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Phys 135B

Midterm 2

2.1. a) $\tau = RC$

Problem states RC time constant must be less than 100, so:

$$100\,\mu s\left(\frac{1.0\times10^{-6}s}{1\,\mu s}\right) > 1\,k\Omega\left(\frac{1\times10^{3}\Omega}{1\,k\Omega}\right)$$

$$1\times10^{-4}s > 1\times10^{3}\Omega\,(C)$$

$$C < \frac{1\times10^{-4}s}{1\times10^{3}\Omega}$$

$$\boxed{C < 1\times10^{-7}F}$$

b) It would not be difficult, just use a capacitor with less capacitance.

c) $V = V_0(1-e^{-(t/\tau)})$ $\boxed{t = 6.9\times10^{-5}\text{ seconds}}$

$$30 = 60(1-e^{-(\frac{t}{100\times10^{-6}})})$$

$$\frac{1}{2} = e^{-(\frac{t}{100\times10^{-6}})}$$

2.2. a) $V(t) = V_0\sin(2\pi ft+\phi)$ $\therefore$ 0 is also equal to $\sin(\pi)$

$$0 = 120V\sin(2\pi(60Hz)t+0)$$

$$\sin(2\pi(60Hz)t) = 0$$

$$\sin(2\pi(60Hz))t = \pi$$

$$t = \frac{\pi}{2\pi(60Hz)} = \boxed{8.33\times10^{-3}\text{ seconds}}$$

b) $Power_{max} = V_{max}(I_{max})$ $\therefore I = \frac{V}{R}$

$$P_{max} = V_{max}\left(\frac{V}{R}\right)$$

$$P_{max} = V^2_{max}\left(\frac{1}{R}\right) \quad R = 1\,k\Omega,\ V_{max} = 120V$$

$$P_{max} = \frac{1}{10^3\Omega}(120V)^2 \quad P = \frac{V^2}{R}$$

$$\boxed{P_{max} = 14.4\,W}$$

c) $P = \frac{V^2}{R}$

Avg power $= \frac{1}{2}\frac{V^2}{R} = \frac{1}{2}(14.4W)$

$\boxed{\text{Avg. Power} = 7.2\ W}$

2.3) $P = VI$

$P = 110V(3A) = 330\,W$

Total watts $= 330\,W + 60\,W + 100\,W + 3\,W = 493\ w/hr$

Per day: $493\ w/hr\ (12\,hrs) = 5916\,W$

$= 5.92\ Kwatt \cdot hr$

If a Kwatt hour costs 0.2 dollars

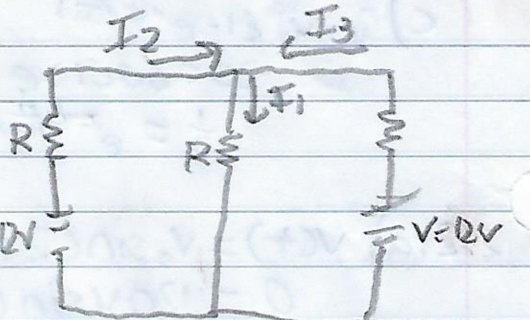
↳ $5.916\ Kwatt \cdot hr\,(0.2\ \text{dollars})$

$= 1.1832$ dollars a day

Per month $= 1.1832\ (30\ \text{days})$

$\boxed{= \$35.50}$

3.1) $i_2 + i_3 = i_1$ (Junction rule)



$1\,K\Omega = 1000\,\Omega$

$V = IR$

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

$12 = I_3 R$

$I_3 = \frac{12V}{1K\Omega} = 0.012A = 12mA$

$I_2 = \frac{12V}{1K\Omega} = 0.012A = 12mA$

$\frac{1}{R_{eq}} = \frac{1}{2k\Omega} + \frac{1}{2k\Omega} = \frac{2}{2k\Omega} = \frac{1}{1k\Omega}$

$I_1 = 12mA + 12mA = 24mA$ (Junction rule)

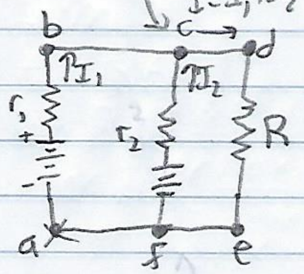
$P = I^2 R$

$\left(\frac{12}{1000}\right)^2 1K\Omega + \left(\frac{24}{1000}\right)^2 1K\Omega + \left(\frac{12}{1000}\right)^2 1K\Omega \qquad 1K\Omega = 1000\,\Omega$

$\boxed{0.864\,W}$

Junction rule

$I = I_1 + I_2$

3,2) 

$\epsilon = 1.5V$
$r = 0.25\Omega$
$R = 50\Omega$

B) $I = \frac{2q}{t}$
$It = 2q$
$t = \frac{2q}{I}$
$t = \frac{2(2.5A\,hr)}{0.030}$
$\boxed{t = 166.7 \text{ hours}}$

a) Loop rule $\quad I = I_1 + I_2$

① $\mathcal{E}_1 - i_1 r_1 - IR = 0$
② $\mathcal{E}_2 - i_2 r_2 - IR = 0 \quad \therefore i_1 = i_2$

$\mathcal{E}_1 - i_1 r_1 - IR = \mathcal{E}_2 - i_2 r_2 - IR$
$\mathcal{E}_1 - \mathcal{E}_2 - i_1 r_1 + i_2 r_2 = 0$
$0.25 i_1 - 0.25 i_2 + 1.5V - 1.5V = 0$
$i_2 r_2 + (i_1 + i_2)R - \mathcal{E}_2 = 0$
$0.25 i_2 + (2 i_2)(50) - 1.5V = 0$
$i_2 = 0.015A$

Since $i_2 = i_1$, total flow is $i_1 + i_2 = 0.015A + 0.015A = \boxed{0.030}$

4.1) a) Left hand rule: magnetic field is into page
Charge is positive

b) The particle is positively charged, but has the mass of an electron. This is strange because you would expect the sub-atomic particle to have the mass of a proton due to the positive charge.

c) Lorentz force $\quad q = 1.6 \times 10^{-19} C$

$\vec{F} = q\vec{v} \times \vec{B}$
$\vec{F} = (1.6 \times 10^{-19} C)(10^6 m/s)(0.05T)$
$\boxed{\vec{F} = 8 \times 10^{-15} N \text{ to the left}}$