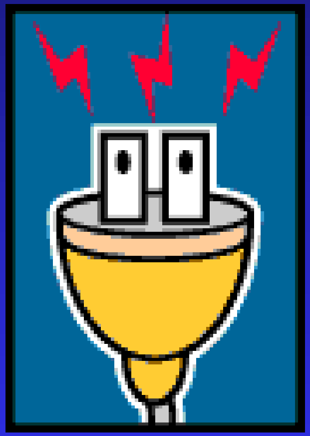
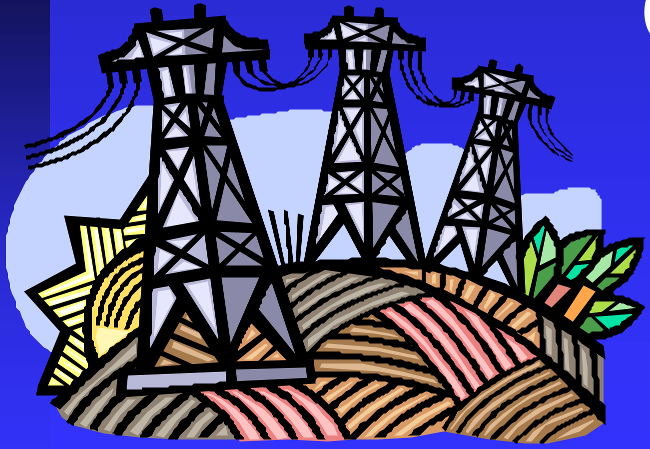
Electricity



Chapter 13



Charge and Force

- All matter is made of atoms that contain electrons, neutrons, and protons
- Recall that protons and electrons in atoms have electric charge
- Electrons have a negative charge
- Protons have a positive charge
- When an object has an equal number of protons and electrons, the object has no charge

- Neutrons have no charge
- Neutrons have no effect on the charge
- Charges in objects can produce a force between the objects
- Objects are forced together or attracted when their charges are different
- “Opposite charges attract”
- Same electric charges they push apart
- “Like charges repel”

Moving charges.

- Electrons can be moved around
- Rubbing fur or cloth against rubber (like a balloon) will move some electrons from the cloth to the balloon
- Both the cloth and the balloon will have a charge.
- What will the charge on the balloon be?
- What will the charge on the cloth be?

Electric Field

- Don’t have to touch to feel a charge.
- An electric field surrounds all charged objects.
- Electric forces act at a distance because or this field.

Static Electricity

- Static means not moving
- Static electricity is electricity at rest
- Friction can cause it
- Objects rub together and electrons move from one object another.

Two ways to move electrons

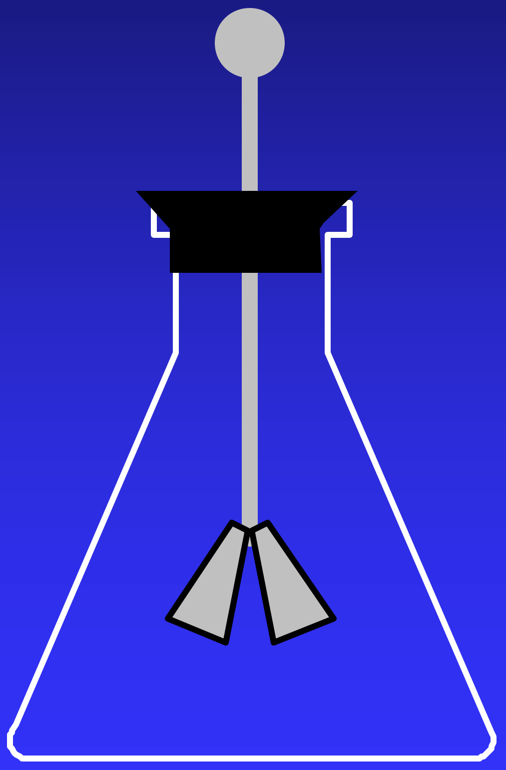
- Conduction: electrons are transferred by direct contact.
- Induction: electrons on an object are rearranged without physical contact.

Two types of materials

- <u>Conductors:</u> a material through which electric charges move easily.
- Metals are good conductors
- <u>Insulators:</u> a material through which electric charges can't move easily.
- Plastics, rubber, ceramics, wood

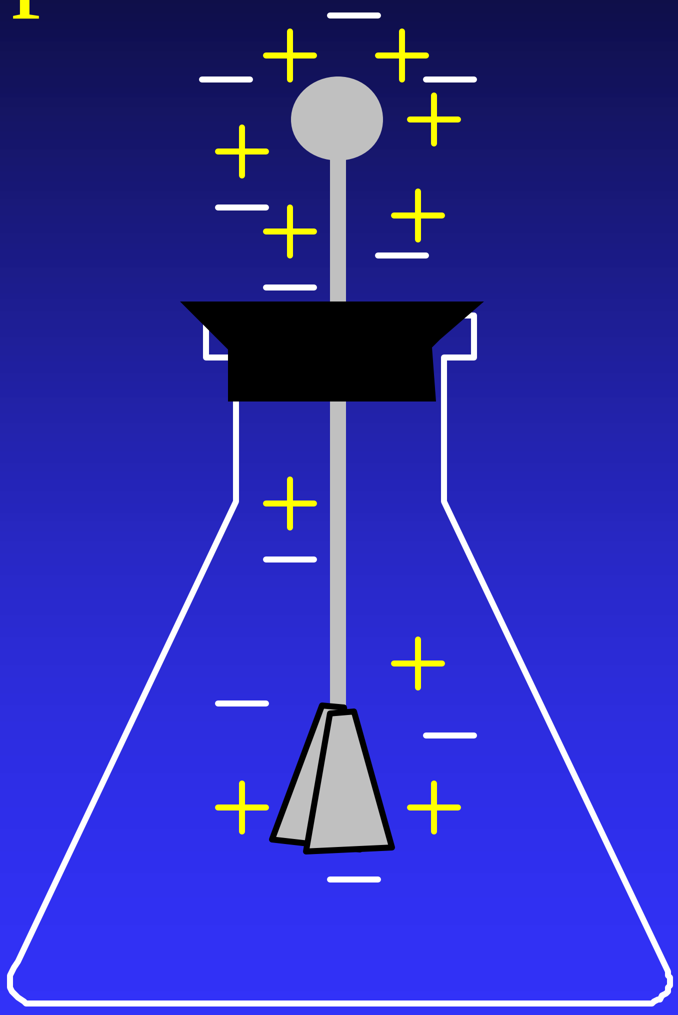
Electroscope

- Flask
- Metal bar (conductor) through rubber stopper (insulator)
- Two pieces of thin foil on the bottom
- Charge on the metal will push the foil apart
- because they have the same charge

