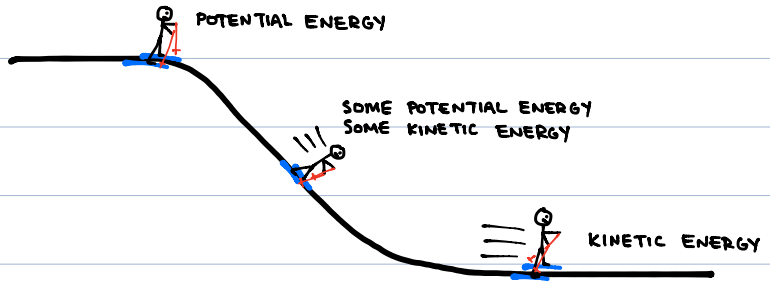
CURRENT ELECTRICITY

8.1 - ELECTRIC POTENTIAL ENERGY AND VOLTAGE

- ENERGY IS THE ABILITY TO DO WORK.
- KINETIC ENERGY IS ENERGY A MOVING OBJECT HAS BECAUSE OF ITS MOTION.
- POTENTIAL ENERGY IS ENERGY STORED IN AN OBJECT.

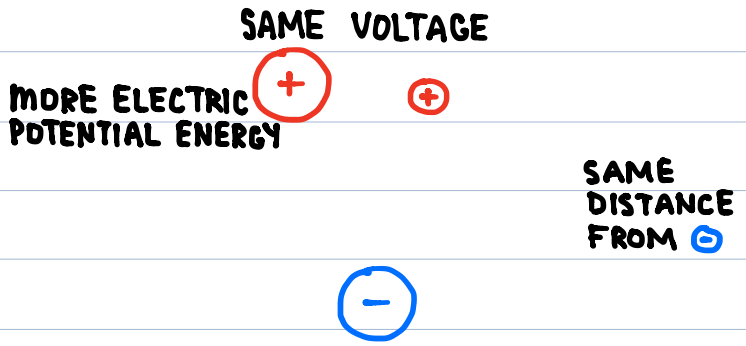
EXAMPLE:



- ELECTRIC POTENTIAL ENERGY IS STORED ENERGY BETWEEN CHARGES.
- THE ENERGY STORED IN A BATTERY IS ELECTRIC POTENTIAL ENERGY

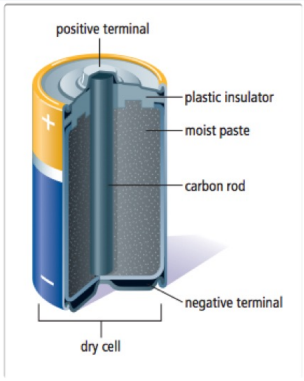
VOLTAGE

- VOLTAGE (ELECTRIC POTENTIAL DIFFERENCE) IS THE CHANGE IN ELECTRIC POTENTIAL ENERGY PER UNIT CHARGE.
- UNITS: VOLTS (V)
- CAN BE MEASURED WITH A VOLTMETER



BATTERIES

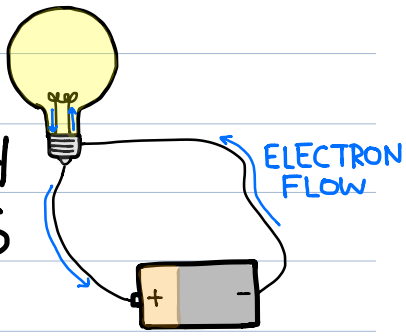
- A BATTERY IS A SOURCE OF ELECTRIC POTENTIAL ENERGY.
- BATTERIES HAVE TWO TERMINALS (END POINTS) CALLED ELECTRODES.
- CHEMICAL ENERGY IS USED TO SEPARATE POSITIVE AND NEGATIVE CHARGES MAKING ONE TERMINAL NEGATIVELY CHARGED AND THE OTHER POSITIVELY CHARGED.



- ONCE THE CHARGES ARE SEPARARATED, THEY HAVE THE ABILITY TO DO WORK (EX. LIGHT A BULB).
- AA, AAA, C AND D BATTERIES ALL HAVE A VOLTAGE OF 1.5 V BUT SEPARATE DIFFERENT AMOUNTS OF CHARGE (I.E. SAME ELECTRIC POTENTIAL DIFFERENCE, DIFFERENT ELECTRIC POTENTIAL ENERGY).

