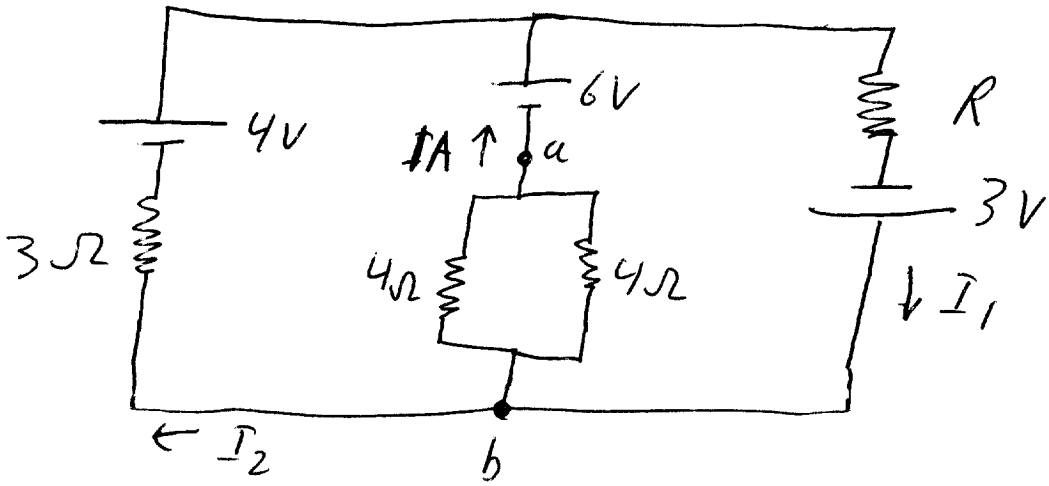
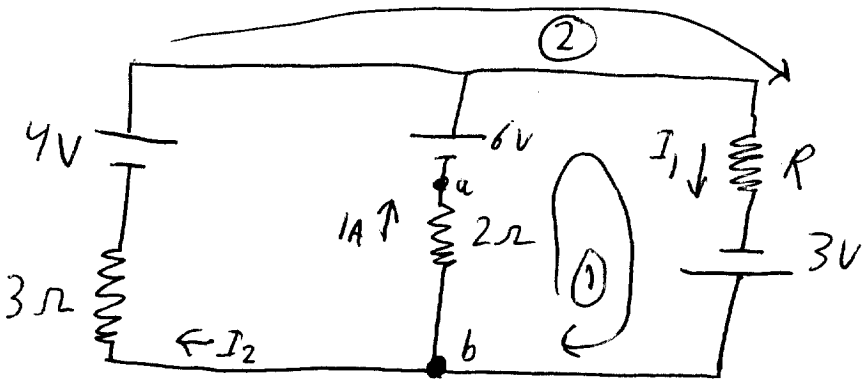
Exam 97

1) Redraw circuit



Simplify



a) $V = IR = (1A)(2\Omega) = \boxed{2V}$

b) $\boxed{I_2 = I_1 - 1A}$ or $I_2 + I_1 = -1A$

or $I_2 + 1A = I_1$

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1C) Loop 1

$$6V - RI_1 + 3V - 2\Omega(1A) = 0$$

$$6V + 3V - 2V - RI_1 = 0$$

$$7V - RI_1 = 0$$

$$RI_1 = 7V$$

$$R = 7V/I_1$$

$$I_1 = 7V/R$$

Loop 2

$$4V - RI_1 + 3V - 3I_2^* = 0$$

$$* \; I_2 = I_1 - 1A$$

$$4V + 3V - 3I_1 + 3V - RI_1 = 0$$

$$10V - I_1(R + 3\Omega) = 0$$

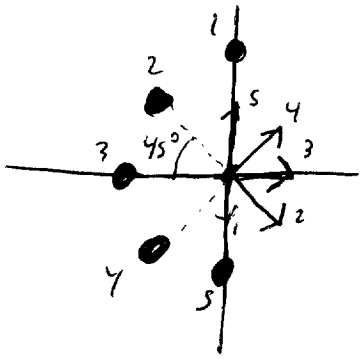
$$I_1 = \frac{10V}{R + 3\Omega}$$

$$I_1 = 1A$$

$$\boxed{R = 7\Omega}$$

2) a) $\boxed{F = 0}$

b)



$$F = q \Sigma E$$

$$F_y = 0 = q[E_1 + E_5 + E_{2y} + E_{4y}]$$

$$F_x = q[E_3 + E_{4x} + E_{2x}]$$

$\therefore F = F_x$

$E_{4x} = E_{2x} \quad \therefore \quad F_x = q[E_3 + 2E_{2x}]$

$$F_x = kq\left[\frac{q_3}{R^2} + 2\left(\frac{q_2}{R^2}\cos 45°\right)\right]$$

$$F_x = \frac{(9\times10^9)(8\times10^{-6})}{0.01}\left[(1\times10^{-6}) + 2(1\times10^{-6})\cos 45°\right]$$

