Model answer

Physics 1

2014-2015

Model answer (11-1-2015).

The first question

a) 1-equipotential surface is the the surface with equal potential on all points lies on it

v_{ab} =0, w_{ab}=0 E perpendicular on the surface

2- Potential gradient define as the change in electric potential with respect to radial distance

$$\frac{dV}{dr} = E$$

3-potential difference between two points is define as the work don per unit charge to transferee between this points

$$V_{ab} = \frac{W_{ab}}{q}$$

b) The derivation on lecture notes

c) 1- $E = E_a = E_b = \frac{\sigma}{\epsilon_0} = \frac{25\ c/m^2}{8.85\times10^{-12}} = 28.25 \times 10^{11}\ \ V/m$

2- the potential difference between the pates a and b

$$V_{ab} = EL = 28.25 \times 10^{11}\ \frac{V}{m} \times 0.25m = 7.06\ V$$

3- the potential gradient at point a equal that at point b each are equal E where

$$\frac{dV}{dr} = E = E_a = E_b = \frac{\sigma}{\epsilon_0} = \frac{25\ c/m^2}{8.85 \times 10^{-12}} = 28.25 \times 10^{11}\ \ V/m$$

4- the kinetic energy of charge 40 μC when transfer between a and b

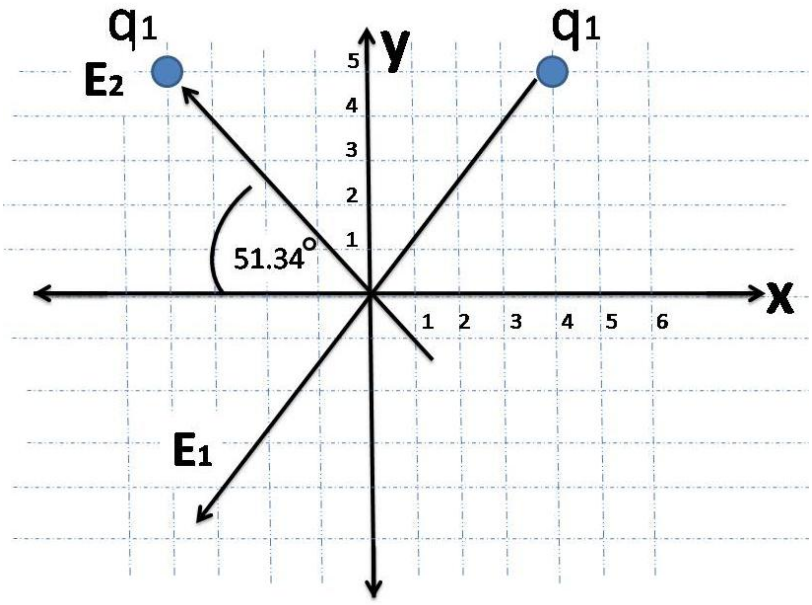
$$K.E = qV_{ab} = 40 \times 10^{-6} C \times 7.06\ V = 2.823 \times 10^{-4}\ Joule$$

The second question

a) The derivation on lecture notes

b) The derivation on lecture notes

c)



2- to find e at origin

$$E_1 = \frac{Kq_1}{r_1^2} = \frac{9 \times 10^9 \times 4 \times 10^{-6}}{[(0.05)^2 + (0.04)^2]\, m^2} = 8.78 \times 10^6\ N$$

$$\boldsymbol{E_X} = -E_1 cos\,\theta - E_2 cos\theta = -2 \times 8.78 \times 10^6\ N \times \cos(51.34) = -10.97 \times 10^6\ N$$

$$\boldsymbol{E_Y} = -E_1 sin\theta$$

$$E_O = \sqrt{E_X^2 + E_Y^2} = \sqrt{(10.97 \times 10^6\ N)^2 + (13.71 \times 10^6\ N)^2} = 17.558 \times 10^6\ N$$

3-

$$\boldsymbol{V_O = V_1 + V_2 = \frac{Kq_1}{r_1} + \frac{Kq_2}{r_2} = \frac{9 \times 10^9 \times 4 \times 10^{-6}}{\sqrt{(0.05)^2 + (0.04)^2}} - \frac{9 \times 10^9 \times 4 \times 10^{-6}}{\sqrt{(0.05)^2 + (0.04)^2}} = 0\ volt}$$

