Midterm Exam No. 2 (Fall 2014, PHYS-205B)

MT02, prob 1

$$a = \frac{qE}{m} = \frac{1.6\times10^{-19}\times 620}{1.67\times10^{-27}} = 5.94\times10^{10}\ \frac{m}{s^2}$$

$$\Delta x = \frac{v_f^2 - v_i^2}{2a} = \frac{(1.40\times10^{6})^2 - 0^2}{2\times(5.94\times10^{10})} = 16.5\ m$$

MT02, prob 2

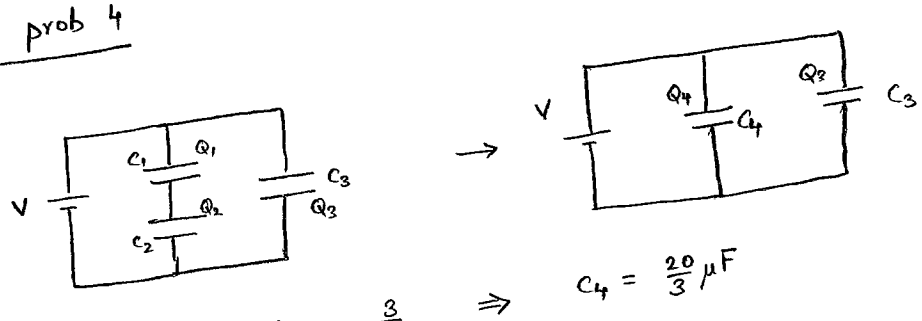
$$V = \frac{kq}{r} = -\frac{8.99\times10^{9}\times 1.6\times10^{-19}}{(3.00\times10^{-3})} = -4.80\times10^{-7}\ V$$

MT02, prob 3

$$\frac{1}{C_{eq}} = \frac{1}{C} + \frac{1}{C} + \cdots + \frac{1}{C} = \frac{100}{C}$$

$$\Rightarrow \quad C_{eq} = \frac{C}{100}$$

MT02, prob 4



$$\frac{1}{C_4} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{10} + \frac{1}{20} = \frac{3}{20} \quad \Rightarrow \quad C_4 = \frac{20}{3}\ \mu F$$

$$Q_4 = V C_4 = 10\ V \times \frac{20}{3}\ \mu F = \frac{200}{3}\ \mu C$$

$$Q_1 = Q_4 = \frac{200}{3}\ \mu C = 66.7\ \mu C$$

MT02, prob 5

$$\text{Energy} \times 0.10 \ \frac{\text{USD}}{\text{kWh}} = 50 \text{ USD}$$

$$1 \text{ kWh} = 10^3 \times 3600 \text{ J} = 3.6 \times 10^6 \text{ J}$$

$$\text{Energy} = \frac{50}{0.10} \times 3.6 \times 10^6 \text{ J}$$

$$= 1.8 \times 10^9 \text{ J}$$

MT02, prob 6

$$R = \frac{V}{I} = \frac{\rho l}{A}$$

$$\rho = \frac{VA}{Il} = \frac{2.0 \times (2 \times 10^{-6})}{3.7 \times 1.9} = 5.69 \times 10^{-7} \ \Omega m .$$

MT02, prob 7

$$P = IV = \frac{Q}{t} V$$

$$Q = \frac{Pt}{V} = \frac{60 \times (12 \times 60 \times 60)}{120} = 21600 \text{ C} = 2.16 \times 10^4 \text{ C} .$$

MT02, prob 8

(a) $\frac{1}{R_{eq}} = \frac{1}{R} + \frac{1}{R} + \frac{1}{R} \Rightarrow R_{eq} = \frac{R}{3} = 100.0 \ \Omega$

(b) $V = 10 \text{ V}$ for all three resistors

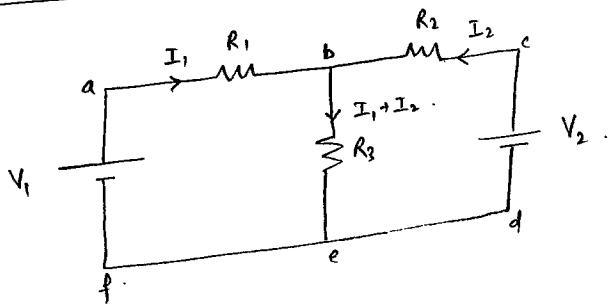
(c) $I_{eq} = \frac{V}{R_{eq}} = \frac{10.0}{100.0} = 0.100 \text{ A}$

$I = \frac{I_{eq}}{3} = 0.033 \text{ A} = 33 \text{ mA}$ → same for each resistor

(d) $P = IV = 33 \text{ mA} \times 10 \text{ V}$

$= 0.33 \text{ W}$ → same for each resistor.

MT 02, prob 9



$$V_1 - I_1 R_1 - (I_1 + I_2) R_3 = 0 \quad \Rightarrow \quad (R_1 + R_3) I_1 + R_3 I_2 = V_1$$

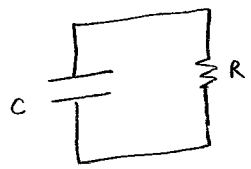
$$V_2 - I_2 R_2 - (I_1 + I_2) R_3 = 0 \quad \Rightarrow \quad R_3 I_1 + (R_2 + R_3) I_2 = V_2 .$$

$$I_1 = \frac{V_1 (R_2 + R_3) - V_2 R_3}{(R_1 + R_3)(R_2 + R_3) - R_3^2} = \frac{V_1 R_2 + (V_1 - V_2) R_3}{R_1 R_2 + R_2 R_3 + R_1 R_3}$$

$I_1 = 0 \quad \Rightarrow \quad V_1 R_2 + (V_1 - V_2) R_3 = 0 .$

$$R_3 = \frac{V_1}{V_2 - V_1} R_2 = \frac{10}{20-10} \times 20\Omega = 20\Omega$$

MT 02, prob 10



$Q(t) = Q_0 \, e^{-\frac{t}{RC}}$. $\quad \tau = RC$.

Given $Q(t) = Q_0 - \frac{2}{3} Q_0$

$= \frac{1}{3} Q_0$

$\frac{1}{3} Q_0 = Q_0 \, e^{-\frac{t}{\tau}}$

$\ln \frac{1}{3} = -\frac{t}{\tau}$

$t = \tau \ln 3$