

14th Feb Sec 2 Science Extra Lesson

3:30 – 4:30 PM

Agenda:

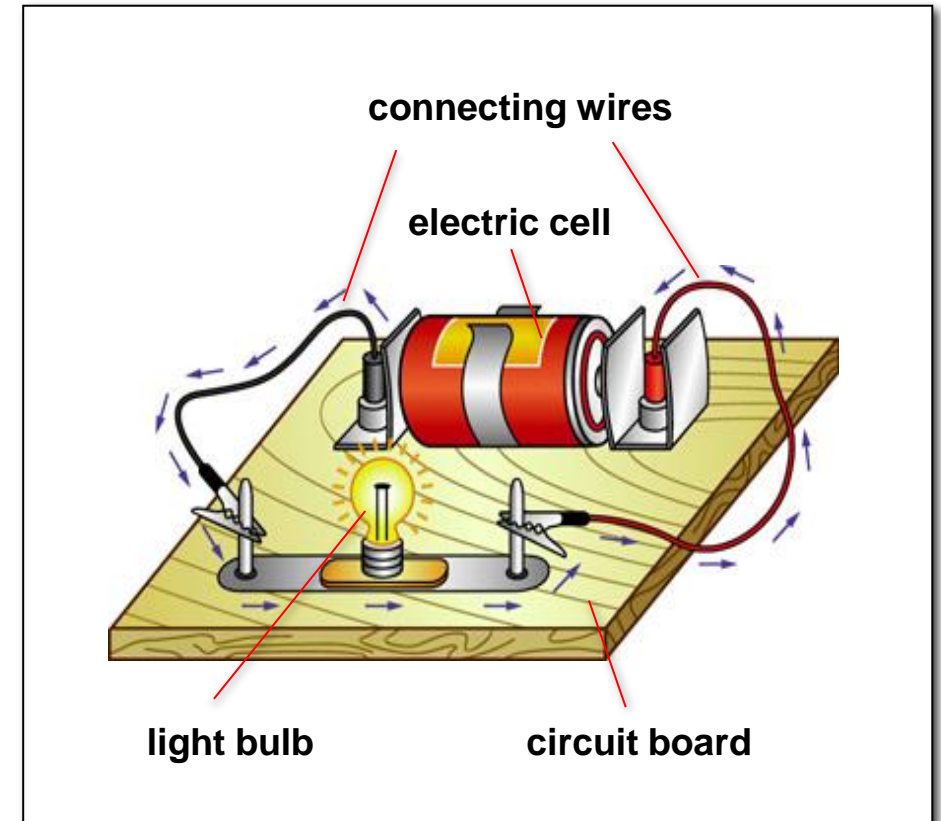
1. Electrical Systems – introducing ideas of current, voltage (potential difference) and resistance.
2. Arrangement of circuits
3. How does resistance affect output of a circuit – brightness of the bulb

Electric Circuits

- Electric circuits are made up of electrical components

Note:

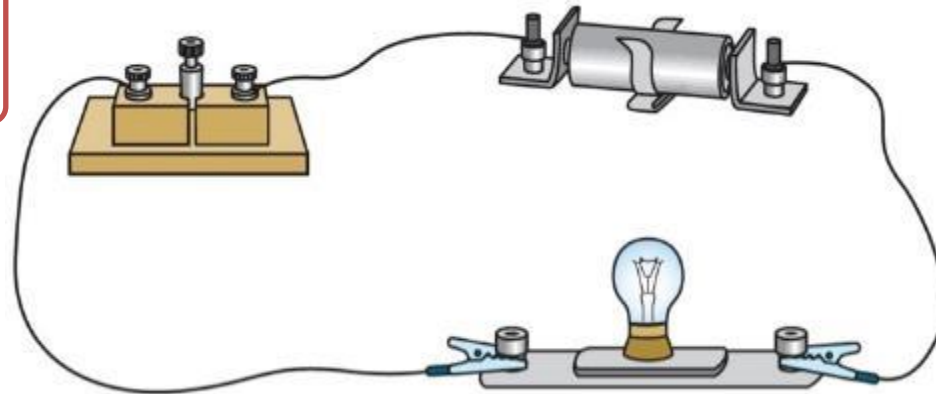
Components refer to the light bulb, wires, battery



Flow of electricity in an electric circuit

- An electric current flows through a path that is set up by an **electric circuit**.
- All the **components** of the electric circuit must be connected correctly for it to work.
- A **circuit diagram** shows how the electrical components are connected in an electrical system.

The switch turns the current on or off.



The battery (energy source) provides energy for electric current to flow in the circuit.

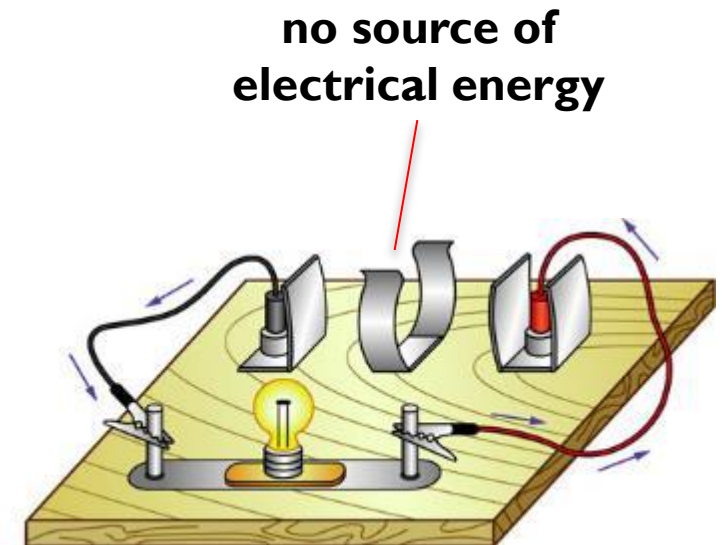
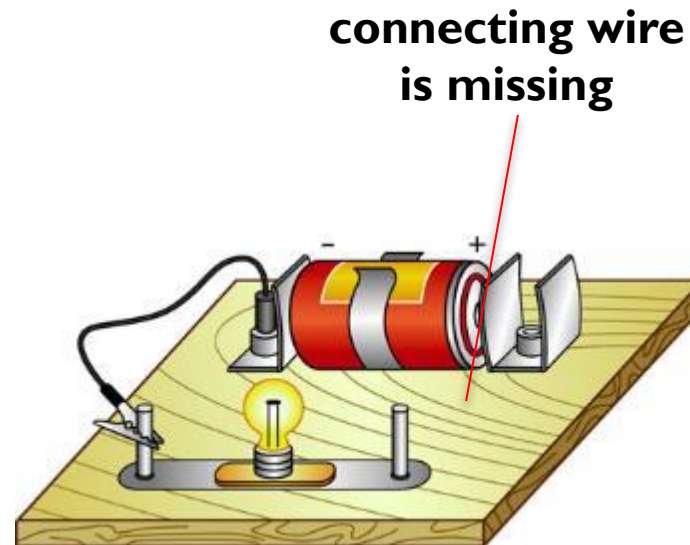
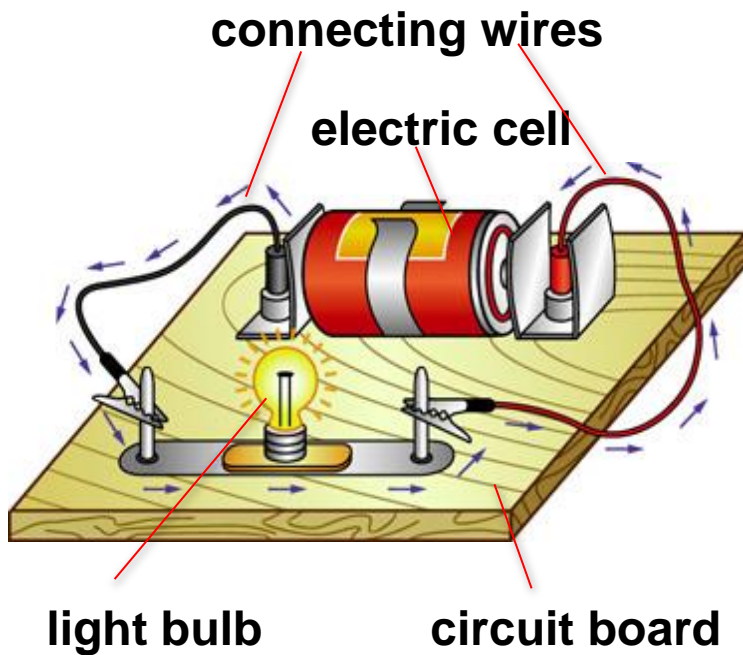
Wires connect the various components together. This provides a complete path for the current to flow.

