Stuff that you should know!

$$F = k\frac{q_1 q_2}{r^2} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

$$A = 4\pi R^2$$

$$A = 2\pi r L$$

$$k = \frac{1}{4\pi\varepsilon_0} = 9.0\times10^9 N\frac{m^2}{C^2}$$

$$e = 1.6\times10^{-19} C$$

$$m_e = 9.11\times10^{-31} kg$$

$$\mu = 10^{-6}$$

$$n = 10^{-9}$$

$$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$$

$$F = Eq$$

$$\Delta x = \left[\frac{v_{0x} + v_{1x}}{2}\right]\Delta t$$

$$\varepsilon_0 = 8.85\times10^{-12}\frac{C^2}{N\cdot m^2}$$

$$\Delta x = v_{0x}\Delta t + \tfrac{1}{2}a_x\Delta t^2$$

$$a = \frac{Eq}{m}$$

$$v_{1x} = v_{0x} + a_x\Delta t$$

$$\Phi = \sum_i\left(E_i\cdot\Delta A_i\cos\theta_i\right)$$

$$v_{1x}^2 = v_{0x}^2 + 2a_x\Delta x$$

$$\Phi\varepsilon_0 = q_{enc}$$

$$\left|\vec{A}\right| = \sqrt{A_x^2 + A_y^2}$$

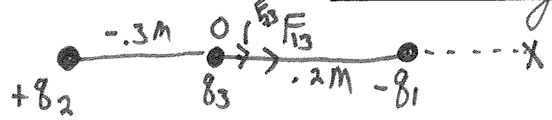
$$\theta = \tan^{-1}\left[\frac{A_y}{A_x}\right]$$

(40)

PHYS 1112
Introductory Physics II
TEST 1

Name Charles Jackson

Show all work in the spaces provided.



1) Three point charges are along the x-axis. Charge q_1=-4.50 nC is at x=0.200 m, and charge q_2=+2.5 nC is at x=-0.300 m. A positive point charge q_3 is located at the origin.

   a) What must the value of q_3 be for the net force on this point charge to have a magnitude of 4.00 μN? (4 pts)

$$\Sigma F = 4\times10^{-6}N$$

$$F_{23} + F_{13} = 4\times10^{-6}N$$

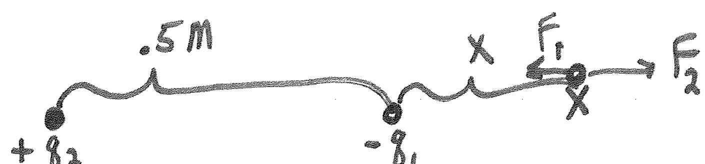
$$k\frac{q_2 q_3}{r_{23}^2} + k\frac{q_1 q_3}{r_{13}^2} = 4\times10^{-6}N$$

$$q_3 = \frac{4\times10^{-6}N}{k\left[\frac{q_2}{r_{23}^2} + \frac{q_1}{r_{13}^2}\right]} = \frac{4\times10^{-6}N}{(9\times10^{9}N\frac{m^2}{c^2})\left[\frac{2.5\times10^{-9}c}{(+.3m)^2} + \frac{4.5\times10^{-9}c}{(.2m)^2}\right]} = 3.17\times10^{-9}c$$

or 3.17 nC

   b) What is the direction of the net force on q_3? (2 pts)

(+) X



   c) Where along the x-axis can q_3 be placed so that the net force on it is zero, other than the trivial answers x=±∞. (4 pts)

