A uniform electric field of magnitude 100 V/m is directed in the positive x-direction. (+2C) charge moves from origin to the point (x, y) = (3m, 4m).

a) What is the change in the potential energy of this charge?

b) Through what potential difference did the charge move? (\( k = 9 \times 10^9 \text{ N.m}^2/\text{C}^2 \))
In an electrical potential field given by \( V(x,y) = 50xy - 10x \), calculate the electrostatic force that would act on a charge of \( q = +2 \text{C} \) at location \( (x,y) = (1m, 2m) \).

\( (k = 9 \times 10^9 \text{ N.m}^2/\text{C}^2) \)

\[
\vec{F} = -\vec{E} = -\left( \frac{\partial V}{\partial x} \hat{i} + \frac{\partial V}{\partial y} \hat{j} \right) = -(50y-10) \hat{i} - 50x \hat{j} \\
\vec{E}(1,2) = (-90 \hat{i} - 50 \hat{j}) \text{ N/C} \\
\vec{F}(1,2) = q \vec{E}(1,2) = (-180 \hat{i} - 100 \hat{j}) \text{ N}
\]
PHYS 102: General Physics 2  
KOÇ UNIVERSITY  
College of Arts and Sciences  
Spring Semester 2013  

Section 3  
Quiz 3  
28 February 2013  

Closed book. No calculators are to be used for this quiz.  
Quiz duration: 10 minutes  

Name:  
Student ID:  
Signature:  

Four equal negative charges \( q = -2C \), are positioned on the corners of a square with side \( a = 1m \). Find the potential at the center of the square, assuming that the potential is zero at infinity.  

\[
V = k \frac{q}{r} 
\]

\[
V_i = k \frac{q_i}{r} = -18.5 \times 10^3 \text{ V} = V_2 = V_3 = V_4 
\]

\[
V = \lim_{r \to \infty} V_i = 0 \quad \checkmark 
\]

\[
V_{\text{tot}} = V_1 + V_2 + V_3 + V_4 = -72.5 \times 10^3 \text{ V} 
\]

by Superposition Principle
Two concentric spherical shells with radii $R$ and $2R$ are uniformly charged with $Q$ and $-Q$, respectively. Find the electric potential at a distance $3R/2$ from the center.

\[ E = \frac{dV}{dr} \quad \text{and} \quad E = E_{1} + E_{2} \]

\[ V = V_{1} + V_{2} = \frac{kQ}{3R} - \frac{kQ}{2R} = \frac{kQ}{6R} \]
PHYS 102: General Physics 2  KOÇ UNIVERSITY  Spring Semester 2013

College of Arts and Sciences

Section 5  Quiz 3  28 February 2013

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name:  Student ID:  Signature:

Point charges $2Q$ and $-Q$ are located at positions $(0,0,0)$ and $(1,0,0)$ respectively. Find two points $(x_1,0,0)$ and $(x_2,0,0)$ on the $x$-axis where the electric potential is zero.

\[ V = \frac{kQ}{r} \quad \text{(potential of a point charge)} \]

\[ \overbrace{0 \quad x_1 \quad 1}^{q_1 = 2Q} \quad x \quad q_2 = -Q \]

For the total potential $V = V_1 + V_2$ to be zero, the points $x_1$ & $x_2$ should be closer to $q_2 = -Q$ than $q_1 = 2Q$.

For point $x_1$:

\[ V = \frac{k(-Q)}{x_1} + \frac{k2Q}{x_1 - 1} = 0 \]

\[ \frac{2kQ}{x_1} = \frac{kQ}{x_1 - 1} \Rightarrow 2x_1 - 2 = x_1 \Rightarrow x_1 = 2 \]

For point $x_2$:

\[ V = \frac{k(-Q)}{1 - x_2} + \frac{k2Q}{x_2} = 0 \]

\[ \frac{2kQ}{x_2} = \frac{kQ}{1 - x_2} \Rightarrow 2 - 2x_2 = x_2 \Rightarrow x_2 = \frac{2}{3} \]
Two conducting spheres with radii $r_1$ and $r_2$ are separated by a distance much greater than both $r_1$ and $r_2$. The spheres are connected by a conducting wire as in the figure. If the charges on the spheres in equilibrium are $q_1$ and $q_2$ respectively,

i.) Find the ratio of the electric fields ($E_1/E_2$) at the surfaces of the spheres.

ii.) Which one is greater?