The bulb converts electrical energy into light and heat.

Electric circuits

Note:
Components refer to the light bulb, wires, battery


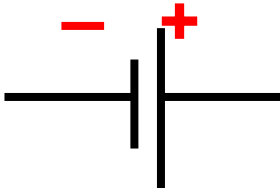

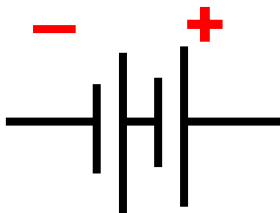

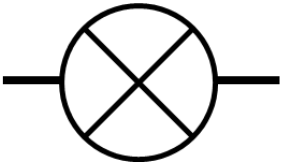
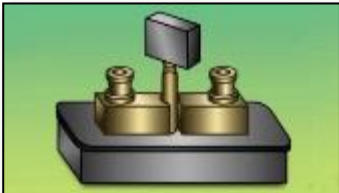
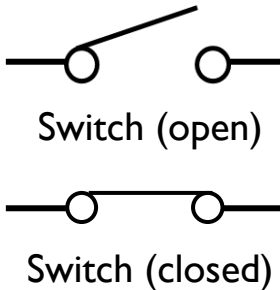

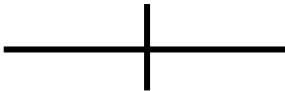
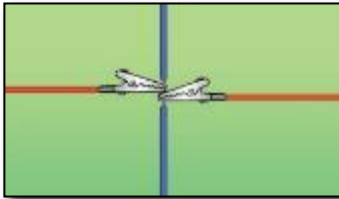

- Electrical components must be joined together without any gap in between to form a **closed circuit**.
- Incomplete circuits are called **open circuits**.



Both the circuits in the diagram are **incomplete**, hence they are known as “open circuits”.

How to draw circuit diagrams

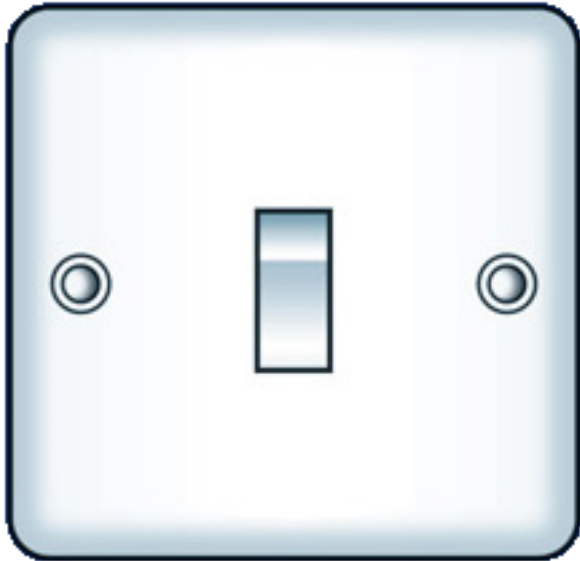
Symbols are used to represent electrical components in circuits.

| Component | Symbol | Component | Symbol |
|--|--|--|---|
| An electric cell (battery)  |  | Two batteries  |  |
| Light bulb (lamp)  |  | Switch  |  |
| Connecting wires (not joined)  |  | Connecting wires (joined)  |  |

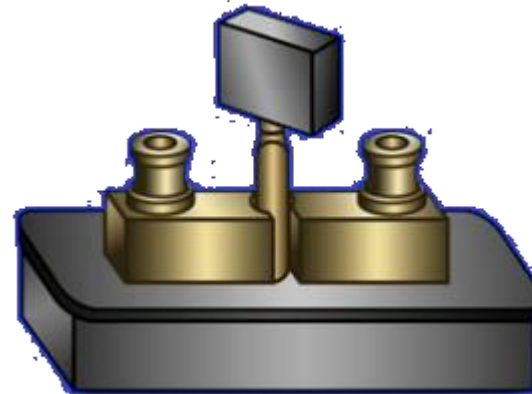
Circuit symbols

A switch is used to open or close a circuit.

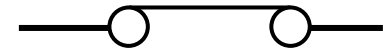
Main switch used
in buildings



Switches used on circuit boards




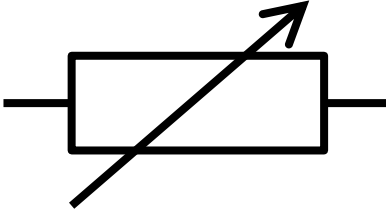



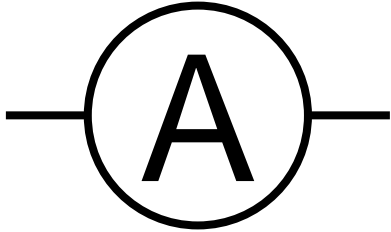

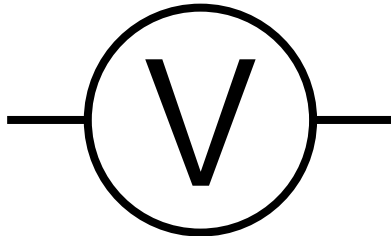
Open



Close

- Resistors contain resistance values
- Fixed resistor has only one resistance value
- Variable resistors have different resistance values

| Component | Symbol |
|--|--|
| <p>Fixed Resistor</p>  |  |
| <p>Variable Resistor</p>  |  |

| Component | Symbol |
|---|---|
| <p>Ammeter</p>  |  |
| <p>Voltmeter</p>  |  |

An ammeter is a device used to measure electric current.

A voltmeter is a device used to measure voltage or potential difference.

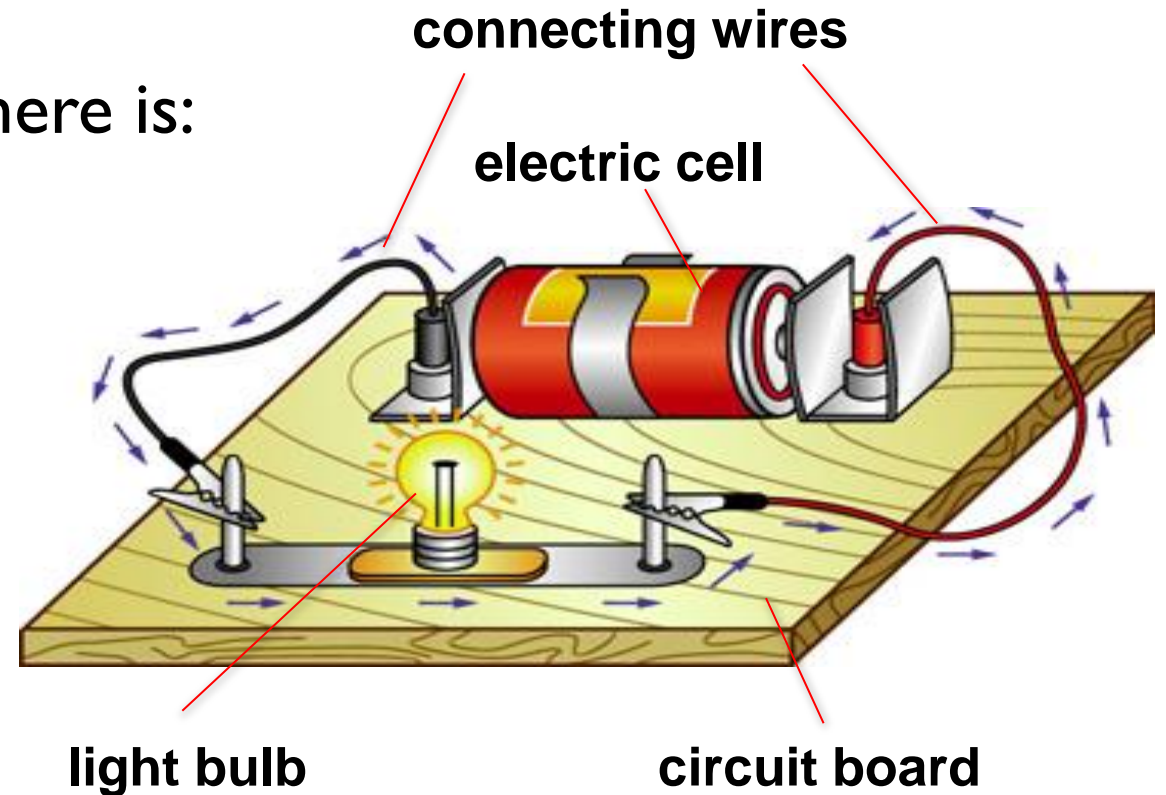
Conditions for current to flow

From the previous two slides, can you tell the conditions for current to flow through a circuit?