$$-F_{13} + F_{23} = 0$$

$$-k\frac{q_1 q_3}{r_{13}^2} + k\frac{q_2 q_3}{r_{23}^2} = 0$$

$$\frac{q_1}{r_{13}^2} = \frac{q_2}{r_{23}^2}$$

$$\frac{q_1}{X^2} = \frac{q_2}{(X+.5m)^2}$$

$$q_2 X^2 = q_1 (X+.5m)^2$$

~~$X^2 = \frac{q_1}{q_2}(X+.5m)^2$~~

$$q_2 X^2 = q_1(X^2 + 1mX + .25m^2)$$

$$\frac{q_2}{q_1}X^2 = X^2 + 1mX + .25m^2$$

$$.44X^2 + 1mX + .25m^2 = 0$$

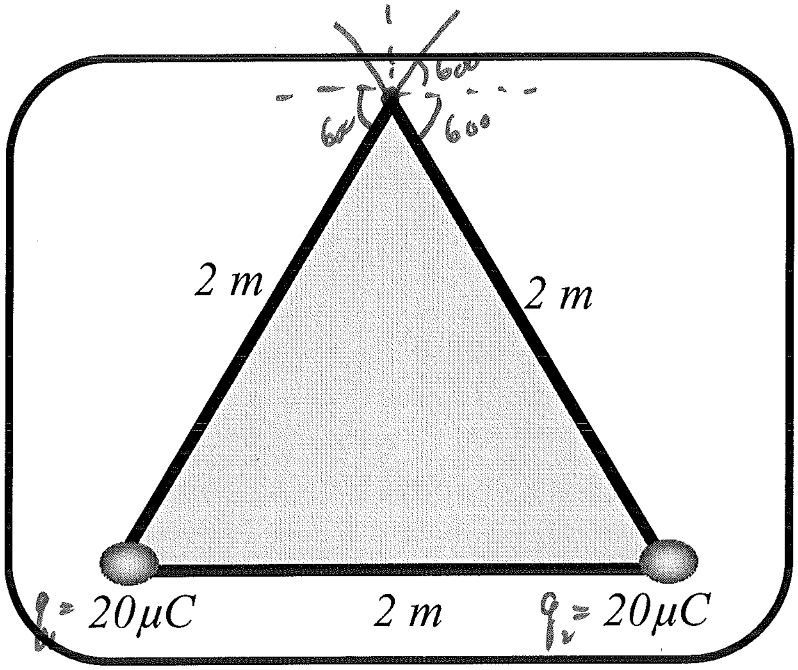
$$X^2 + 2.25m + .56m^2 = 0$$

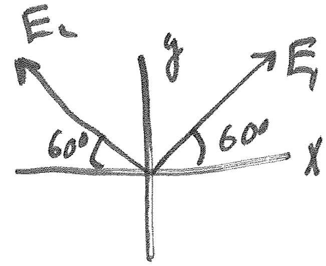
$$X = \frac{-b \mp \sqrt{b^2 - 4ac}}{2a}$$

$$X = \frac{-2.25m \pm \sqrt{(2.25m)^2 - 4(.56m^2)}}{2}$$

$$X = \frac{-2.25m \pm 1.68m}{2}$$

X = -.285m or -1.965m





2) Positive point-charges of *20 μC* are fixed at two of the vertices of an equilateral triangle with sides of *2.0 m*. Determine the magnitude of the electric field at the third vertex. (10 pts)

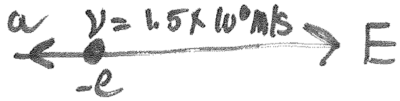
$$E_1 = E_2 = k\frac{q}{r^2} = \left(9\times10^9\, N\frac{m^2}{C^2}\right)\frac{(20\times10^{-6}\,C)}{(2\,m)^2} = 4.5\times10^4\, N/C$$

$$\sum E_x = 0$$

$$\sum E_y = 2E\sin(60°) = 2(4.5\times10^4\, N/C)\sin(60°) = 7.79\times10^4\, N/C$$

3) An electron with speed $v_0 = 1.5\times10^6 m/s$ is traveling parallel to an electric field of magnitude $E = 7.7\times10^3 N/C$.

a) How far will it travel before it stops? (5 pts)



$$a = \frac{Eq}{m} = \frac{(7.7\times10^3 N/C)(1.6\times10^{-19} C)}{9.11\times10^{-31} kg}$$

$$a = 1.35\times10^{15} m/s^2$$

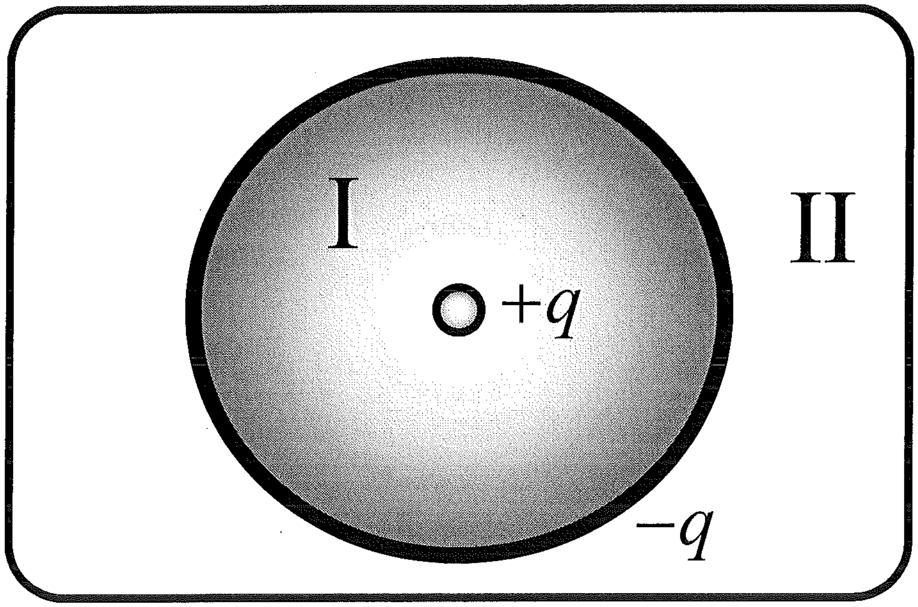
$$v_x^2 \overset{0}{=} v_{x_0}^2 + 2a_x \Delta x$$

