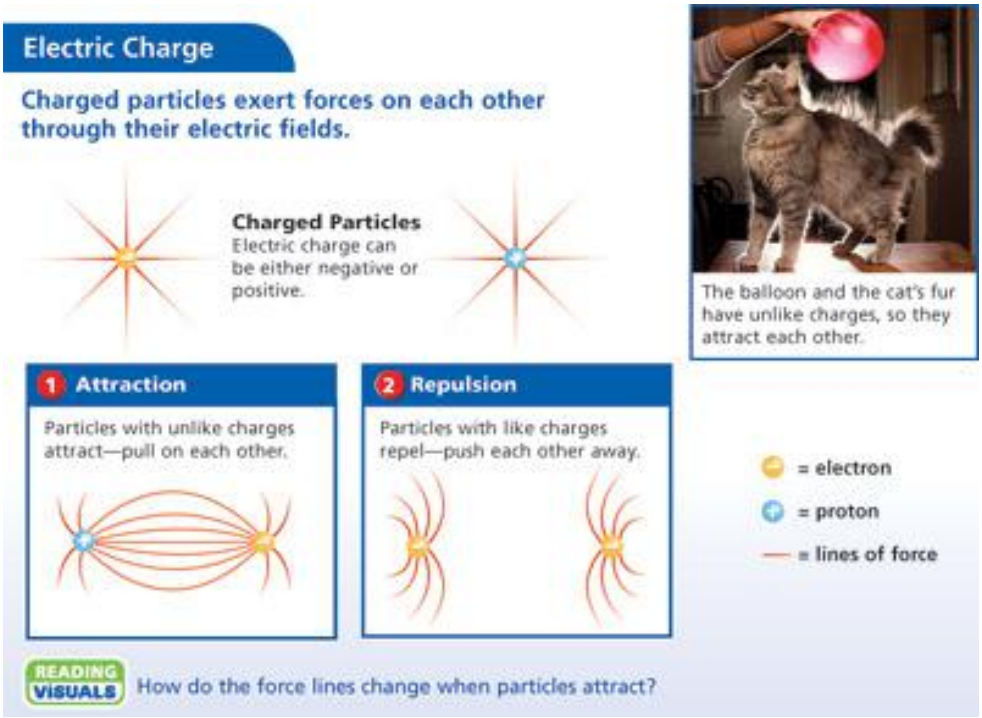
SECTION 1 (PP. 633-641): MATERIALS CAN BECOME ELECTRICALLY CHARGED.

Georgia Standards: S8P2c – *Compare and contrast the different forms of energy (heat, light, electricity, mechanical motion, sound) and their characteristics.*

1. **Electric charge is a property of matter.**
   Objects can have a positive, negative, or neutral charge. A proton has a positive charge. An electron has a negative charge. **Electric charge** is measured in a unit called coulombs. Two objects with electric charge exert an electric charge on each other. Electric force can be exerted even if the objects are separated by empty space (vacuum). The amount of force is greater if the charges are greater and less if the distance between the objects is greater. Remember that a force is a push or a pull. Like charges, such as two positive charges, will repel each other while unlike charges will attract one another. Neutrally charged objects do not exert a force on each other. The space around a charge where an electric force is present is called an **electric field**.



2. **Static charges are caused by the movement of electrons.**
   Objects that have the same number of electrons and protons have a neutral, or zero, charge. An object with more protons than electrons has a positive charge. An object with more electrons than protons has a negative charge. The greater the imbalance, the greater the charge an object has. In most cases, it is the movement of electrons that causes an object to gain a **static charge**.

