

Physics 30 – Lesson 13
Electric Charge & The Transfer of Electric Charge Activity
Part A – Pre-Investigation

/ 36

1. Opposite charges attract each other
Similar charges repel each other
/2 Charged objects attract some neutral objects
2. In a closed system, the net charge is conserved (i.e. Fur loses as many electrons as a rod gains.)
/2
3. If an object is charged, it is a result of excess or missing electrons. Electrons are /2 free to move, but protons and neutrons (in the nucleus) are not.
4. A conductor is a solid in which electrons are able to move easily from one atom to /2 another. An insulator does not allow electrons to flow freely.
5.
/6

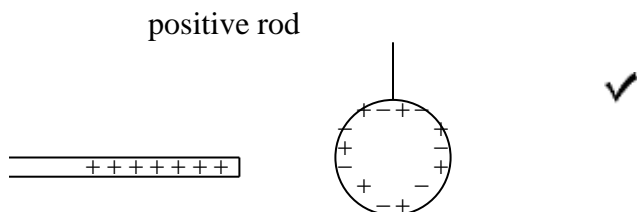
Brass	-	Paraffin wax	+
Wool	-	Glass	+
Wool	+	Lead	-
Paraffin wax	+	Ebonite	-
Ebonite	-	Fur	+
Glass	+	Silk	-
6. If Electrons are removed from an object it will have a net **positive** charge. If
/2 electrons are added to an object it will have a net **negative** charge.
7. An induced charge separation is only temporary
/1 An induced charge is permanent

Lesson 13 Investigations

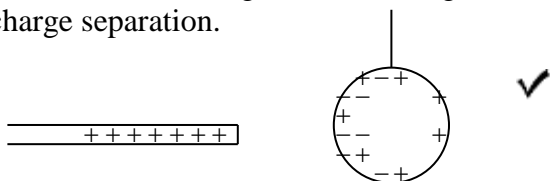
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Investigation 1 Induced Charge Separation

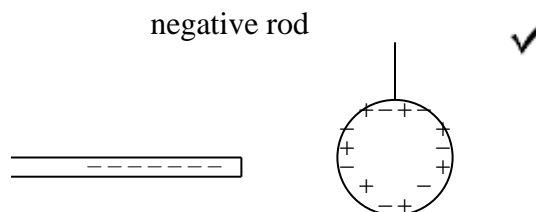
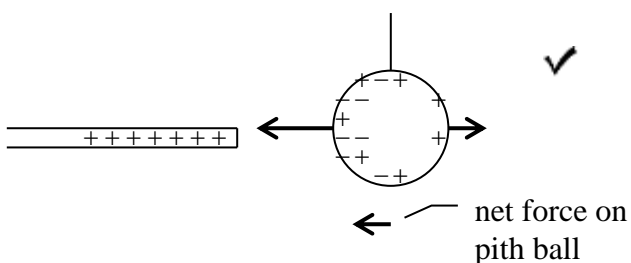
1,2. Initially nothing appears to happen, but after a few seconds the pith ball is attracted to the charged rod. The attraction is due to an induced charge separation.



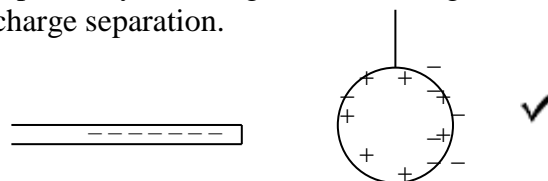
The negative charges on the pith ball are attracted to the charged rod resulting in a charge separation.



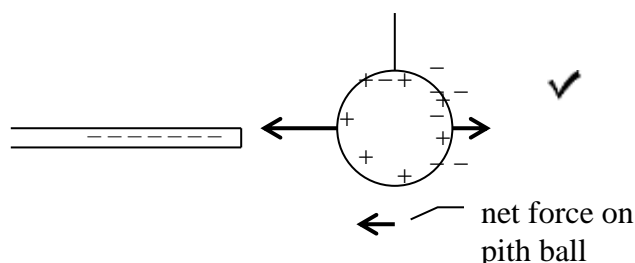
Since the negative side of the pith ball is closer to the rod than the positive side, the attractive force between the negative side of the pith ball and the rod is slightly greater than the repulsive force between the positive side of the pith ball and the rod. The result is a net force toward the rod.



