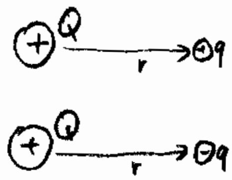
8.02X PSET 3 SOLUTIONS

PROBLEM 1



$U_+ = \frac{kQq}{r}$

$U_- = -\frac{kQq}{r}$

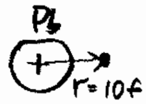
$U_{r\to\infty} = 0$

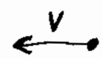
a) the charge +q has greater potential energy at r than at ∞.

b) $U_+ - U_- = 2\frac{kQq}{r}$

c) the electric potential doesn't depend on q, $V = \frac{U_+}{q} = k\frac{Q}{r} \left(= \frac{U_-}{-q} \right)$

PROBLEM 2





conservation of energy:

at infinity $E_K = \frac{1}{2}mv^2$

at closest distance $E_p = k\frac{Qq}{r}$

$E_{K(\infty)} = E_{P(r)}$

giving $v = \sqrt{\frac{2kQq}{mr}}$

take $q = 1.6 \times 10^{-19}$ C

$m = 1.7 \times 10^{-27}$ kg

$k = 9.0 \times 10^9 \frac{Nm^2}{C^2}$

$Q = 82q$

$1f = 10^{-15}$ m

we obtain $v \simeq 1.5 \times 10^8$ m/s

PROBLEM 3

$Q = Q_A + Q_B$

a) the potential of both spheres is constant, because the charge distribution is static now. If there was a place with lower potential, the charge would flow there freely. It doesn't ⇒ V = const.

b) The potentials of the spheres are equal $V_A = k\frac{Q_A}{A}$ $V_B = k\frac{Q_B}{B}$ ⇒ $\frac{Q_A}{Q_B} = \frac{A}{B}$

The ratio of electric field strengths is

$$\frac{E_A}{E_B} = \frac{k\frac{Q_A}{A^2}}{k\frac{Q_B}{B^2}} = \frac{Q_A}{Q_B}\frac{B^2}{A^2} = \frac{B}{A}$$

The electric field is stronger near the smaller sphere.