Module 09: Conductors and Insulators; Conductors as Shields

Conductors

Conductors and Insulators

Conductor: Charges are free to move

Electrons weakly bound to atoms

Example: metals

Insulator: Charges are NOT free to move

Electrons strongly bound to atoms

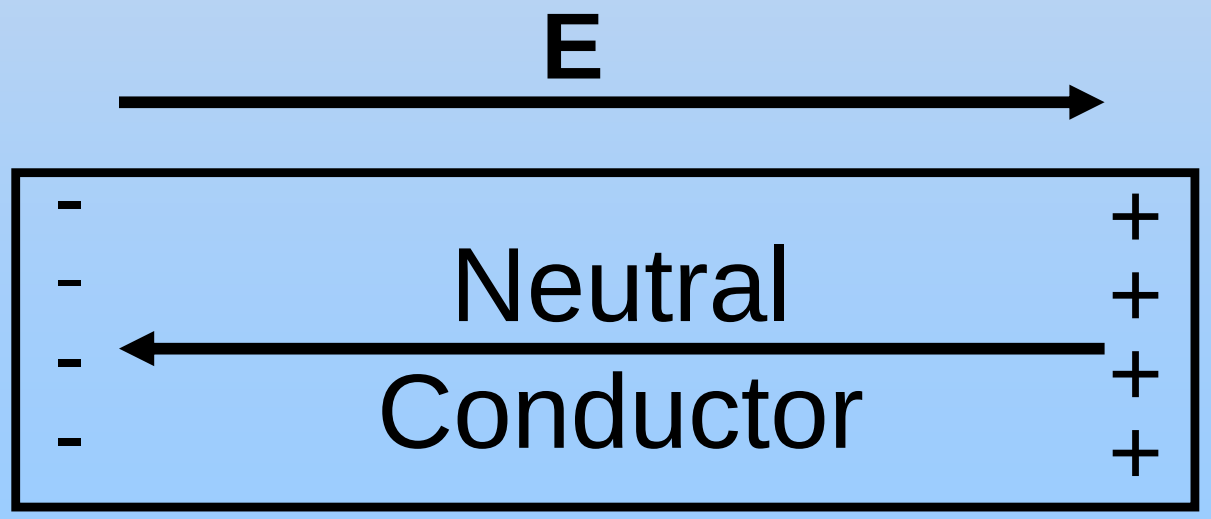
Examples: plastic, paper, wood

Conductors

Conductors have free charges

→ E must be zero inside the conductor

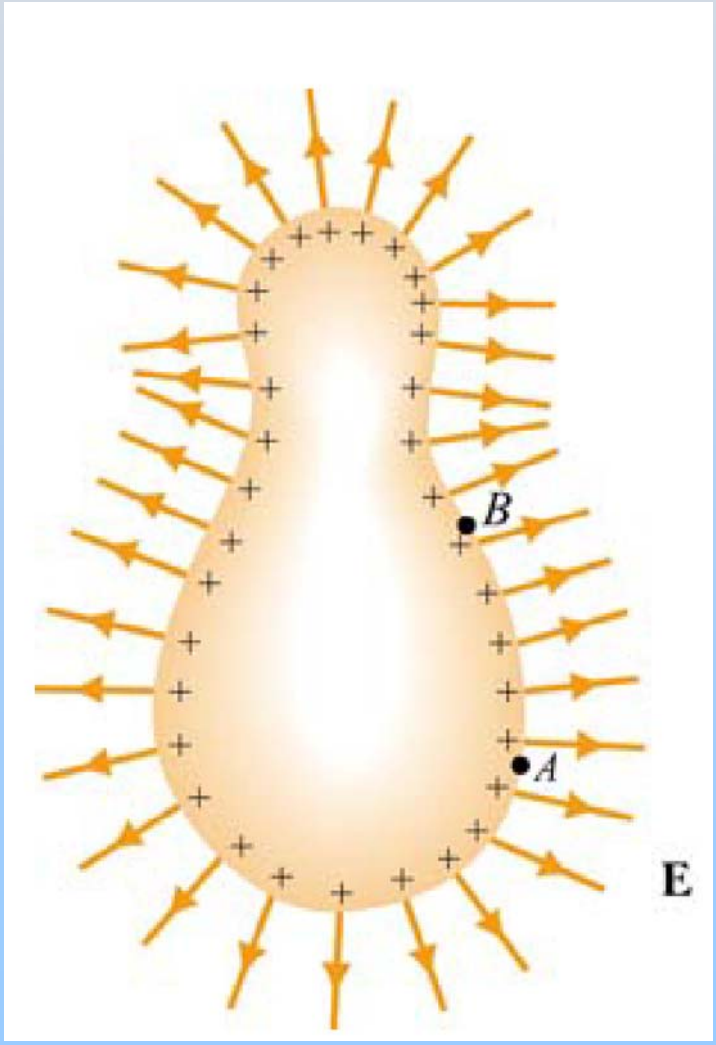
→ Conductors are equipotential objects



Conductors in Equilibrium

Conductors are equipotential objects:

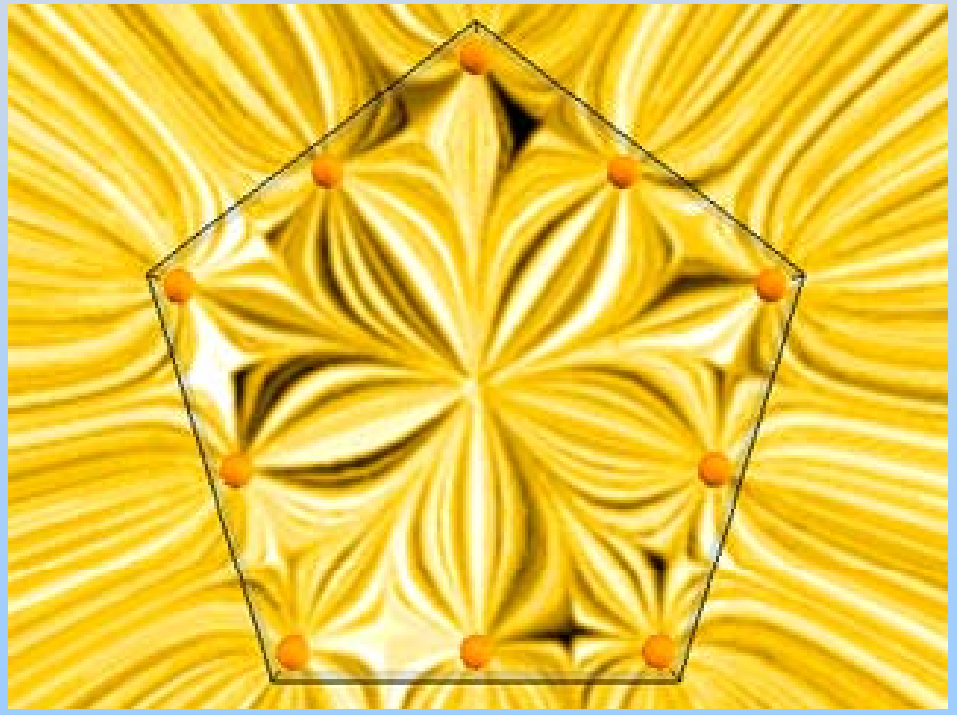
1) E = 0 inside
2) E perpendicular to surface
3) Net charge inside is 0



Conductors in Equilibrium: Free Charges Move To Surface

Put net charge inside conductor

It moves to get away from other charges



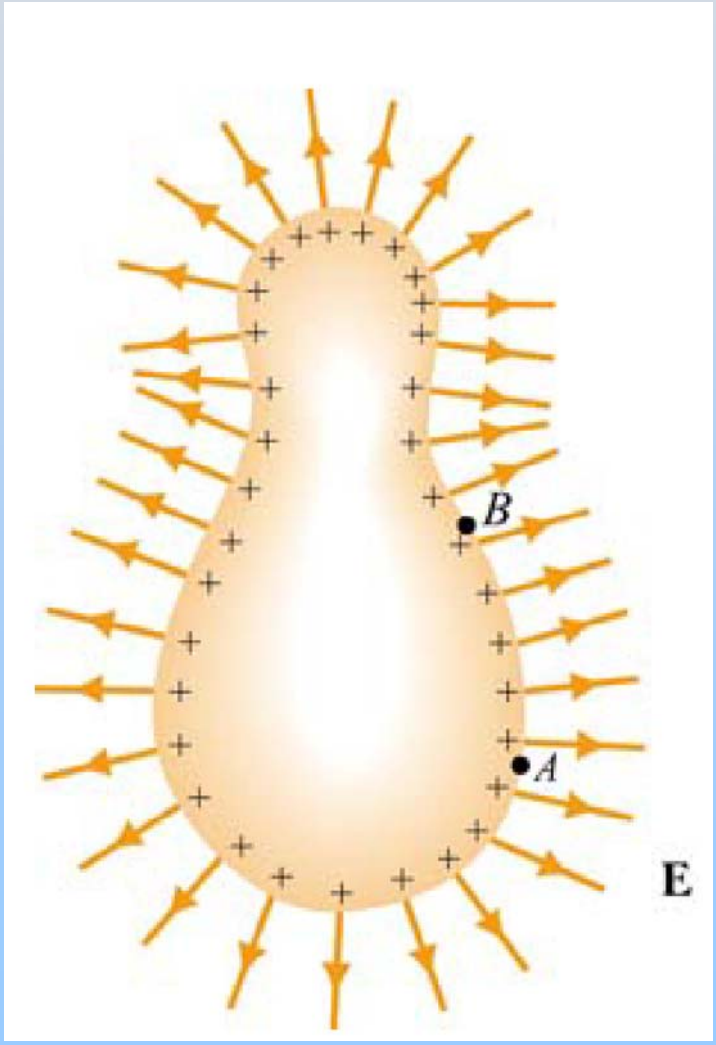
Java applet link

Conductors in Equilibrium

Conductors are equipotential objects:

1) E = 0 inside (Does V=0?)
2) E perpendicular to surface
3) Net charge inside is 0
4) Excess charge on surface

$$E = \sigma / \varepsilon_0$$

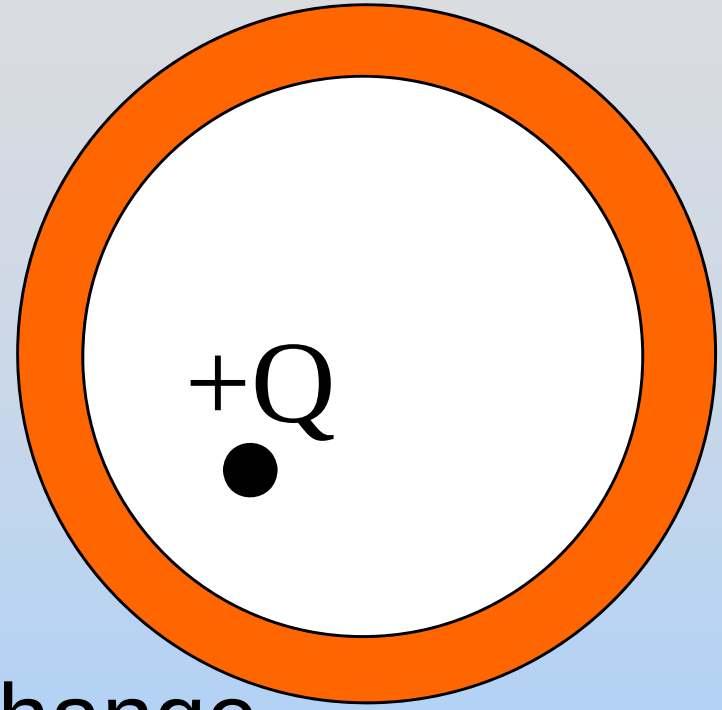


Conductors as Shields

Concept Question Question: Point Charge Inside Conductor

Concept Question: Point Charge in Conductor

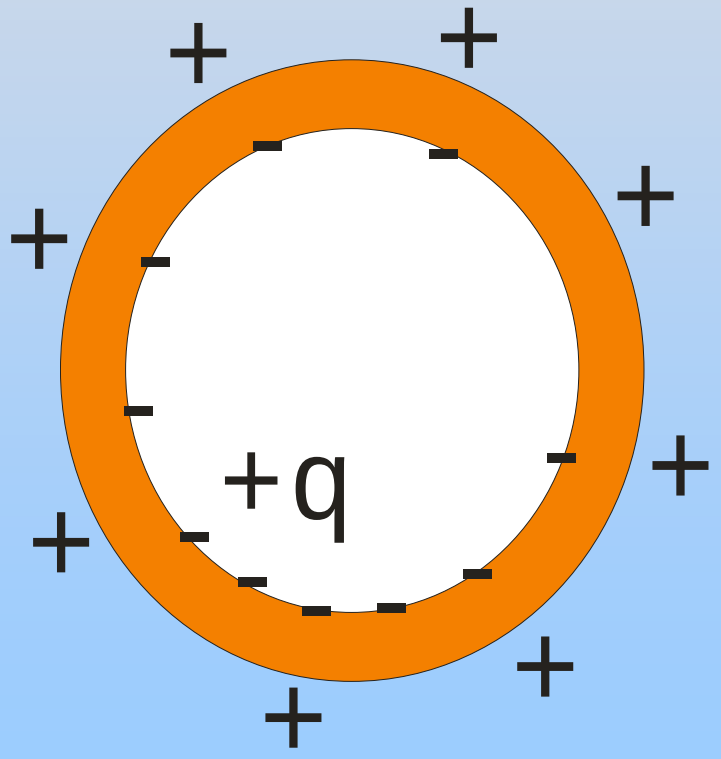
A point charge +Q is placed inside a neutral, hollow, spherical conductor. As the charge is moved around *inside*, the electric field ***outside***

