

Section 1. Sketching electric field vectors; sketching charge distribution and polarization

1. A neutral piece of glass is in a region of uniform electric field. Sketch the effect of the electric field on the plastic.

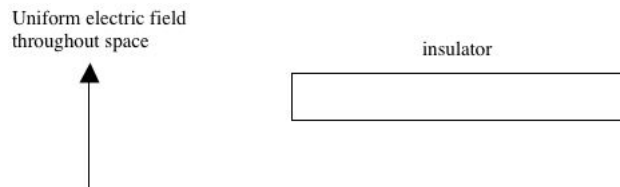


Figure 1:

2. A neutral piece of copper is in a region of uniform electric field. Sketch the effect of the electric field on the copper.

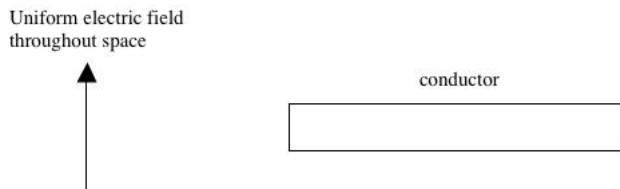


Figure 2:

3. Two oppositely charged spheres are very near a solid, charged disk (or "plate"). The charges on each object and their locations are such that a point A, the electric field due to the disk is equal in magnitude to the electric field due to the dipole. Sketch the net electric field at the following points: (1) point A; (2) point B; (3) at the center of the sphere with charge $+q$; (4) at the center of the sphere with charge $-q$. (Note that the radius of the disk is not drawn to scale.)

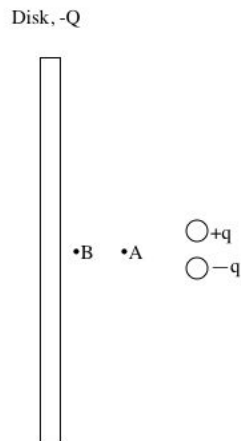


Figure 3:

A metal sphere has a charge of $+2Q$ and a plastic sphere has a uniformly distributed surface charge of $+Q$. The spheres are initially very far apart. The spheres are then brought closer together.

4. Sketch the charge distribution on each sphere when they are very far apart.

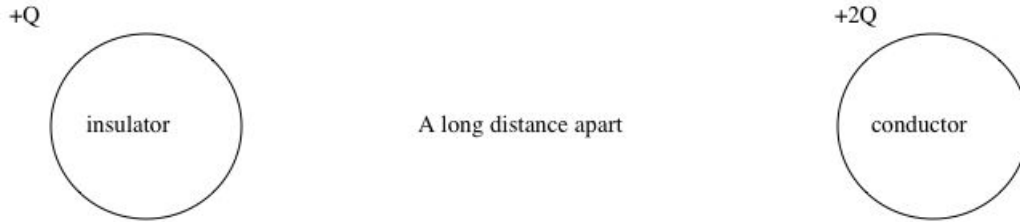


Figure 4:

5. Sketch the charged distribution on each sphere when they are close together. At the center of each sphere, sketch the following three vectors: (1) the electric field due to the charge on the surface of the sphere; (2) the electric field due to the other sphere; (3) the net electric field.

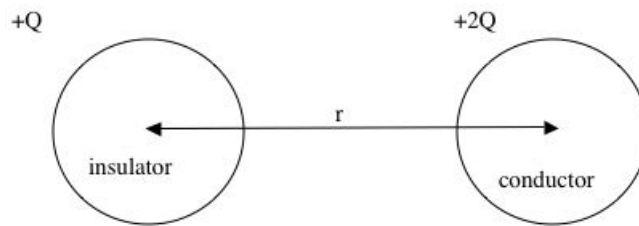


Figure 5:

6. In Figure 5, what is the electric field at the center of the conductor due to the charge on its surface if $|Q| = 1e - 7 \text{ C}$ and $r = 2.0 \text{ cm}$?

7. In Figure 5, what is the net electric field at the center of the insulator? Also, state two necessary assumptions that you must make in order to apply your simplified model.

A capacitor has two charged disks with charge $|Q| = 1e - 6$ C of radius 40 cm, separated 1 mm. Note: in the figure below, the radius of the disk is not drawn to scale.

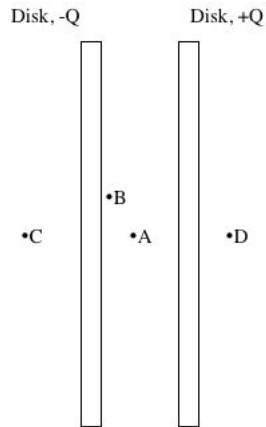


Figure 6:

8. Sketch the electric field vector at point A, point B, point C, and point D.
9. What is the magnitude of the electric field at point A?

Answer Key for Exam A

Section 1. Sketching electric field vectors; sketching charge distribution and polarization

1. A neutral piece of glass is in a region of uniform electric field. Sketch the effect of the electric field on the plastic.