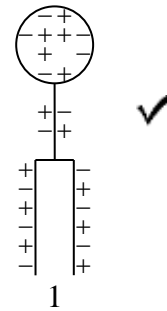
The negative charges on the pith ball are repelled by the charged rod resulting in a charge separation.



Since the positive side of the pith ball is closer to the rod than negative the side, the attractive force between the positive side of the pith ball and the rod is slightly greater than the repulsive force between the negative side of the pith ball and the rod. The result is a net force toward the rod.

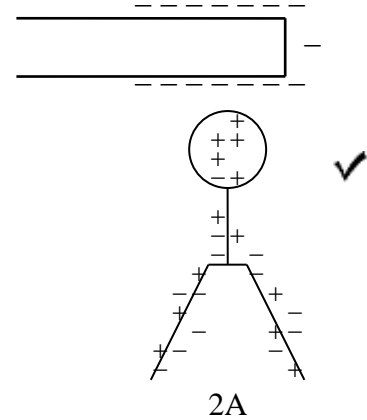


3,4. The three diagrams of an electroscope indicate the steps involved in inducing a charge separation. Diagram 1 indicates a neutral electroscope where the number of electrons and protons are the same everywhere.



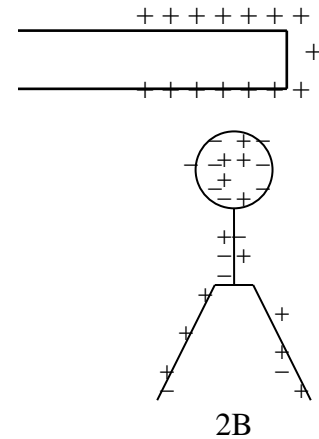
✓

Diagram 2A indicates the arrival of a negative rod. The excess electrons on the negative rod push the electrons from the knob of the electroscope down into the leaves (remember only electrons move). The leaves spread apart because the excess electrons in one leaf repel the excess electrons in the other leaf. Due to the loss of electrons from the knob, the knob is now positive.



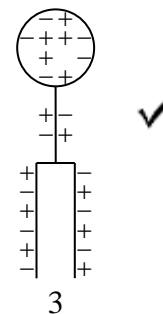
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Diagram 2B indicates the arrival of a positive rod. The excess positive on the positive rod pull the electrons from the leaves up to the knob of the electroscope (remember only electrons move). Since each leaf is positive they repel each other and the leaves spread apart.



✓

When the rod is removed from the vicinity, diagram 3, the electrons return to the knob (or to the leaves if a positive rod was used) and the electroscope is as it was before – neutral.



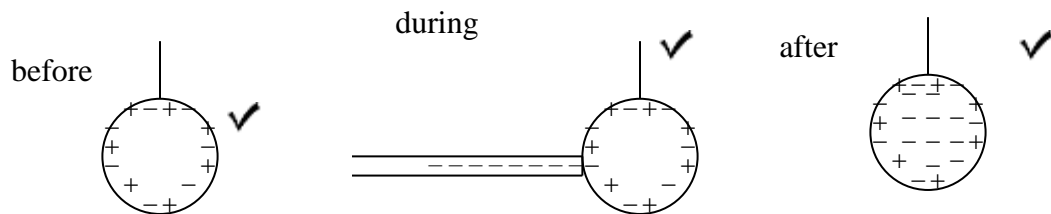
✓

5. Your body is very large and therefore it acts like an infinite “sink” of electrons which can take in more electrons or give away electrons without being overly effected. An analogy is a sink full of water. If one takes away a cup of water from the sink, the water level is not overly affected. Similarly, if a cup of water is added to the sink the water level is again not overly affected.