$$\Delta x = \frac{-v_{x_0}^2}{2a_x} = \frac{-(1.5\times10^6 m/s)^2}{2(-1.35\times10^{15} m/s^2)} = 8.33\times10^{-4} m$$

b) How much time elapse before it returns to its starting point? (5 pts)

$$v_x \overset{0}{=} v_{x_0} + a_x t$$

$$t = \frac{-v_{x_0}}{a_x} = \frac{-(1.5\times10^6 m/s)}{-1.35\times10^{15} m/s^2} = 1.11\times10^{-9} s \times 2$$



4) Consider a positive point charge surrounded by a spherical shell with a negative charge. Find the electric field:

a) Between the point charge and the shell (region I). (5 pts)

$EA_s = \frac{q_{enc}}{\epsilon_0}$

$E(4\pi r^2) = \frac{q}{\epsilon_0}$

$E = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}$

b) Outside the spherical shell (region II). (5 pts)

$\Phi = \frac{q_{enc}}{\epsilon_0}$

$\Phi = \frac{0}{\epsilon_0}$

$\Phi = 0$

so

$E = 0$ //

Stuff that may help!

$$F = k\frac{q_1 q_2}{r^2}$$

$$E = k\frac{q}{r^2}$$

$$V = k\frac{q}{r}$$

$$k = \frac{1}{4\pi\varepsilon_0} = 9\times10^9 N\frac{m^2}{C^2}$$

$$\Delta U = \Delta V q$$

$$W = \Delta U$$

$$\Delta U + \Delta KE = 0$$

$$KE = \tfrac{1}{2}mv^2$$

$$F = qE$$

$$e = 1.6\times10^{-19} C$$

$$m_e = 9.11\times10^{-31} kg$$

$$\mu = 10^{-6}$$

$$n = 10^{-9}$$

$$C = \frac{\kappa\varepsilon_0 A}{d}$$

$$\varepsilon_0 = 8.85\times10^{-12}\frac{C^2}{N\cdot m}$$

$$q = CV$$

$$E = \tfrac{1}{2}CV^2$$

$$V = iR$$

$$P = i^2 R$$

$$P = iV$$

$$\frac{1}{R_{tot}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \quad \text{or} \quad R_{tot} = R_1 + R_2 + R_3$$

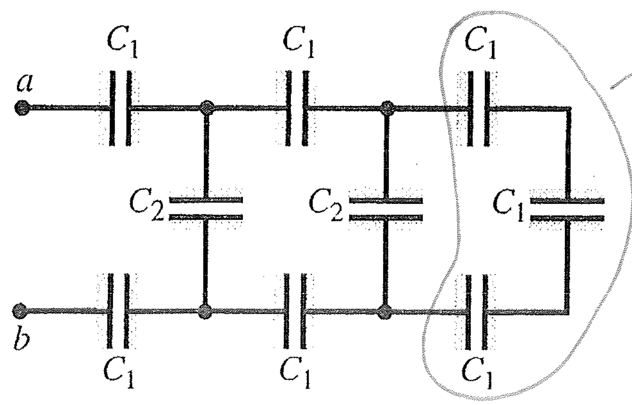
$$\frac{1}{C_{tot}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \quad \text{or} \quad C_{tot} = C_1 + C_2 + C_3$$

$$F = ma$$

PHYS 1112
Introductory Physics II
TEST 2

Name Charles Johnson

Show all work in the spaces provided.

