AP Physics – Electric Fields – 5 ans

1. If a metal sphere is given a positive charge, does its mass change? What would happen? Why?

2. A balloon is vigorously rubbed with a piece of fur so that it gains a charge. You place it against the wall and it sticks. Does the wall therefore have a positive charge? Explain your answer.

3. A 125 kg 4.00 m plank sticks out from the wall. A cable is hooked to the end of it and ties into the wall above. It makes a 62.0° angle with the plank. A barrel of nails with a total weight of 545 N sits on the plank, 1.10 m from the outside end. Find the tension in the cable and the components of the force exerted by the wall on the plank.

$$\tau_{Cable} - \tau_{Beam} - \tau_{nails} = 0 \qquad (T\sin\theta)d - m_B g\frac{d}{2} - F_{Nails}d_{nails} = 0 \qquad T = \frac{m_B g\frac{d}{2} + F_{nails}d_{nails}}{d\sin\theta}$$

$$T = \frac{(125\ kg)\left(9.8\ \frac{m}{s^2}\right)\frac{(4.00\ m)}{2} + (545\ N)(4m - 1.10\ m)}{(4.00\ m)\sin 62.0^0} = \boxed{1140\ N}$$

Y direction: $T\sin\theta + F_y - F_{Beam} - F_{nails} = 0 \qquad F_y = F_{Beam} + F_{nails} - T\sin\theta$

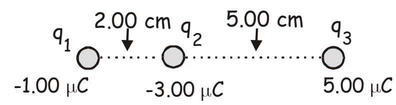
$$F_Y = 125\ kg\left(9.8\ \frac{m}{s^2}\right) + 545\ N - (1140\ N)\sin 62.0^0 = \boxed{763\ N}$$

X direction $T\cos\theta - F_X = 0 \qquad F_X = T\cos\theta = (1140\ N)\cos 62.0^0 = \boxed{535\ N}$

4. Find the force between charges of +100.0 μC and -75.0 μC. They are 13.5 cm apart.

$$F = \frac{1}{4\pi\in_0}\frac{q_1q_2}{r^2} = \left(8.99\ x\,10^9\ \frac{Nm^2}{C^2}\right)\frac{(100.0\ x\,10^{-6}\ C)(75.0\ x\,10^{-6}\ C)}{(0.135\ m)^2} = 3\ 700\ 000\ x\,10^{-3}\ N = \boxed{3.70\ x\,10^3\ N}$$

5. Three charges are arranged as shown. Find the force acting on the center charge.



$$F_{12} = \frac{1}{4\pi\in_0}\frac{q_1q_2}{r^2} = \left(8.99\ x\,10^9\ \frac{Nm^2}{C^2}\right)\frac{(1.00\ x\,10^{-6}\ C)(3.00\ x\,10^{-6}\ C)}{(0.0200\ m)^2} = 67420\ x\,10^{-3}\ N = 67.42\ N$$

$$F_{23} = \frac{1}{4\pi\in_0}\frac{q_1q_2}{r^2} = \left(8.99\ x\,10^9\ \frac{Nm^2}{C^2}\right)\frac{(3.00\ x\,10^{-6}\ C)(5.00\ x\,10^{-6}\ C)}{(0.0500\ m)^2} = 53940\ x\,10^{-3}\ N = 53.94\ N$$

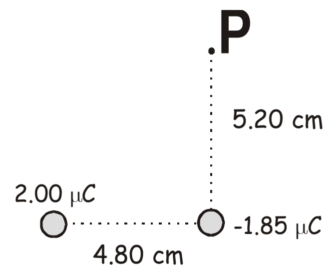
$$F = F_{12} + F_{23} = 67.42\ N + 53.94\ N = \boxed{121\ N}$$

6. How does an electrophorus work?

7. A charge of 15.5 μC is placed 12.8 cm from a second charge. If the force between the charges is 22.5 N, what is the magnitude of the second charge?

$$F = \frac{1}{4\pi\in_0}\frac{q_1q_2}{r^2} \qquad q_2 = \frac{Fr^2}{\left(\frac{1}{4\pi\in_0}\right)q_1} \qquad q_2 = \frac{(22.5\ N)(0.128\ m)^2}{\left(8.99\ x\,10^9\ \frac{Nm^2}{C^2}\right)(15.5\ x\,10^{-6}\ C)} = 0.00264\ x\,10^{-3}C = \boxed{2.65\ \mu C}$$

8. Three charges are arranged as shown. (a) Find the electric potential at P. (b) how much work would it take to bring in a charge of 1.25 μC from infinity to point P?



$$V = \frac{1}{4\pi \epsilon_0} \sum_i \frac{q_i}{r_i} \qquad V = \frac{1}{4\pi \epsilon_0} \frac{q}{r} \qquad \text{for } q_2$$

$$V_2 = \left(8.99\, x\, 10^9 \frac{Nm^2}{C^2}\right)\left(-1.85\, x\, 10^{-6} C\right)\left(\frac{1}{0.0520\, m}\right)$$

$$V_2 = -320.\, x\, 10^3 V \quad = \quad -3.20\, x\, 10^5\, V$$

Need r₁: $r_1 = \sqrt{(0.0480\, m)^2 + (0.0520\, m)^2} = 0.0708\, m$

$$V_1 = \left(8.99\, x\, 10^9 \frac{Nm^2}{C^2}\right)\left(2.00\, x\, 10^{-6} C\right)\left(\frac{1}{0.0708\, m}\right) = 254\, x\, 10^3 V \quad = 2.54\, x\, 10^5 V$$

$$V = V_1 + V_2 \quad = 2.54\, x\, 10^5 V - 3.20\, x\, 10^5 V \quad = -0.660\ \ x\, 10^5 V \quad = \quad \boxed{-6.60\, x\, 10^4 V}$$

(b) How much work to bring a third point charge of 1.25 μC from infinity to P?

$$V = \frac{W}{q} \qquad W = qV \qquad W = \left(1.25\, x\, 10^{-6} C\right)\left(6.60\, x\, 10^4 \frac{J}{C}\right) \quad = \quad \boxed{8.25\, x\, 10^{-2} J}$$

9. A proton is accelerated from rest through a potential difference of 9.0 V. Find (a) the energy of the particle, and (b) the speed of the particle.

(a) $U = qV \quad = \left(1.60\, x\, 10^{-19} C\right)\left(9.0 \frac{J}{C}\right) \quad = 14.4\, x\, 10^{-19} J = \boxed{1.44\, x\, 10^{-18} J}$

(b) $U = K = \frac{1}{2} mv^2 \qquad v = \sqrt{\frac{2U}{m}} \quad = \sqrt{\frac{2\left(1.44\, x\, 10^{-18} \frac{kg \cdot m^2}{s^2}\right)}{1.67\, x\, 10^{-27} kg}}$

$$v = \sqrt{1.725\, x\, 10^9 \frac{m^2}{s^2}} \quad = \sqrt{17.25\, x\, 10^8 \frac{m^2}{s^2}} \quad = \quad \boxed{4.15\, x\, 10^4 \frac{m}{s}}$$