- Charging by **contact** occurs when electrons move because materials are touching. In this case, one material attracts electrons more strongly than the other.
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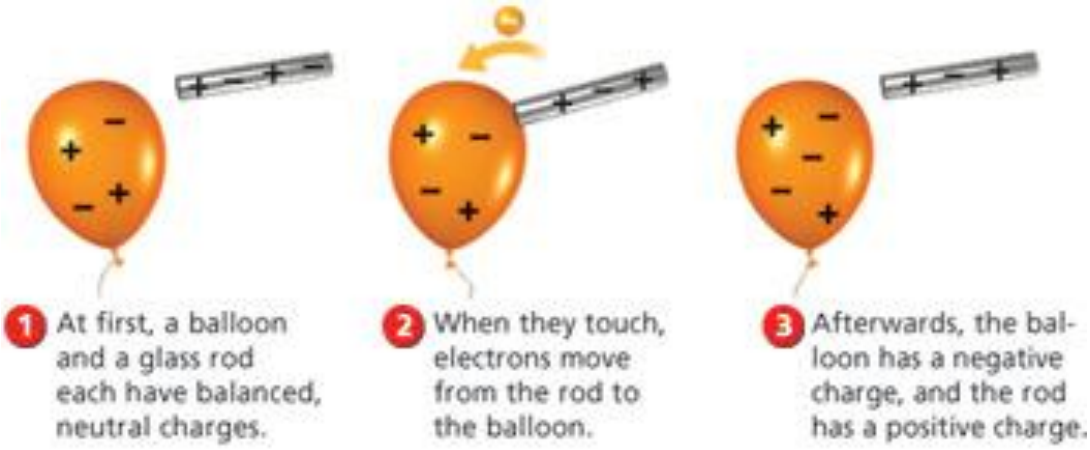
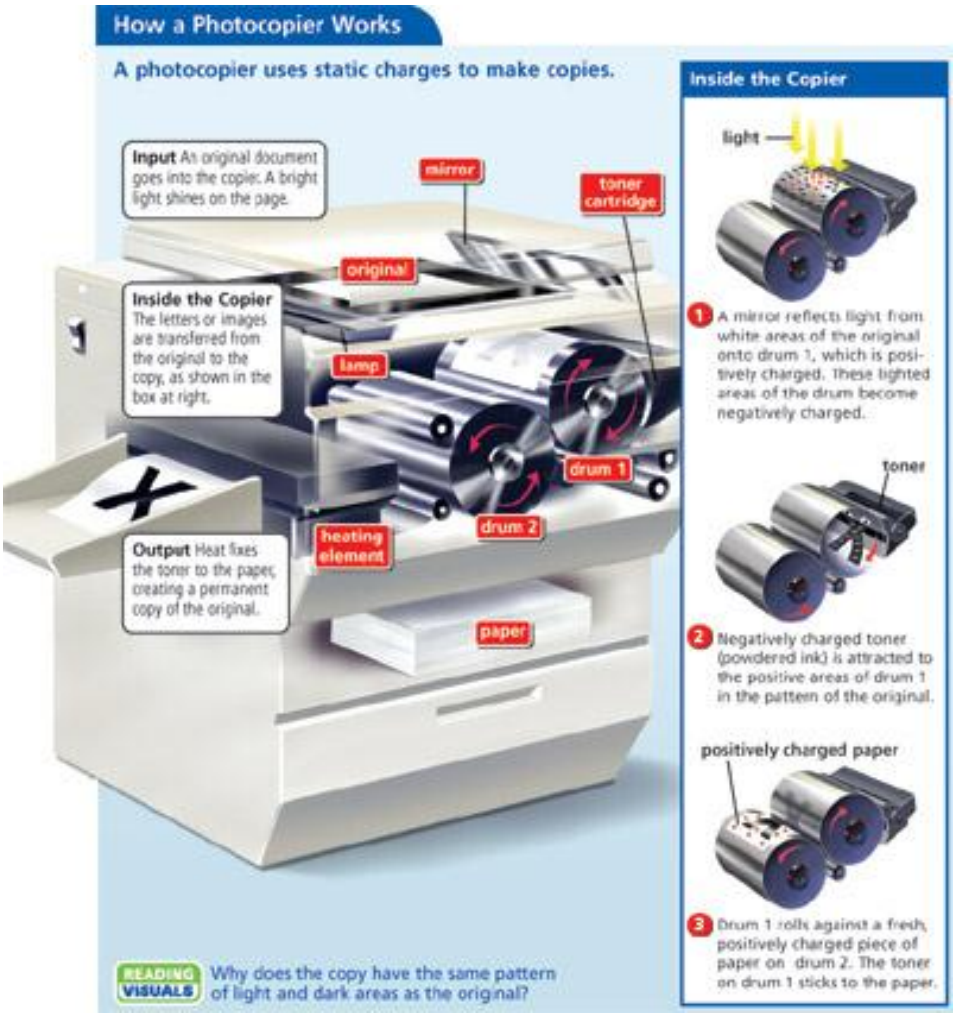


- Charging by **induction** occurs when a charge object produces a temporary movement of electrons in another object. This movement creates a temporary charge imbalance within the object.

3. **Technology uses static electricity.**
   Differences in charge attract toner to letters or images on paper in a photocopier. In electrostatic air filters, charged plates attract oppositely charged particle in the air. Static charges are used to make paint stick better to new cars.