4- potential energy on q_1

$$\boldsymbol{\in_P = \frac{Kq_1q_2}{r_{21}} = \frac{9 \times 10^9 \times 4 \times 10^{-6} \times (-4 \times 10^{-6})}{0.08\ m} = -1.8\ joule}$$

5- potential energy on q_2 is the same on q_1 equal $\boldsymbol{-1.8\ joule}$

6- the electric potential at point a is due to charge q_2

$$V_a = \frac{Kq_2}{\boldsymbol{r_{12}}} = \frac{9 \times 10^9 \times (-4 \times 10^{-6})}{\boldsymbol{0.8\ m}} = -4.5 \times 10^5\ V$$

7- the electric potential at point b is due to charge q_1

$$V_b = \frac{Kq_1}{\boldsymbol{r_{12}}} = \frac{9 \times 10^9 \times (+4 \times 10^{-6})}{\boldsymbol{0.8\ m}} = +4.5 \times 10^5\ V$$

8-the electric potential difference between points a and b

$$\boldsymbol{V_{ab}} = V_a - V_b == -4.5 \times 10^5\ V - 4.5 \times 10^5\ V = -9 \times 10^5\ V$$

9- the electric flux at sphere surface of center at origin and radius 7cm
The two charges lies inside the sphere so the electric flux

$$\varphi = \frac{q_1 + q_2}{\epsilon_0} = \frac{4 \times 10^{-6} - 4 \times 10^{-6}}{\epsilon_0} = 0$$

The third question:

1- The capacitance of a capacitor of given dimensions is several times larger with a dielectric separating its plates due to the fact that the dielectric strength of the dielectric material is larger than that of air.
2- Since the charges in the dielectric are not free to move (they are bounded to a molecule), their displacement does not proceed to such an extent that the induced field in the dielectric is weakened but not reduced to zero, as it would be in the interior of the conductor.
3- The resistivity of semiconductor decreases rapidly with increasing the temperature due to the rapid increase in the number of charge carriers (n). This increase in (n) outweighs any increase in the constant (k) according to the relation $\rho = k / n q2$. So , the resistivity will decrease by increasing the temperature.
4- In winter, temperature is low. This affects on the movement of the ions in the battery, so the internal resistance increases and the drawn current decreases. This will affect on the emf of the battery.

b- d = 1.5 cm , A = 25 cm^2 , V = 250 V , k = 4

C = ε_o A/ d = 1.474 PF Q = CV = 368.4 PC

There is no change in the charge of the capacitor after the immersion in water.
2- C after immersion = 4 x 1.474 = 5.896 PF

V after immersion = 250 / 4 = 62.5 V
3- Change in the energy = ½ Q^2 (1/ C after - 1/ C before) = - 3.453 x 10^{-8} J

The forth question:

a- Ohmic conductor obeys Ohm′s law if its resistance between any two points is independent of the magnitude and the polarity of the potential difference applied between these points. Also, it obeys Ohm′s law if its resistivity is independent of the magnitude and the direction of the electric field. Also,

according to the relation $\rho = k / n q2$, if k and n are constants, the resistivity is constant and Ohm's law is obeyed .

Definitions : 1- Electromotive force is the work done per coulomb on the charge passing through a battery, generator, or other source of electrical energy. It is equal to the potential difference across the terminals of the source when no current flows. This potential difference is less than e m f because of the internal resistance of the battery or the source

$$V = \varepsilon - I r,$$

Where V is the terminal voltage, ε is e m f and I r is the potential drop due to the internal resistance of the battery. E m f is measured in volts.

2- Electric power: It is the rate of transfer of the electric energy. This energy may be transferred to mechanical energy (motors) or to chemical energy (battery) or to heat (resistor). Power = du /dt = VI = I^2R = V^2 /R J/s =Watt

3- Terminal velocity: Because of the inelastic collision between a free charged particle in a conductor with one of the fixed particles, the free electron moves with an average velocity in the direction of the driving force .This is called the drift velocity .When the driving force equals the viscous force, the free electron moves with constant terminal velocity.

4- Non-polar molecule is one in which the center of gravity of the positive charges coincide normally on the center of gravity of the negative charges.

C- Solving the following equatios

$I_3 = I_1 + I_2$

…….... (1)

$12 - 4 = (1+3) I_1 - (5+1) I_2$

……(2) in loop (1)

$4 = (1+5) I_2 + 8 I_3$

……(3) in loop (2)

We get $I_1 = 1.308$, $I_2 = - 0.462$ and $I_3 = 0.846$ A