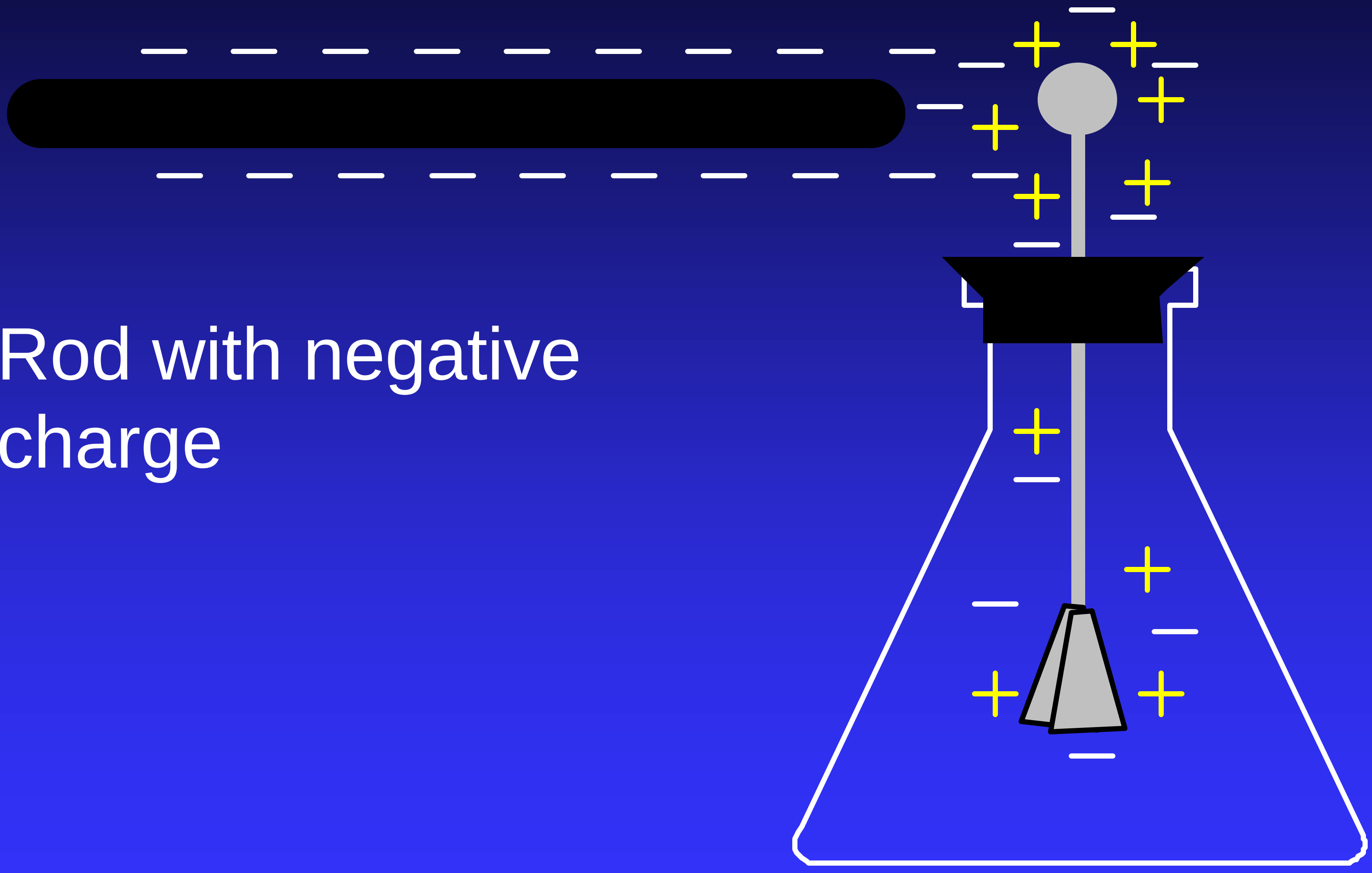


Electroscope

No Charge- leaves hang straight down

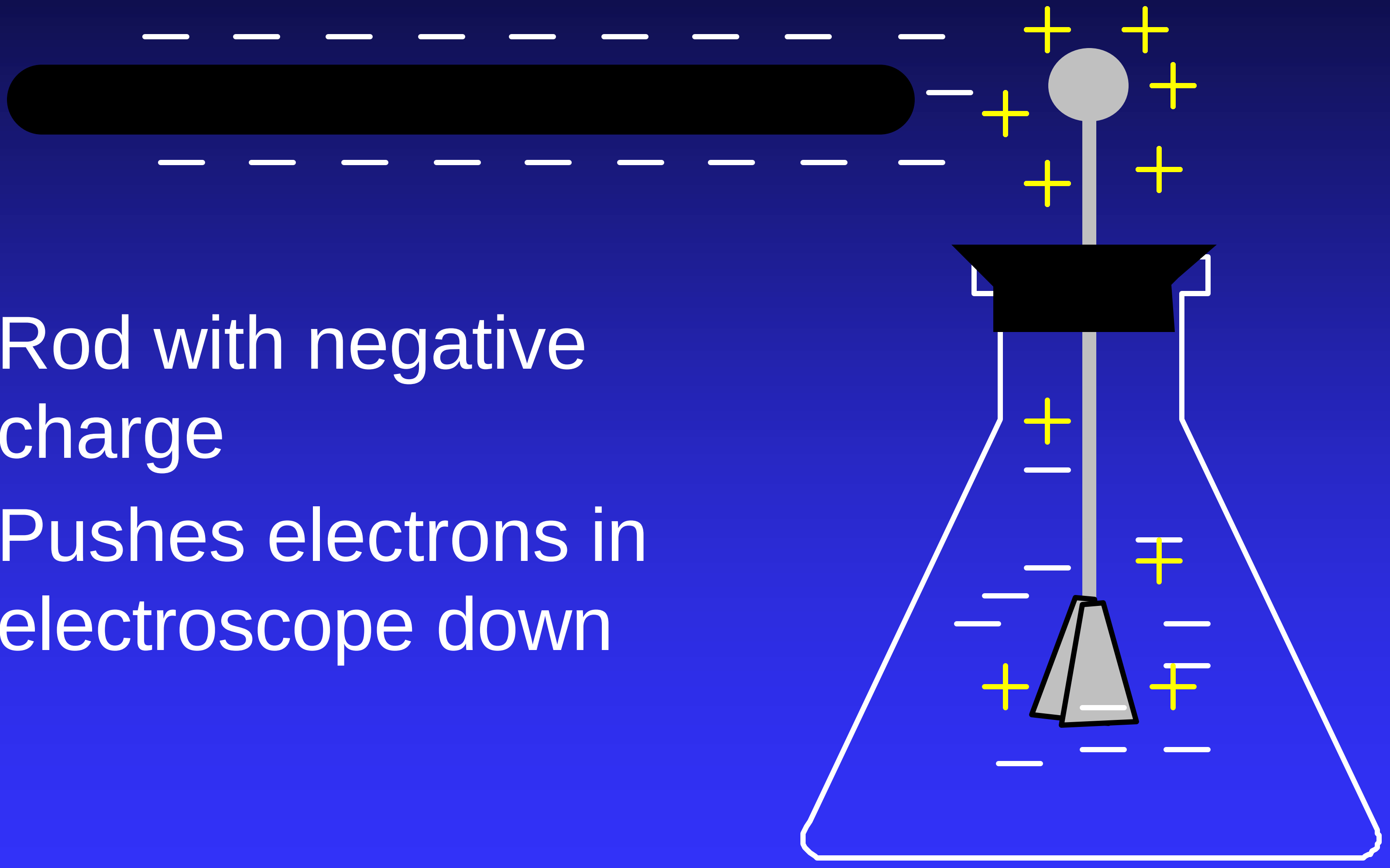


Induction



Rod with negative charge

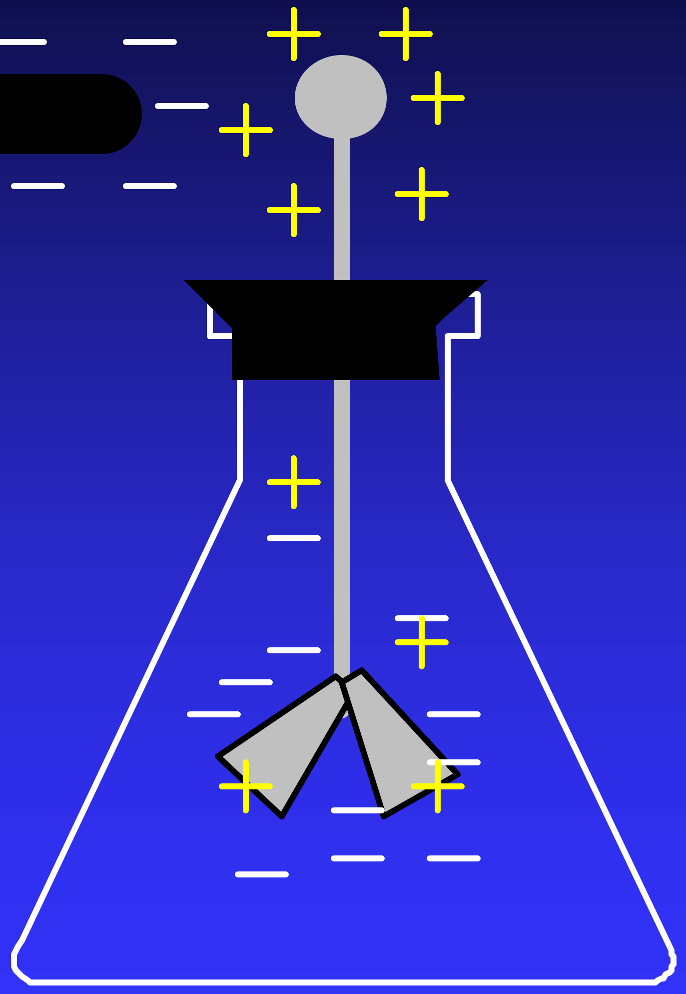