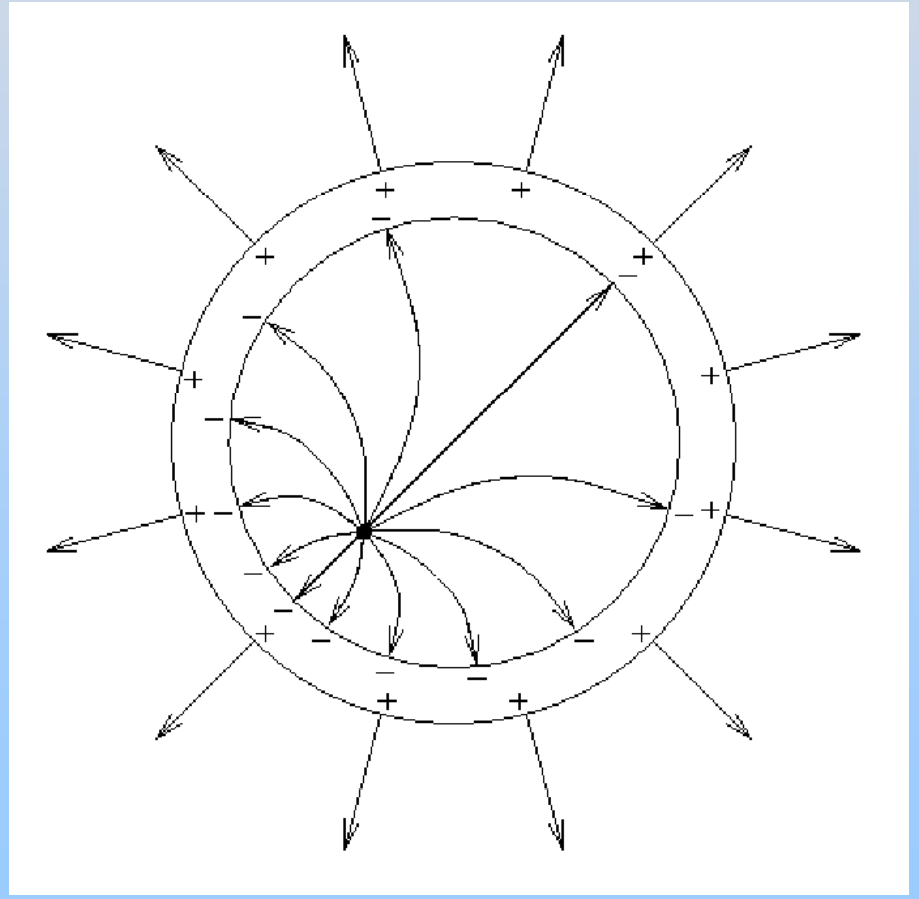


1. is zero and does not change
2. is non-zero but does not change
3. is zero when centered but changes
4. is non-zero and changes
5. I don't know

Hollow Conductors

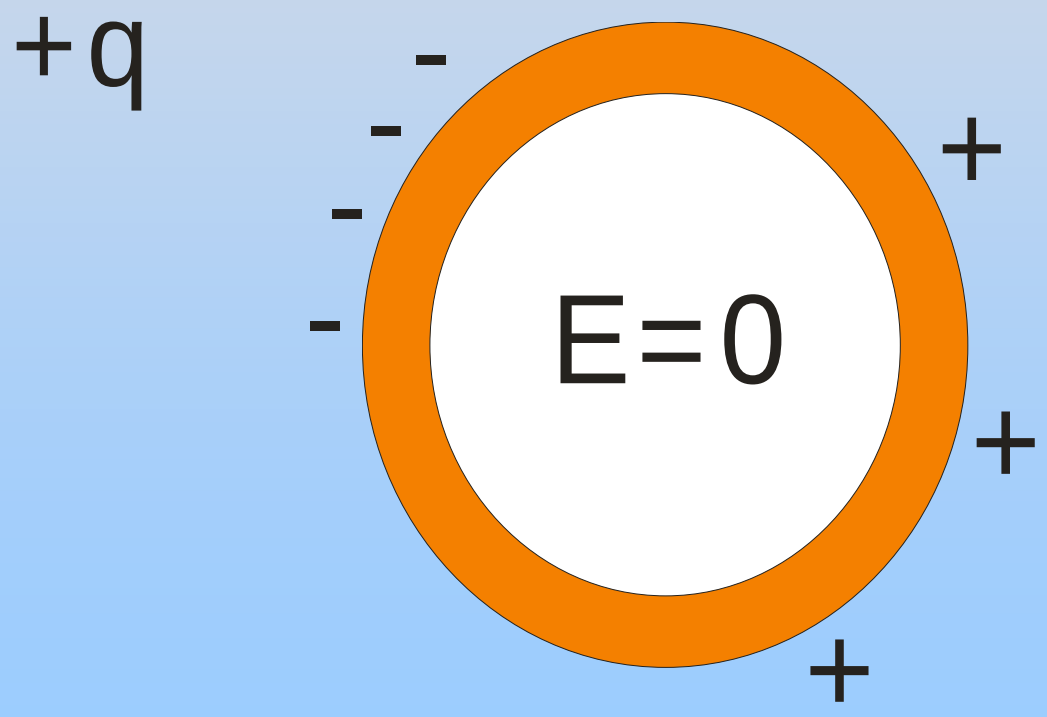
Charge placed INSIDE induces balancing charge ON INSIDE