SECTION 2 (PP. 642-651): CHARGES CAN MOVE FROM ONE PLACE TO ANOTHER.

Georgia Standards: S8P2b – *Explain the relationship between potential and kinetic energy*; S8P2c - *Compare and contrast the different forms of energy (heat, light, electricity, mechanical motion, sound) and their characteristics.*

1. **Static charges have potential energy.**
   A charged object held near another charged object has potential energy. Just as a rock falls to the ground when it is let go, one charge will move toward or away from another charge if it is not fixed in place. A proton placed near a charged object will have a certain amount of potential energy due to its position. The **electric potential** of a charged object is the potential energy per unit charge that another charge would have if it were in the object's electric field. Electric potential is measured in **volts**. The difference in the

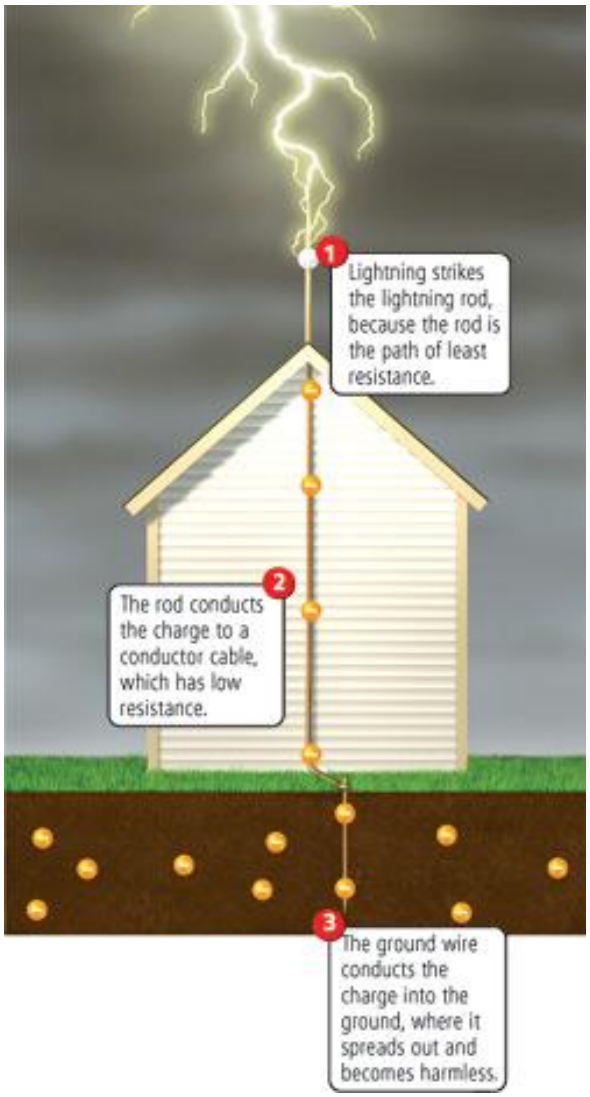
electric potential at two different points is called the voltage between two points. Just as water will not flow between two towers of the same height, a charge will not move between two positions with the same electric potential. For a charge to move there must be a difference in potential between the two positions.

The shock you get from a doorknob is a small-scale version of lightning. **Lightning** is a high-energy static discharge. This static electricity is caused by storm clouds. Lightning comes from the electric potential of millions of volts, which releases large amounts of energy in the form of light, heat, and sound.

- **Charge Separation**. Particles of moisture inside a cloud collide with the air and with each other, causing the particles to become electrically charged. Wind and gravity separate charges, carrying the heavier, negatively charged particles to the bottom of the cloud and the lighter, positively charged particles to the top of the cloud.
- **Charge Buildup.** Through induction, the negatively charged particles at the bottom of the cloud repel electrons in the ground, causing the surface of the ground to build up a positive charge.
- **Static Discharge.** When the electric potential, or voltage, created by the difference in charges is large enough, the negative charge moves from the cloud to the ground. The energy released by the discharge produces the flash of lightning and the sound of thunder.

2. **Materials affect charge movement.**
   Electrical **resistance** is a measure of how easily a charge moves through a material. Resistance is measured in ohms. Resistance depends on the size, the shape, and the type of material.
   - A material that allows an electric charge to pass through it easily is called a **conductor**. Metals such as iron, steel, copper, and aluminum are good conductors. Most wire used to carry a charge is made of copper, which conducts very well.
   - A material that does not easily allow a charge to pass through it is called an **insulator**. Plastic and rubber are good insulators. Many types of electric wire are covered with plastic, which insulates well. The plastic allows a charge to be conducted from one end of the wire to the other, but not through the sides of the wire. Insulators are also important in electrical safety, because they keep charges away from the body.
   - **Superconductors** have almost no resistance at extremely low temperatures.