An electric current flows only when there is:

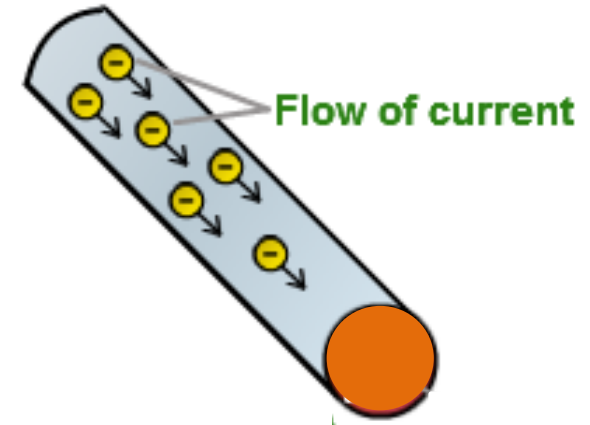
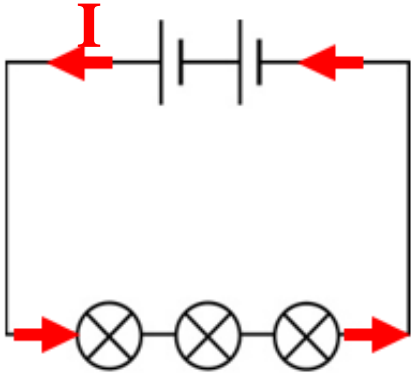
- and

-



What causes electricity?

Electricity is due to the flow of negatively charged particles called electrons.



The electrons that flows in the wire are free electrons (only in metals and graphite.)

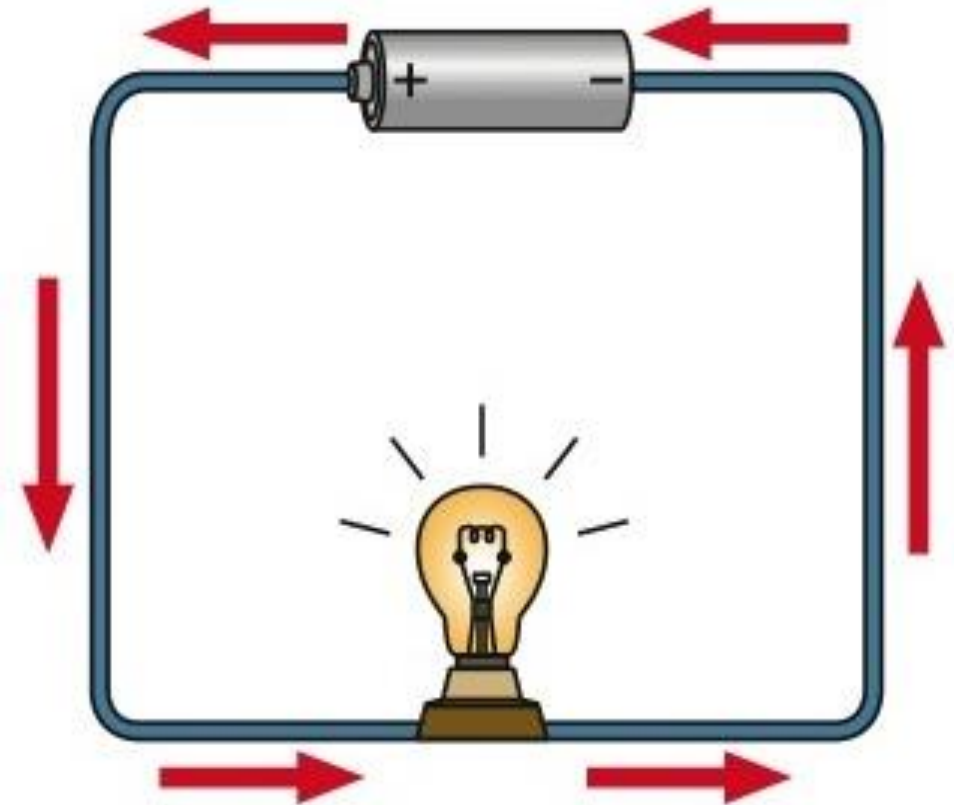
What is an electric current?

An electric current is the rate of flow of electric charges in a circuit.

- It has a symbol of I.
- The SI unit for electric current is ampere (A).

Current flow

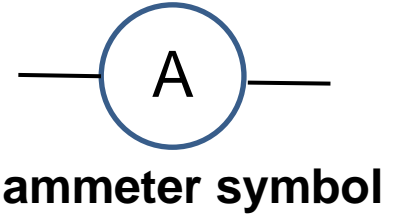
Current flows from the positive terminal of a battery to the negative terminal



Direction of current flow

Instrument to measure current

- The **ammeter** is an instrument used for measuring electric current.



Two types of ammeters:

1. Analogue ammeter

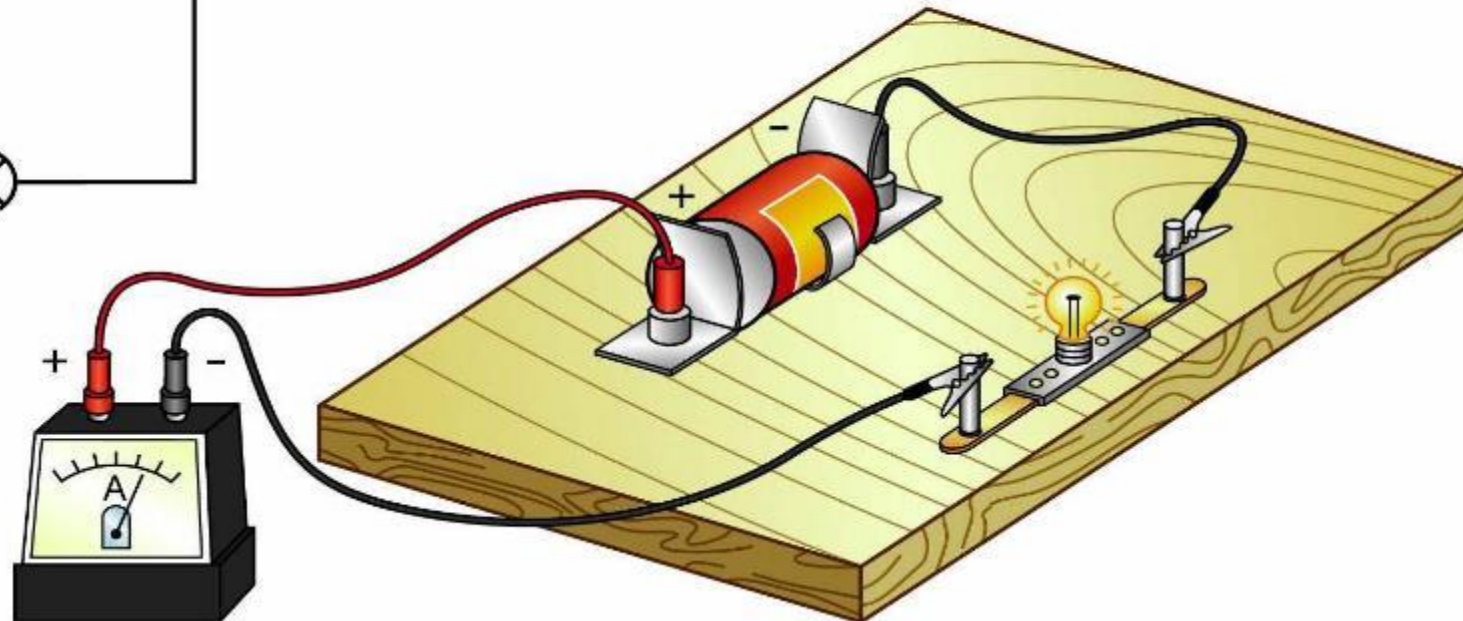
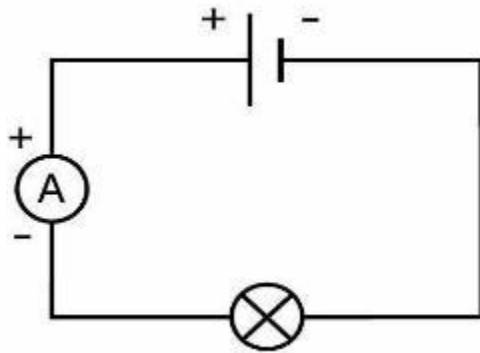


2. Digital ammeter



How to connect ammeter

- Ammeters are always connected in **series** in a circuit.
- **Positive** side of ammeter must be connected nearest to the **positive** terminal of the battery (electric cell), and vice versa.



Voltage

Voltage is the amount of energy given to each unit of electrical charge, driving them around a complete circuit.

- It has a symbol of V.
- SI unit of voltage is volts (V).

