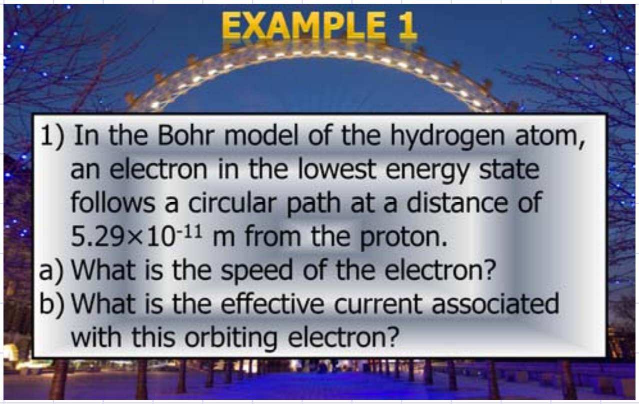
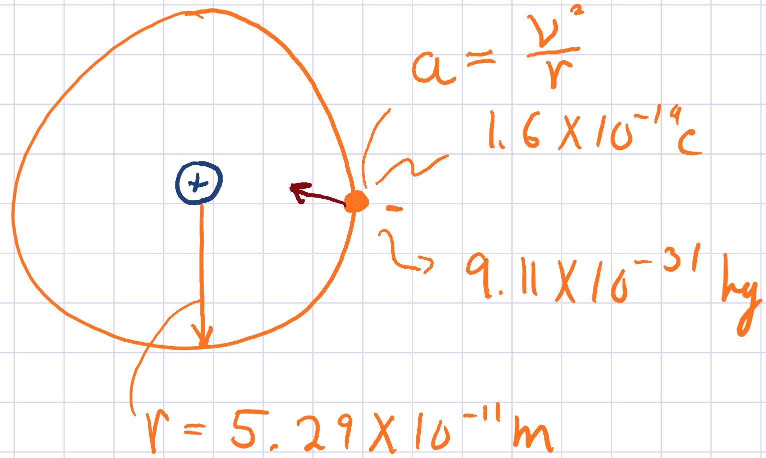
Example 1

Monday, March 9, 2015 7:38 AM





$$\Sigma F = ma$$

$$F = m\frac{v^2}{r}$$

$$k\frac{q_1 q_2}{r^{\not 2}} = m\frac{v^2}{\not r}$$

$$v = \sqrt{\frac{k q_1 q_2}{m r}}$$

$$v = \sqrt{\frac{(9\times10^9\, N\frac{m^2}{C^2})(1.6\times10^{-19}\,C)^2}{(9.11\times10^{-31}\,kg)(5.27\times10^{-11}\,m)}}$$

$N \rightarrow kg\, m/s^2$

$$v = 2.19\times10^6\ m/s$$

b) $i = \frac{q}{t}$ $\qquad v = \frac{d}{t}$

$$i = \frac{qv}{2\pi r} \qquad v = \frac{2\pi r}{t}$$

$$i = \frac{(1.6\times10^{-19}\,C)(2.19\times10^6\,m/s)}{2\pi(5.27\times10^{-11}\,m)} \qquad t = \frac{2\pi r}{v}$$

$$i = 1.05\times10^{-3}\ A \longrightarrow \boxed{1.05\ mA}$$

Stuff that may help!

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

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

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

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

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

$$W = \Delta U$$

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

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

$$F = qE$$

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

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

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

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

1

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

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

$$q = CV$$

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

$$V = iR$$

$$P = i^2 R$$

$$P = iV$$

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

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

$$F = ma$$

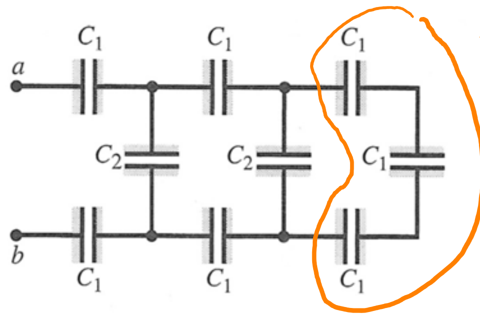
Question 1

Wednesday, March 11, 2015 7:09 AM

Review
TEST 2

Name_______________________________

Show all work in the spaces provided.

