STUDENT'S WORKSHEET.

LESSON 1.

Warm up.

Electricity is pervasively present in our daily lives. We shall begin our study of electricity by studying Electrostatics. Suggest some words you believe can be related to this subject.

Activity 1. You will see some experiments on electrostatics.

task: Try to find what questions they raise. Discuss them with your teacher and the other students in your class.

Activity 2. Watch the video on conductors and insulators your teacher will show you and do the following tasks.

task 1 Write down all the verbs which describe the charged particles' actions. For ex: move around, are stuck, ...

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task 2 Identify the main differences between an insulator and a conductor and, in small groups of three, write a paragraph using at least 6 of the verbs from task 1.

task 3 Work in pairs, Discuss in detail how the video can explain the experimental results and answer the following questions. Then Read your answers and discuss them with your class mates.

1. What happened when I rubbed the plastic bar?

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2. Why did the leaves of the electroscope diverge when I touched them with the charged bar?

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3. Why could I not charge the metal bar?

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Activity 3/ HOMEWORK : Access the page http://education.jlab.org/reading/electrostatics.html and do the exercise. Don't forget to either save / download your exercise or write down your answers in your notebook.

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LESSON 2.

<u>Activity 1</u>:

task 1 (3 min.) Answer your teacher's questions and try to say what questions /problems still have to be tackled.

task 2: (5 min.) Watch the video at

<u>http://www.ck12.org/physics/Electrostatics/lecture/Electrostatics/?referrer=featured_content</u>

Activity 3: (10 min.)

Read the following summary on electrostatics, find the wrong words and replace them with the correct ones (10 minutes).

(Courtesy of Zanichelli www.zanichelli.it)

electric charge

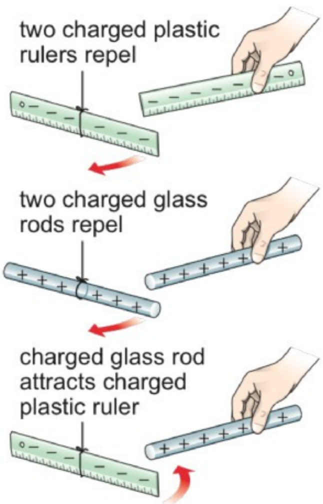
The ruler is charged by rubbing it with a cloth towel. Protons transfer from the cloth to the ruler, leaving it with a net positive charge.

The excess electric charge on the ruler induces a magnetization in scraps of paper, and thus repels them.

This phenomenon is known as static electricity.
The ancient Greeks knew that a piece of iron would attract small pieces of leaves or dust after being rubbed with some wool.

electric charge and its conservation

Are all electric charges the same, or is there more than one type?



Charge comes in two types, positive and negative; like charges attract and opposite charges repel.

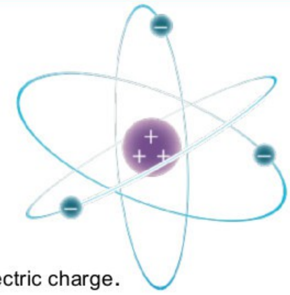
The law of conservation of electric charge:

Whenever a certain amount of charge is produced on one object an equal amount of charge of the same sign is produced on another

Electric charge can either be created or destroyed

atoms and molecules

Only within the past century has it become clear that an understanding of electricity originates from within the atom itself. This simplified model of an atom shows a small,dense, negatively charged nucleus containing a mixture of protons and electrons surrounded by negatively charged neutrons.



All protons and electrons have exactly the same magnitude of electric charge.

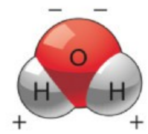
Charge on the electron:

$e = -1.602\times 10^{-19}$ C

In the SI, the unit of electric charge is the ampere. Electric charge is quantized in units of electron charge. The total charge carried by any object is a whole multiple of the electron charge.

A polar molecule is neutral overall, but its charge is not evenly distributed.

water molecule



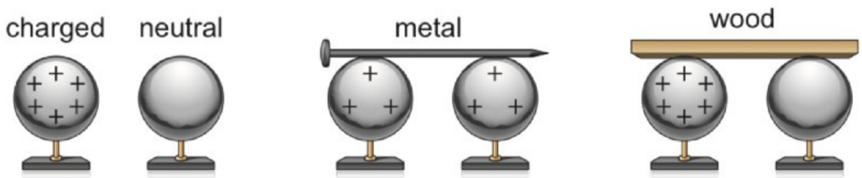
insulators and conductors

Conductors
Charge flows freely:
plastics

Insulators
Almost no charge flows:
most other materials

From an atomic point of view:

- For insulators, the protons are bound very tightly to the nuclei;
- For good conductors, some of the protons are bound very loosely and can move freely within the material

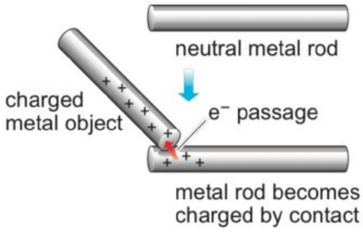


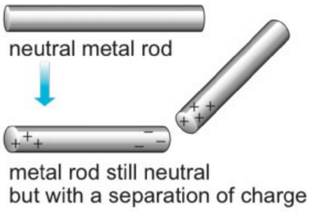
The relative magnitude of conductivity between silver (a good conductor) and rubber (a good insulator) is on the order of 10^{21}.

charging methods

Charging by conduction

If a positively charged metal rod is brought into contact with an uncharged metal rod, the free protons in the neutral rod are attracted by the positively charged rod and some will pass over it.



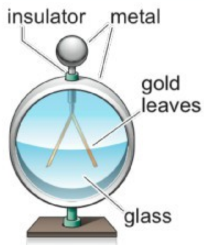


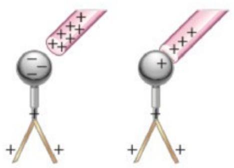
Charging by induction

If a positively charged metal rod is brought close to an uncharged plastic rod, but does not touch it, the free electrons in the neutral rod do not leave it, but move within the plastic rod away from the external positive charge.

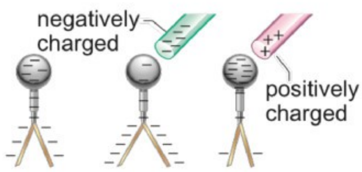
electroscope

An **electroscope** is a device used to detect electric current.
It is made of two wooden leaves that are free to move, which are situated inside an insulated case.





The electroscope on the left is charged by conduction and the one on the left by induction.



A previously charged electroscope can be used to determine the sign of a charged object.

Activity 4: (10 min.)

Now answer the questions at
http://www.ck12.org/physics/Electrostatics/asmtpractice/Electrostatics-Practice/?referrer=featured_content

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LESSON 3.

Activity 1.

- In our approach to electrostatics there is something which we have left unexplained. Can you say what?
- Watch the video at https://www.youtube.com/watch?v=x1-SibwIPM4
- Any questions?

Activity 2.

The electrostatic force has been investigated by the French physicist Charles-Augustin de Coulomb in the 1780s. He found that the module of the force between two point-like charges q_1 and q_2 at a distance d in vacuum is

$$F=\frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{d^2} .$$

We shall now investigate the meaning of that ε_0.

Activity 3.

Look at the following table. Discuss in pairs how it explains the observation that salt (NaCl) dissolves in water. (3 min.)

Relative permittivities of some materials at room temperature

Material	ε_r
Vacuum	1 (by definition)
Air	1.00058986 ± 0.00000050
PTFE/Teflon	2.1
Polyethylene/XLPE	2.25
Polyimide	3.4
Paper	3.85
Concrete	4.5
Pyrex (Glass)	4.7 (3.7–10)
Diamond	5.5–10
Salt	3–15
Graphite	10–15
Silicon	11.68
Methanol	30
Ethylene glycol	37
Water	88, 80.1, 55.3, 34.5 (0, 20, 100, 200°C)
ydrofluoric acid	175, 134, 111, 83.6 (-73°C, -42°C, -27°C, 0°C)
Formamide	84.0 (20°C)

Activity 4: assessment.

1. What happens when a glass bar is positively charged by rubbing it with some piece of cloth?

    a) Some electrons jump from the cloth to the bar
    b) Some electrons jump from the bar to the cloth
    c) Some protons jump from the cloth to the bar
    d) Both protons jump from the cloth to the bar and electrons from the bar to the cloth

2. You want to charge by induction a neutral electroscope using a charged body. Here are the actions you can perform, written in a casual order:

    a) ___ remove the connection of the electroscope from the ground
    b) ___ touch the electroscope with the charged body
    c) ___ connect the electroscope to the ground
    d) ___ bring the charged body close to the electroscope, without touching it
    e) ___ turn the charged body away from the electroscope

    fill in the blank spaces with the number indicating the correct order of the action; pay attention: one of the actions must not be done: leave the space empty!

3. Fill in the blanks

    _______________________ charges attract;

    _______________________ charges _______________________.

4. Why is it not possible to charge an insulator by induction?

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5. Where do the excess electrons end up in a negatively charged conductor, and why?

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