Induction



Rod with negative charge

Pushes electrons in electroscope down

Induction

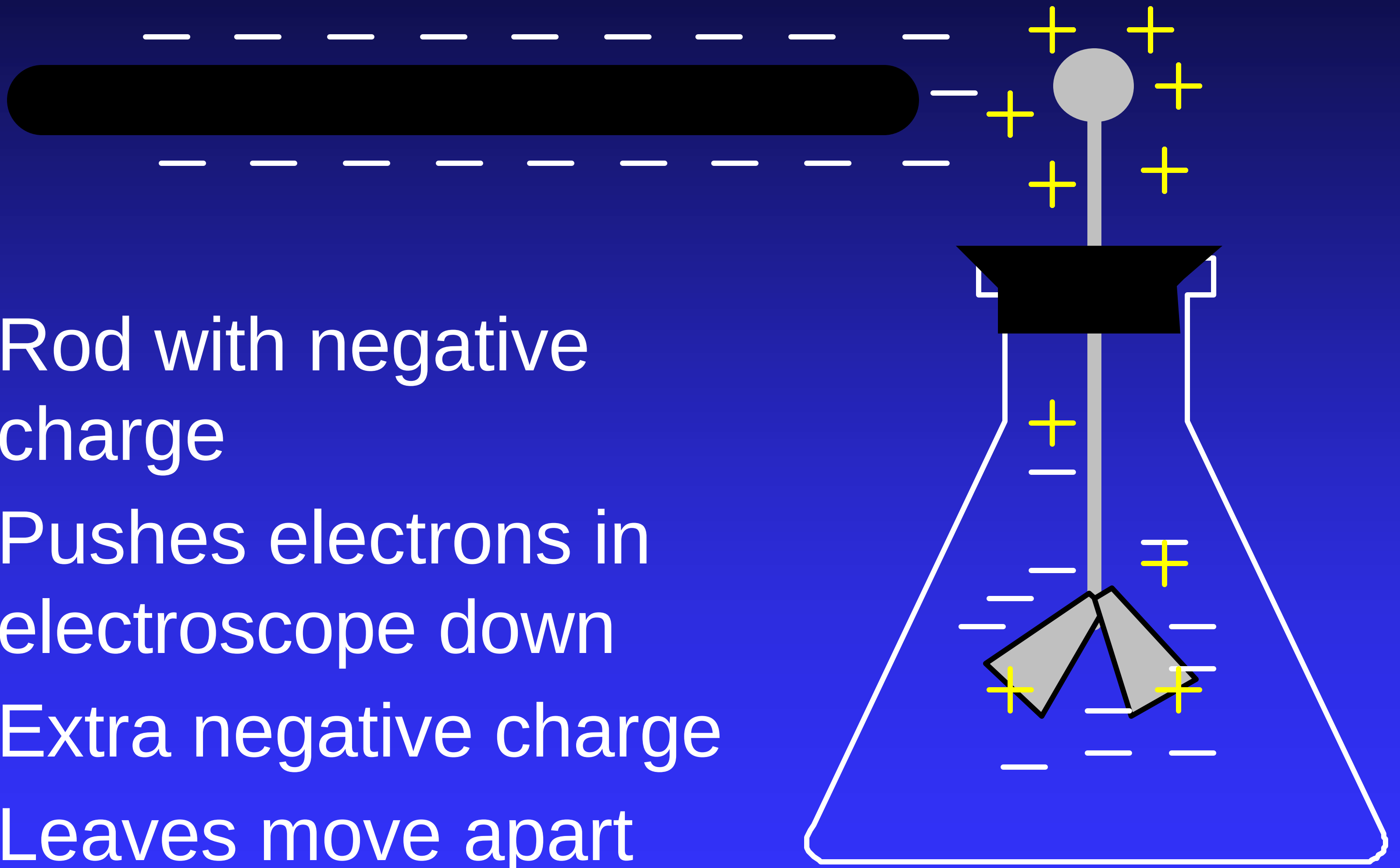


Rod with negative charge

Pushes electrons in electroscope down

Extra negative charge