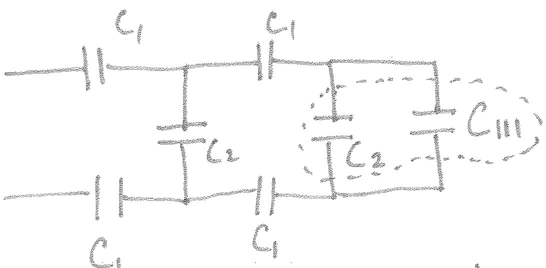


$\frac{1}{C_{111}} = \frac{1}{C_1} + \frac{1}{C_1} + \frac{1}{C_1}$

$\frac{1}{C_{111}} = \frac{3}{6.9\mu F}$

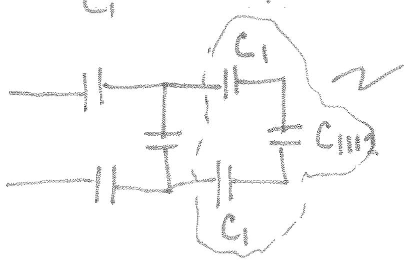
$C_{111} = 2.3\mu F$

1) In the figure above each capacitance C_1 is 6.9 μF and each capacitance C_2 is 4.6 μF.
   a) Compute the equivalent capacitance of the circuit between points a and b. (5 pts)



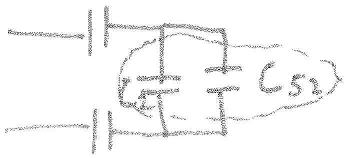
$C_{1112} = C_{111} + C_2$

$C_{1112} = 2.3\mu F + 4.6\mu F = 6.9\mu F$

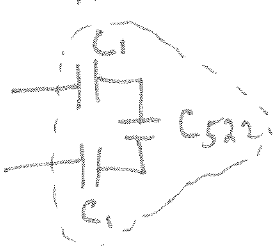


$\frac{1}{C_{52}} = \frac{1}{C_1} + \frac{1}{C_1} + \frac{1}{C_{1112}} = \frac{3}{6.9\mu F}$

$C_{52} = 2.3\mu F$



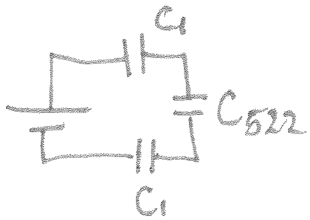
$C_{522} = C_2 + C_{52} = 6.9\mu F$



$\frac{1}{C_{tot}} = \frac{1}{C_1} + \frac{1}{C_1} + \frac{1}{C_{522}} = \frac{3}{6.9\mu F}$

$C_{tot} = 2.3\mu F$

b) Compute the charge on each of the three capacitors nearest a and b when the voltage between a and b is 420V. (5 pts)



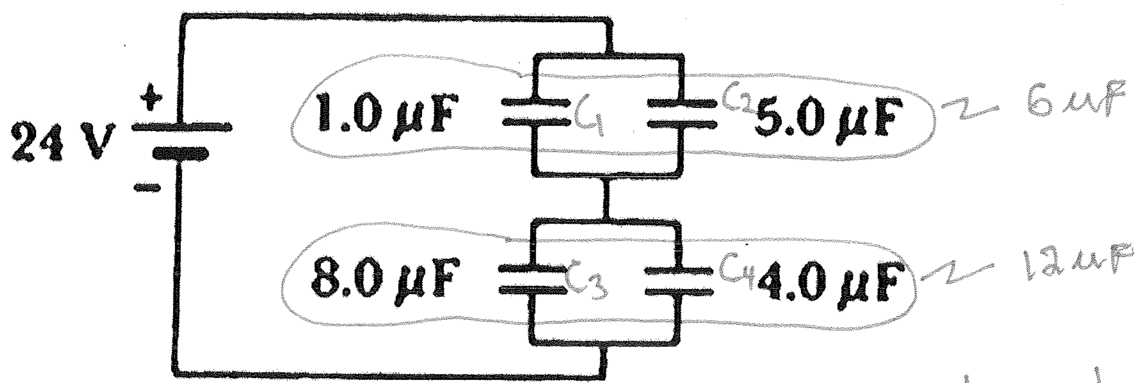
$C_1 = C_1 = C_{522}$ so

$V_1 = V_1 = V_{522} = \frac{420V}{3} = 140V$

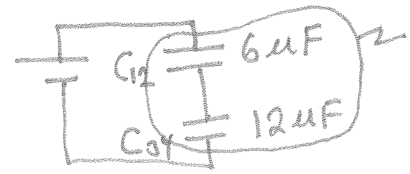
$q = CV$

$q = (6.9\mu F)(120V)$

$q = 966 \mu C$



2) For the above capacitors find:
   a) The equivalent capacitance. (5 pts)

