

Phys132 - Fund. Phys. 2
Homework 6

Name: Solutions
Due Wed, Jan 31, 2007

Reading Assignment: Make sure you have read all of Chapter 19, Sections 19.1 through 19.5 and 19.7.

1. If it takes 10 J of work to push a 2 C charge through an electric field, (a) what will its electric potential (i.e. voltage) be with respect to the starting point? (b) If you then let go of it, what will its kinetic energy be as it flies past the starting position?

$$\Delta V = W/q = (10 \text{ J}) / (2 \text{ C}) = 5 \text{ V}$$

Answer: (a) 5V (b) 10J

2. A charge of $q_1 = +2.5 \times 10^{-6} \text{ C}$ exerts a force on another charge $q_2 = 7.5 \times 10^{-6} \text{ C}$. The force has a magnitude of $F_{21} = 6.0 \text{ N}$. What is the magnitude of F_{12} , the force exerted on q_1 by q_2 ?

- (a) 2.0 N
(b) 6.0 N
(c) 18.0 N

Action - Reaction

$$F_{12} = F_{21}$$

3. Measurements show that there is an electric field surrounding the earth. The field points down (toward the center of the earth) with a magnitude of 100 N/C. Use Gauss's Law to find the charge of the earth.

$$A_{\text{earth}} = 5.12 \times 10^{14} \text{ m}^2$$

$$Q_{\text{enc}} = Q_{\text{earth}} = -4.53 \times 10^5 \text{ C}$$

$$A_{\text{earth}} = 4\pi R_{\text{earth}}^2$$

$$= 5.115 \times 10^{14} \text{ m}^2$$

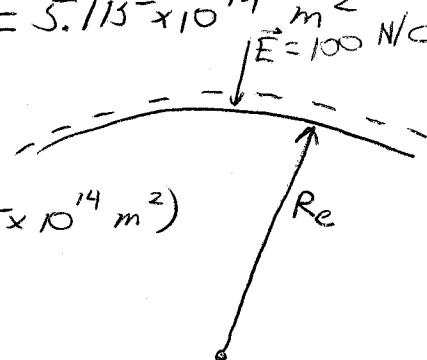
$$\Phi = EA = \frac{Q_{\text{enc}}}{\epsilon_0}$$

$$Q_{\text{enc}} = \epsilon_0 EA$$

$$= (8.85 \times 10^{-12} \frac{\text{C}^2}{\text{N}\cdot\text{m}^2}) (100 \text{ N/C}) (5.115 \times 10^{14} \text{ m}^2)$$

$$= -4.53 \times 10^5 \text{ C}$$

Negative
b/c inward



4. A charge $q = -4.0 \mu\text{C}$ is moved 0.25 m **horizontally** through a region where the electric field is $E = 150 \text{ V/m}$ directed **vertically**. What is the change in the electric potential energy of the charge?

- (a) $-2.4 \times 10^{-3} \text{ J}$
(b) $-1.5 \times 10^{-4} \text{ J}$
(c) zero joules
(d) $+1.5 \times 10^{-4} \text{ J}$
(e) $+2.4 \times 10^{-3} \text{ J}$

$$W = F_{\text{ave}} d$$

L displacement along the force

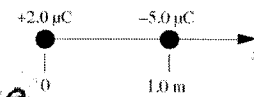
$d=0$, b/c force is vertical

See Section 6.1 of the book.

5. Two point charges are arranged along the x axis as shown in the figure. At which of the following values of x is the electric potential equal to zero? (Note: at infinity, the electric potential is zero.)
 (a) +0.05 m (b) +0.29 m (c) +0.40 m (d) +0.54 m (e) +0.71 m

$$V = k \frac{q_1}{R_1} + k \frac{q_2}{R_2} = 0 \quad \frac{2}{x} - \frac{5}{1-x} = 0$$

$$0 = 2(1-x) - 5x = 2 - 7x \rightarrow x = 0.29 \text{ m}$$



6. The electric potential difference between a storm cloud and the ground is 100 million volts. If a charge of 2 C is transferred from the cloud to the earth during the flash of a lightning bolt, what is the change in potential energy of the charge?

Answer: $200 \times 10^6 \text{ J}$

$$\Delta EPE = q_0 \Delta V = (2 \text{ C})(100 \times 10^6 \text{ V}) = 200 \times 10^6 \text{ J}$$

7. An electron and a proton are initially very far apart (effectively, $r = \infty$). They are then brought together to form a hydrogen atom, in which the electron orbits the proton at an average distance of $5.29 \times 10^{-11} \text{ m}$. What is the change in the electric potential energy?

Answer: $-4.35 \times 10^{-18} \text{ J}$ Take the proton to be the "cause"

$$V = \frac{kq}{R} = (8.99 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2}) \frac{(1.6 \times 10^{-19} \text{ C})}{(5.29 \times 10^{-11} \text{ m})} = 27.2 \text{ V}$$

$$EPE = q_0 V = (-1.6 \times 10^{-19} \text{ C})(27.2 \text{ V}) = -4.35 \times 10^{-18} \text{ J}$$

8. Two point charges are separated by a distance R . If the distance between the charges is cut in half, what happens to the total electric potential energy of the system?

- (a) It is doubled
 (b) It remains the same.
 (c) It increases by a factor of 4.
 (d) It is reduced to one-half of the original value.
 (e) It is reduced to one-fourth of the original value.

$$\boxed{2} \cdot EPE = kq_1q_2 \frac{1}{\boxed{\frac{1}{2}}R}$$