6 **(a)** A lamp is connected in parallel to a resistor of resistance R. These are connected in series to a resistor of resistance 3.0 Ω and a power supply of electromotive force (e.m.f.) 6.0 V and of negligible internal resistance, as shown in Fig. 6.1.

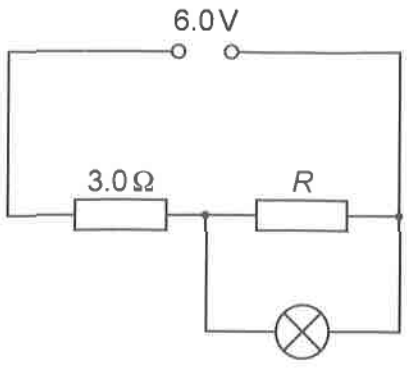

Fig. 6.1

The current in the lamp is 0.30 A and its resistance is 5.0 Ω.

(i) Determine the resistance R. Show your working.

R = ... Ω [3]

(ii) The power supply transfers 120 J of energy to the circuit.

Determine the energy transferred in the lamp. Show your working.

energy = ... J [3]

(iii) Explain why the current in the filament lamp is greatest when the current is first switched on.

.....

.....

.....

..... [2]

(b) Two lengths of resistance wire, X and Y, made from different materials, are connected in series to a power supply, as shown in Fig. 6.2.

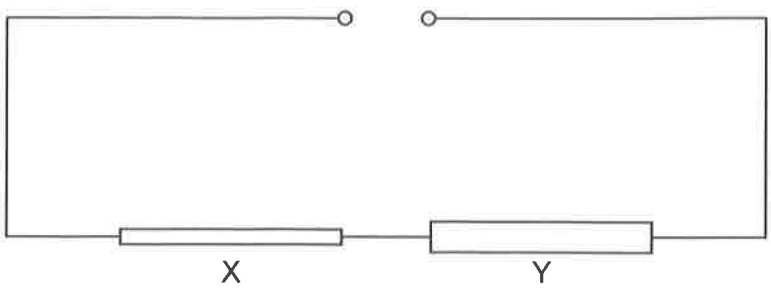

Fig. 6.2

Wire X has half the radius of wire Y.

The drift velocity of the electrons in wire X is three times the drift velocity of the electrons in wire Y.

Determine the ratio

$$\frac{\text{number density of charge carriers in Y}}{\text{number density of charge carriers in X}}.$$

Show your working.

ratio = ... [3]

[Total: 11]