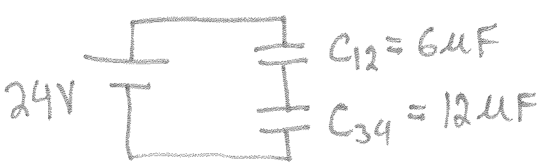


$$\frac{1}{C_{tot}} = \frac{1}{6\mu F} + \frac{1}{12\mu F}$$

$$\frac{1}{C_{tot}} = \frac{3}{12\mu F}$$

$$C_{tot} = 4\mu F$$

   b) The charge on and the potential difference across each capacitor. (5 pts)



$$q_{12} = q_{34} = q_{tot} = C_{tot} V_{tot} = (4\mu F)(24V) = 96\mu C$$

$$V_{12} = \frac{q_{12}}{C_{12}} = \frac{96\mu C}{6\mu F} = 16V$$

$$V_{34} = \frac{q_{34}}{C_{34}} = \frac{96\mu F}{12\mu F} = 8V$$

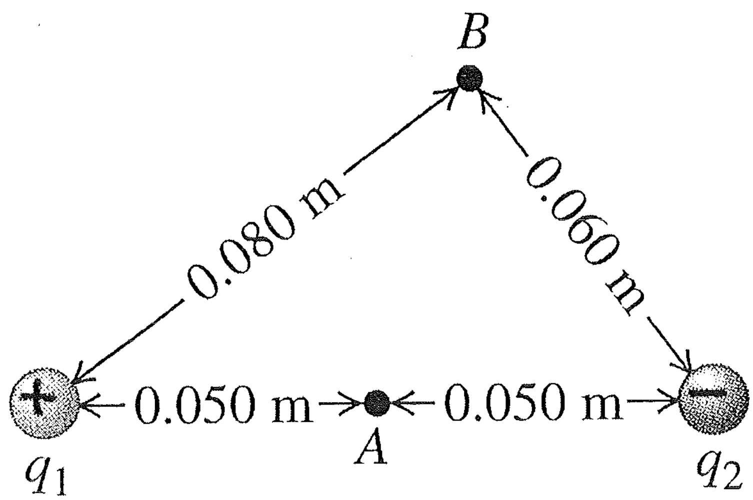
so

$V_1 = 16V \rightarrow q_1 = C_1 V_1 = 16\mu c$

$V_2 = 16V \rightarrow q_2 = C_2 V_2 = 80\mu c$

$V_3 = 8V \rightarrow q_3 = C_3 V_3 = 64\mu c$

$V_4 = 8V \rightarrow q_4 = C_4 V_4 = 32\mu c$



3) Two point charges q_1=+2.4 nC and q_2=−6.50 nC are 0.100 m apart. Point A is midway between them; point B is 0.80 m from q_1 and 0.060 m from q_2 (see figure above.)

a) What is the electrical potential at point A due to the charges q_1 and q_2? (3 pts)

$$V_A = k\frac{q_1}{r_{1A}} + k\frac{q_2}{r_{2A}} = \left(9\times10^9 N\frac{m^2}{C^2}\right)\left[\frac{2.4\times10^{-9}C}{.05m} - \frac{6.5\times10^{-9}C}{.05m}\right] = -738\,V$$

b) What is the electrical potential at point B due to the charges q_1 and q_2? (3 pts)

$$V_B = k\frac{q_1}{r_{1B}} + k\frac{q_2}{r_{2B}} = \left(9\times10^9 N\frac{m^2}{C^2}\right)\left[\frac{2.4\times10^{-9}C}{.08m} - \frac{6.5\times10^{-9}C}{.06m}\right] = -705\,V$$

c) What is the work done by the electric field on a charge of 2.50 nC that travels from point B to Point A? (4 pts.)

$$W = q\Delta V = (2.5\times10^{-9}C)[V_A - V_B] = (2.5\times10^{-9}C)[-738-(-705V)] =$$

$$-8.25\times10^{-8}J$$

4) Just as you touch a metal door knob, a spark of electricity (electrons) jumps from your hand to the knob. The electrical potential of the knob is greater than that of your hand. The work done by the electric force on the electrons is $1.5 \times 10^{-7} J$. How many electrons jump from your hand to the knob? (10 pts)

$W = \Delta V q$

Stuff that may help!