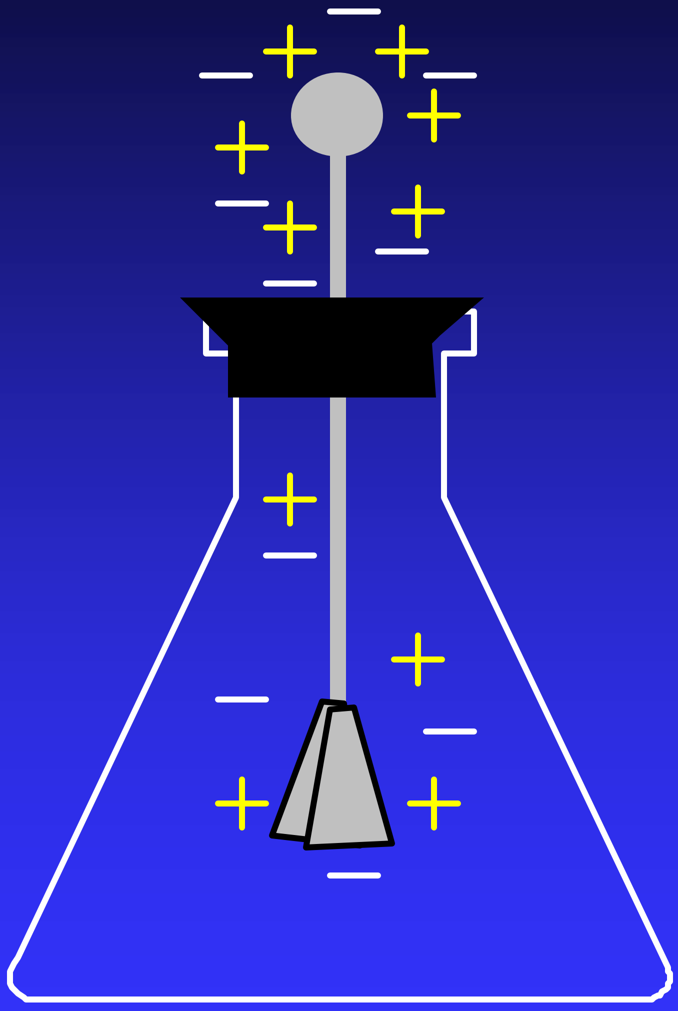
Induction



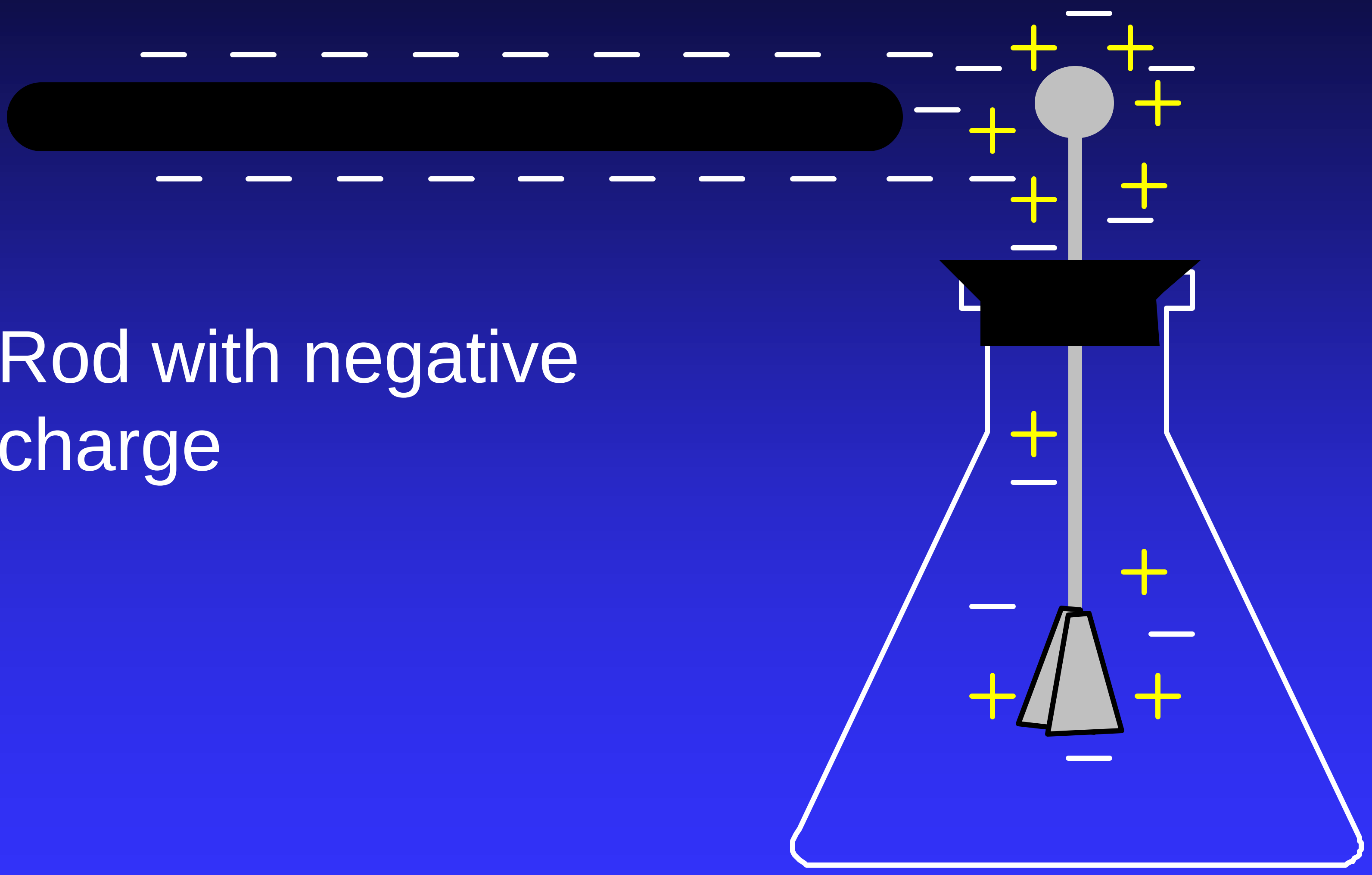
- Rod with negative charge
- Pushes electrons in electroscope down
- Extra negative charge
- Leaves move apart

