Exercise 1: Electrostatic charge

Purpose: To study a static electric charge placed on an object through conduction and induction.

Introduction

Electrical charge can be either positive, neutral, or negative. The term "electrostatics" refers to charges that are in equilibrium. Electroscopes detect the presence or absence of static electric charge. A metal needle pivots inside an electroscope, where it is in contact with the outside metal parts via a metal rod passing through a plastic insulator. The metal disk on top simply allows charge to be detected more efficiently.

Charges of the same variety repel one another while charges of the opposite variety attract. Charges exert greater forces on one another when closer together according to Coulomb's law. All materials are composed of positive and negative charges. The positive charges in solid materials are in the atomic nuclei and are not free to move. Electric charges from either an excess or lack of electrons in insulators such as rubber are locally bound in the material. Conductors such as some metals allow a fraction of their negative charge to essentially move around freely within the conductor.

Laboratory assignment

Electroscope response

1. Charge the rubber rod by rigorously rubbing either fur or wool on it. Try to place as much negative charge (electrons stripped from fabric and attached to rubber surface) as possible.
2. Place the rubber rod very close to the electroscope's metal disk, but do not make contact.
3. Describe what happens to the electroscope needle when a charged section of the rubber rod is brought into close proximity to the metal plate. Also describe what happens to the needle when you pull the rubber rod away from the metal plate.

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4. Explain why the needle reacted to the rubber rod's presence near the metal plate.

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Conduction

5. Now recharge the rubber rod and bring it into contact with the metal plate and begin to slide the rubber surface across as much of the plate as you can. The needle may start to drop or fully drop at this point. (you may need to do this step more than once)
6. Remove the rubber rod so that it is far from the electroscope. The needle should move into a non-neutral position.
7. Explain why the needle moves into the charged position. Use this information and that the rubber rod is negatively charged to determine the electroscope's charge.

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8. Recharge the rubber rod with more electrons and then place it near the metal plate, but do not touch the metal plate.
9. Describe what the needle does and explain why it behaves this way.

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10. Move the rubber rod far away from the metal plate and get the lighter.
11. Move the lighter's tip a few cm above the metal plate and strike a flame.
12. Describe what the needle does and explain why it behaves this way.

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Induction

13. Now recharge the rubber rod and ground the electroscope at its base.
14. Place the rubber rod near the electroscope's metal plate (but not touching) while grounding the scope.
15. Disconnect the ground wire while the rubber rod is still near the metal plate, then remove the rubber rod from the vicinity of the electroscope.

16. Describe what the needle does and explain why it behaves this way.

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17. Place the rubber rod near the metal plate, but do not touch the metal plate.
18. Describe what the needle does and explain why it behaves this way. Use this information and that the rubber rod is negatively charged to determine the electroscope's charge.

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19. Move the rubber rod far away from the metal plate and get the lighter.
20. Move the lighter's tip a few cm above the metal plate and strike a flame.
21. Describe what the needle does and explain why it behaves this way.

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22. Do your explanations of the flame discharging both the negatively charged and positively charged electroscope make sense?

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Equipment list: rubber rod, wool/fur, electroscope, banana cord, lighter, prepare room with closed doors and AC to create cold/low concentration water in air an hour+ before lab begins.