4 A cell of electromotive force (e.m.f) of 0.48 V is connected to a metal wire, as shown in Fig. 4.1.

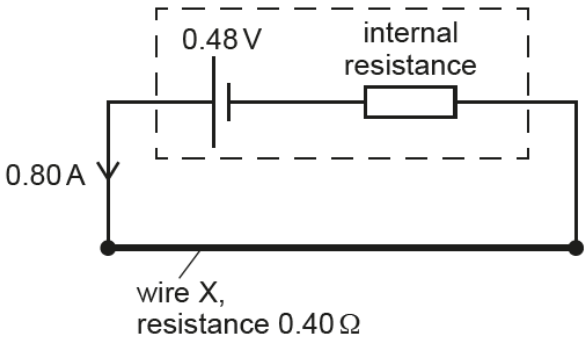

Fig. 4.1

The cell has internal resistance. The current in the cell is 0.80 A.

Wire X has length of 3.0 m, cross-sectional area 1.3×10^{-7} m^2 and resistance of 0.40 Ω.

(a) There are 3.2×10^{22} free electrons contained in the volume of wire X.

For wire X, calculate

(i) the number density *n* of the free electrons.

n = …… m^{-3} [1]

(ii) the average drift velocity of the free electrons.

average drift velocity = …… m s^{-1} [2]

(b) **(i)** Determine the internal resistance of the battery.

internal resistance = …… Ω [2]

(ii) Determine the percentage power loss in the internal resistance.

percentage loss = ……..…… [1]

(c) A wire Y has the same cross-sectional area as wire X and is made of the same material. Wire Y is shorter than wire X.

Wire X in the circuit is replaced by wire Y. Assume that wire Y has the same temperature as wire X.

(i) State and explain whether the average drift velocity of the free electrons in wire Y is greater than, the same as, or less than that in wire X.

……...

……...

……...

…….. [2]

(ii) State and explain whether the efficiency of the battery increases, stays the same or decreases when compared to that in wire X.

……...

……...

……...

…….. [2]