Induction

Remove rod
everything returns

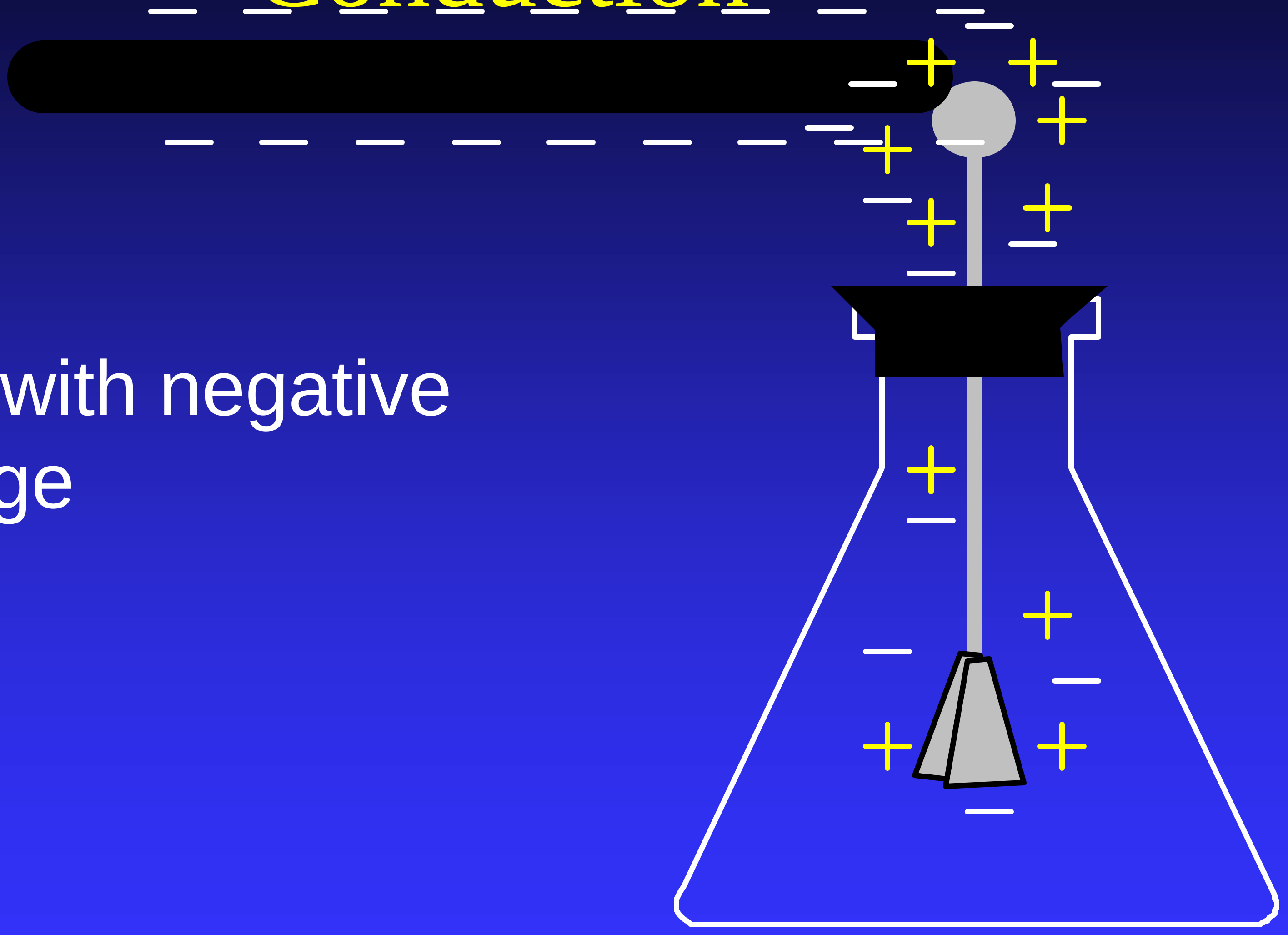


Conduction



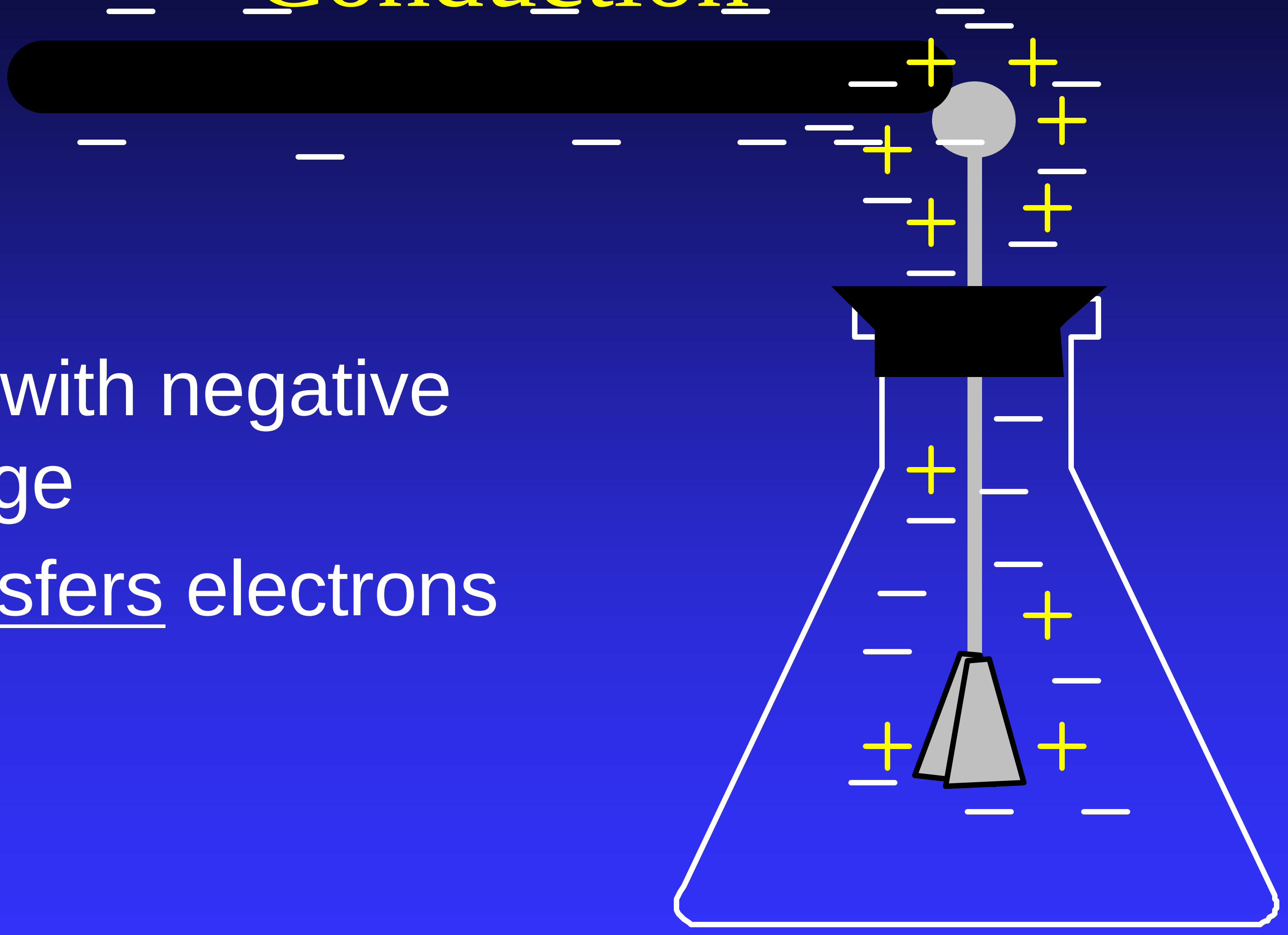
Rod with negative charge

Conduction



Rod with negative charge

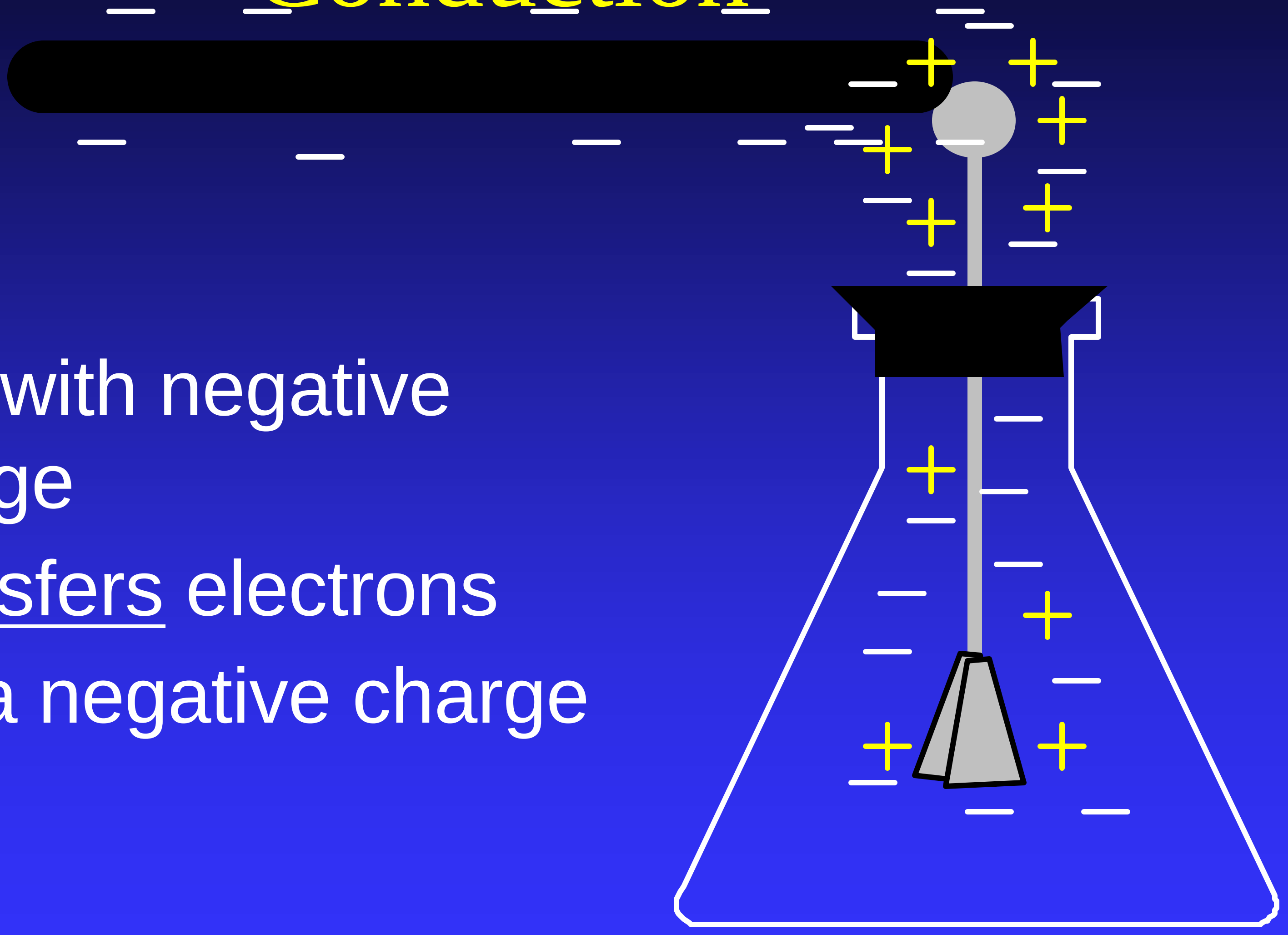
Conduction



Rod with negative charge