$$C = \frac{\kappa \varepsilon_0 A}{d}$$

$$\varepsilon_0 = 8.85 \times 10^{-12} \frac{C^2}{N \cdot m}$$

$$q = CV$$

$$E = \tfrac{1}{2} CV^2$$

$$V = iR$$

$$P = i^2 R$$

$$P = iV$$

$$\frac{1}{R_{tot}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \quad \text{or} \quad R_{tot} = R_1 + R_2 + R_3$$

$$\frac{1}{C_{tot}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \quad \text{or} \quad C_{tot} = C_1 + C_2 + C_3$$

$$F = ma$$

$$F = k\frac{q_1 q_2}{r^2}$$

$$E = k\frac{q}{r^2}$$

$$V = k\frac{q}{r}$$

$$k = \frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 N \frac{m^2}{C^2}$$

$$\Delta U = \Delta V q$$

$$W = \Delta U$$

$$\Delta U + \Delta KE = 0$$

$$KE = \tfrac{1}{2} mv^2$$

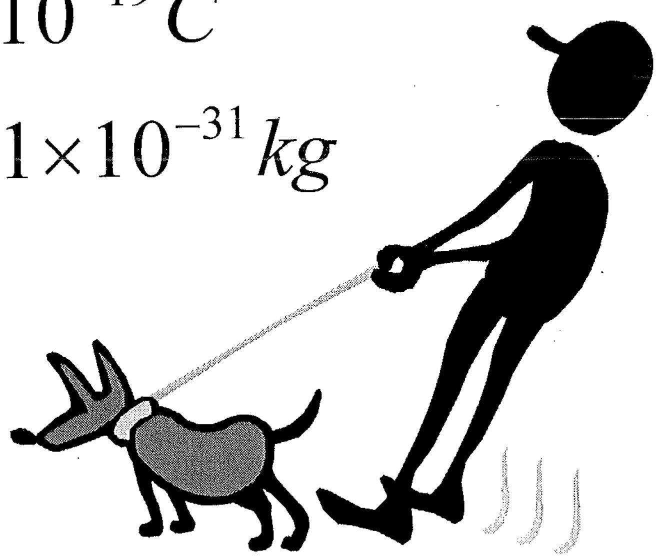
$$F = qE$$

$$e = 1.6 \times 10^{-19} C$$

$$m_e = 9.11 \times 10^{-31} kg$$

$$\mu = 10^{-6}$$

$$n = 10^{-9}$$



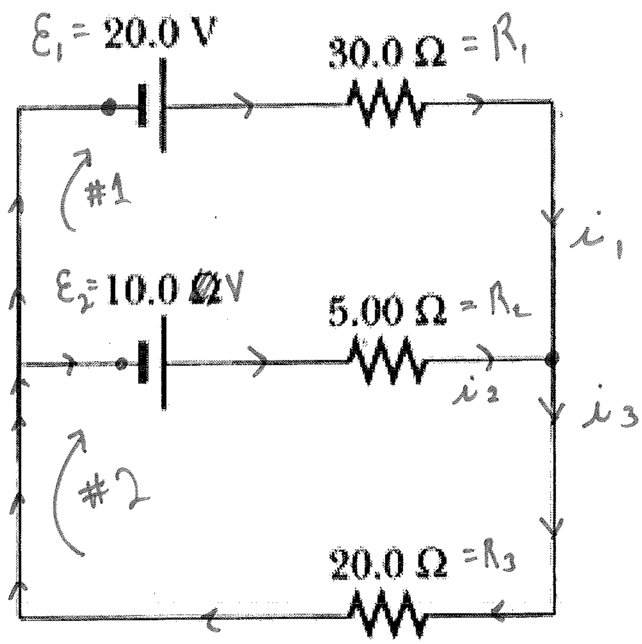
Test 3

PHYS 1112
Introductory Physics II
Test 3

Name Charles Johnson

Show all work in the spaces provided.

1) Using the figure below do the following:



a) Show the direction of the three unknown currents on the diagram. (3 pts)

b) Apply the junction rule to the circuit. (2 pts)