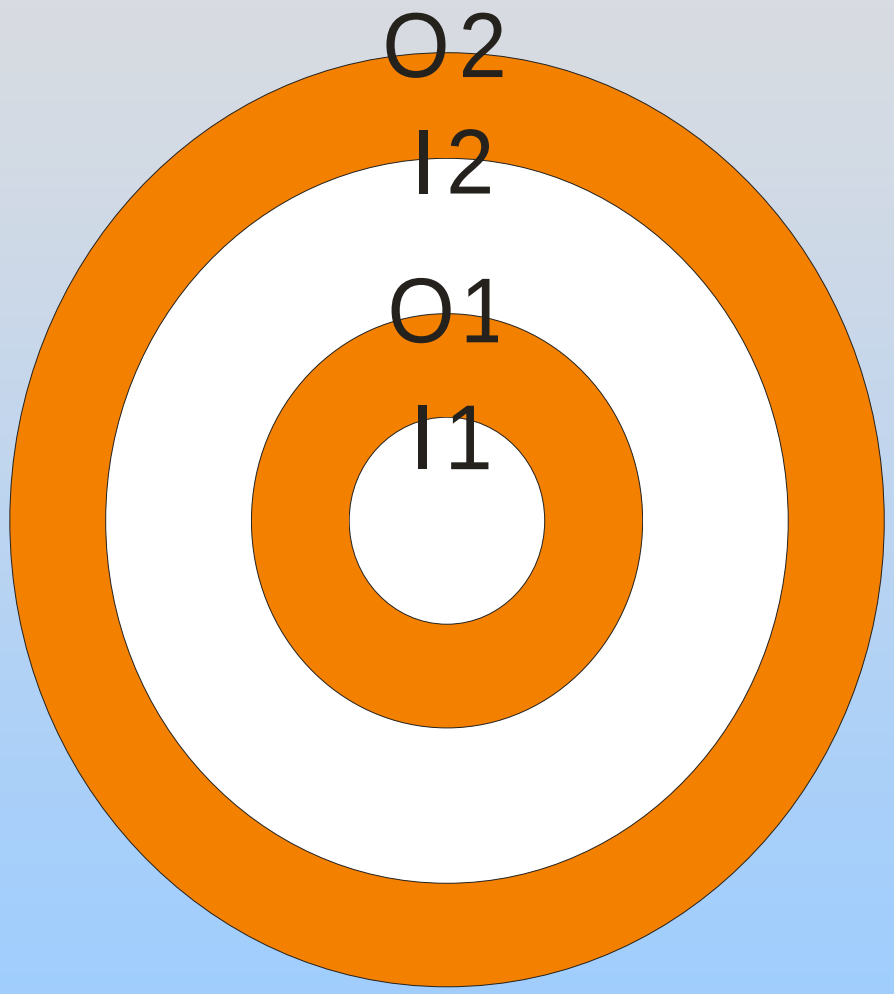
Hollow Conductors

Charge placed OUTSIDE induces charge separation ON OUTSIDE



Concept Question Questions:
Point Charge
Inside Conductor

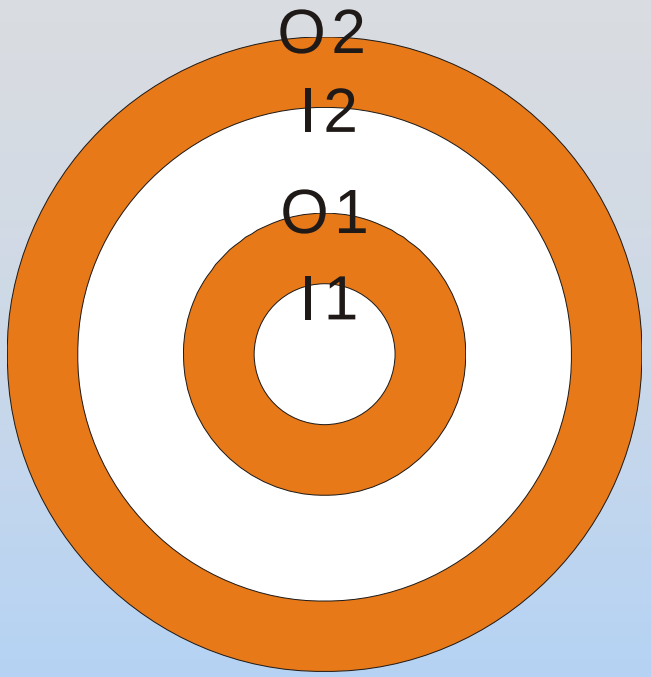
Concept Question Setup



What happens if we put Q in the center of these nested (concentric) spherical conductors?