Different voltages are supplied by different cells and batteries.



12 V Car Battery

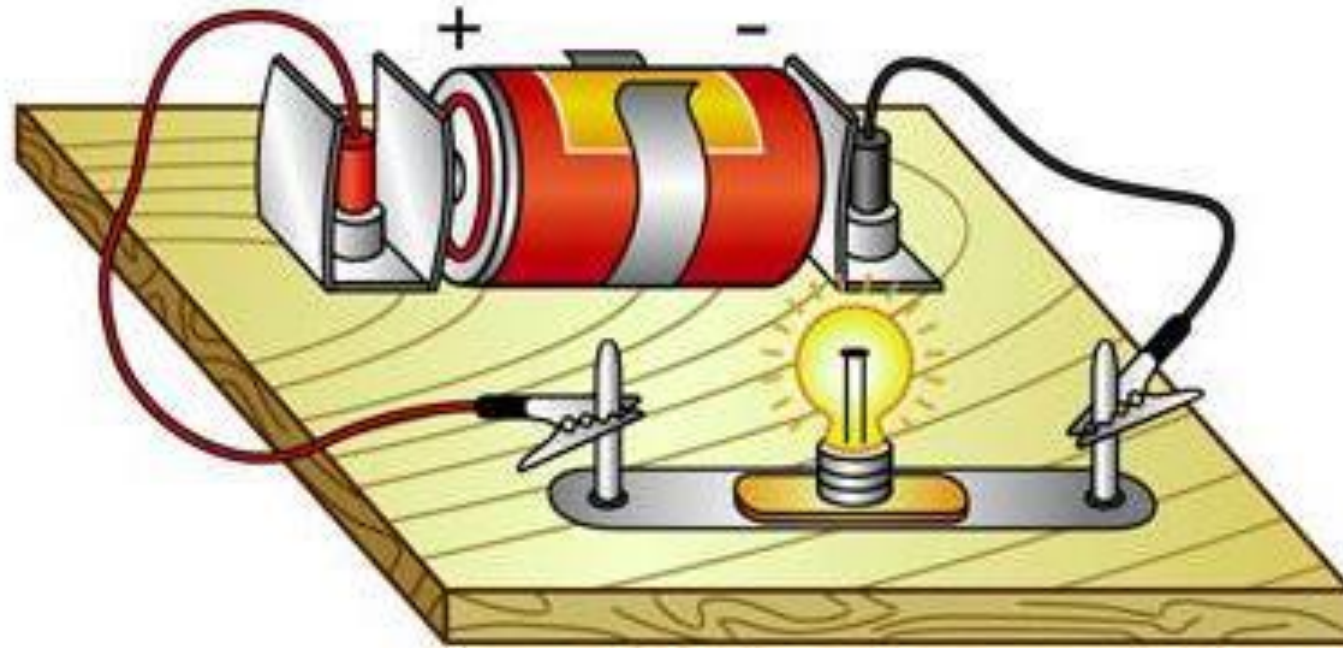
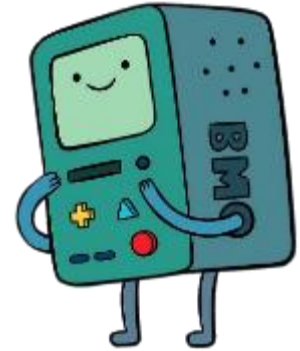


1.5 V Dry Cell



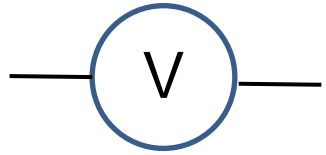
9 V Dry Cell

What causes the electrical charges to move?



The battery in a circuit gives energy to the electrical charges and causes them to flow through the circuit.

How to measure voltage?



voltmeter symbol

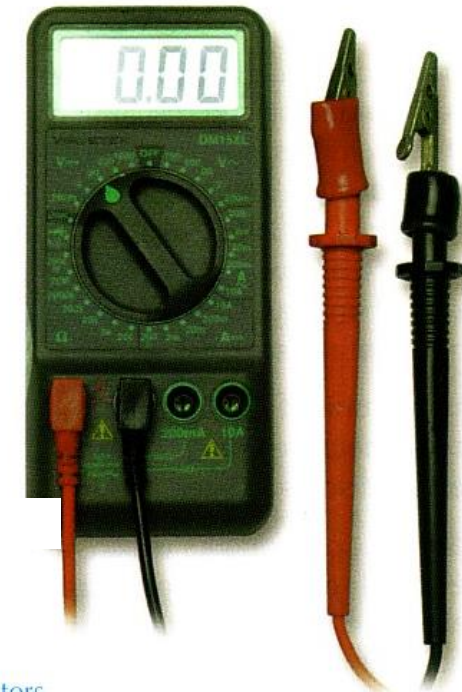
A **voltmeter** is the instrument used for measuring voltages.

Two types of ammeters:

1. Analogue voltmeter

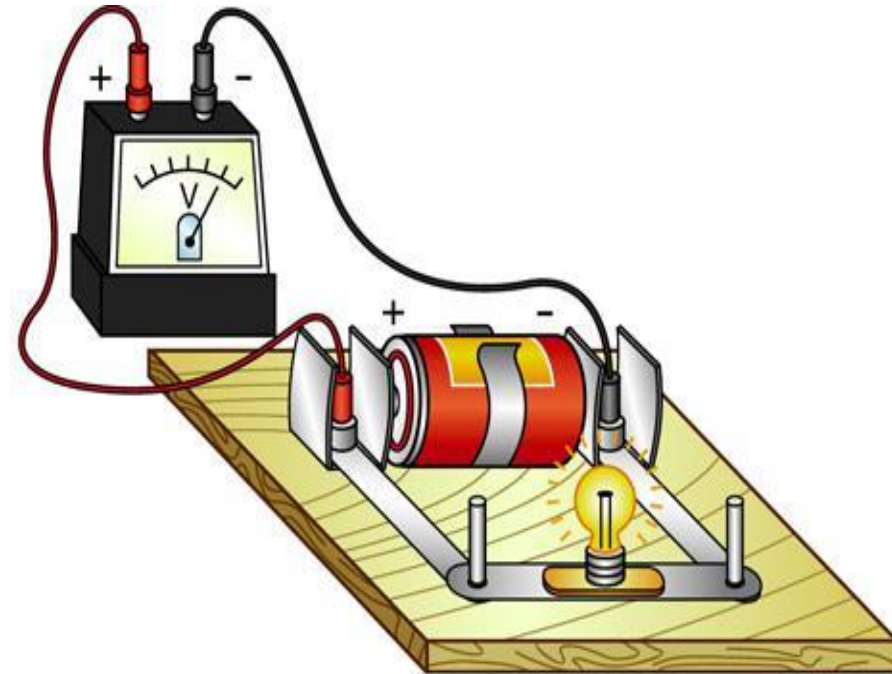
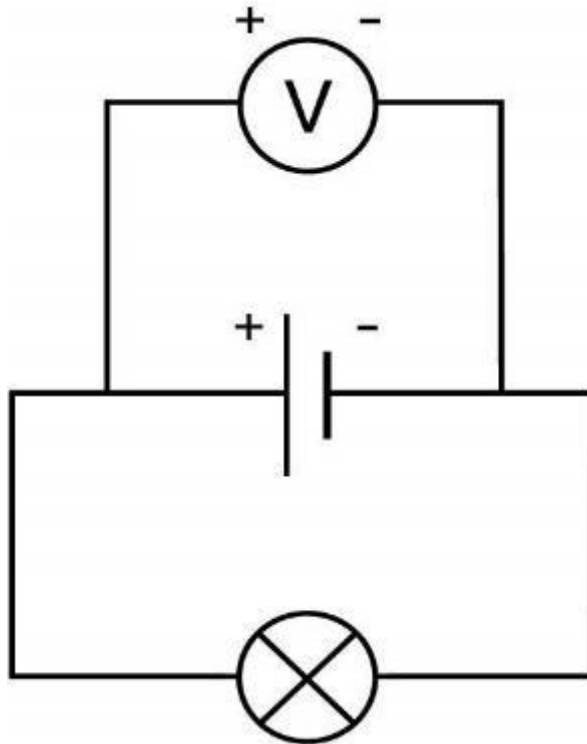