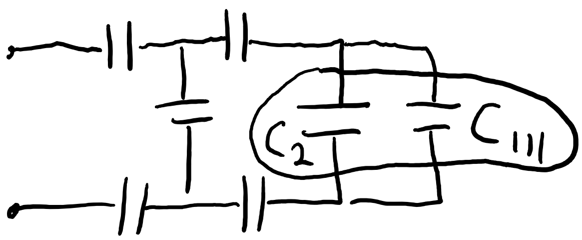


$$\frac{1}{C_{111}} = \frac{1}{C_1} + \frac{1}{C_1} + \frac{1}{C_1}$$

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

$$C_{111} = 2.3\,\mu F$$

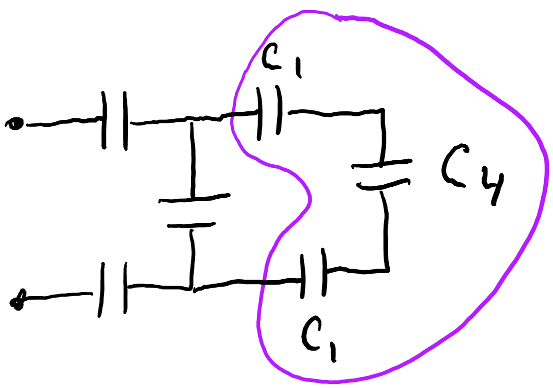
1) In the figure above each capacitance C_1 is 6.9 μF and each capacitance C_2 is 4.6 μF.
   a) Compute the equivalent capacitance of the circuit between points a and b. (5 pts)



$$C_4 = C_2 + C_{111}$$

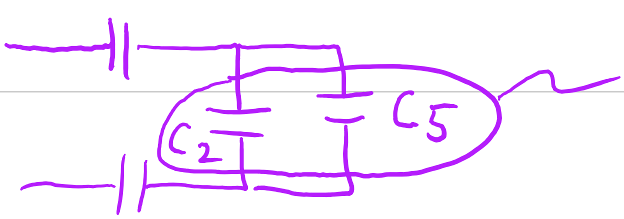
$$C_4 = 4.6\,\mu F + 2.3\,\mu F$$

$$C_4 = 6.9\,\mu F = C_1$$



$$\frac{1}{C_5} = \frac{1}{C_1} + \frac{1}{C_1} + \frac{1}{C_1}$$

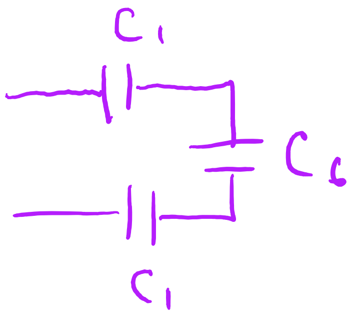
$$C_5 = 2.3\,\mu F$$



$$C_6 = C_2 + C_5$$

$$C_6 = 4.6\,\mu F + 2.3\,\mu F$$

$$C_6 = 6.9\,\mu F = C_1$$



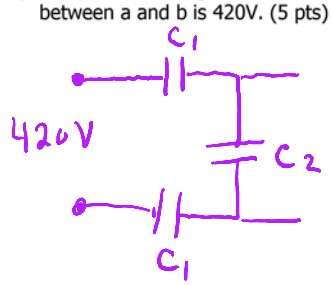
$$\frac{1}{C_{tot}} = \frac{1}{C_1} + \frac{1}{C_1} + \frac{1}{C_6}$$

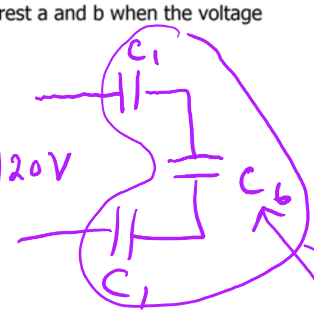
$$C_{tot} = 2.3\ \mu F$$

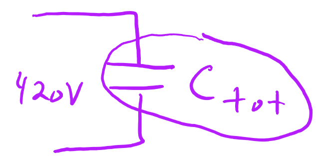
Question 1 B

Wednesday, March 11, 2015 7:09 AM

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)