If a charge can pass through two different materials, it will pass through the one with the lower resistance. This is the principle behind an important electrical safety procedure—grounding. **Grounding** means providing a harmless, low-resistance path—a ground—for electricity to follow. In many cases, this path actually leads into the ground, that is, into the Earth.



SECTION 3 (PP. 652-659): ELECTRIC CURRENT IS THE FLOW OF CHARGE.

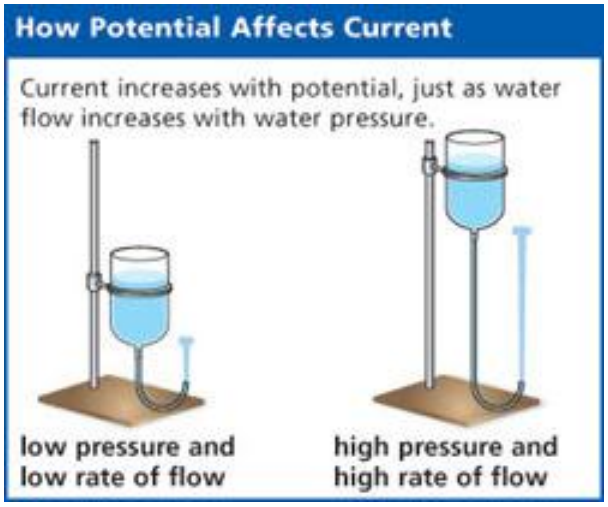
Georgia Standards: S8P2c - ***Compare and contrast the different forms of energy (heat, light, electricity, mechanical motion, sound) and their characteristics;*** **S8CS4b –** ***Use appropriate tolls and units for measuring objects and/or substances*****.**

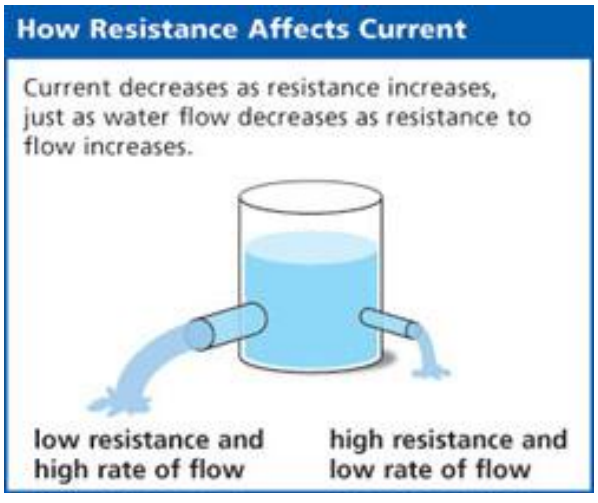
1. **Electric charge can flow continuously.**
   If a constant potential difference, or voltage, is maintained between two points and there is a path along which electrons can move between two points, **electric current** results.
   - Electric current, the continuous flow of change between two points at different potentials, is measured in **amperes** (amps).

- Current can be measured using an ammeter, voltage using a voltmeter, and resistance using an ohmmeter. A multimeter can measure all three values.
- You now have three important measurements for the study of electricity: volts, ohms, and amps. The scientist for whom the ohm is named discovered a mathematical relationship among these three measurements. The relationship, called Ohm's law, is expressed in the formula below.

