ELECTRICITY

MS ORUBAH ATHAR

→ if electrons in an atom change, there is electricity

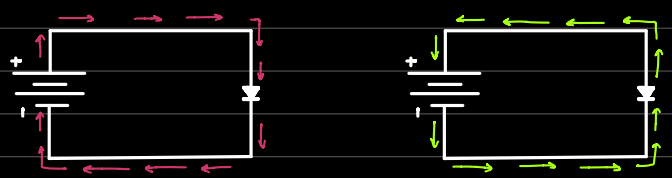
→ electricity is the movement of electrons from one atom to another atom
→ a material that allows electrons to move is called a conductor
- copper, aluminium, water, human body
→ a material that resists the movement of free electrons is called insulator
- wood, glass, rubber

BACKGROUND: THE ATOM AND ELECTRIC CHARGE

→ a neutral atom has the same number of protons (positive charge) and electrons (negative charge)
→ there are times when an atom's electrons ≠ protons
↳ THIS MEANS THERE IS ELECTRICITY PASSING THROUGH!!!
→ flow of electrons causes electricity
→ in an electric wire, atoms are held together tightly but electrons are free to move

ELECTRIC CIRCUITS

→ circuits such as Figure 17.1 are drawn using standard symbols, such as Figure 17.2
→ the energy to move the electrons comes from the cell
- a chemical reaction causes electrons to move from one terminal to the other
- when the chemical runs out, the current stops
- number of electrons in a circuit doesn't change
→ circuits that are open do not have any current flowing through them
→ circuits that are closed have current flowing through them
→ the flow of convectional current is from the positive end of the cell or power source
↳ this is incorrect but is the method used today
- Benjamin Franklin thought electricity flowed from a positively charged substance to a negatively charged substance
- it was later discovered that the flow of negatively charged electrons produced a current
→ in actuality, electrons flow from the negative end of the cell or power source



convectional current electron current

→ wire in the lamp filament is more resistant to the flow of electrons
→ as the current flows through, some of its electrical energy is transferred to heat and light energy

CIRCUIT SYMBOLS

COMPONENT	SYMBOL	COMPONENT	SYMBOL	COMPONENT	SYMBOL
cell		closed switch		ammeter	
battery		resistor		voltmeter	
connecting wire		variable resistor		(LDR) light-dependant resistors	
lamp / bulb		buzzer		diodes	
open switch		fuse		(LED) light-emitting diodes	

CURRENT

→ flow of electrical charges from the negative terminal to the positive terminal of a power source
→ "I" is the symbol of electric current
→ instrument used to measure current is called an ammeter
→ SI unit is ampere (A)
- other units : milliampere (mA), microampere (μA)
→ can cause heat, chemical and magnetic effects

VOLTAGE

→ also known as potential difference
→ amount of energy supplied by the source of electrical energy to each unit of electric charge
OR
→ difference in electric potential between two points of a circuit → which is the cause of current flow
- current flows from a higher (negative) to a lower (positive) potential

*energy used to push electrons from one point to another is voltage.

→ symbol for voltage : V
→ measured using a voltmeter
→ SI unit : volts (V)

RESISTANCE

→ ratio of voltage across an electrical component to the current flowing through it
→ symbol for resistance / resistors : R
→ measured using resistors
→ SI unit : ohm (Ω)
→ insulators have high resistance
→ conductors have low resistance

↳ ability an electric component has to stop the flow of electrons

ELECTRICITY

SIR UMAIR HAFEEZ

→ electricity : flow of electrons
→ conductors are materials that have electrons free to move
  - let electricity pass through themselves
  - e.x metal
→ insulators : do not have free electrons
  - electricity cannot pass through them
  - e.x wood, plastic, rubber
→ electrons travelling from negative terminal to positive terminal is the flow of electricity
→ if a circuit is broken, electrons cannot pass through

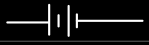
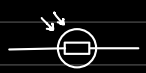
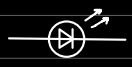
CELLS

→ electrons need energy to flow through the circuit → energy provided by cell
→ chemical reaction of certain materials creates energy
→ electrons push into the wire and flow through, creating current of electricity
→ when the materials run out in the cell, it stops working
→ number of electrons does not change
→ it is the chemical energy in a cell that runs out
→ wire filaments are more resistant to flow of electricity → doesn't let a lot of electricity pass through
  - electrical energy transfers to heat and light energy
→ battery : two or more cells
→ cells lined up next to each other, end to end, is known as a series

