Midterm 2

Andy P
Physics 180

2 : Current and Resistance

① $\tau = RC$, $\tau < 100\mu s$, $R = 1k\Omega$
$< 1\times10^{-4} s$ $= 1\times10^{3}\,\Omega$

a)
$RC < 1\times10^{-4} s$

$\frac{1\times10^{3}\cdot C}{1\times10^{3}\,\Omega} < \frac{1\times10^{-4} s}{1\times10^{3}\,\Omega} \Rightarrow C < 1\times10^{-7} F$

$\Rightarrow \boxed{C < 100\,nF}$

b) No it wouldn't be difficult because the time constant is $\tau < 100\mu s$ therefore we can limit the capatcitance to less than 100 nF.

c) $R = 10^{3}\,\Omega$ $\varepsilon_1 = 60mV$ $v = 30mV$ $RC = \tau = 1\times10^{-4}$

$V_c(t) = \varepsilon_1(1 - e^{(-t/\tau)})$

$\Rightarrow 30mV = 60mV(1 - e^{(-t/10^{-4})})$

$\Rightarrow 30mV = 60 - 60e^{-(t/10^{-4})}$

$\Rightarrow 0.5 = e^{-(t/10^{-4})}$ $\Rightarrow \ln(.5) = -\left(\frac{t}{10^{-4}}\right)$

$\Rightarrow .693 = \frac{t}{10^{-4}}$ $\Rightarrow \boxed{t = 6.93\times10^{-5} s}$

2. $V(t) = V_0 \sin(2\pi f t + \phi)$, $f = 60\,Hz$ $V_0 = 120\,V$

a) $\phi = 0$ $V(t) = 120 \sin(120\pi t)$

$V(t) = 0$

$0 = 120 \sin(120\pi t)$

$V(t) = 0$ when $\rightarrow$ $\sin(120\pi t) = 0$

$\sin(120\pi t) = 0$ when $\rightarrow$ $120\pi t = n\pi$

$\Rightarrow t = \frac{n}{120}$

so $V(t) = 0$ at $t = \frac{1}{120}s$, $t = \frac{2}{120}s$, $t = \frac{3}{120}s$ ... $\boxed{t = \frac{n}{120}s}$

b) $P = IV$

$P = I^2 R$

$P = \frac{V_0^2}{R}$

$P = \frac{120^2 V}{10^3 \Omega} = \frac{14400}{1000} = \boxed{14.4W}$

c) Since its AC the formula would be

$P = \frac{120^2 V}{2 \times 10^3 \Omega} = \boxed{7.2W}$

3) $P = IV$

$P = 3(110) = 330W$

total Power $= 330W + 100W + 60W + 3W = 163W + 330W$

$= 493W$

$= .493\ kW$

Consumption per Day $= .493 \times 12 = 5.916\,kW$

Consumption per Month $= 5.916 \times 30 = 177.48\,kW$

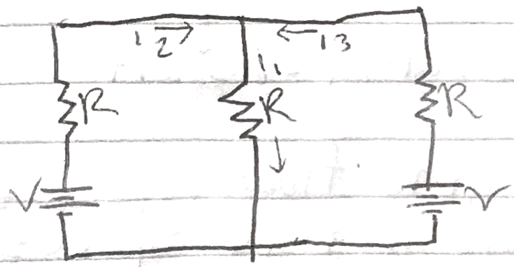
Cost per Month $= 177.48 \times 0.2 = \boxed{35.50\$}$

3 Direct-Current Circuits

1.

$R_{tot}^{-1} = R_1^{-1} + R_2^{-1} = \frac{1}{2R} + \frac{1}{2R} = \frac{2}{2R} = \frac{1}{R}$

$R_{tot} = R$ so,



$$\frac{X-12}{1000\Omega} + \frac{X}{1000\Omega} + \frac{X-12}{1000\Omega} = 0$$

$$\frac{3x}{1000} = \frac{24}{1000} \Rightarrow x = 8V$$

$$\boxed{i_1 = \frac{8}{1000} = 8mA \quad i_2 = \frac{12-8}{1000} = 4mA \quad i_3 = \frac{12-8}{1000} = 4mA}$$

1 Continued) $P = (i_1^2 + i_2^2 + i_3^2) R$

$$\Rightarrow (8^2 + 4^2 + 4^2) \times 10^{-6} \times 1000 = P$$

$$\Rightarrow \boxed{P = 0.096 W}$$

2) $\varepsilon = 1.5V$ $r = 0.25 \Omega$

a) loop 1:

$$i_1 r_1 - i_2 r_2 + E_1 + E_2 = 0$$

$$0.25 i_1 - 0.25 i_2 + 1.5 - 1.5 = 0$$

$$i_1 - i_2 = 0 \Rightarrow i_1 = i_2$$

loop 2: $I_2 r_2 + (I_1 + I_2) R - E_2 = 0$

since $i_1 = i_2$

$$0.25 i_2 + 2 i_2 (50) - 1.5 = 0$$

$$\Rightarrow 100.25 i_2 = 1.5$$

$$\Rightarrow i_2 = .0149 = .015 A$$

So total current is $2 i_2$ since $i_1 = i_2$

so current flow $= \boxed{0.03A}$

b) $q = 2.5$ A·hr $I = \frac{2q}{t} \Rightarrow t = \frac{2q}{I}$

$$\Rightarrow t = \frac{5}{.03} \Rightarrow \boxed{t = 166.667 \text{ hrs}}$$

4

Magnetic Forces and Fields

a) Q is $\boxed{\text{positive}}$ as it corresponds with the right hand rule. The particle is moving upwards and thats the + direction

b) This is strange because the particle has the mass of an electron yet its behavior corresponds to a positive charged particle and as we know, electrons are negatively charged.

c) $B = 0.05\,T$ and $V = 10^6\, m/s$, $q = 1.6 \times 10^{-19}\, C$
$\theta = 90°$

$$F = qvb \Rightarrow F = (1.6 \times 10^{-19})(10^6)(0.05)$$
$$= (0.8 \times 10^{-19})(10^6)$$
$$= .8 \times 10^{-13}$$
$$\boxed{F = 8 \times 10^{-14}\, N}$$