2. Digital voltmeter



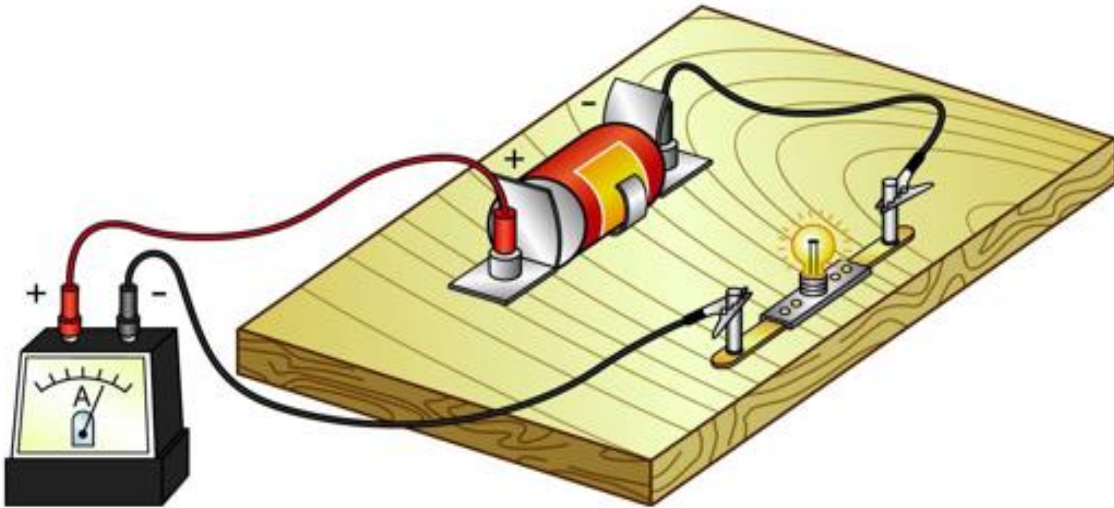
How to connect the voltmeter

- Voltmeters must be connected in parallel to a circuit or electrical component.
- The positive side of voltmeter is connected to the positive terminal of the cell, and vice versa.

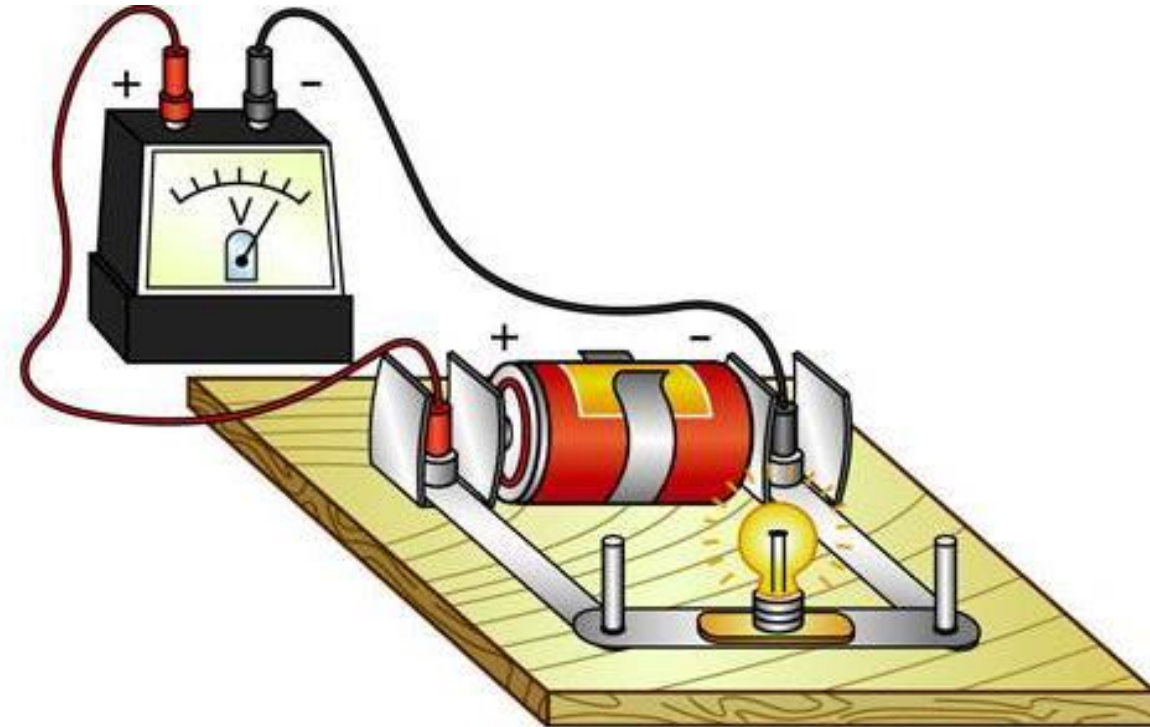


Ammeter vs Voltmeter

Ammeter must be connected in series



Voltmeter must be connected in parallel

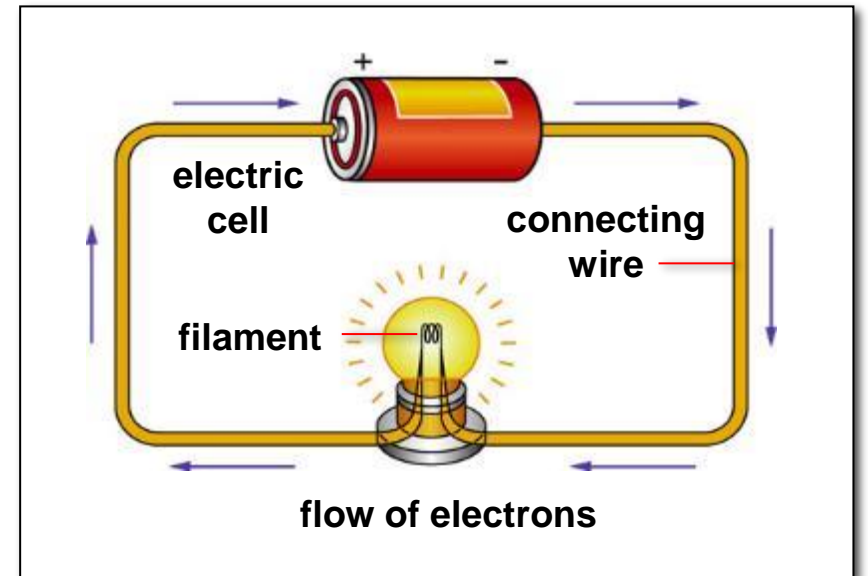


Potential Difference (p.d)

- P.d is a measure of the amount of electrical energy converted to other forms of energy when *per unit of electric charge flows through the component*.
- Units: volts (V)

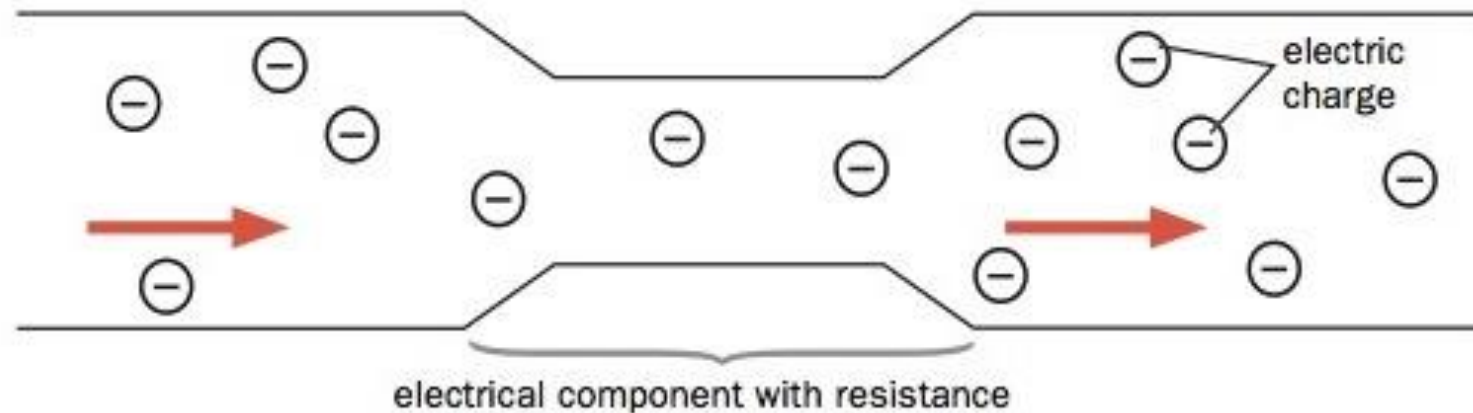
What exactly is potential difference (p.d)?

- Electric charges will flow from a point of higher potential (energy) to lower potential.
- This difference in electric potential between 2 points in a circuit is the potential difference.