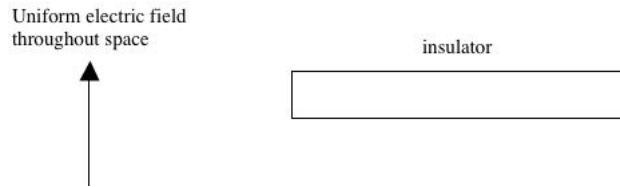


Figure 7:

Induced dipoles throughout material.

2. A neutral piece of copper is in a region of uniform electric field. Sketch the effect of the electric field on the copper.

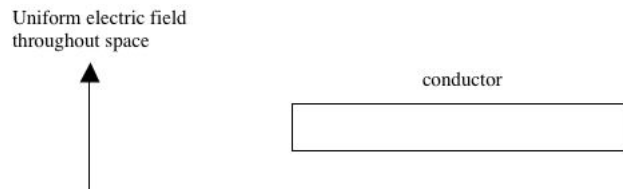


Figure 8:

Surface charge with + charge on top and — charge on bottom.

3. Two oppositely charged spheres are very near a solid, charged disk (or "plate"). The charges on each object and their locations are such that a point A, the electric field due to the disk is equal in magnitude to the electric field due to the dipole. Sketch the net electric field at the following points: (1) point A; (2) point B; (3) at the center of the sphere with charge $+q$; (4) at the center of the sphere with charge $-q$. (Note that the radius of the disk is not drawn to scale.)

A metal sphere has a charge of $+2Q$ and a plastic sphere has a uniformly distributed surface charge of $+Q$. The spheres are initially very far apart. The spheres are then brought closer together.

4. Sketch the charge distribution on each sphere when they are very far apart.
Uniformly spaced $+$ charge on each sphere; twice as much on the metal sphere.
5. Sketch the charged distribution on each sphere when they are close together. At the center of each sphere, sketch the following three vectors: (1) the electric field due to the charge on the surface of the sphere; (2) the electric field due to the other sphere; (3) the net electric field.

Surface charge on the plastic sphere is the same. Surface charge on the metal sphere is redistributed such that it piles up on the left side of the sphere. The net electric field inside the plastic sphere is due to the metal sphere and is to the right. The net electric field inside the metal sphere is zero. Thus, the surface charge on the metal sphere creates an electric field to the right that is equal in magnitude and opposite in direction to the electric field created by the plastic sphere that is to the left.

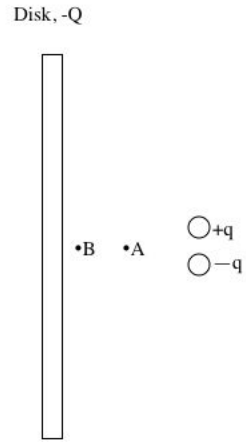


Figure 9:

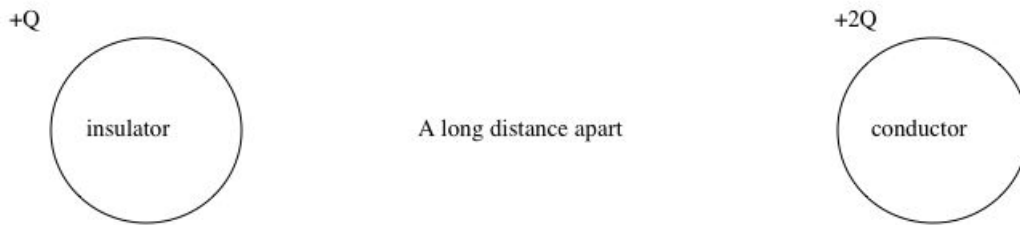


Figure 10:

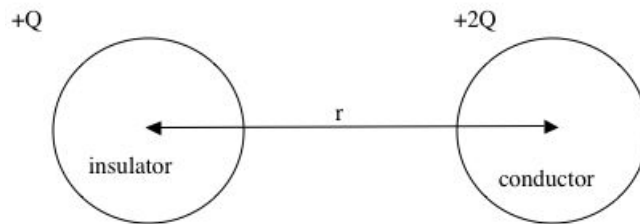


Figure 11:

6. In Figure 5, what is the electric field at the center of the conductor due to the charge on its surface if $|Q| = 1e - 7 C$ and $r = 2.0 \text{ cm}$?

7. In Figure 5, what is the net electric field at the center of the insulator? Also, state two necessary assumptions that you must make in order to apply your simplified model.

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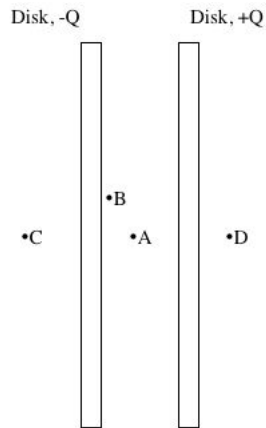


Figure 12:

8. Sketch the electric field vector at point A, point B, point C, and point D.
9. What is the magnitude of the electric field at point A?

10. What is the magnitude of the electric field at point B?

11. How does the magnitude of the electric field at points C and D compare with the electric field at points A and B?

12. You wish to find the electric field at a point P due to a charged rod. Describe the steps required to calculate the electric field. Note: these steps are the same whether you are doing it numerically or analytically.