Concept Question: Hollow Conductors

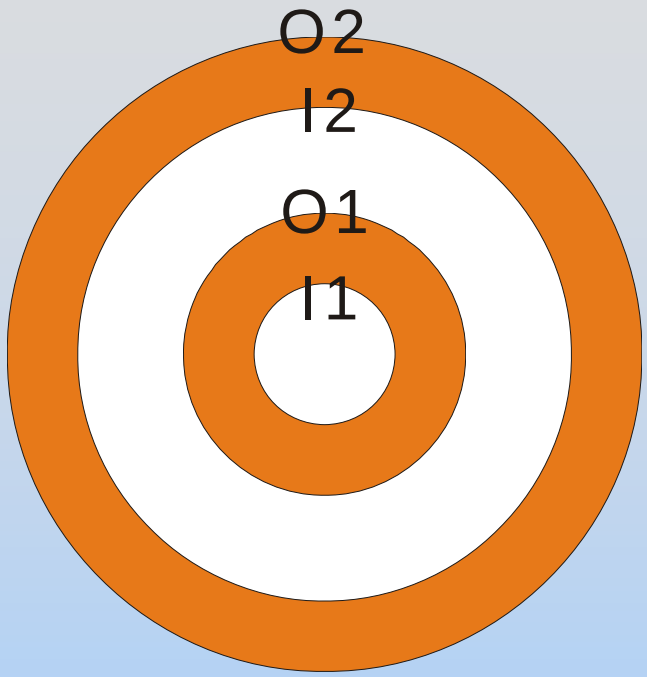
A point charge +Q is placed at the center of the conductors. The induced charges are:



1. Q(I1) = Q(I2) = -Q; Q(O1) = Q(O2)= +Q
2. Q(I1) = Q(I2) = +Q; Q(O1) = Q(O2)= -Q
3. Q(I1) = -Q; Q(O1) = +Q; Q(I2) = Q(O2)= 0
4. Q(I1) = -Q; Q(O2)= +Q; Q(O1) = Q(I2)= 0

Concept Question: Hollow Conductors

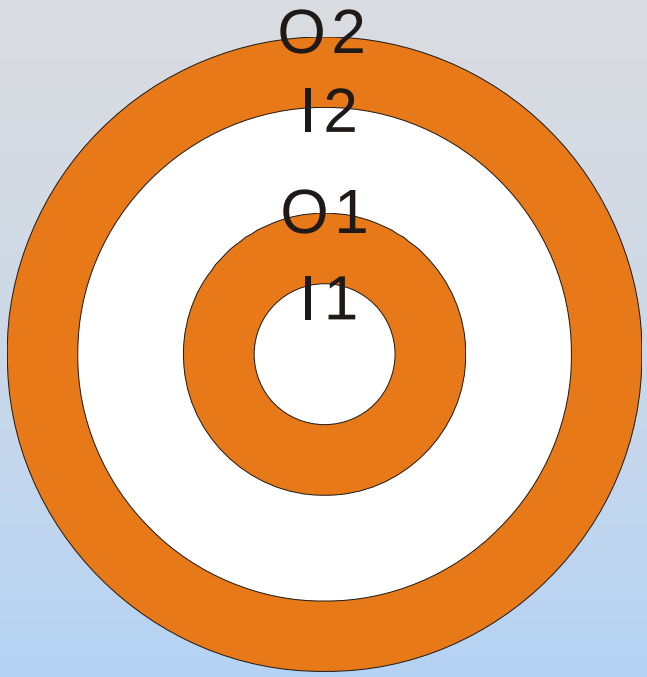
A point charge +Q is placed at the center of the conductors. The potential at O1 is:



1. Higher than at I1
2. Lower than at I1
3. The same as at I1

Concept Question: Hollow Conductors

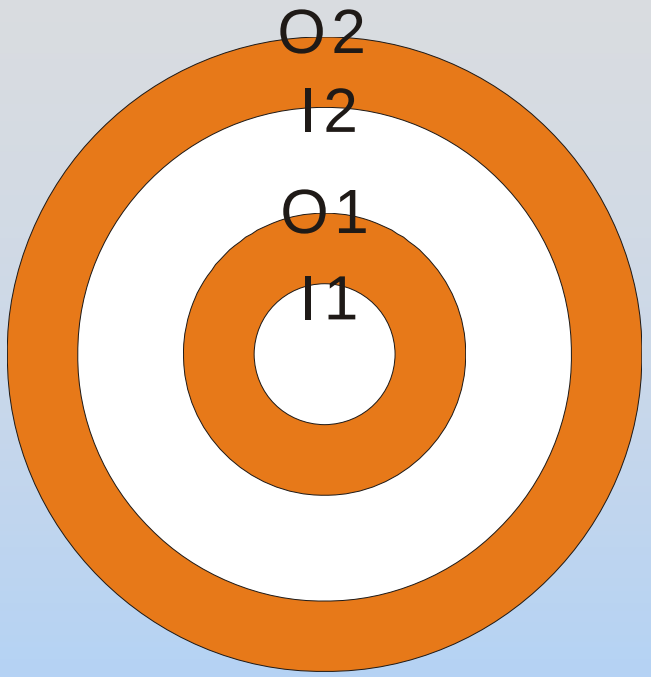
A point charge +Q is placed at the center of the conductors. The potential at O2 is:



1. Higher than at I1
2. Lower than at I1
3. The same as at I1

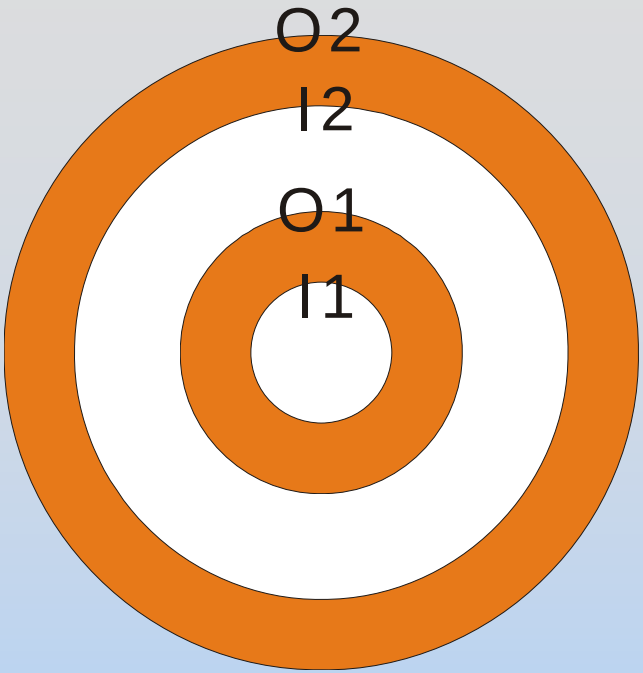
Concept Question: Hollow Conductors

A point charge +Q is placed at the center of the conductors. If a wire is used to connect the two conductors, then current (positive charge) will flow



1. from the inner to the outer conductor
2. from the outer to the inner conductor
3. not at all

Concept Question: Hollow Conductors

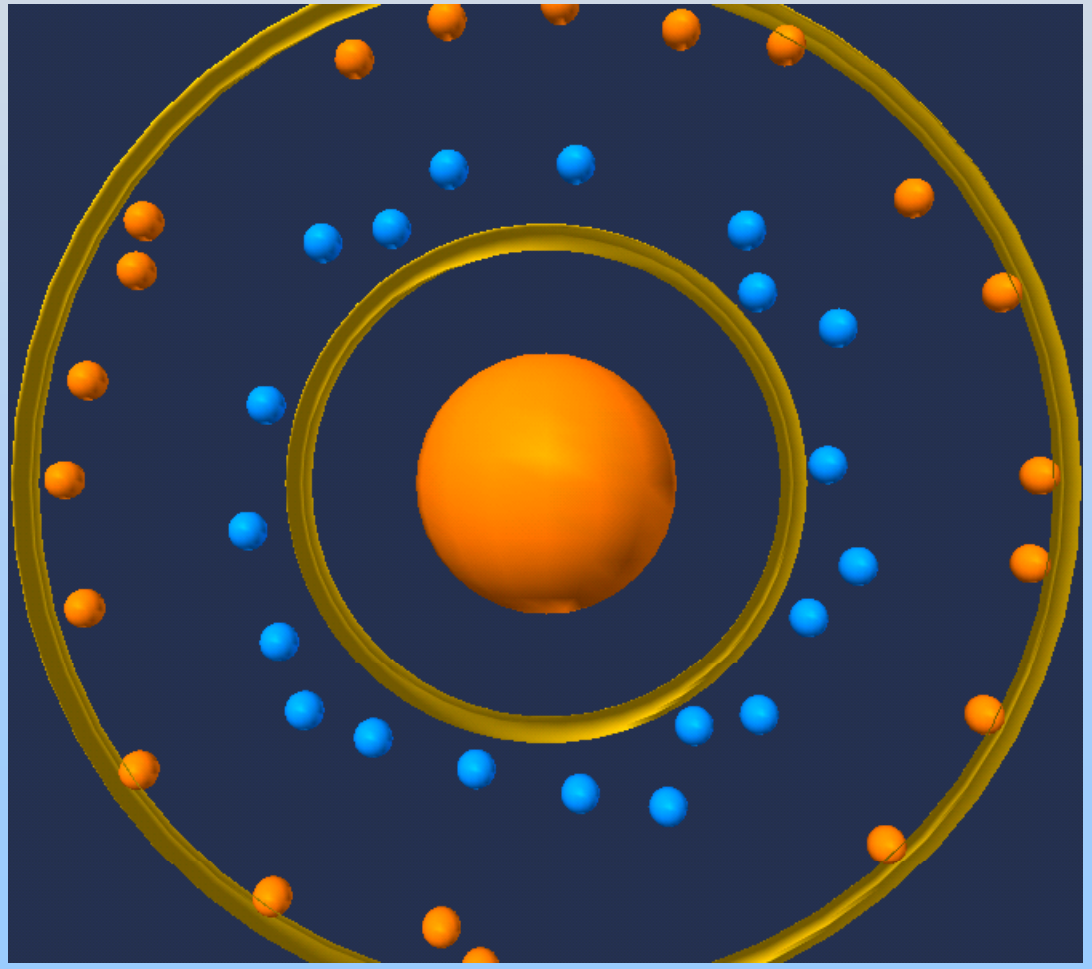


You connect the “charge sensor’s” red lead to the inner conductor and black lead to the outer conductor. What does it actually measure?

