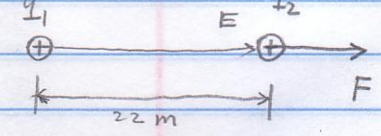
physics 1B spring 2010

Quiz 1

Version A

1. We can draw a diagram on the right side.



charge q_2 is repelled by the force F

$$F = q_2 \cdot E$$

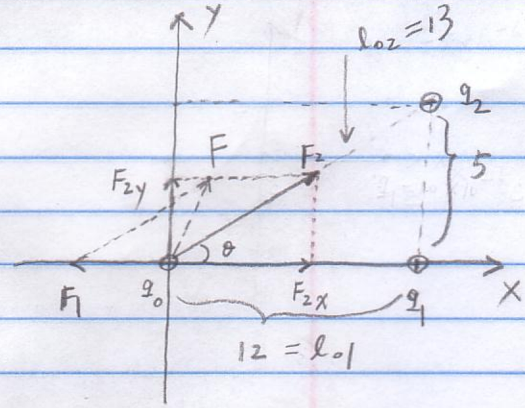
$$\text{so, } E = \frac{F}{q_2} = \frac{340 \times 10^{-6}\,N}{1.7 \times 10^{-6}\,C} = 200\ N/C$$

The answer is (C).

2. $q_0 = -4 \times 10^{-6}$ C

$q_1 = 10 \times 10^{-6}$ C

$q_2 = -5 \times 10^{-6}$ C



q_2 attracts q_0, and q_1 repels q_0.
The forces produced by q_1, q_2 are labeled by F_1, F_2.

$$F_1 = \frac{k|q_0||q_1|}{(l_{01})^2} = \frac{8.99 \times 10^9\ N \cdot m^2/C^2 \times 4 \times 10^{-6}\,C \times 10 \times 10^{-6}\,C}{(12\,m)^2}$$

$$= 2.497 \times 10^{-3}\ N \qquad (\text{pointing to } -x)$$

$$F_2 = \frac{k|q_0||q_2|}{(l_{02})^2} = \frac{8.99 \times 10^9\ N \cdot m^2/C^2 \times 4 \times 10^{-6}\,C \times 5 \times 10^{-6}\,C}{(12^2 + 5^2)\ m^2}$$

$$= 1.064 \times 10^{-3}\ N$$

$F_{2x} = F_2 \cos\theta \qquad \cos\theta = \frac{12}{13}$

$F_{2y} = F_2 \sin\theta$

$$F = \sqrt{(F_{2x} - F_1)^2 + F_{2y}^2}$$

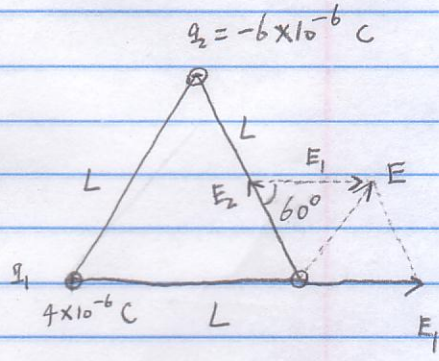
$$= \sqrt{F_{2x}^2 + F_1^2 - 2F_1 F_{2x} + F_{2y}^2} = \sqrt{F_1^2 + F_2^2 - 2F_1 F_{2x}}$$

$= \sqrt{F_1^2 + F_2^2 - 2F_1 \cdot F_2 \cos\theta}$

$= \sqrt{(2.497 \times 10^{-3} N)^2 + (1.064 \times 10^{-3} N)^2 - 2 \times 2.497 \times 10^{-3} N \times 1.064 \times 10^{-3} N \times \frac{12}{13}}$

$= 1.57 \times 10^{-3}$ N

The answer is (e).



3. Draw a diagram like this.
q_1 creates E_1, q_2 creats E_2.
The marked angle is $60°$ since this is an equilateral triangle.
The magnitude of E_1 & E_2

$$E_1 = \frac{k|q_1|}{L^2} = \frac{8.99 \times 10^9 N \cdot m^2/C^2 \times 4 \times 10^{-6} C}{(0.1)^2 m^2} = 35.96 \times 10^5 \frac{N}{C}$$

$$E_2 = \frac{k|q_2|}{L^2} = \frac{8.99 \times 10^9 N \cdot m/C^2 \times 6 \times 10^{-6} C}{(0.1)^2 m^2} = 53.94 \times 10^5 \frac{N}{C}$$

For total E,

$$E = \sqrt{E_1^2 + E_2^2 - 2E_1 \cdot E_2 \cdot \cos\theta} \quad (\text{here } \theta = 60°)$$

$$= \sqrt{E_1^2 + E_2^2 - E_1 \cdot E_2}$$

$$= \sqrt{(35.96 \times 10^5 \frac{N}{C})^2 + (53.94 \times 10^5 \frac{N}{C})^2 - 35.96 \times 10^5 \frac{N}{C} \times 53.94 \times 10^5 \frac{N}{C}}$$

$$= 47.57 \times 10^5 \frac{N}{C}$$

$$\approx 4.8 \times 10^6 \frac{N}{C}$$

The answer is (d)

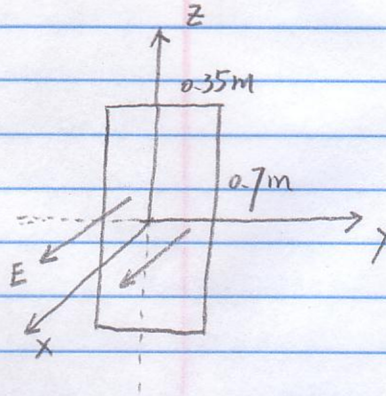
4.