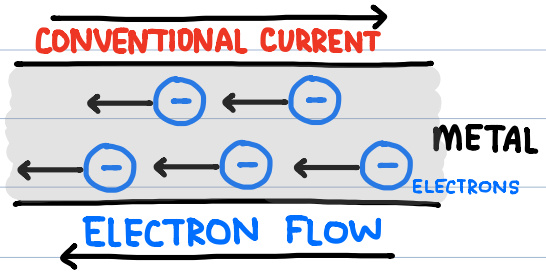
8.2 - ELECTRIC CURRENT

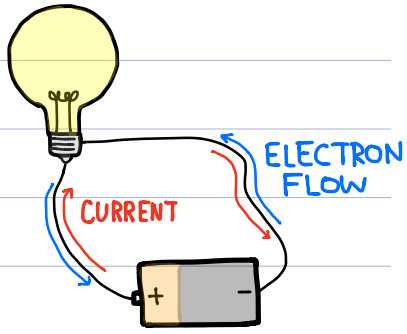
- RECALL: STATIC ELECTRICITY IS CHARGE THAT IS HELD IN ONE PLACE.
- CURRENT ELECTRICITY IS A CONTINUOUS MOVEMENT OF CHARGE THROUGH A CONDUCTOR.
- AN ELECTRIC CIRCUIT IS A COMPLETE PATHWAY THAT ALLOWS ELECTRONS TO FLOW.



CURRENT

- CURRENT IS HOW FAST ELECTRIC CHARGE IS FLOWING.
- UNITS: AMPERES OR AMPS (A)
- CAN BE MEASURED WITH AN AMMETER
- CONVENTIONAL CURRENT HAS BEEN USED TRADITIONALLY AND GOES FROM POSITIVE TO NEGATIVE.
- WE NOW KNOW THAT ELECTRONS ACTUALLY FLOW FROM NEGATIVE TO POSITIVE.

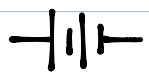




CIRCUIT DIAGRAMS

- THE PARTS OF A CIRCUIT CAN BE SHOWN USING SYMBOLS

BATTERY + -



WIRE

JUNCTION

RESISTOR

BULB

OPEN SWITCH

CLOSED SWITCH

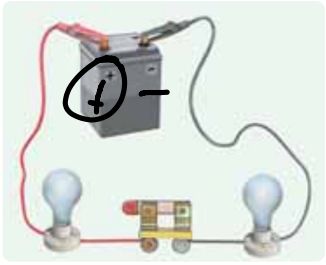
VOLTMETER

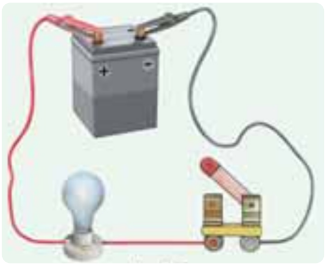
AMMETER

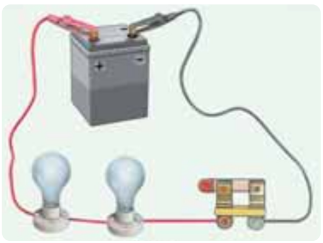
- GUIDELINES
  - WIRES SHOULD BE STRAIGHT
  - CONNECTIONS ARE MADE AT RIGHT ANGLES
  - NEVER LET WIRES CROSS
  - DIAGRAM SHOULD BE RECTANGULAR

EXAMPLE:

DRAW CIRCUIT DIAGAMS FOR THE FOLLOWING CIRCUITS:





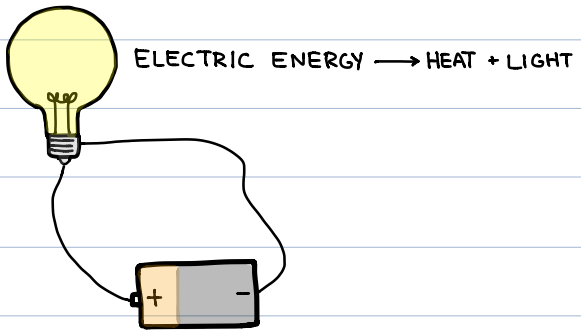


8.3 - RESISTANCE AND OHM'S LAW

RESISTANCE

- RESISTANCE IS A PROPERTY OF ANY MATERIAL THAT SLOWS DOWN ELECTRONS
- RESISTANCE CONVERTS ELECTRIC ENERGY INTO OTHER FORMS OF ENERGY.

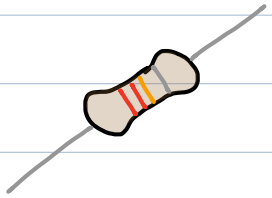
EXAMPLE:



- UNITS: OHMS (Ω)

RESISTORS

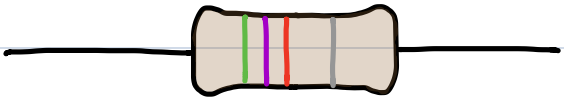
- A RESISTOR IS AN ELECTRICAL COMPONENT THAT HAS A SPECIFIC RESISTANCE.