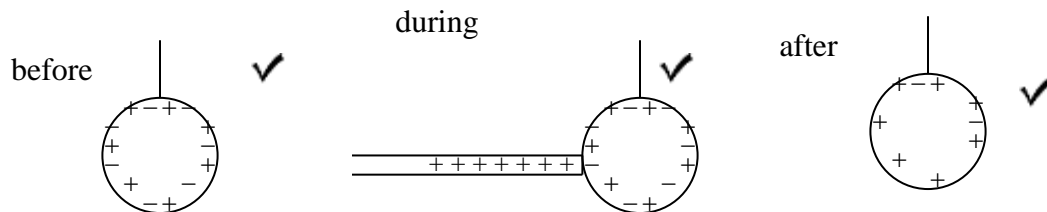
6. An induced charge separation can be made on either a conductor or an insulator. The only difference is the amount of displacement in the charges. For a conductor the negative electrons are relatively free to move which induces a large displacement between charges, while an insulator will only allow a small amount of displacement of the electrons.

Investigation 2 Charging by Conduction/Contact

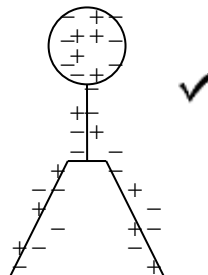
1. When the ebonite rod touched the pith ball excess electrons from the ebonite rod were conducted onto the pith ball. We know this because the pith ball then had the same charge as the ebonite rod which resulted in repulsion between the rod and the ball.



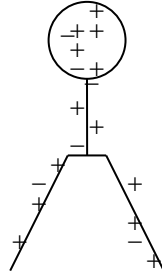
2. The positive acetate strip pulls electrons from the pith ball which results in the pith ball having a positive charge.



3. When touched with an ebonite rod the electrons on the rod are conducted onto the electroscope. The electroscope has an excess of electrons.



4. When touched with an acetate rod the electrons on the electroscope are conducted onto the rod. The electroscope has a deficit of electrons. ✓



5. Charging an object by conduction results in the object having the same charge as charging rod. ✓

6. When a rod of the same charge is brought near the knob of a charged metal-leaf electroscope the leaves spread further apart. This is due to the fact that the leaves become even more charged in the process. ✓

For example, if a negative rod is brought near a negatively charged electroscope the electrons in the knob are forced down toward the already negative leaves. The increased negative charge in the leaves results in the leaves moving further apart. ✓

Similarly when a positive rod is brought near the knob of a positively charged electroscope, electrons remaining in the leaves are pulled up toward the knob resulting in the leaves becoming even more positive. The result is the leaves move further apart.

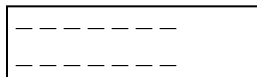
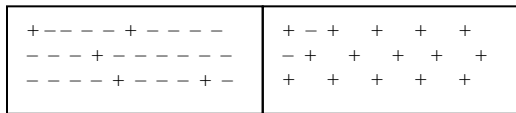
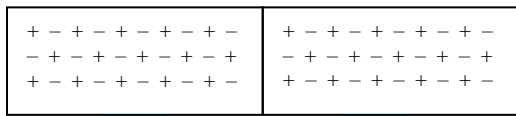
7. When a rod of the opposite charge is brought near the knob of a charged metal-leaf electroscope the leaves are observed to come together. This is due to the fact that the leaves become slightly neutralised in the process. ✓

For example, if a negative rod is brought near a positively charged electroscope the electrons in the knob are forced down toward the leaves. The negative charges partially neutralise the excess positive in the leaves resulting in the leaves moving closer together. ✓

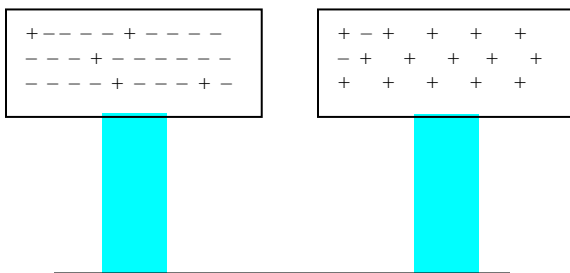
Similarly when a positive rod is brought near the knob of a negatively charged electroscope, electrons in the leaves are pulled up toward the knob resulting in the leaves becoming less negative. The result is the leaves move closer together.

Investigation 3 Charging by Induction

1. The metal rods were placed on beakers for three reasons: glass is an insulator, the spout of the glass holds the aluminum rods in place, and the beakers can be easily moved apart.



