**Q. 06** (a) Consider circuit in figure. How much energy is absorbed by electrons from the initial state of no current (Ignore thermal motion) to the state of drift velocity?

(b) Electrons give up energy at the rate of $RI^2$ per second to the thermal energy. What time scale would number associate with energy in problem (a)? n = number of electrons/volume = $10^{29}/m^3$. Length of circuit = 10 cm cross-section . = A = $(1\ mm)^2$.

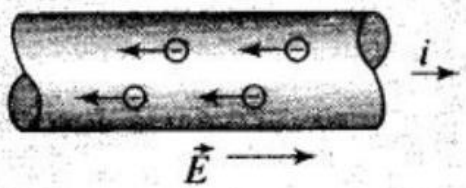
Solution:

(a)

**Key concept:** Relation between current and drift velocity is given by

$$I = ne\,Av_d$$

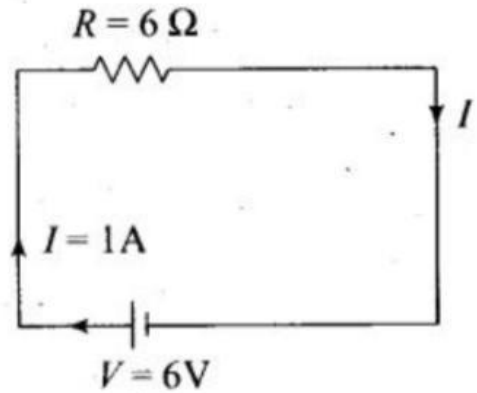
where $v_d$ is the drift speed of electrons and $n$ is the number density of electrons.



According to the Ohm's law current in the circuit

$$I = \frac{V}{R}$$

$$I = 6\ \text{V}/6\ \Omega = 1\ \text{A}$$




But, $I = neAv_d$

or $v_d = \frac{I}{neA}$

On substituting the values,

For, $n$ = number of electrons/volume = $10^{29}/\text{m}^3$

length of circuit = 10 cm, cross-section = $A = (1\ \text{mm})^2$

$$v_d = \frac{1}{10^{29} \times 16 \times 10^{-19} \times 10^{-6}}$$

$$= \frac{1}{1.6} \times 10^{-4}\ \text{m/s}$$

Therefore, the energy absorbed in the form of KE is given by

Total KE = KE of 1 electron × no. of electrons