Resistance

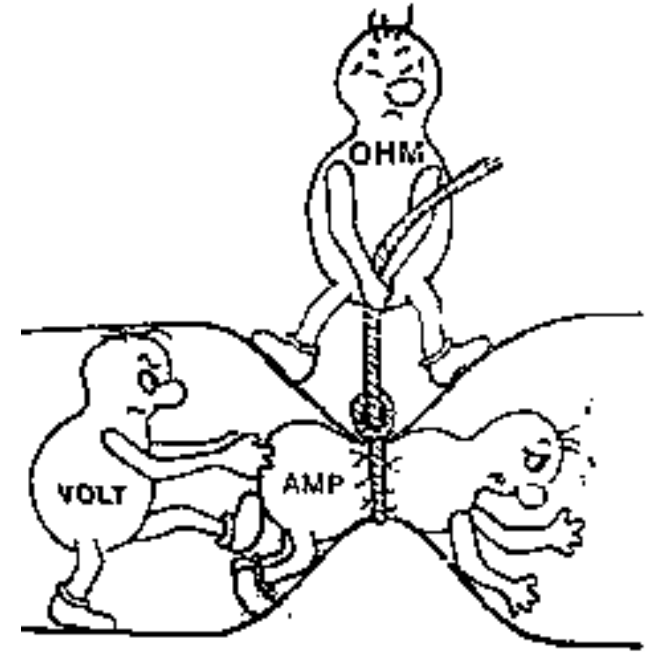
- *An electrical component hinders the flow of electric charges when it is connected in a circuit.*
- *The resistance to the flow of charges is similar to how a narrow channel resists the flow of water.*



Resistance

The resistance of a conductor refers to its ability to **hinder** current flow.

- *When an electric current flows through a circuit, there will be some resistance that opposes it. (similar to friction)*
- It has a symbol of **R**.
- The SI unit for resistance is **ohm(Ω)**



Instrument to measure resistance

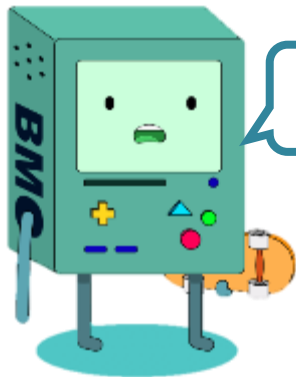
The ohmmeter is the instrument used to measure resistance.



Resistance

- Different electrical components have **different resistance**
- For example, nichrome wires have a **higher** resistance than copper wires.

| Good conductor | Poor conductor |
|---|---|
| Low resistance | High resistance |
| Electricity is able to flow through easily. e.g. metal objects | Electricity is NOT able to flow through easily. e.g. wood, cloth |



So when do we use nichrome wires or copper wires?

(Hint: The resistance of a substance allows it to convert some of the electrical energy into other forms of energy, such as heat.)

Nichrome is used for heating element of a electrical appliances.
Copper is used to make electrical wires

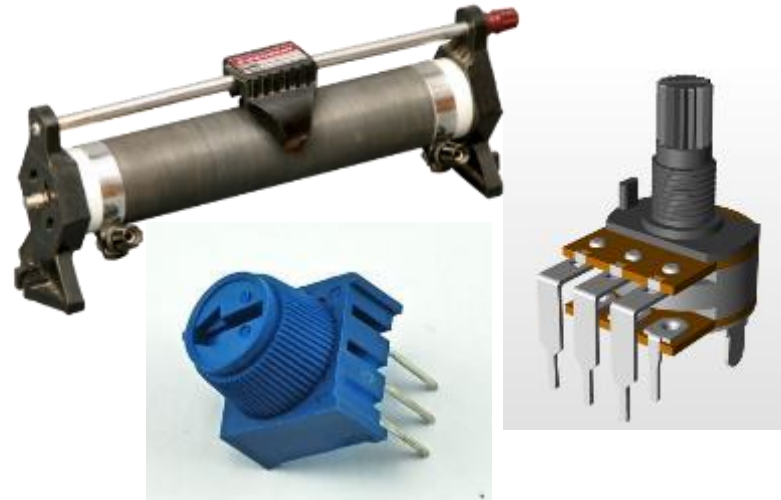
Resistors

- An electrical component that is specially made to have a certain resistance is called a **resistor**.
- *They can be connected in a circuit to resist the current flow.*
- There are two types of resistors:

1 Fixed resistors



2 Variable resistors



1

Fixed resistors

- Fixed resistors have only one resistance value



fixed resistor symbol

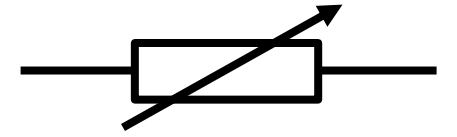


Coloured bands indicate the resistance of the resistor.

*In a circuit contains only fixed resistors, we can change the total effective resistance of the circuit by adding or removing fixed resistors in **different arrangements** (either in series or parallel arrangements).*

2

Variable resistors

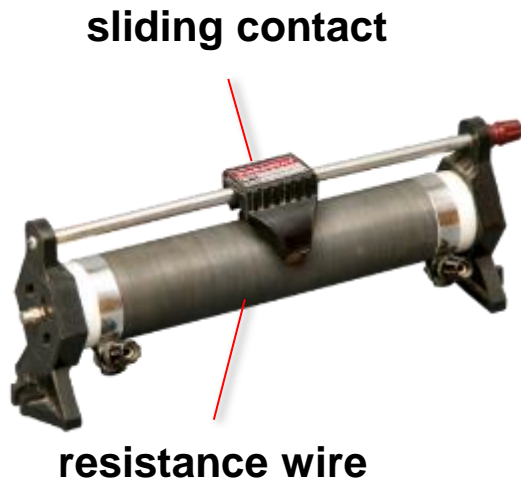


variable resistor symbol

- Variable resistors or rheostat can be **adjusted to change** the resistance.
- There are two types of rheostats:

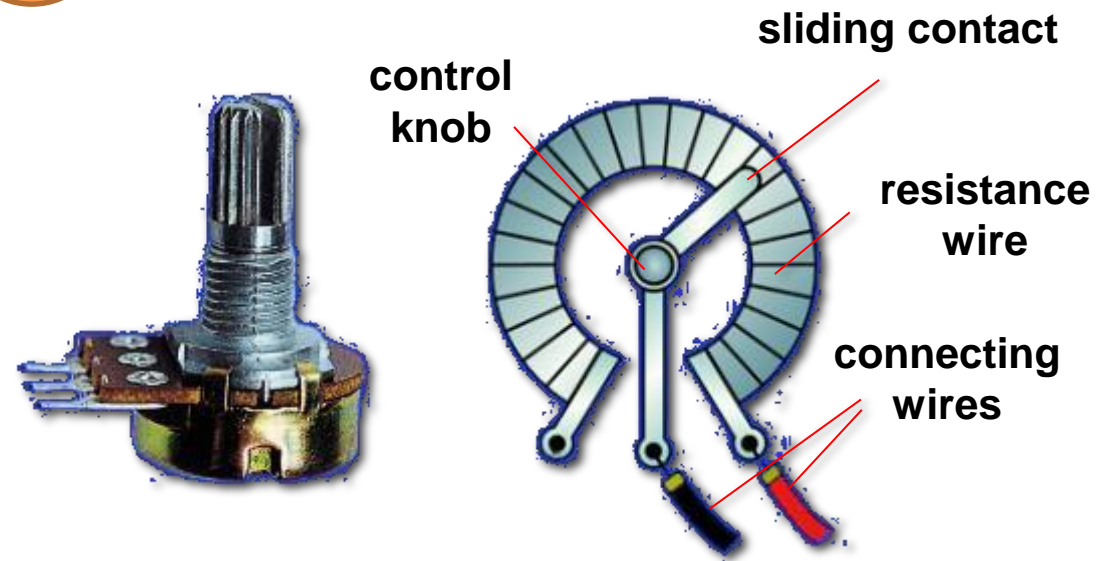
1

Sliding rheostat



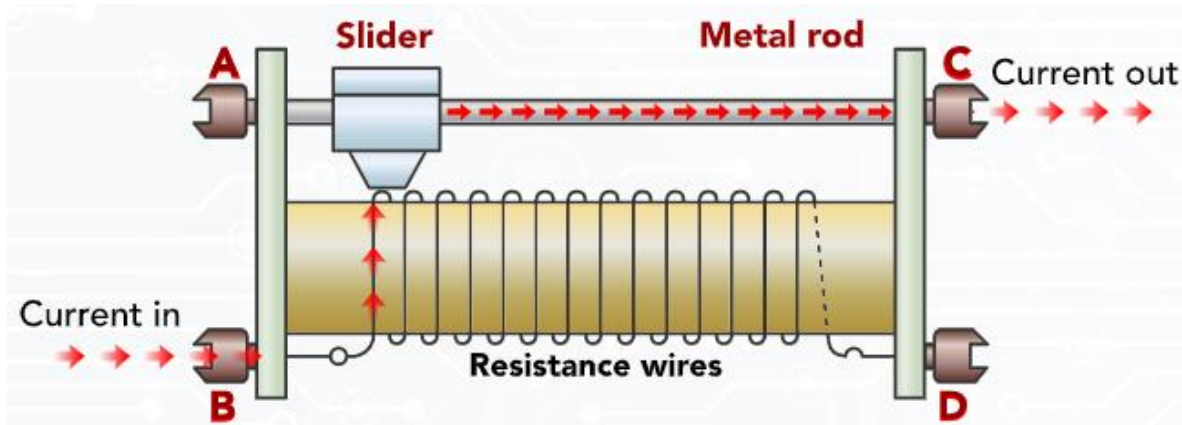
2

Rotating rheostat



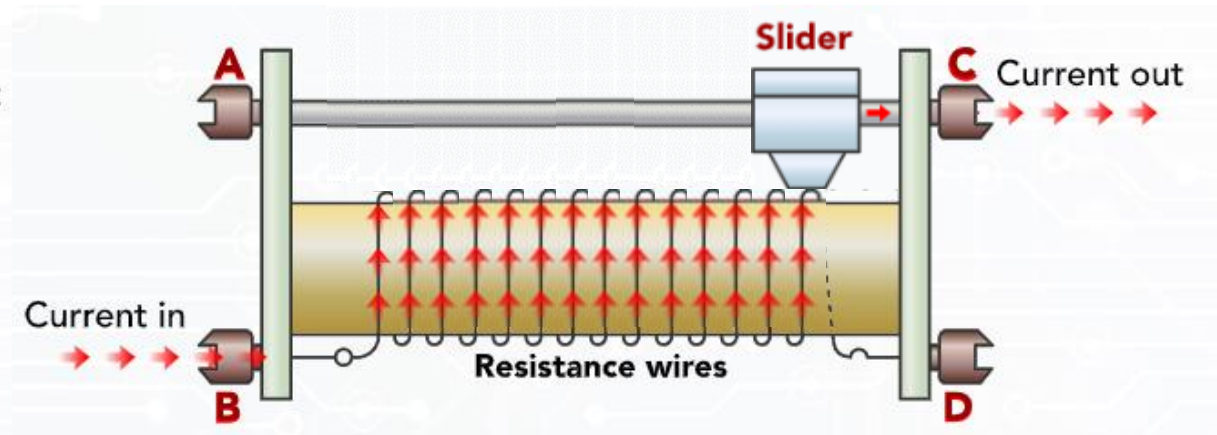
How does resistance affect brightness of a bulb?

When the slider is on the left, current passes through lesser wires, hence **lower** resistance.



- Current flowing through the circuit increases.
- Hence, the light bulb is brighter.

When the slider is on the right, current passes through more wires, hence **higher** resistance.



- Current flowing through the circuit decreases.
- Hence, the light bulb is dimmer.

2

Variable resistors

Rheostats have many uses.

volume controls on radios



light dimmers

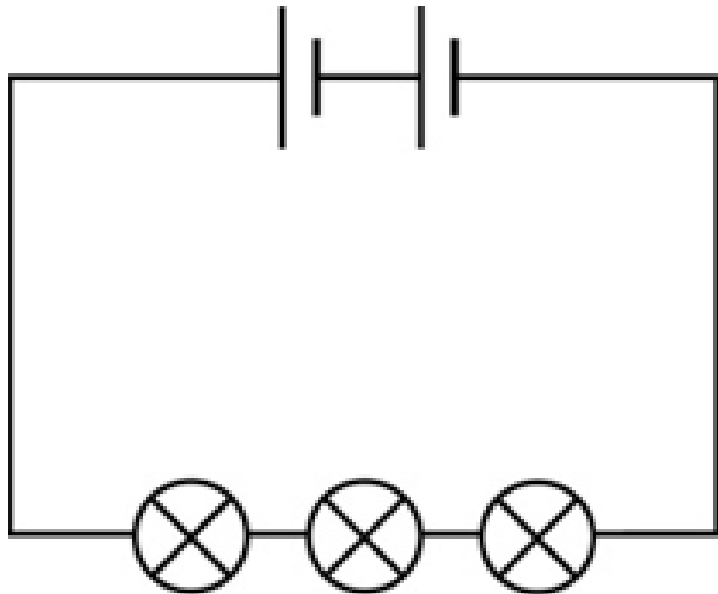
speed controller of a
remote-control car



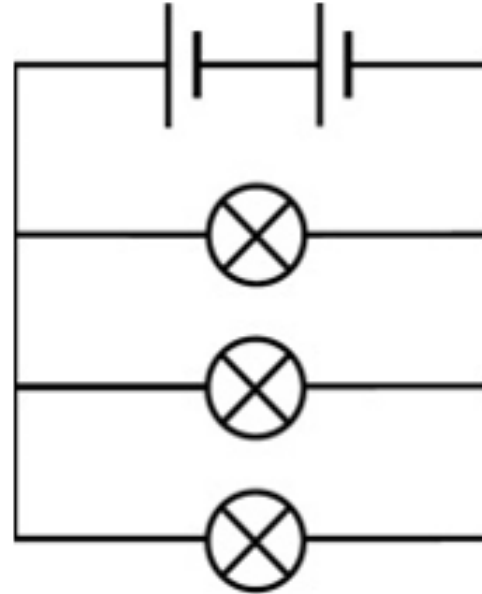
Arrangement of circuits

There are 2 ways in which an electric circuit can be arranged:

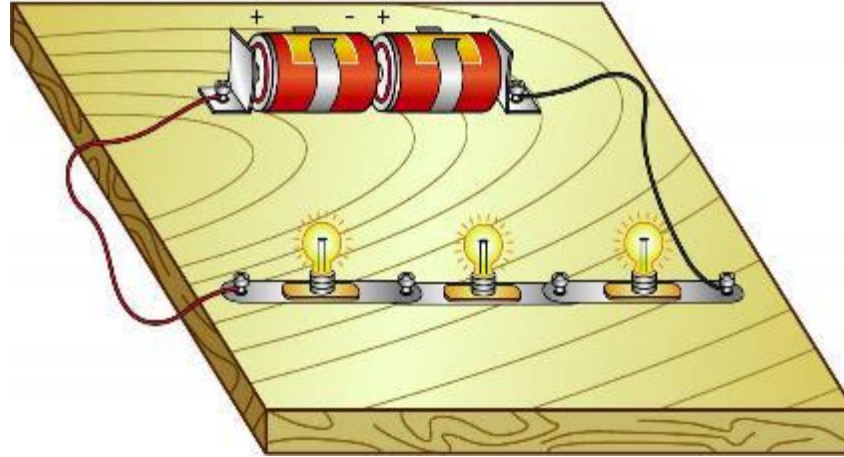
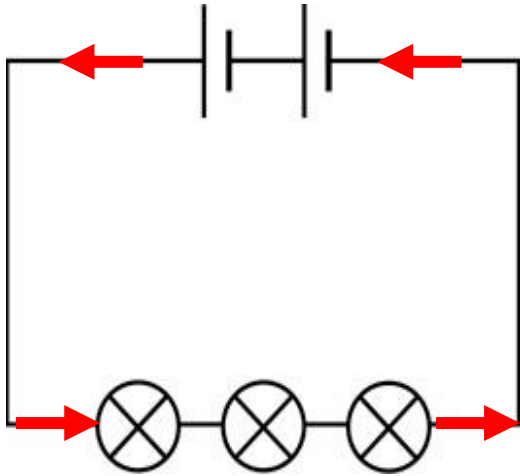
1. Series



