Name:___________________________ Points:___/10

SMITH - INDUSTRIAL SCIENCE B – 3RD PERIOD - OFF-SITE LEARNING PACKET DAY 3

Chapter 9 Electricity
Lesson 3 – Electric Charge

Lesson Objectives

- **define the bellwork vocabulary words** (**polarization**, **ionization, volt**) with 100% accuracy
- **define and differentiate between electric potential and electric potential energy including definition of the volt** with 100% accuracy
- **state why voltage alone is not necessarily harmful** with 100% accuracy

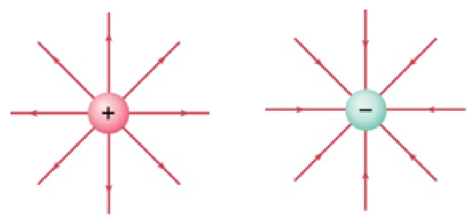
Associated Text:

Chapter 9 Lesson 3

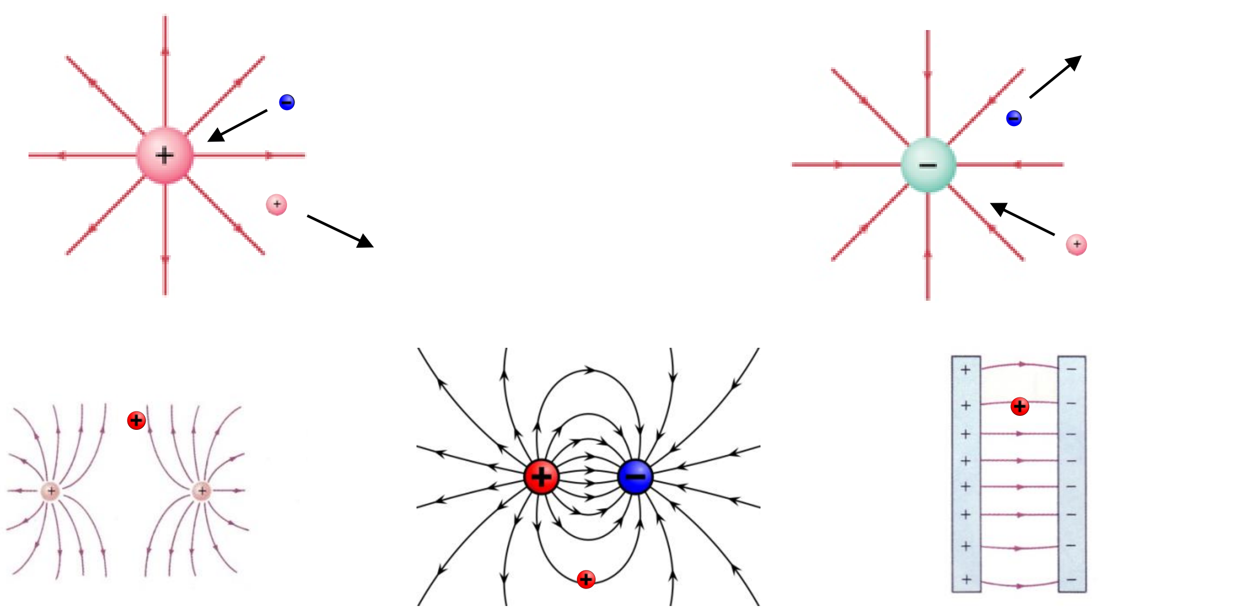
Alessandro Volta (1745 –1827), whom the volt is named after. Volta is credited with inventing the battery and discovering methane.

Electric Fields

Electric forces, like gravitational forces, act between things that are not in contact with each other. For both electricity and gravity, there exists a force field that influences distant charges and masses, respectively. Just as the space between any two masses is filled with a gravitational field, the space around every electric charge is filled with an **electric field** – a kind of aura that extends through space. About a proton, the electric field extends radially away from the proton. About an electron, the field is in the opposite direction, shown by the field lines in the following figure.



The electric fields around two charges. Notice that the direction of the field is defined as what direction the charge would have on a positive test charge.



Place a charged particle in an electric field and the particle experiences an electric force. The direction of force on a positive charge is the same as the direction of the electric field.

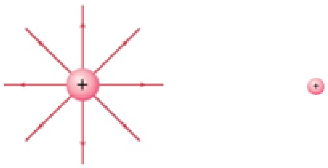
Charge Polarization

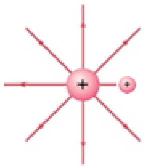
Charge an inflated balloon by rubbing it on your hair. The balloon becomes negatively charged. Then place the balloon against a wall and it sticks. It is important to remember, that the balloon would not stick to the wall unless some force held it there. This force is the electrical force. But the electrical force needs to have opposite charges for attraction. How does the wall become positively charged? The atoms in the wall itself hold on to their electrons tightly, they are not electrical conductors. What happens is the charge on the balloon alters the charge distribution in the atoms in the wall, effectively inducing an opposite charge in the wall. The atoms cannot move from their relatively fixed positions, but their "centers of charge" are moved. The positive part of each atom is attracted toward the balloon, and the negative part is repelled. This has the net effect of distorting the atoms, which are said to be **electrically polarized**. So an electrically polarized atom is an atom where the electrons themselves are pushed to one side of the atom due to an external negative electric field.