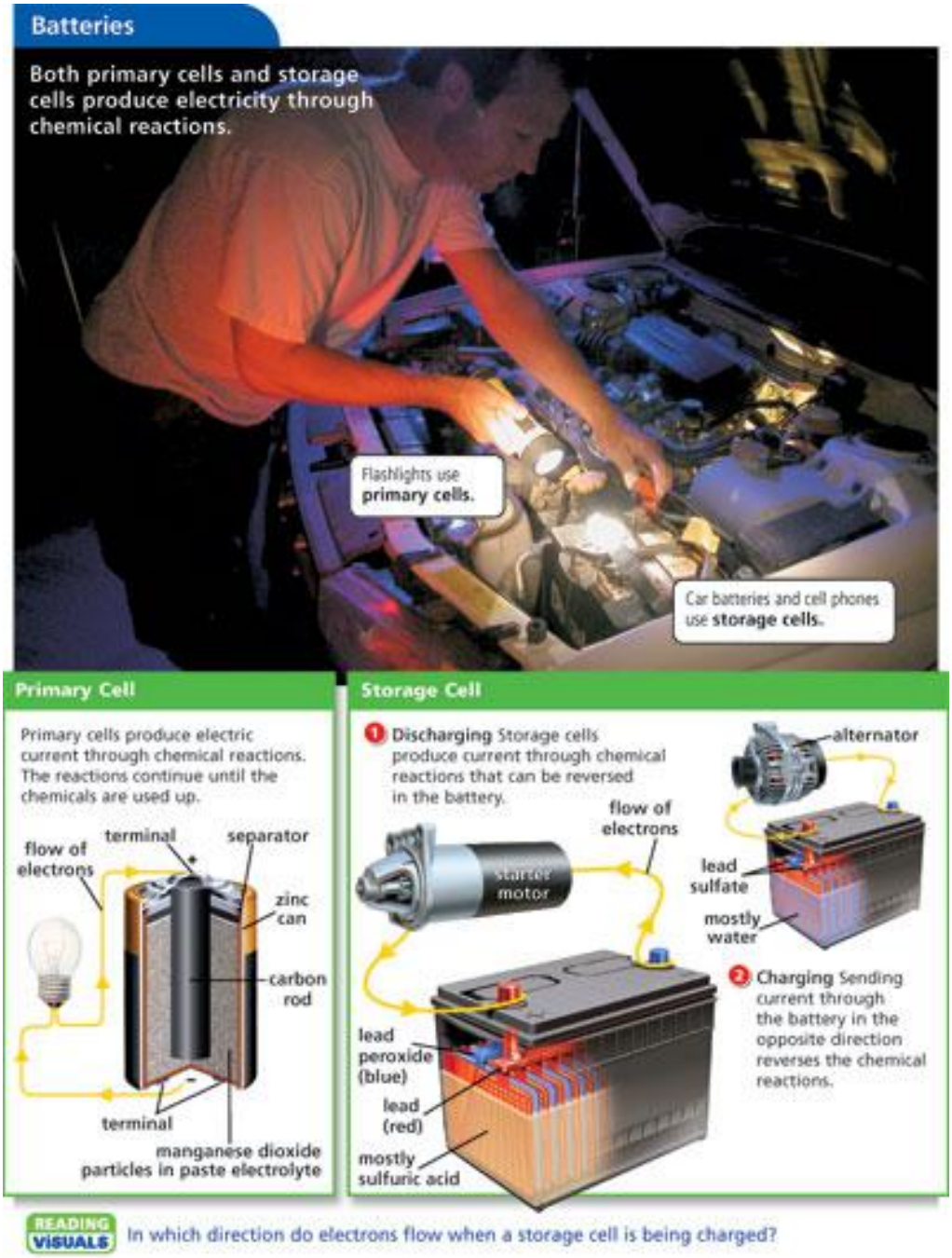
$$\textbf{\textit{Current}} = \frac{\textbf{\textit{Voltage}}}{\textbf{\textit{Resistance}}} \textbf{\textit{ or }} \textbf{\textit{I}} = \frac{\textbf{\textit{V}}}{\textbf{\textit{R}}}$$

- **I** is current measured in amps (A), **V** is voltage measured in volts (V), and **R** is resistance measured in ohms (Ω).





2. **Electric cells supply electric current.**
   An **electric cell** maintains a constant voltage between its two terminals by using the physical and chemical properties of different materials.
   - An electrochemical cell contains two electrodes suspended in an **electrolyte**, which undergoes chemical reactions with the electrodes.
   - Primary cells are either wet cells or dry cells in which chemical reactions continue until at least one reactant is used up. Most household batteries are primary dry cells.



- Some batteries are **storage cells** in which the chemical reactions can be reversed. Such batteries are rechargeable.
- **Solar cells** contain materials that absorb energy from the Sun or other sources of light and then release electrons to create an electric current. Solar cells are often used to make streetlights come on automatically at night. Current from the cell operates a switch that keeps the lights turned off. When it gets dark, the current stops, and the switch closes, and the streetlights come on.

Many houses and other buildings now get at least some of their power from solar cells. Sunlight provides an unlimited source of free, environmentally safe energy. However, it is not always easy or cheap to use that energy. It must be collected and stored because solar cells do not work at night or when sunlight is blocked by clouds or buildings.