2. Parallel

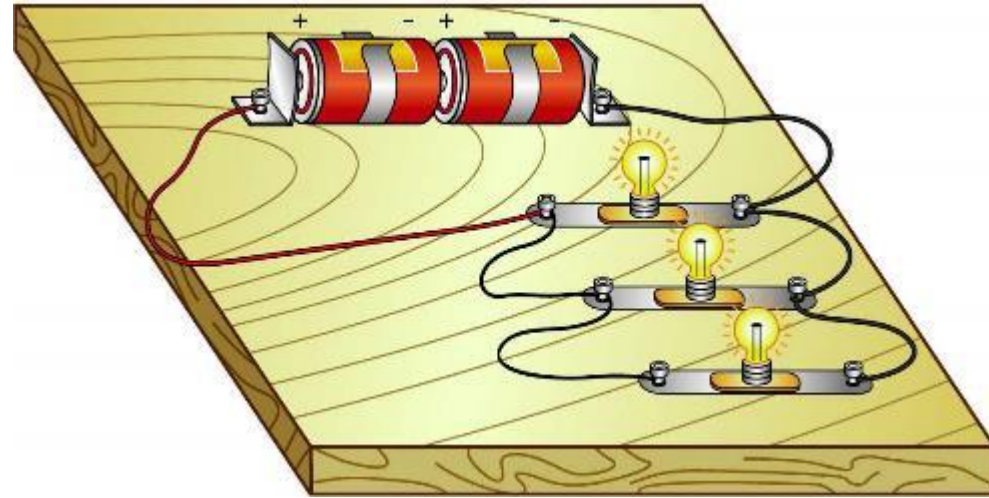
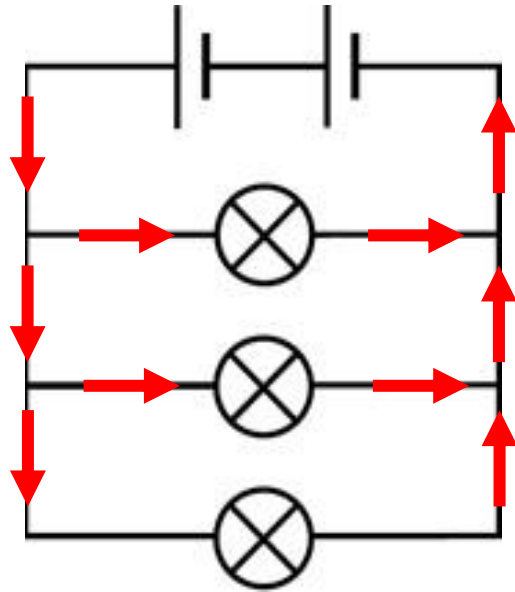


Series Circuit



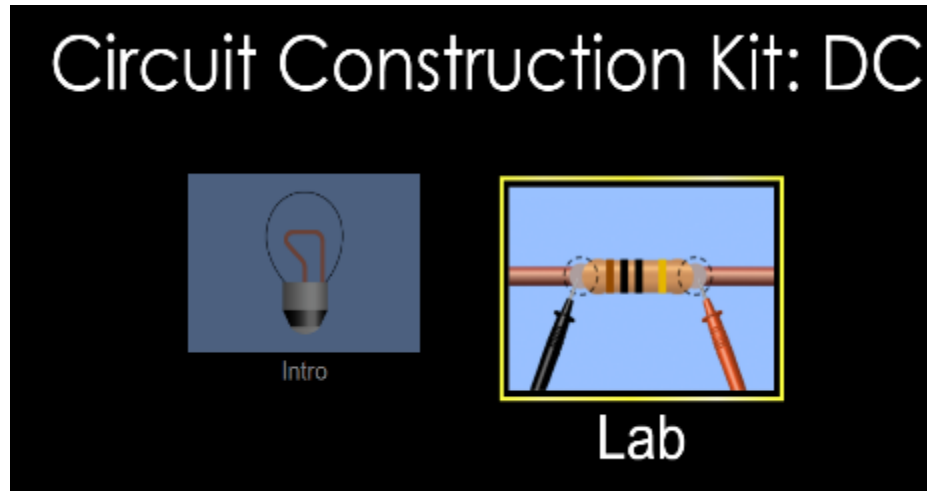
- A **series** circuit connects the components one after the other.
- Same current flows through the components.
- A break in any part of a series circuit stops the flow of current in the whole circuit.

Parallel Circuit



- A parallel circuit divides into two or more branches.
- The current divides and flows through each parallel branch.
- If a component breaks or is removed, the other components remain on.

pHet Simulation:



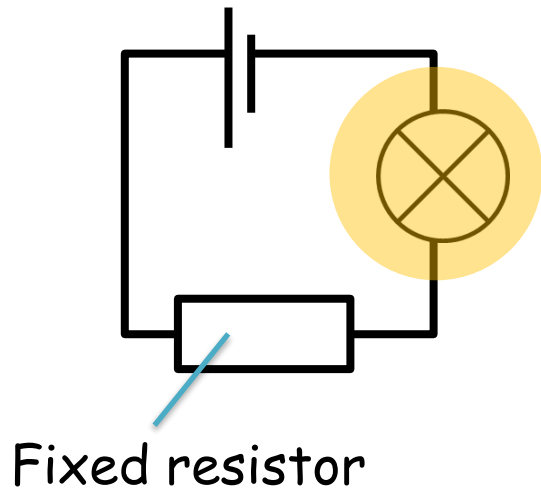
Use the “Lab” settings!
**Use the handout to help you
in your investigation.**

Conclusions:

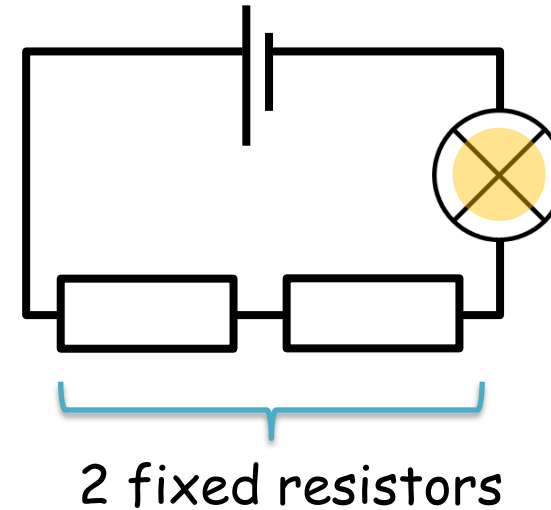
1. How does adding a resistor in series affect the total resistance of a circuit?
2. How does adding a resistor in parallel affect the total resistance of a circuit?
3. How does adding a resistor in series affect the brightness of the light bulb?
4. How does adding a resistor in parallel affect the brightness of the light bulb?

Adding a resistor in SERIES

In this circuit the light bulb lights up.



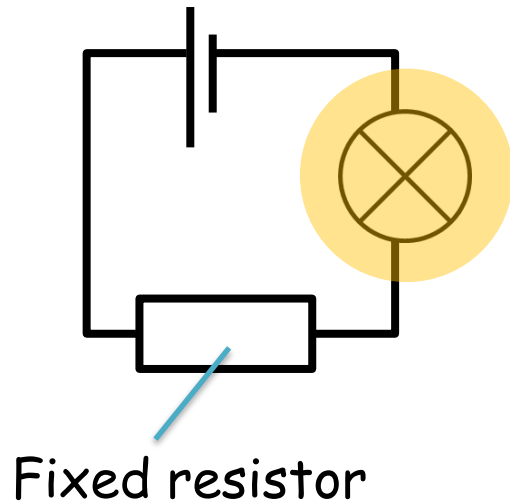
When another resistor is **added in series**, the light bulb becomes dimmer.



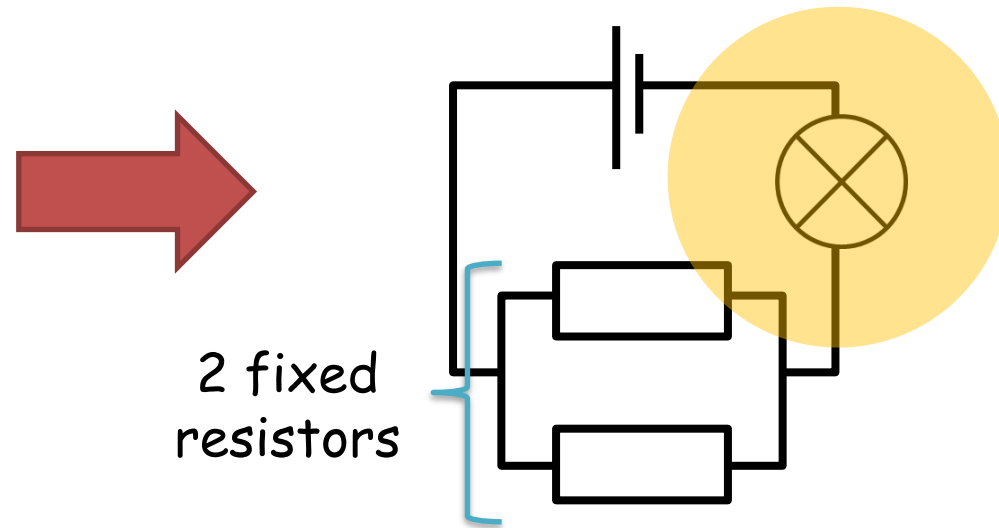
Adding another resistor in series increases the total resistance in the circuit. Hence the current flowing through the light bulb decreases.

Adding a resistor in PARALLEL

In this circuit the light bulb lights up.



When another resistor is added in parallel, the light bulb becomes **brighter**.



Adding another resistor in parallel **decreases** the total resistance in the circuit. Hence, the current flowing through the light bulb **increases**.

Observation: How does resistance affect brightness of a bulb?

Resistors can be added in **series** or **parallel**.