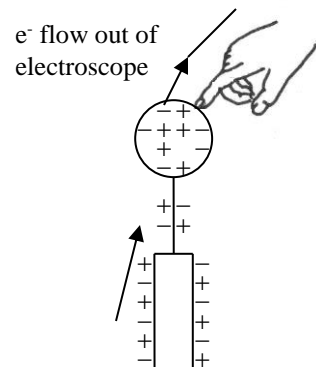
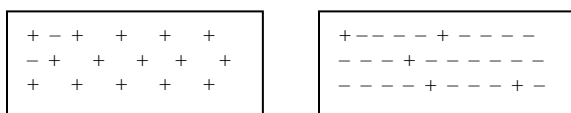
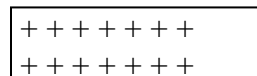
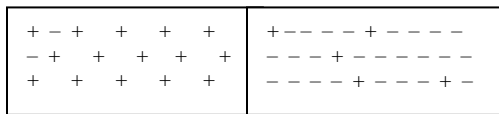
The negatively charged rod causes the electrons in the metal rods to move away from the rod – i.e. a charge separation.



When the metal rods are manually separated and the negative rod is removed, an induced charge exists on each metal rod – i.e. charge by induction.

When the metal rods are put back together the charges redistribute themselves and we have two neutral objects again.

2. If a charged acetate strip had been used the only difference would be that the electrons would have been attracted to the metal rod closest to the strip resulting in the metal rods having opposite charges when they were separated.



3.

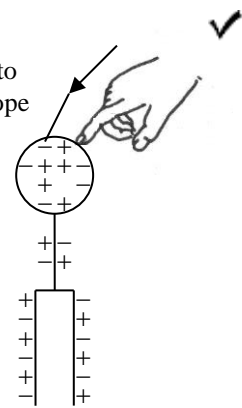


- When the charged ebonite rod was brought near and before the finger was applied to the knob, the electron flow toward the knob induced a charge separation which caused the leaves to separate slightly.
- When the knob was touched the finger acted like a ground and electrons were able to escape from the electroscopes.
- If the ground was still on the knob when the negative rod is removed the electroscope returns to being neutral.

4.

- When the charged acetate strip was brought near and before the finger was applied to the knob, the electron flow toward the strip induced a charge separation.
- When the knob was touched the finger acted like a ground and electrons were able to come into the electroscope.

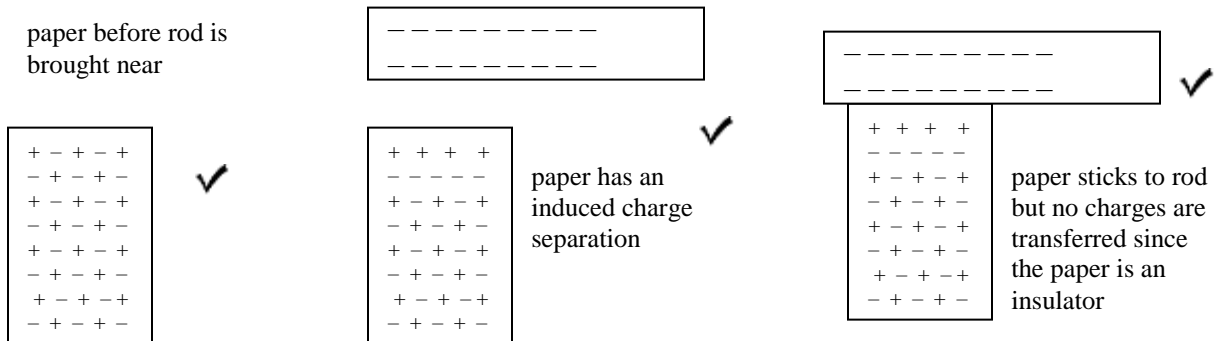
e⁻ flow into electroscope



5. When charged by induction as illustrated above the object receives a charge that is opposite the charge on the rod.

Investigation 4 Dancing paper

1. Like the pith ball electroscope in Investigation 1 above the charged rod induced a charge separation in the pieces of paper. The paper was attracted due to the attraction of the protons in the atoms of the paper for the negatively charged rod.



2. The slips of paper are insulators. Therefore when they touch the rod there is no transfer of charge.