The electrix flux is

$$\phi = E \cdot S$$

$$= 3.5 \times 10^3 \frac{N}{C} \times 0.7m \times 0.35m$$

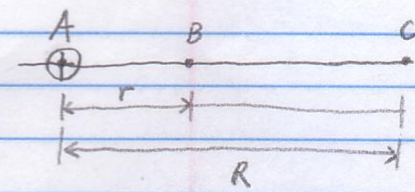
$$= 858 \; N \cdot m^2/C$$



The answer is (d).

5. The electric field of a charge is

$$E = \frac{kQ}{r^2}$$



We put a charge Q at A. Then

$$E_B = \frac{kQ}{r^2} = E \quad (\text{here } r = 2m)$$

$$E_C = \frac{kQ}{R^2} = \frac{E}{9}$$

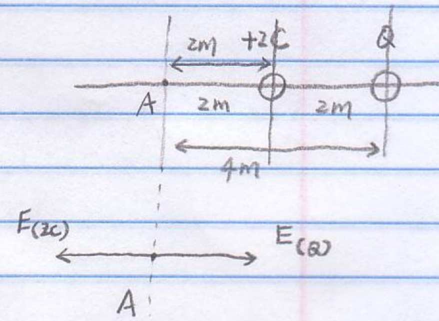
So,

$$\frac{E_B}{E_C} = \frac{E}{E/9} = 9 = \frac{\frac{kQ}{r^2}}{\frac{kQ}{R^2}} = \left(\frac{R}{r}\right)^2 \Rightarrow \frac{R}{r} = 3 \qquad R = 6m$$

The answer is (b)

6. At point A, the E field is zero.

$$E_{(2C)} = \frac{k \cdot (2C)}{(2m)^2}$$



$$E_{(Q)} = \frac{k \cdot Q}{(4m)^2}$$

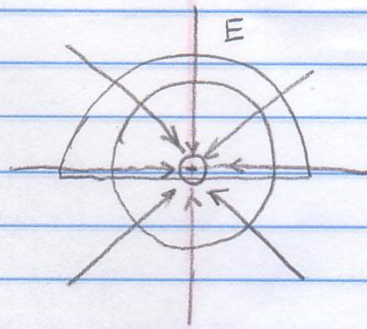
$$E_{(2C)} + E_{(Q)} = 0$$

So, $$\frac{K(2C)}{(2m)^2} + \frac{kQ}{(4m)^2} = 0 \Rightarrow Q = -8C$$

The answer is (d)

7. The total electric flux through the sphere is

$$\phi = \frac{q}{\varepsilon_0}$$



This shell is spherical, and it means the numbers of the electric lines through each hemisphere are the same.

so,

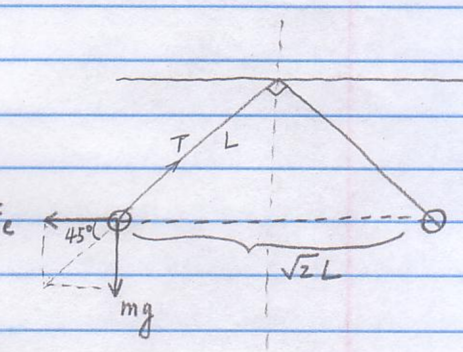
$$\phi_{(hemi)} = \frac{1}{2}\frac{q}{\varepsilon_0} = \frac{1}{2} \times \frac{-15 \times 10^{-9}\ C}{8.85 \times 10^{-12}\ C^2/(N \cdot m^2)}$$

$$= -0.85 \times 10^{3}\ \frac{N \cdot m^2}{C}$$

this "minus" sign tells us it's pointing in.

The answer is (a).

8. This figure shows a stable case. It means the net forces along x and y are 0. But in this problem, $\theta = 45°$,



so. $F_e = mg$ ...... ①

And from the geometrical relation, two masses are seperated by $\sqrt{2}L$.

$$F_e = \frac{kQ^2}{(\sqrt{2}L)^2} \quad \text{....} \ ②$$

Combine ① & ②.

$$\frac{kQ^2}{(\sqrt{2}L)^2} = mg \Rightarrow Q = \sqrt{\frac{mg}{k}} \times \sqrt{2}L$$

$$= \sqrt{\frac{10 \times 10^{-3}\,kg \times 10\,\frac{N}{kg}}{8.99 \times 10^{9}\,N \cdot m^2/C^2}} \times \sqrt{2} \times 120 \times 10^{-2}\,m$$

$$= 5.6 \times 10^{-6}\ C = 5.6\,\mu C$$

The answer is (d).