- THE RESISTANCE CAN BE DETERMINED BY LOOKING AT THE COLOURS OF THE BANDS.
  - FIRST BAND: FIRST DIGIT
  - SECOND BAND: SECOND DIGIT
  - THIRD BAND: MULTIPLIER ($\times 10^{x}$)
  - FOURTH BAND: ACCURACY (GOLD: ±5%, SILVER: ±10%, NO COLOUR: ±20%)

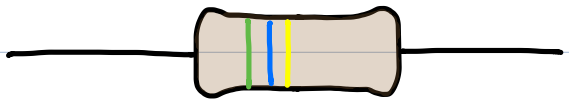
COLOUR	VALUE
BLACK	0
BROWN	1
RED	2
ORANGE	3
YELLOW	4
GREEN	5
BLUE	6
VIOLET	7
GREY	8
WHITE	9

EXAMPLE:



$57 \times 10^{2} \pm 10\%$

$= 5700\ \Omega$



OHM'S LAW

- OHM'S LAW RELATES VOLTAGE, CURRENT AND RESISTANCE.

$$V = IR$$

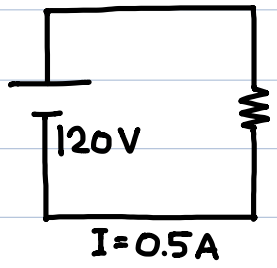
V: VOLTAGE, V
I: CURRENT, A
R: RESISTANCE, Ω

EXAMPLES:

DETERMINE THE VOLTAGE OF A CIRCUIT THAT DRAWS 0.4 AMPERES THROUGH A 2300Ω RESISTANCE.

DETERMINE THE CURRENT OF A CIRCUIT CONSISTING OF A 9 V BATTERY AND A 55 kΩ RESISTOR.

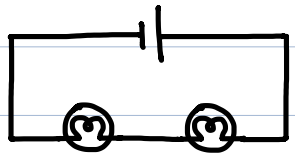
DETERMINE THE RESISTANCE.



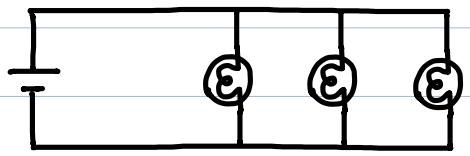
	VOLTAGE	CURRENT	RESISTANCE
WHAT IS IT?	ENERGY PER CHARGE	RATE OF FLOW	SLOWS DOWN FLOW
SYMBOL	V	I	R
UNITS	VOLTS(V)	AMPERES(A)	OHMS(Ω)

9.1 - SERIES AND PARALLEL CIRCUITS

- A SERIES CIRCUIT HAS ONLY ONE PATH.

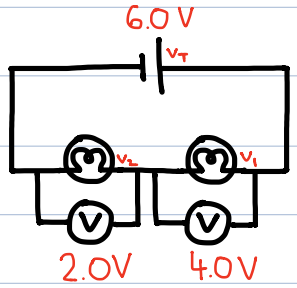


- A PARALLEL CIRCUIT HAS MORE THAN ONE PATH.



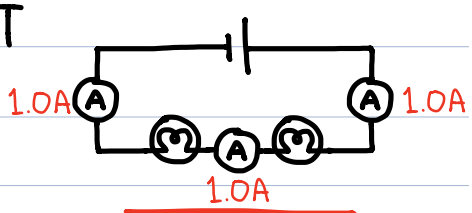
SERIES CIRCUITS

- VOLTAGE: THE TOTAL VOLTAGE OF THE BATTERY IS SHARED BY ALL THE LOADS IN A SERIES CIRCUIT.



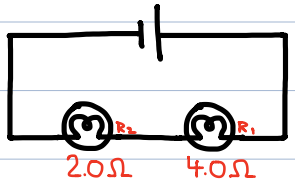
$$V_T = V_1 + V_2$$

- CURRENT: THE CURRENT IS THE SAME EVERYWHERE IN A SERIES CIRCUIT.



$$I_T = I_1 = I_2$$

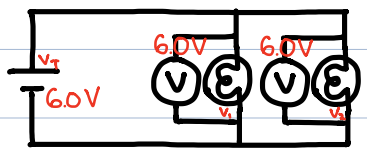
- RESISTANCE: THE TOTAL RESISTANCE INCREASES WHEN RESISTORS ARE ADDED IN SERIES.



$$R_T = R_1 + R_2$$

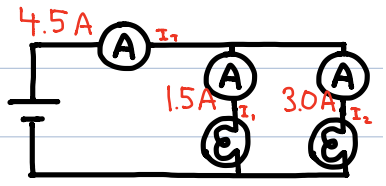
PARALLEL CIRCUITS

- VOLTAGE: ALL THE LOADS IN A PARALLEL CIRCUIT HAVE THE SAME VOLTAGE AS THE BATTERY.