Transfers electrons

Conduction

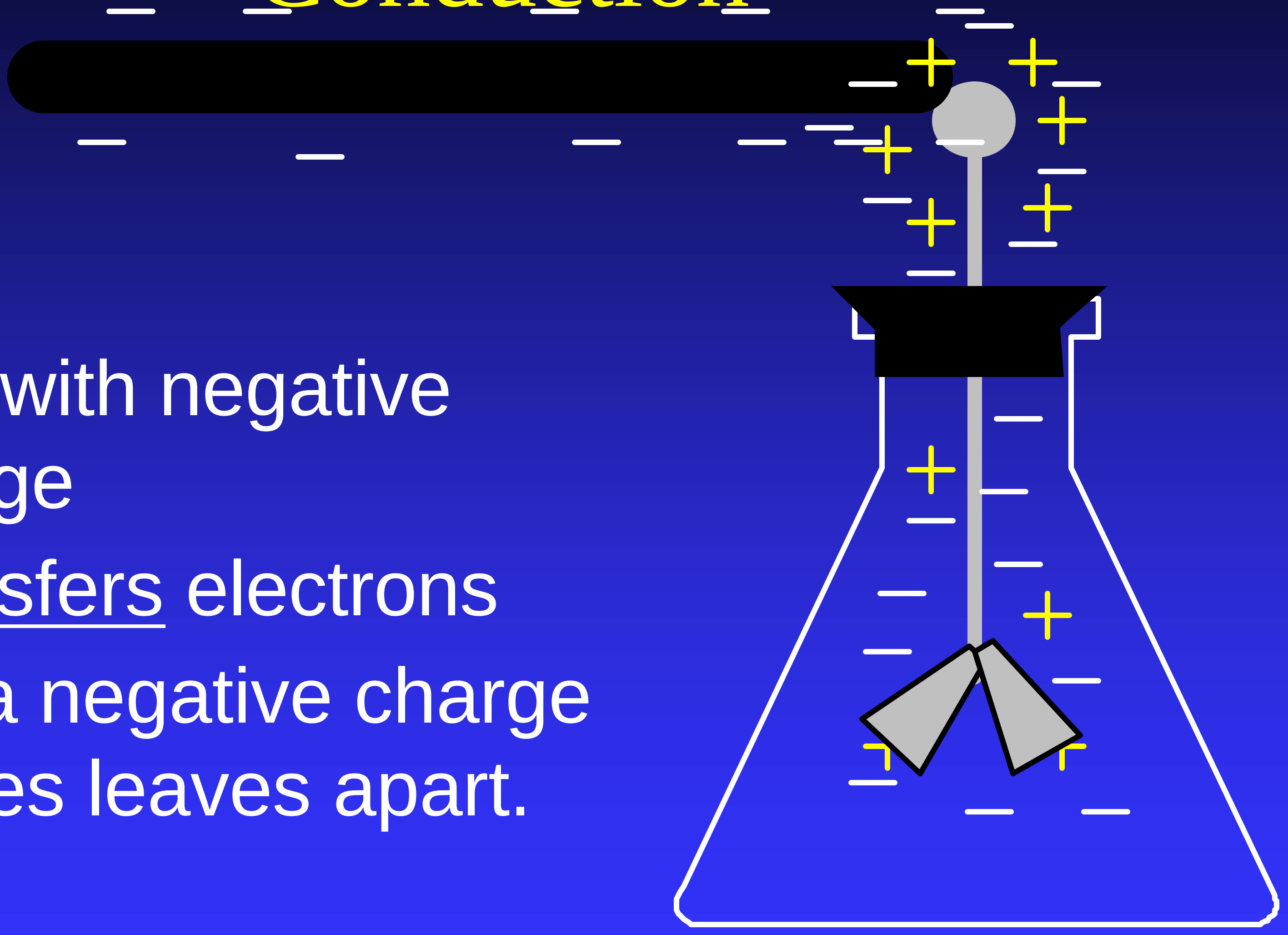


Rod with negative charge

Transfers electrons

Extra negative charge

Conduction



Rod with negative charge

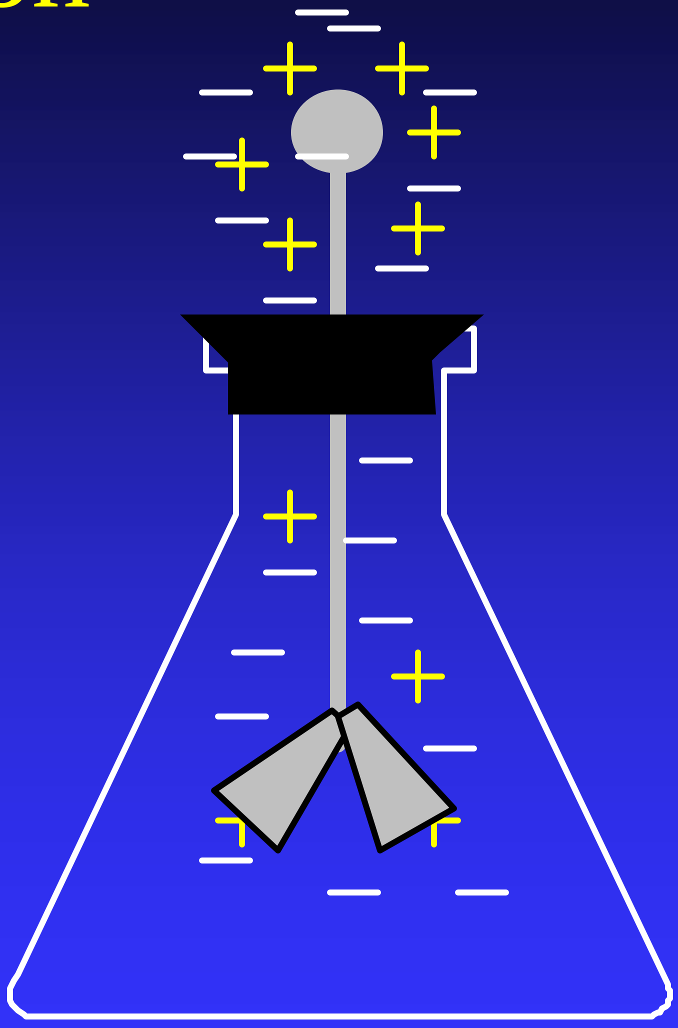
Transfers electrons

Extra negative charge

Moves leaves apart.

