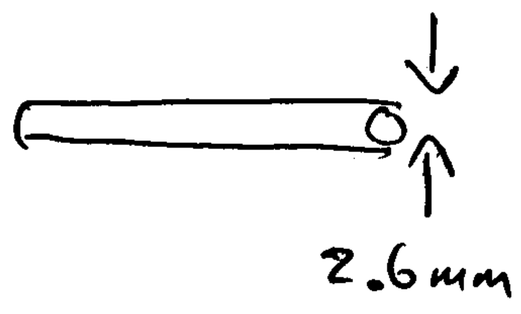
Corrected 10/3/2008

1st Year E&M Problem Set 5 Solutions 2008

① a) I is the amount of charge transferred in unit time, so



$$I = \frac{420\,C}{80 \times 60\,s} = 0.875\,\frac{C}{s} = \underline{87.5\,mA}$$

b) $j = nqv_d = \frac{I}{\text{area}}$ Re-arranging gives

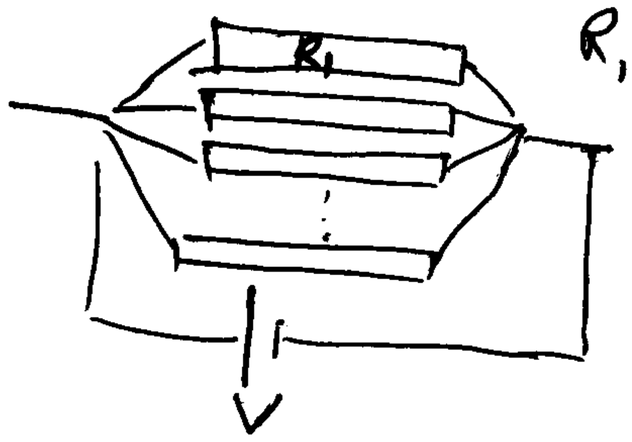
$$v_d = \frac{I}{ne\pi r^2} = \frac{87.5\times10^{-3}}{5.8\times10^{28}\,1.6\times10^{-19}\,3.14\,(1.3\times10^{-3})^2} = \underline{1.78\times10^{-6}\,\frac{m}{s}}$$

c) $\epsilon = \frac{V}{L} = \eta j = \eta\frac{I}{A}$ so $V = \frac{\eta I L}{A}$

Putting in numbers: $V = \frac{1.47\times10^{-8}\,87.5\times10^{-3}\,1}{3.14\,(1.3\times10^{-3})^2} = 2.42\times10^{-4}\,V$

$= \underline{0.242\,mV}$

② a) Let each strand have $R_1 = 5.6\,\mu\Omega$
Then connect as shown and apply voltage V across system.
Each strand will carry $I_1 = \frac{V}{R_1}$



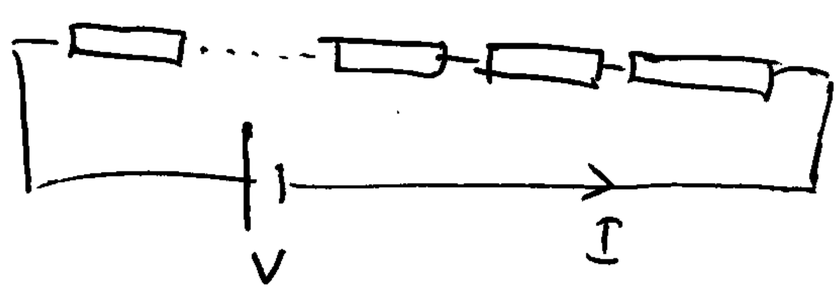
so $I_{tot} = 120 \times I_1 = 120\,\frac{V}{R_1} \Rightarrow \frac{V}{I_{tot}} = R_{tot} = \frac{R_1}{120}$

ie $R_{tot} = \frac{5.6\times10^{-6}}{120} = \underline{4.67\times10^{-8}\,\Omega}$

b) In this case,

$$V = \Sigma I R_1 = 120 R_1 I$$

(note I same through all strands).



Thus $R_{tot} = \frac{V}{I} = 120 R_1 = 120 \times 5.6\,\mu\Omega = 672\,\mu\Omega$

$= 6.72\times10^{-4}\,\Omega$

[I don't know how book can get 6.74 ?]