Unit 7 - Week 6

Assignment 6

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2020-03-11, 23:59 IST.

Energy of an assembly of point charges

Three charges, $\{-q, +q, -q\}$ are situated at the corners of a square of side a, such that a nearest neighbor always has opposite charge.

1) How much work does it take to bring in another charge, $+q$, from far away and place it in the fourth corner, diagonally opposite to the other $+q$ charge? *4 points*

- Work = $\frac{q}{4\pi\epsilon_0 a}\left(-2-\frac{1}{\sqrt{2}}\right)$
- Work = $\frac{q^2}{4\pi\epsilon_0 a}\left(-2+\frac{1}{\sqrt{2}}\right)$
- Work = $\frac{1}{4\pi\epsilon_0 a}\left(2+\frac{1}{\sqrt{2}}\right)$
- Work = $\frac{q^2}{4\pi\epsilon_0 a}\left(-2-\frac{1}{\sqrt{5}}\right)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
Work = $\frac{q^2}{4\pi\epsilon_0 a}\left(-2+\frac{1}{\sqrt{2}}\right)$

2) How much work does it take to assemble the whole configuration of four charges? *5 points*

- Total Work = $\frac{2q^2}{4\pi\epsilon_0 a}\left(-2+\frac{1}{\sqrt{2}}\right)$
- Total Work = $\frac{3q^2}{4\pi\epsilon_0 a}\left(-2+\frac{1}{\sqrt{2}}\right)$
- Total Work = $\frac{3q^2}{4\pi\epsilon_0 a}\left(-2-\frac{1}{\sqrt{5}}\right)$
- Total Work = $\frac{3q^2}{4\pi\epsilon_0 a}\left(2-\frac{1}{\sqrt{2}}\right)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
Total Work = $\frac{2q^2}{4\pi\epsilon_0 a}\left(-2+\frac{1}{\sqrt{2}}\right)$

Cavities in a conductor

Two spherical cavities of radii a and b are hollowed out from the interior of a neutral conducting sphere of radius R. At the center of each cavity a point charge is placed – call these charges $q_a$and q_b

3) What are the surface charge densities σ_a (on the surface of the sphere with radius a), σ_b (on the surface of the sphere with radius b), and σ_R (on the surface of the sphere with radius R)? *6 points*

- $\sigma_a = \frac{q_q}{4\pi a^2}$; $\sigma_b = \frac{q_b}{4\pi b^2}$; $\sigma_R = \frac{q_a - q_b}{4\pi R^2}$
- $\sigma_a = -\frac{q_q}{4\pi a^2}$; $\sigma_b = -\frac{q_b}{4\pi b^2}$; $\sigma_R = -\frac{q_a - q_b}{4\pi R^2}$
- $\sigma_a = -\frac{q_q}{4\pi R^2}$; $\sigma_b = -\frac{q_b}{4\pi R^2}$; $\sigma_R = -\frac{q_a + q_b}{4\pi(a^2+b^2)}$
- $\sigma_a = -\frac{q_q}{4\pi a^2}$; $\sigma_b = -\frac{q_b}{4\pi b^2}$; $\sigma_R = \frac{q_a + q_b}{4\pi R^2}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\sigma_a = -\frac{q_q}{4\pi a^2}$; $\sigma_b = -\frac{q_b}{4\pi b^2}$; $\sigma_R = \frac{q_a + q_b}{4\pi R^2}$

4) What is the electric field outside the conductor?($\vec{r}$ is a vector from the center of the large sphere) *4 points*

- $\vec{E}_{out} = -\frac{1}{4\pi\epsilon_0}\frac{q_a - q_b}{r^3}\hat{r}$
- $\vec{E}_{out} = \frac{1}{4\pi\epsilon_0}\frac{q_a + 2q_b}{r^4}\hat{r}$
- $\vec{E}_{out} = \frac{1}{4\pi\epsilon_0}\frac{q_a + q_b}{r^2}\hat{r}$
- $\vec{E}_{out} = \frac{1}{4\pi\epsilon_0}\frac{q_a - q_b}{r^2}\hat{r}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\vec{E}_{out} = \frac{1}{4\pi\epsilon_0}\frac{q_a + q_b}{r^2}\hat{r}$

5) What is the electric field inside each cavity? *4 points*

- $\vec{E}_a = \frac{1}{4\pi\epsilon_0}\frac{q_a}{r_a^2}\hat{r}_a$; $\vec{E}_b = \frac{1}{4\pi\epsilon_0}\frac{q_b}{r_b^2}\hat{r}_b$
- $\vec{E}_a = \frac{1}{4\pi\epsilon_0}\frac{q_b}{r_a^2}\hat{r}_a$; $\vec{E}_b = \frac{1}{4\pi\epsilon_0}\frac{q_a}{r_b^2}\hat{r}_b$
- $\vec{E}_a = \frac{1}{4\pi\epsilon_0}\frac{q_a - q_b}{r_a^2}\hat{r}_a$; $\vec{E}_b = \frac{1}{4\pi\epsilon_0}\frac{q_a + q_b}{r_b^2}\hat{r}_b$
- $\vec{E}_a = \frac{1}{4\pi\epsilon_0}\frac{q_a}{r_R^2}\hat{r}$; $\vec{E}_b = \frac{1}{4\pi\epsilon_0}\frac{q_b}{r_R^2}\hat{r}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\vec{E}_a = \frac{1}{4\pi\epsilon_0}\frac{q_a}{r_a^2}\hat{r}_a$; $\vec{E}_b = \frac{1}{4\pi\epsilon_0}\frac{q_b}{r_b^2}\hat{r}_b$

6) **Coaxial cable** *5 points*

What is the capacitance per unit length c of two coaxial metal cylindrical tubes of radii a and b $(b > a)$?

- $c = \frac{2\pi\epsilon_0}{exp\left(\frac{b}{a}\right)}$
- $c = \frac{2\pi\epsilon_0}{ln\left(\frac{b}{a}\right)}$
- $c = \frac{2\pi\epsilon_0}{\left(\frac{b}{a}\right)}$
- $c = \frac{2\pi\epsilon_0}{ln\left(\frac{a}{b}\right)}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$c = \frac{2\pi\epsilon_0}{ln\left(\frac{b}{a}\right)}$