CIRCUITS

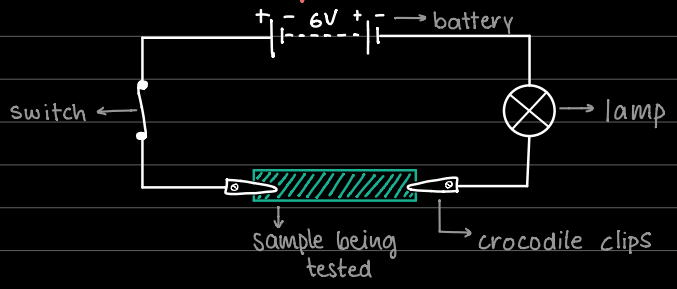
→ Benjamin Franklin thought electricity flowed from positively charged substances to negative ones
  - he was wrong!!
→ it was actually the flow of negatively charged electrons that produced a current
→ however, Benjamin's ideas still used today - known as convectional current

CIRCUIT SYMBOLS

COMPONENT	SYMBOL	COMPONENT	SYMBOL	COMPONENT	SYMBOL
cell		closed switch		ammeter	
battery		resistor		voltmeter	
connecting wire		variable resistor		(LDR) light-dependant resistors	
lamp / bulb		buzzer		diodes	
open switch		fuse		(LED) light-emitting diodes	

TESTING FOR CONDUCTIVITY

→ with the help of this circuit:



if the material is a conductor	if the material is an insulator
↓	↓
electrons will be able to flow through	electrons will not be able to flow through
↓	↓
circuit will be complete	circuit will be broken/incomplete
↓	↓
lamp will light up	lamp will not light up

RESISTANCE

→ current and resistant are inversely proportional

→ the higher the resistance, the smaller the current passing through

CIRCUIT COMPONENTS

RESISTORS

→ short piece of wire with high resistance

→ purpose: introduce a particular resistance into a circuit

→ resistance directly proportional to the length of the resistor wire
- the longer the resistor wire, the greater the resistance and vice versa

VARIABLE RESISTOR

→ the resistance can be changed

→ also called a rheostat

→ length of resistor wire included in circuit controls the amount of resistance

→ to make it more compact, the length of wire is wound in a coil

→ a sliding contact is made to move freely across the top of the coil

BUZZER

current passes through
↓
vibrates
↓
produces a sound

FUSES AND CIRCUIT BREAKERS

→ safety devices

→ appliances are designed to work when a current of certain size flows through them

→ fuse: wire that melts when the current exceeds a certain value
- when it melts, the circuit breaks before the appliance is damaged from high current
- disadvantage: needs replacement, not reusable

→ circuit breaker: opens the switch when the current exceeds a certain value
- more commonly used
- reusable

AMPERES

→ rate at which electrons flow through a wire
→ SI unit of current
→ short form: amps
→ symbol: A
→ 1A = 6×10^{18} electrons passing any given point in the wire in a second

MEASURING CURRENT

→ measured using an ammeter
→ arrow on the ammeter scale moves right depending on the current
→ positive terminal of ammeter always connected to positive terminal of cell !!
→ negative terminal of ammeter always connected to negative terminal of cell !!
→ always connected in series
→ they have low resistance
  - current passes through them without affecting the rest of the circuit

CURRENT IN SERIES CIRCUIT

→ in series, the current remains the same at every point
→ when lamps are connected in series, their resistances combine (add together)
→ size of a current can be estimated by looking at a lamp's brightness in the circuit

CURRENT IN PARALLEL CIRCUIT

→ components arranged side by side
→ current does not stay the same at every point
→ components' resistance cannot be added up
→ for circuit paths that are identical, current will be divided equally
→ if circuit paths are different:
  - the path with more resistance will get less current
  - the path with less resistance will get more current

*inverse relationship: the more the resistance, the less the current

VOLTAGE

→ ability of a cell to drive a current
→ also known as potential difference
→ measure of the electrical energy a cell can give to the electrons in a circuit
→ measured in volts (V)
→ when cells are connected in series, voltage can simply be added together

MEASURING VOLTAGE

→ using a voltmeter
→ voltmeters are only connected in parallel
  - voltmeters have high resistance
  - in a parallel, it gets low current and other components get enough current
  - in series, voltmeter would take all the current

OHM'S LAW

→ ohm : scientist who developed the relationships between voltage, current and resistance

→ voltage and current are directly proportional only if the resistance is constant

voltage (volts - V) ↖ → resistance (ohm - Ω)

$$V = I R$$

↳ current (ampere - A)

voltage = current × resistance

Q1: The battery provides a voltage of 4V to a lamp of resistance 2Ω. What is the current?

$V = I R$

$4 = I \times 2$

$I = \frac{4}{2}$

$I = 2A$

Q2: The battery provides a voltage of 4.5 V to a lamp through which the ammeter reading is 1.5 A. Find the resistance of the lamp.

$V = IR$

$4.5 = 1.5 \times R$

$R = \frac{4.5}{1.5}$

$R = 3\Omega$