Quiz #9

Physics 221

Names: Solution

1. A capacitor has an electric field of 4.0×10^5 V/m between the plates. If the plates have an area of 2×10^{-4} m^2 and are separated by 5 mm, find
   a. The energy stored between the plates.
   b. If a proton is placed 1 mm from the positive plate, what is the magnitude of the acceleration of the proton?
   c. If a proton is placed 1 mm from the negative plate, what is the magnitude of the acceleration of the proton?

Energy stored in a capacitor.

a) $U_C = \frac{1}{2} Q \Delta V = \frac{1}{2} C \Delta V^2 = \frac{1}{2} Q^2/C$

$\vec{E} = 4.0 \times 10^5$ V/m

$\Delta V = -E \Delta x = 4.0 \times 10^5 \text{ V/m} \cdot 5 \times 10^{-3} \text{ m} = 2000 \text{ V}$ ← This is very large!

$$C = \frac{\varepsilon_0 A}{d} = \frac{8.85 \times 10^{-12} \frac{C^2}{Nm^2} \cdot 2 \times 10^{-4} m^2}{5 \times 10^{-3} m} = 3.54 \times 10^{-13} F$$

$U_C = \frac{1}{2} C \Delta V^2$

$= \frac{1}{2} 3.54 \times 10^{-13} F \cdot (2000 \text{ V})^2$

$= 7.08 \times 10^{-7} J$

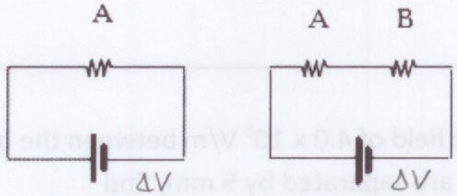
b) $\vec{F} = q\vec{E}$ & $\vec{F} = m\vec{a}$ so $q\vec{E} = m\vec{a}$

$$\vec{a} = \frac{q\vec{E}}{m} = \frac{1.6 \times 10^{-19} C \cdot 4.0 \times 10^5 \text{ V/m}}{1.67 \times 10^{-27} kg} = 3.83 \times 10^{13} \text{ m/s}^2$$

c) same as b)

The electric field of a capacitor is uniform. No matter where you place the proton between the plates, it feels the same force.

2. How does the power delivered to resistor A change when resistor B is added?



Circuit 1 Circuit 2

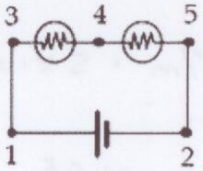
$\Delta V_A + \Delta V_B = \Delta V$

Potential difference has to divide between A & B so A has less power than before.

a. Power of A in circuit 1 is greater than Power of A in circuit 2
b. Power of A in circuit 1 is less than power of A in circuit 2
c. Power of A in circuit 1 is equal to the power of A in circuit 2

3. Rank the potential difference between points 1 and 2, points 1 and 3, points 3 and 4, and points 4 and 5 in the circuit shown below from highest to lowest.

$\Delta V_{13} = 0$



$\Delta V_{45} = 0$

$\Delta V_{12} = \Delta V_{34} + \Delta V_{45}$

a. $\Delta V_{12} > \Delta V_{34} = \Delta V_{45} > \Delta V_{13}$
b. $\Delta V_{12} = \Delta V_{34} = \Delta V_{45} > \Delta V_{13}$
c. $\Delta V_{12} > \Delta V_{34} > \Delta V_{45} > \Delta V_{13}$
d. $\Delta V_{13} > \Delta V_{34} > \Delta V_{45} > \Delta V_{13}$
e. None of the above: _____

$\Delta V = IR$ $I = \Delta Q/\Delta t$ $P = I\Delta V = (\Delta V)^2/R = I^2R$

proton mass: 1.67×10^{-27} kg