Conduction

Remove rod leaves stay apart.



Static discharge

- Eventually static electric charge will move.
- Slowly the electrons may move into moisture in the air
- Or quickly in a spark.

Lightning

- Wind rubs particles in cloud together
- Cloud gains charge
- Induce charge in ground
- Eventually a big charge jumps
- Lightning rod protects buildings

Electric Current

- Electrons in motion.
- Current: The number of electrons that pass a specific point in a circuit in one second
- Voltage: how hard the electrons are being pushed.
- Circuit: electric current flows through a closed, continuous path.

Generating Electric Current

- Electrochemical cell: (battery) changes chemical energy into electric energy. Two types wet cell and dry cell.
- Thermocouples: a tool that uses differences in temperature to generate electric currents.
- Generator- next chapter but make alternating current

Types of current

- Direct current: electrons that flow in the same direction in a wire. (DC)
- From batteries
- Alternating current: electrons that flow in different directions in a wire. (AC)
- From Genrators
- Used in your home
- Transformers change AC to DC

Measuring Electricity

- Current: The number of electrons that pass a specific point in a circuit in one second
- Measured in Amperes or amps (A)
- Voltage: how hard the electrons are being pushed
- Measured in volts (V)
- Higher voltage, the more work the electrons can do.

Measuring Electricity

- Resistance: the force opposing the flow of electrons.
- Measured in ohms
- Symbol is Greek letter omega Ω
- Thicker wire- less resistance
- Longer wire- more resistance
- Conductors- low resistance
- Insulators- high resistance

Ohm's Law

- The relationship among current, voltage, and resistance.
- Ohm's law states that the current in a circuit is equal to the voltage divided by the resistance
- $I = \frac{V}{R}$

Do the Math

- A car has a 12 volt system. The headlights are on a 10 amp circuit. How much resistance do they have?
- Your house uses 120 volts. What amount of current would flow through a 20 ohm resistor?

Circuits

- For current to flow there must be a complete loop
- Electric circuit: complete, a closed path through which electrons travel.
- Electrons flow from negative to positive terminal
- Work is done if there is a resistance in the wire.

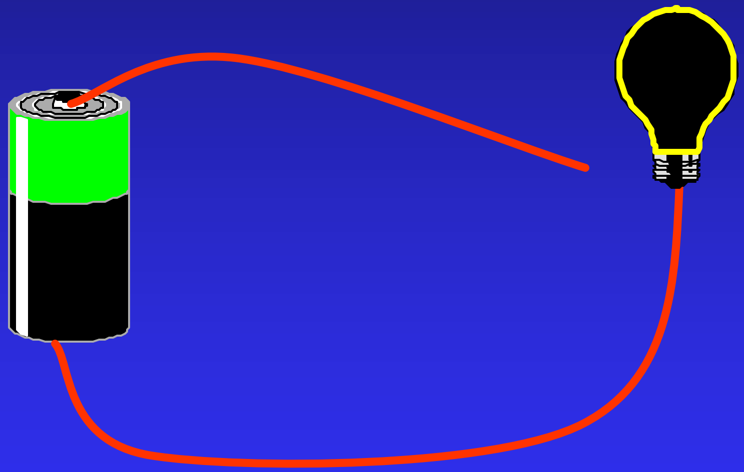
Circuits

- Resistance is supplied by a resistor.
- A resistor is a device that uses electric energy to do work.
- A wire connected from the resistor to the positive terminal completes the circuit.
- An open switch breaks the circuit.

Two Types of Circuits

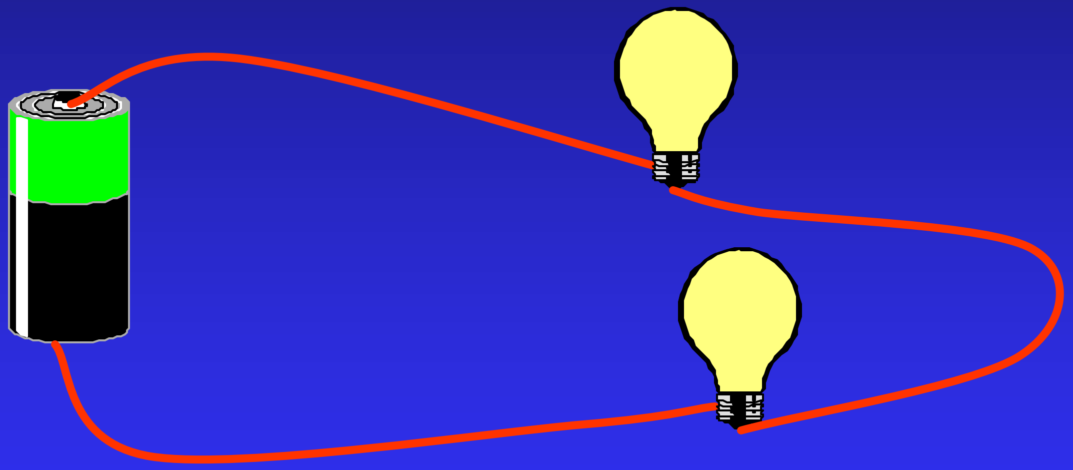
- <u>Series circuits</u>: A circuit with only one path.
- All the resistors in a series circuit lie along a single path.
- The amount of current in a series circuit is the same at all parts of the circuit.
- Resistance in the circuit changes if resistors are added or taken away.