1. Charge on I1
2. Charge on O1
3. Charge on I2
4. Charge on O2
5. Charge on O1 – Charge on I2
6. Average charge on inner – ave. on outer
7. Potential difference between outer & inner
8. I don’t know

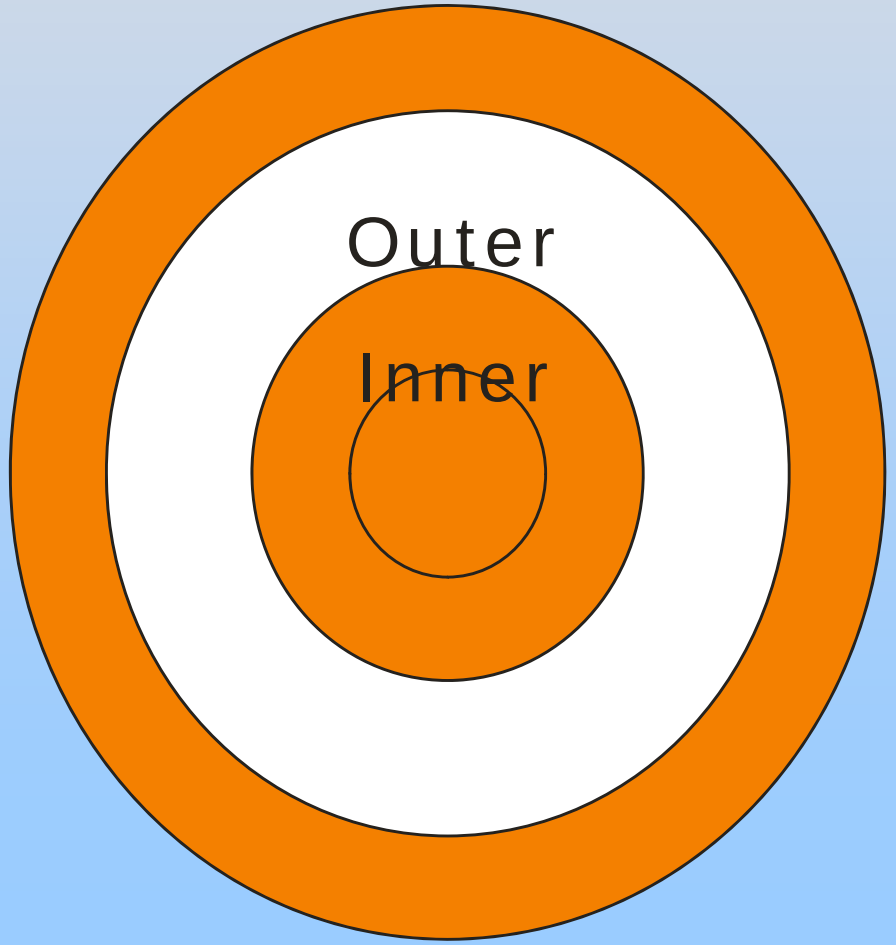
Demonstration: Conductive Shielding

Visualization and Lab Prep: Inductive Charging

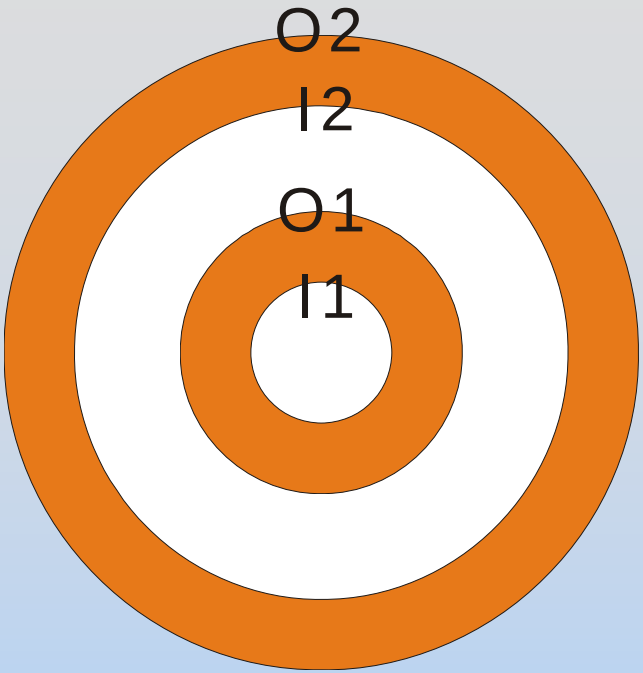


Link to applet

Experiment 2: Faraday Ice Pail



Concept Q.: Hollow Conductors



You connected the “charge sensor’s” red lead to the inner conductor and black lead to the outer conductor. What does it actually measure?

1. Charge on I1
2. Charge on O1
3. Charge on I2
4. Charge on O2
5. Charge on O1 – Charge on I2
6. Average charge on inner – ave. on outer
7. Potential difference between inner & outer
8. I don’t know

8.02SC Physics II: Electricity and Magnetism

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