$i_3 = i_1 + i_2$

c) Apply the loop rule to two loops in the circuit. (4 pts)

loop #1

$\mathcal{E}_1 - i_1 R_1 + i_2 R_2 - \mathcal{E}_2 = 0$

$\mathcal{E}_1 - \mathcal{E}_2 + i_2 R_2 - i_1 R_1 = 0$

loop #2

$\mathcal{E}_2 - i_2 R_2 - i_3 R_3 = 0$

d) Find the unknown currents. (4 pts)

$$i_3 = i_1 + i_2 \rightarrow i_1 = i_3 - i_2$$

$$\mathcal{E}_1 - \mathcal{E}_2 + i_2 R_2 - i_1 R_1 = 0 \qquad \mathcal{E}_2 - i_2 R_2 - i_3 R_3 = 0$$

$$i_3 = + \frac{\mathcal{E}_2}{R_3} - i_2 \frac{R_2}{R_3}$$

$$\mathcal{E}_1 - \mathcal{E}_2 + i_2 R_2 - (i_3 - i_2) R_1 = 0$$

$$\mathcal{E}_1 - \mathcal{E}_2 + i_2 (R_2 + R_1) - i_3 R_1 = 0$$

$$\mathcal{E}_1 - \mathcal{E}_2 + i_2 (R_2 + R_1) - \left[+ \frac{\mathcal{E}_2}{R_3} - i_2 \frac{R_2}{R_3} \right] R_1 = 0$$

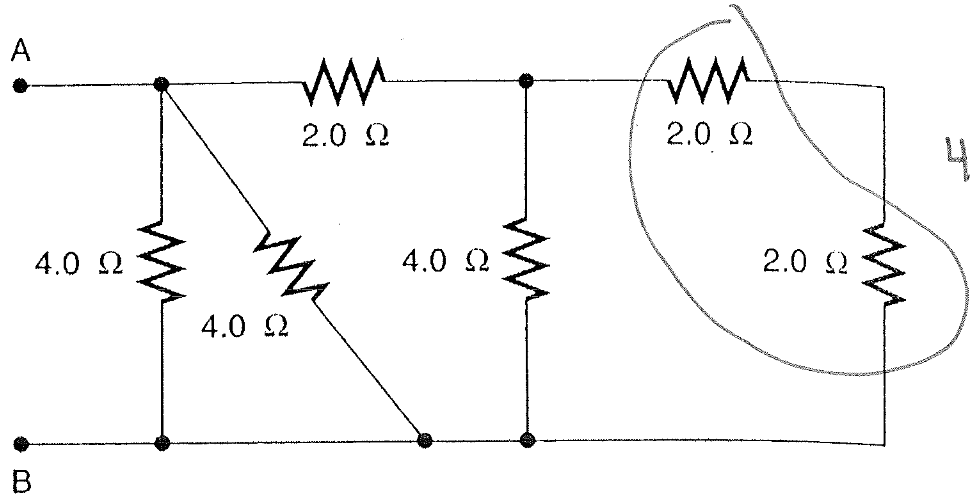
$$\mathcal{E}_1 - \mathcal{E}_2 - \frac{\mathcal{E}_2}{R_3} R_1 + i_2 \left[R_2 + R_1 + \frac{R_2 R_1}{R_3} \right] = 0$$

$$i_2 = \frac{\mathcal{E}_2 - \mathcal{E}_1 + \mathcal{E}_2 \frac{R_1}{R_3}}{R_2 + R_1 + \frac{R_2 R_1}{R_3}} = \frac{10V - 20V + (10V)\frac{30\Omega}{5\Omega}}{5\Omega + 30\Omega + \frac{(5\Omega)(30\Omega)}{20\Omega}} = \frac{10V - 20V + 60V}{5\Omega + 30\Omega + 7.5\Omega}$$

$$i_2 = \frac{50V}{42.5\Omega} = 1.176A$$

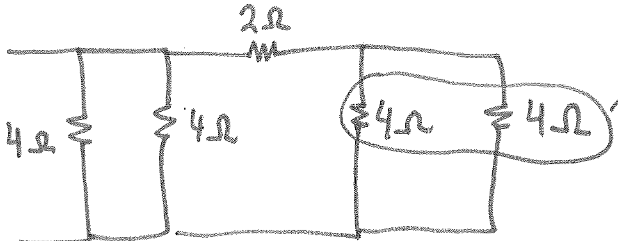
$$i_3 = \frac{10V}{20\Omega} - (1.176A)\frac{(5\Omega)}{20\Omega} = .206A$$

$$i_1 = .206A - 1.176A = -.97A$$



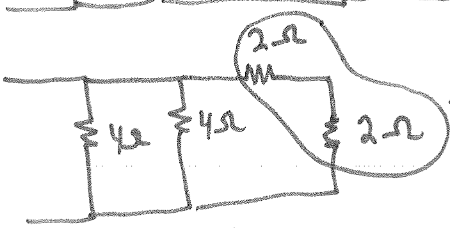
$4\Omega = 2\Omega + 2\Omega$

2) Find the equivalent resistance of the circuit above. (10 pts)