Series Circuits

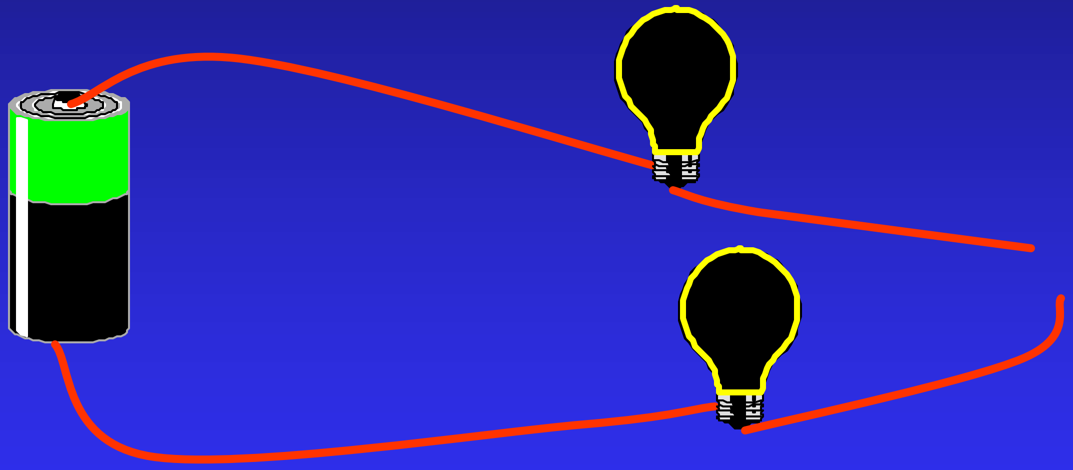


Series Circuits

Series Circuits



Series Circuits

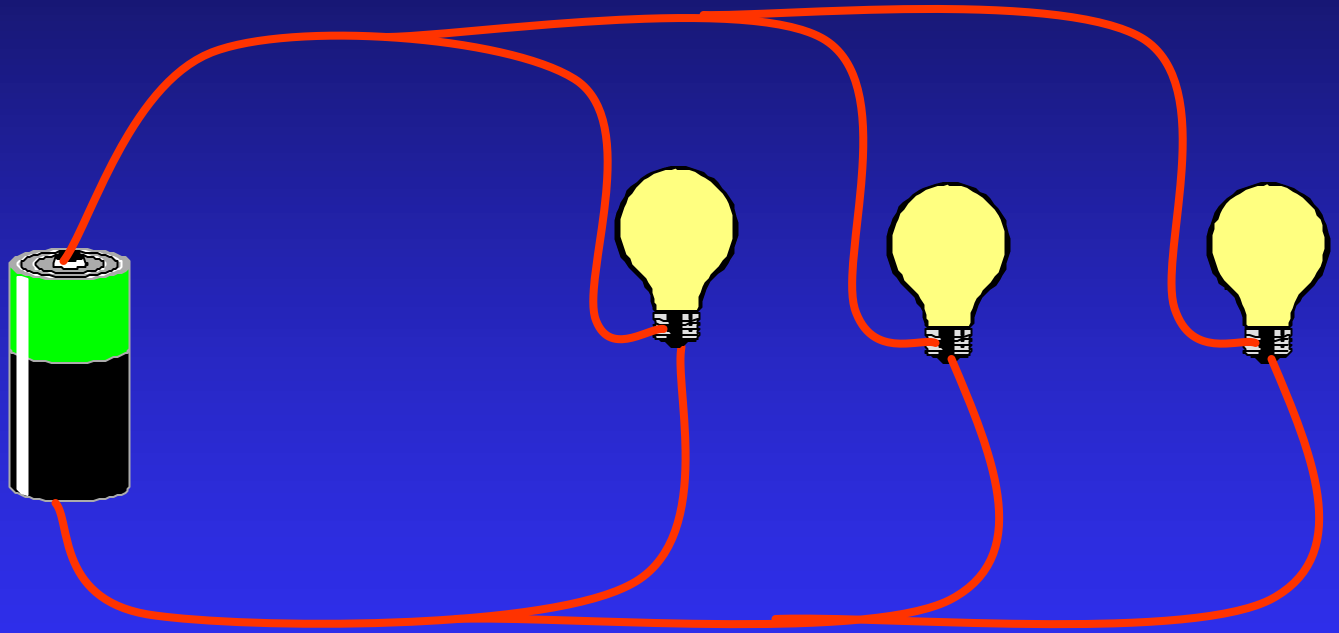


Break in the wire turns off all the lights

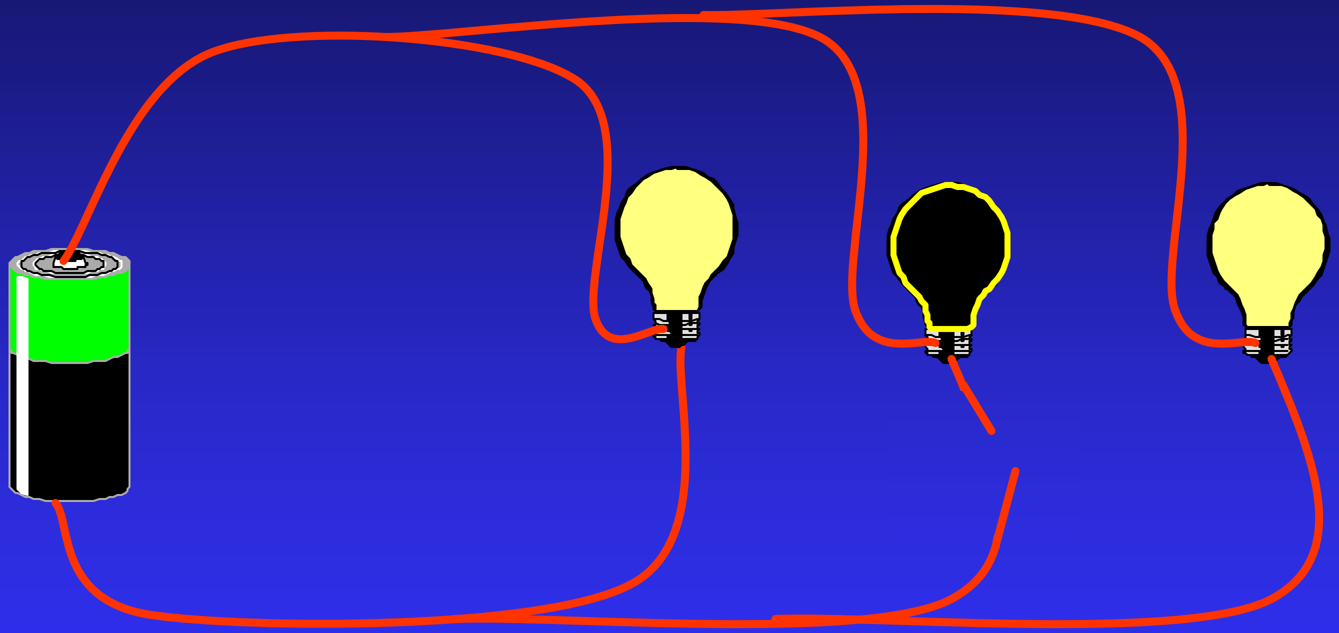
Parallel Circuit

- Parallel circuits: The electrons in a parallel circuit can travel through more than one path, each path is separate.
- If there’s a break in one path in the circuit, electrons can still flow through the other paths and maintain a complete circuit.

Parallel Circuit



Parallel Circuit



- Parallel circuits in your home allow each light or appliance to use the amount of current it needs to work.
- A parallel circuit prevents all the lights or appliances from shutting off when one of them stops working.

Electric power and energy

- <u>Power</u>: The rate at which electricity does work or provides energy The amount of electric power a device uses to do work is determined by its resistance.
- $P = V \times I$
- (P) power = (V) voltage x (I) current in the circuit.

- Formula for energy
- E = P x t
- (E) energy used = (P) power x (t) time
- The SI unit for energy is a joule.
- Kilowatt-hour meters measure the electricity used in your home.
- (kWh)

Electric safety

- Many appliances are equipped with a “ground” wire on the plug.
- The ground wire prevents electric shock. The rounded third prong of a three-way electric plug is attached to the ground wire.
- It constantly moves static electricity from the appliance to the ground.

- Broken wires or water can cause electric appliances to short-circuit.
- A short circuit occurs when electricity takes a short path and bypasses the resistors in the circuit.
- Because of this the resistance of the circuit is less and the circuit wire increases.
- The increased current can produce enough heat to melt wires and start a fire, or cause serious electric shock.

Circuit protectors

- Fuses and circuit breakers protect against overloaded circuits.
- A number on the fuse indicates the max. current that will flow through it.
- Circuit breakers are often used in place of fuses.A circuit breaker is a switch that opens automatically when electric current in a circuit reaches its max.