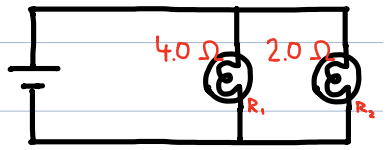
$$V_T = V_1 = V_2$$

- CURRENT: THE TOTAL CURRENT IS SHARED BY ALL THE PATHS IN A PARALLEL CIRCUIT.



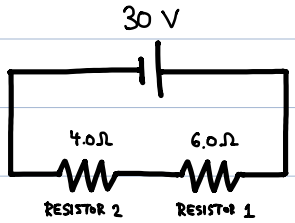
$$I_T = I_1 + I_2$$

- RESISTANCE: THE TOTAL RESISTANCE DECREASES WHEN RESISTORS ARE ADDED IN PARALLEL.



$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

EXAMPLE:



a) WHAT IS THE TOTAL RESISTANCE?

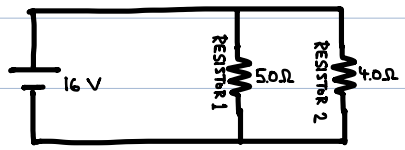
b) WHAT IS TI CURRENT THROUGH RESISTOR 1?

c) WHAT IS THE CURRENT THROUGH RESISTOR 2?

d) WHAT IS THE VOLTAGE DROP ACROSS RESISTOR 1?

e) WHAT IS THE VOLTAGE DROP ACROSS RESISTOR 2?

EXAMPLE:



9.2 - THE POWER OF ELECTRICITY

ENERGY

- ELECTRIC COMPANIES PROVIDE YOUR HOME WITH ELECTRIC ENERGY.
- UNITS: JOULES (J)

POWER

- ELECTRIC POWER IS THE RATE AT WHICH ELECTRIC POTENTIAL ENERGY IS USED OR TRANSFORMED.
- A DEVICE THAT USES ENERGY FASTER HAS A HIGHER POWER RATING.
- UNITS: WATTS (W)

$$P = \frac{E}{t}$$

$$E = Pt$$

P: POWER (W)
E: ENERGY (J)
t: TIME (s)

$$P = IV$$

POISON IVY

P: POWER (W)
I: CURRENT (A)
V: VOLTAGE (V)

EXAMPLES:

HOW MUCH ELECTRICAL ENERGY IS CONSUMED BY A 60 W LIGHT BULB IF IT IS LEFT ON FOR 25 MINUTES?

A FLASHLIGHT BULB OPERATES ON 3.0 V AND DRAWS A CURRENT OF 4.0 A. WHAT IS THE POWER OF THIS BULB?

A 60 W LIGHT BULB IS CONNECTED TO 120 V. WHAT CURRENT PASSES THROUGH THE LIGHT BULB?

A KETTLE USES 300 000 J OF ENERGY IN 3.0 MINUTES. WHAT IS THE POWER OF THE KETTLE?

HOW MUCH ELECTRICAL ENERGY IS CONSUMED BY A 100 W LIGHT BULB LEFT ON FOR 4.0 HOURS?

PAYING FOR ELECTRICITY

- ELECTRIC COMPANIES TYPICALLY MEASURE ENERGY IN LARGER UNITS.
- A LARGER UNIT FOR ENERGY: KILOWATT-HOURS (kW·h)

$$P = \frac{E}{t}$$

$$E = Pt$$

P: POWER (kW)
E: ENERGY (kW·h)
t: TIME (h)

- BC HYDRO CHECKS HOW MANY KILOWATT-HOURS OF ENERGY WE USE AND CHARGES ABOUT $0.08 PER kW·h.

$$\text{COST} = (\text{ENERGY IN kW·h})\left(\frac{\$0.08}{\text{kW·h}}\right)$$

EXAMPLE:

HOW MUCH ELECTRICAL ENERGY IS CONSUMED BY A 100 W LIGHT BULB LEFT ON FOR 4.0 HOURS?

HOW MUCH WOULD YOU HAVE TO PAY BC HYDRO TO POWER THAT LIGHT BULB OVER THOSE FOUR HOURS?