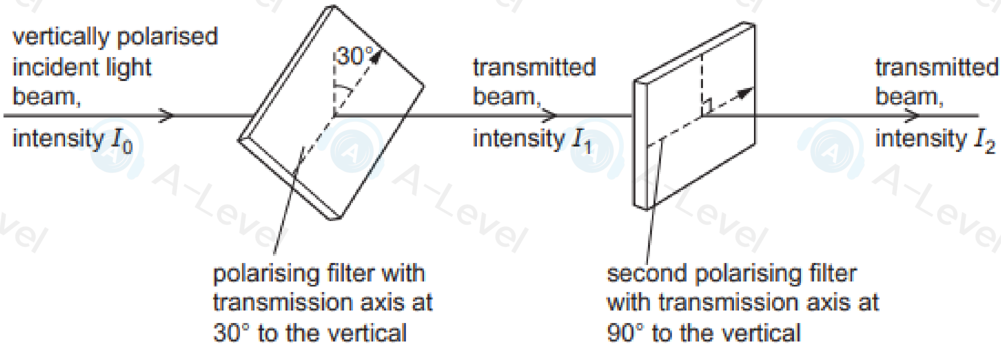

Fig. 5.2

The transmitted light from the first polarising filter has intensity I_1. This light is then incident normally on a second polarising filter that has its transmission axis at 90° to the vertical. The transmitted light from the second filter has intensity I_2.

Calculate:

(i) the ratio $\frac{I_1}{I_0}$

$\frac{I_1}{I_0}$ = ... [2]

(ii) the ratio $\frac{I_2}{I_0}$.

$\frac{I_2}{I_0}$ = ... [2]

[Total: 10]

2 A spherical balloon is filled with a fixed mass of gas. A small block is connected by a string to the balloon, as shown in Fig. 2.1.

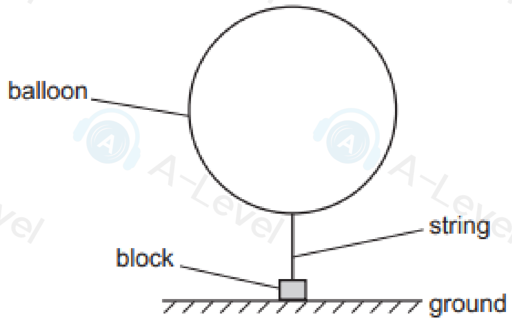

Fig. 2.1 (not to scale)

The block is held on the ground by an external force so that the string is vertical. The density of the air surrounding the balloon is $1.2\,\mathrm{kg\,m^{-3}}$. The upthrust acting on the balloon is 0.071 N. The upthrust acting on the string and block is negligible.

(a) By using Archimedes' principle, calculate the radius *r* of the balloon.

r = ... m [2]

(b) The total weight of the balloon, string and block is 0.053 N.

The external force holding the block on the ground is removed so that the released block is lifted vertically upwards by the balloon.

Calculate the acceleration of the block immediately after it is released.

acceleration = ... $\mathrm{m\,s^{-2}}$ [3]

(c) The balloon continues to lift the block. The string breaks as the block is moving vertically upwards with a speed of $1.4\,m\,s^{-1}$. After the string breaks, the detached block briefly continues moving upwards before falling vertically downwards to the ground. The block hits the ground with a speed of $3.6\,m\,s^{-1}$.

Assume that the air resistance on the block is negligible.

(i) By considering the motion of the block after the string breaks, calculate the height of the block above the ground when the string breaks.

height = ... m [2]

(ii) The string breaks at time $t = 0$ and the block hits the ground at time $t = T$.

On Fig. 2.2, sketch a graph to show the variation of the velocity v of the block with time t from $t = 0$ to $t = T$.

Numerical values of t are not required. Assume that v is positive in the upward direction.

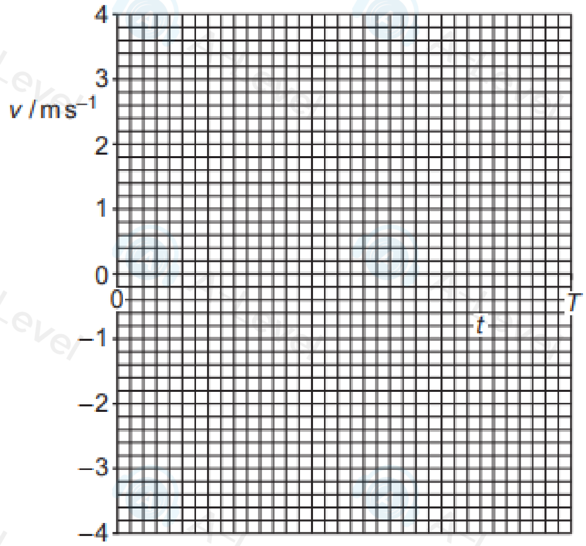

Fig. 2.2

[2]

[Total: 9]