Progress

Mentor

4 points

## Unit 7 - Week 6

## Course outline

How does an NPTEL online course work?

Week 1

Week 2

Week 3

Week 4

Week 5

Week 6

- Boundary conditions on electric field and potential
- Work and energy of an assembly of point charges
- General idea of energy in
- electrostatics
- Electrostatics with conductors
- Capacitors
- Boundary conditions and the

Laplace equation

- uniqueness theorems
- Week 6 Feedback :

Quiz : Assignment 6

Electromagnetism

Week 7

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Week 11

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Week 12

**Download Videos** 

Lecture materials

# **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,  $\left\{ -q, +q, -q \right\}$  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?
- 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.

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

Accepted Answers:

Score: 0

$$4\pi\epsilon_0 a \left( -\sqrt{2} \right)$$

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  $\sigma_a$  (on the surface of the sphere with radius a),  $\sigma_b$  (on the surface of the sphere with radius b), 6 points

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

and  $\sigma_R$  (on the surface of the sphere with radius R)?

 $\sigma_a = -\frac{q_q}{4\pi a^2}$ ;  $\sigma_b = -\frac{q_b}{4\pi b^2}$ ;  $\sigma_R = \frac{q_a + q_b}{4\pi R^2}$ No, the answer is incorrect.

## Score: 0 Accepted Answers:

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

$$4\pi a^2$$
  $4\pi b^2$   $4\pi R^2$   
4) What is the electric field outside the conductor?( $\vec{r}$  is a vector from the center of the large sphere)

4 points

4 points

5 points

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

### Score: 0 Accepted Answers:

No, the answer is incorrect.

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

- 5) What is the electric field inside each cavity?
- $\vec{E}_a = \frac{1}{4\pi\epsilon_0} \frac{q_a}{r_a^2} \hat{r}_a \; ; \; \vec{E}_b = \frac{1}{4\pi\epsilon_0} \frac{q_b}{r_b^2} \hat{r}_b$  $\vec{E}_a = \frac{1}{4\pi\epsilon_0} \frac{q_b}{r_a^2} \hat{r}_a$ ;  $\vec{E}_b = \frac{1}{4\pi\epsilon_0} \frac{q_a}{r_b^2} \hat{r}_b$
- $\vec{E}_a = \frac{1}{4\pi\epsilon_0} \frac{q_a q_b}{r_a^2} \hat{r}_a \; ; \; \vec{E}_b = \frac{1}{4\pi\epsilon_0} \frac{q_a + q_b}{r_b^2} \hat{r}_b$
- $\vec{E}_a = \frac{1}{4\pi\epsilon_0} \frac{q_a}{r_p^2} \hat{r}; \ \vec{E}_b = \frac{1}{4\pi\epsilon_0} \frac{q_b}{r_p^2} \hat{r}$ No, the answer is incorrect. Score: 0

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

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

Score: 0

Accepted Answers:

No, the answer is incorrect.