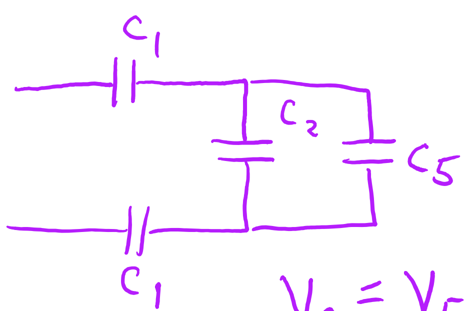


$q_{tot} = (420V)(2.3\mu F)$

$q_{tot} = 966 \mu C$

$q_1 = 966 \mu C$

$q_6 = 966 \mu C$



$V_2 = V_5 = V_6$

$q_6 = C_6 V_6$

$V_6 = \frac{q_6}{C_6}$

$V_6 = \frac{966 \mu C}{6.9 \mu F}$

$V_6 = 140 V$

$V_2 = 140V$

$q_2 = V_2 C_2 = (140V)(4.6\mu F)$

$q_2 = 644 \mu C$

Question 2

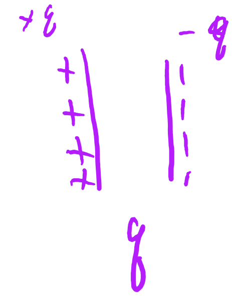
Wednesday, March 11, 2015 7:09 AM

2) A nervous Physicist worries that two metal shelves of his wood frame bookcase might obtain a high voltage if charged by static electricity, perhaps produced by friction.

a) What is the capacitance of the empty shelves if they have area 0.100 m² and are 0.200 m apart? (5 pts)

$$C = \frac{\kappa \epsilon_0 A}{d} = \frac{(1)(8.85 \times 10^{-12} \frac{C^2}{N \cdot m})(.1 m^2)}{.2 m}$$

$$C = 4.43 \times 10^{-12} F = 4.43 pF$$



b) What is the voltage between them if the opposite charges of magnitude 2.00 nC are placed on them? (5 pts)

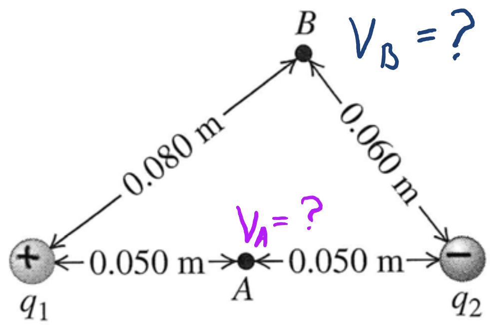
$$q = CV$$

$$V = \frac{q}{C} = \frac{2 \times 10^{-9} c}{4.43 \times 10^{-12} F}$$

$$V = 451.47 V$$

Question 3

Wednesday, March 11, 2015 7:09 AM



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)

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

$$V_A = -738\,V$$

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

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

$$V_B = -705\,V$$

c) What is the work done by the electric field on a charge of 2.50 nC (q_3) that travels from point B to Point A? (4 pts.)

$$W = q\,\Delta V$$

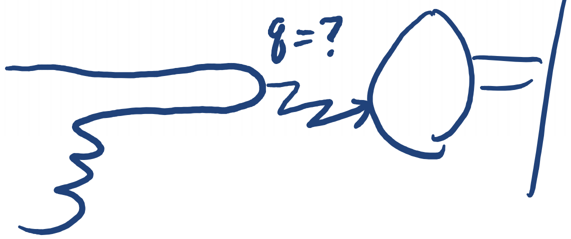
$$W = q_3\left[V_f - V_i\right] = q_3\left[V_A - V_B\right]$$

$$W = (2.5\times10^{-9}C)\left[-738\,V - (-705\,V)\right]$$

$$W = -8.25\times10^{-8}\,J$$

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 $1.5\times10^{-7}J$. How many electrons jump from your hand to the knob? (10 pts)

$\Delta V = 3\times10^{4}\,V$



$W = \Delta V q$

$q = \frac{W}{\Delta V}$

$q = \frac{1.5\times10^{-7}J}{-3\times10^{4}V}$

$q = -5\times10^{-12}C$

$\#\text{ electrons} = \frac{-5\times10^{-12}C}{-1.6\times10^{-19}C/e} = 3.125\times10^{7}\text{ electrons}$