$\boxed{F_x = 1.738 \approx 1.74\ N \text{ in the } \hat{x} \text{ direction } (0° \text{ relative to the x-axis})}$

3)

$q<0$

a) $ma = F = qE \qquad a = \frac{-qE}{m} \qquad E = \frac{+\sigma}{2\epsilon_0}$

$$a = \frac{-q\sigma}{2m\epsilon_0}$$

$$V = V_0 + at$$

$$V = V_{0x} - \frac{q\sigma}{2m\epsilon_0}t = V_{0x} - \frac{q\sigma}{2m\epsilon_0}\cdot\frac{2m\epsilon_0 V_{0x}}{q\sigma}$$

$$= V_{0x} - V_{0x} = 0$$

$$\boxed{V_x(t) = 0}$$

b) $x = \cancel{x_0}^{0} + V_0 t + \frac{1}{2}at^2$

$$x = V_{0x}\left(\frac{2\epsilon_0 m V_{0x}}{q\sigma}\right) - \frac{1}{2}\cdot\frac{q\sigma}{2m\epsilon_0}\cdot\frac{4\epsilon_0^2 m^2 V_{0x}^2}{q^2\sigma^2}$$

$$x = \frac{2V_{0x}^2\epsilon_0 m}{q\sigma} - \frac{V_{0x}^2\epsilon_0 m}{q\sigma} = \frac{V_{0x}^2 m\epsilon_0}{q\sigma}$$

$$\boxed{x(t) = \frac{V_{0x}^2 m\epsilon_0}{q\sigma}}$$

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3C)

$$E = \frac{\sigma}{\epsilon_0} \qquad q<0 \qquad a = \frac{-q\sigma}{\epsilon_0 m}$$

$$KE_i = PE_f$$

$$\tfrac{1}{2} m V_{0x}^2 = m a x$$

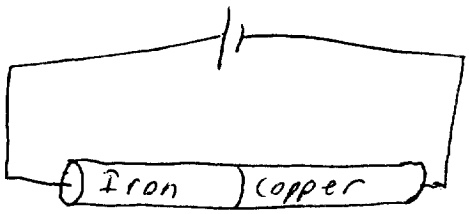
$$\tfrac{1}{2} V_{0x}^2 = \frac{q\sigma}{\epsilon_0 m} x$$

$$\sigma = \frac{\epsilon_0 m V_{0x}^2}{2 q x}$$

$$\sigma = \frac{(8.85\times10^{-12})(9.11\times10^{-31})(1.0\times10^{6})^2}{2(1.6\times10^{-19})(1\times10^{-3})}$$

$$\boxed{\sigma = 2.52\times10^{-8}\ C/m^2}$$

4)



$$\rho = \frac{RA}{L}$$

a) $A = \pi \times 10^{-6}\ m^2$

$R_{Fe} = .318\ \Omega$

$R_{cu} = .054\ \Omega$

$$R_T = R_{Fe} + R_{cu} = 0.3725\ \Omega$$

b) $P = I_T^2 R_T$

$R_T = R_{Fe} + R_{cu} = 0.3725\ \Omega$

$V = IR \quad I = V/R = 100V/.37\Omega = 268.5\ A$

$P = I^2 R = (268.5A)^2(.37\Omega) = 26{,}851.2\ W$

$$P = 2.69 \times 10^4 \text{ Watts}$$

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4 c) max power?

$P_{||} = V^2/R$ $\qquad R_{||T} = 4.7 \times 10^{-2}\ \Omega$

$P_{||} = (100\text{v})^2 / 4.7 \times 10^{-2}\ \Omega = 2.11 \times 10^5$ watts

$P_{series} < P_{||}$

Connect in || to maximize powerloss

$\Delta P = 1.848 \approx 1.85$ watts

EZ