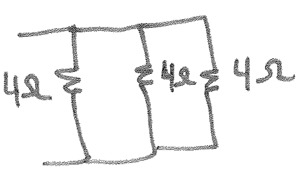


$\frac{1}{R} = \frac{1}{4\Omega} + \frac{1}{4\Omega} = \frac{2}{4\Omega}$

$R = 2\Omega$

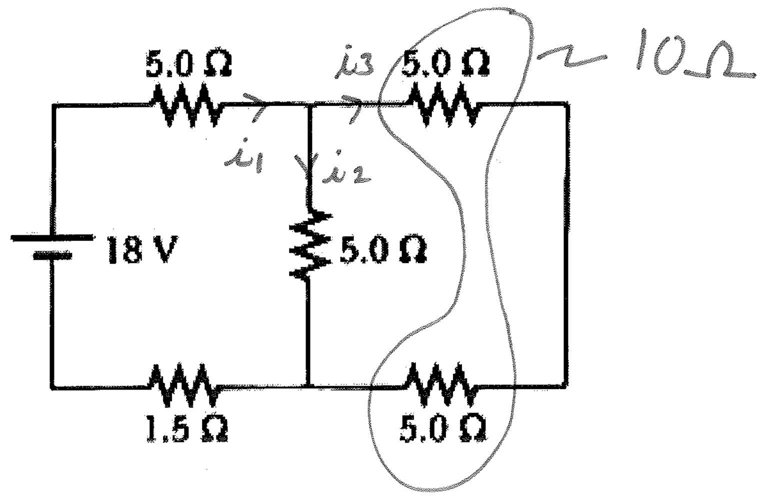


$\sim 4\Omega$

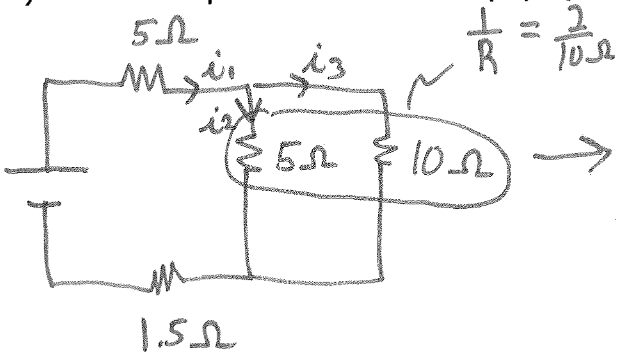


$\frac{1}{R_{tot}} = \frac{1}{4\Omega} + \frac{1}{4\Omega} + \frac{1}{4\Omega} = \frac{3}{4\Omega}$

$R_{tot} = \frac{4}{3}\Omega$ or 1.75Ω //

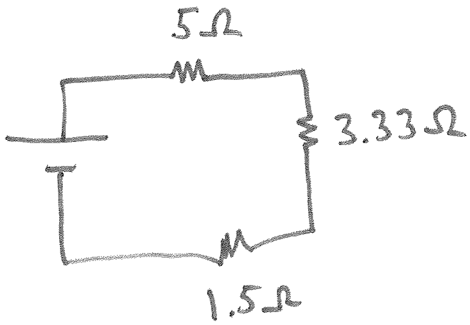


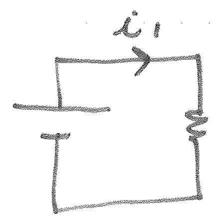
3) Use the circuit above to:
   a) Find the equivalent resistance (5 pts)



$\frac{1}{R} = \frac{2}{10\Omega} + \frac{1}{10\Omega} = \frac{3}{10\Omega}$

$R = \frac{10\Omega}{3} = 3.33\Omega$





$R_{tot} = 5\Omega + 3.33\Omega + 1.5\Omega$
$= 9.83\Omega$ //

$V = iR$

b) Find the 3 currents. (5 pts)

$$i_1 = \frac{\mathcal{E}}{R_{tot}} = \frac{18V}{9.83\Omega} = 1.83A$$

$$V \text{ for } 3.33\Omega = (1.83A)(3.33\Omega) = 6.1V$$

so

$$i_2 = \frac{6.1V}{5\Omega} = 1.22A$$

$$V \text{ for } 10\Omega = V \text{ for } 5\Omega = (5\Omega)(1.22A) = 6.1V$$

so

$$i_3 = \frac{6.1V}{10\Omega} = .61A$$

does $i_1 = i_2 + i_3$?

$$1.83A \stackrel{?}{=} (1.22A) + (.61A) = 1.83A \quad \text{O.K.}$$