Where Charge Goes

Trace electron movement and account for charge

HS-PSII-4.1 "Describe the methods of charging an object (i.e., contact, induction, and polarization) and apply the principle of conservation of charge to determine the charges on each object after charge is transferred between two objects by contact."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline places where electrons move between objects, and circle places where they shift within an object. Number the steps that leave a metal sphere charged without contact.

Three Stations at the Charge Lab

(1) At a science museum, two identical metal spheres sit on insulating stands. Sphere A begins with a charge of +8 nC, and sphere B begins with a charge of -2 nC. A positive charge means a shortage of electrons; a negative charge means an excess. When the spheres touch, electrons can move through the metal from one sphere to the other. After they are separated, each identical sphere has the same charge. The combined charge stays constant because electrons move only between the spheres, not into or out of the isolated pair. Add the starting charges, then split the total equally.

(2) At another station, a negatively charged plastic rod is held near a neutral metal sphere without touching it. Electrons in the sphere move away from the rod. While the rod remains nearby, a wire connects the sphere to Earth, allowing some electrons to leave. The wire is removed before the rod is taken away. The sphere is now positively charged, even though the rod never touched it. This method is induction: charge transfers between the sphere and Earth, not between the rod and sphere. The rod's position and the order of the steps matter.

(3) A third display uses a negatively charged comb and a tiny, neutral piece of paper. Without contact, electrons shift slightly within the paper's molecules, away from the comb. The side nearest the comb becomes slightly positive relative to the far side, so the paper is attracted. No electrons have entered or left the paper, and its overall charge remains zero. This rearrangement is polarization, not charging by contact or induction. In contact, electrons cross between touching objects. In induction, electrons can cross to or from Earth when a nearby charged object influences a grounded conductor.

2 ANSWER WITH EVIDENCE

Use the passage

1. The two museum spheres touch and separate. What is the final charge on each sphere? Show how you use the combined starting charge.

2. A positively charged metal rod touches a neutral metal sphere, then separates. Which charging method is this? What charge does the sphere gain, and which way do electrons move?

3. A positive rod is brought near a neutral metal sphere. The sphere is grounded, the ground wire is removed, and then the rod is removed. Name the method, state the sphere's final charge, and explain where electrons move.

4. A positive comb is held near a neutral piece of paper without touching it. Which side becomes slightly negative, and does the paper's total charge change? Explain.

3 YOUR TURN

Your own words

Invent a contact experiment with two identical, isolated metal spheres whose starting charges differ from those in the passage. In four sentences, give their starting charges, explain electron movement, calculate each final charge, and describe how you could demonstrate polarization without changing a third object's total charge.

ANSWER KEY

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HIGH SCHOOL · HS-PSII-4.1

PART 1 · READ AND MARK

Underline places where electrons move between objects, and circle places where they shift within an object. Number the steps that leave a metal sphere charged without contact. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	The two museum spheres touch and separate. What is the final charge on each sphere? Show how you use the combined starting charge.	**+8 nC + (-2 nC) = +6 nC total. Each identical sphere ends at +3 nC.**
2	A positively charged metal rod touches a neutral metal sphere, then separates. Which charging method is this? What charge does the sphere gain, and which way do electrons move?	**Contact. The sphere gains a positive charge as electrons move from the sphere to the rod.**
3	A positive rod is brought near a neutral metal sphere. The sphere is grounded, the ground wire is removed, and then the rod is removed. Name the method, state the sphere's final charge, and explain where electrons move.	**Induction leaves the sphere negatively charged. Electrons move from Earth onto the sphere while it is grounded.**
4	A positive comb is held near a neutral piece of paper without touching it. Which side becomes slightly negative, and does the paper's total charge change? Explain.	**The side nearest the comb becomes slightly negative as electrons shift toward it within the paper's molecules. The paper's total charge stays zero.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

My identical metal spheres begin at +10 nC and -4 nC. When they touch, electrons move from the negative sphere to the positive sphere. Their total charge is +6 nC, so each sphere has +3 nC after separation. For polarization, I bring a positive rod near neutral paper; electrons shift slightly toward the rod, but the paper stays neutral.

For contact, accept any starting charges different from the passage's if the final equal charges each equal half the initial total and the electron direction is correct. The polarization example must involve a shift within the third object without changing its total charge.