Compare charge polarization with ionization. When and atom is ionized, one or more of its electrons are removed or electrons are forced on to the atom. When an atom is polarized, then only it's distribution of charge within the atom is affected. Conductors are typically ionized, insulators are typically polarized.

Electric Potential

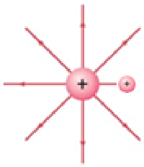
When we studied energy earlier in the year, we learned that an object has gravitational potential energy because of its location in a gravitational field. Similarly, a charged object has electric potential energy by virtue of its location in an electric field. Just as work is required to lift a massive object against the gravitational field of the Earth, work is also required to push a charged particle against an electric field of a charged body. This work changes the electrical potential energy of the charged particle. The work done in compressing a spring increases the potential energy of the spring, and the work done pushing a charged particle closer to a charged sphere increases the potential energy of the charged particle.



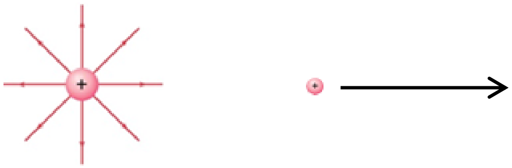


If the particle is released, it accelerates in a direction away from the sphere and its electrical potential energy changes to kinetic energy.

Release charge



Kinetic energy



If we push a particle that carries twice the charge, we do twice as much work, and the double charge in the same location has twice the potential energy as before; three times the charge, and we have three times as much potential energy, and so on. Rather than dealing wit the total electrical potential energy of a charged body, it is convenient to consider the electrical potential energy per charge. We simply divide the amount of potential energy in any case by the amount of charge. The concept of electrical potential energy per charge is called **electric potential**:

$$\text{Electric potential} = \frac{\text{electric potential energy}}{\text{amount of charge}}$$

The unit of measurement of electric potential is the volt, so electric potential is often called voltage. A potential of 1 volt (V) equals 1 joule (J) of energy per 1 coulomb (C) of charge.

$$1\text{ volt} = \frac{1\text{ joule}}{\text{coulomb}}$$

Thus a 1.5-volt battery gives 1.5 joules of energy for every 1 coulomb of charge passing through it. The terms electric potential and voltage are synonymous and they are both common, so either may be used.

The significance of electric potential (voltage) is that a definite value for it can be assigned to a location. We can speak about the electric potentials at different locations in an electric field whether or not charges occupy those locations. Likewise with electric potentials at various locations in an electric circuit. Later we shall see that the location of the positive terminal of a 12-volt battery is maintained at a voltage of 12 volts higher than the location of the negative terminal. When a conducting medium connects this voltage difference, charges in the medium move between these two locations.

Example of the Difference Between Electric Potential and Electric Potential Energy (VOLTS)

Rub a balloon on your hair, and the balloon becomes negatively charged – perhaps to several thousand volts! That would be several thousand joules of energy if the charge were 1 coulomb. However, 1 coulomb is a fairly respectable amount of charge. The charge on a balloon rubbed on hair is more typically much less than a millionth of a coulomb. Therefore, the amount of energy associated with a charged balloon is very, very small**. A high electric potential means a lot of energy only if a lot of charge is involved.** There is an important difference between electric potential energy and electric potential.

Now we see what happens when one electric potential is applied to one end of a piece of metal wire and a different electric potential is applied to the other end. Any difference in electric potential is called a **potential difference** (or voltage difference) and acts like an "electric pressure" that produces an electric current – a flow of electric charge.

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<u>Guided Reading Questions:</u> *(10 pts.)*
use the chapter text and guided notes found above

1. Who is the volt named for?

Electric Fields

2. Give two examples of common force fields.

3. How is the direction of an electric field defined?

Charge Polarization

4. What is charge polarization?

5. What is charge ionization?

6. Can a conductor be polarized?

7. Can an insulator be polarized?

Electric Potential

8. What is a volt?

9. What is the difference between electric potential and electric potential energy?

10. If, while rubbing a balloon against your head you give the balloon a few thousand volts, why do you not get electrocuted when it discharges.

Lesson Notes:

Charge Polarization

- in materials that have electrons that cannot move from one atom to another, the charge distribution around each individual atom can be altered
- this is charge polarization
- conductors typically are ionized
- insulators typically are polarized

Electric Fields

- the space around every electric charge is filled with an electric field
- charged particles in an electric field experience an electric force
- the direction of force on a positive charge is the same as the direction of the electric field

Electric Potential

- a charged object has electric potential energy (EPE) by virtue of its location in an electric field.
- work is required to push a charged particle against an electric field of a charged body.
- this work changes the electrical potential energy of the charged particle.
- if the particle is released, it accelerates in a direction away from the sphere and its electrical potential energy changes to kinetic energy.

Electric Potential And the Volt

$$\text{Electric potential} = \frac{\text{electric potential energy}}{\text{amount of charge}}$$

- the unit of measurement of electric potential is the volt
- a potential of 1 volt (V) equals 1 joule (J) of energy per 1 coulomb (C) of charge

$$1\,\text{volt} = \frac{1\text{ joule}}{\text{coulomb}}$$

Electric Potential And Current

- when one electric potential is applied to one end of a piece of metal wire and a different electric potential is applied to the other end
- any difference in electric potential is called a **potential difference** (or voltage difference) and acts like an "electric pressure" that produces an electric current – a flow of electric charge

Vocabulary

polarization – redistribution of charge inside an atom
ionization – the removal or addition of one or more electrons to an atom or molecule
volt – the unit of electrical potential