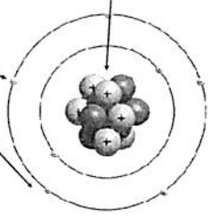
Week of Sept 3-7

Nucleus:
- Contains **protons (+)** & **neutrons (no charge)**
- Overall positive charge (+)
- Provides the biggest mass contribution (dense)

Electrons:
- Located outside nucleus
- Easily moved, lost or gained
- Negative charge (-)



Ch 5. Electricity & Magnetism
5.1 Electrical Charge

Write this in your notebook.

- Most objects are <u>neutral</u> because they have an equal # of protons (+) and electrons (-).
- Electrons can be transferred, this causes an object to become charged.
  - Negative charge = object has more electrons than protons.
  - Positive charge = object has more protons than electrons.

Only negative charges move!
Positive charges **NEVER** move!!

- **Triboelectric series** is a list that ranks objects' ability to take **negative charges**

Rubber
Ebonite
Polyethylene
Cotton
Paper
Silk
Wool
Glass
Acetate
Fur / hair

Items at top **take** negatives

Write this in your notebook.

Items at bottom lose negatives

(5.1 continued)

Write this in your notebook.

- One electron has a charge of 1.602×10^{-19} C.
- 1Coulomb (C) = the charge of 6.25×10^{18} electrons (-) or protons (+).
- <u>Conductors</u> permit the movement of electrons.
  - Eg. Metals, graphite, electrolytic solutions
- <u>Semiconductors</u> slow their movement.
- <u>Insulators</u> stop their movement electrons.
  - Eg. Plastics, ceramics, wood, glass
- The <u>triboelectric</u> series (p146) is a list that ranks an object's ability to take negative charges.

5.2 Static electricity.

Write this in your notebook.

- You can create a charge by cause electrons to be transferred from one item to another by:
  - <u>Friction</u>. Items high on the triboelectric series pull electrons away from lower items.
  - <u>Conduction</u>. Once in contact, a charged object can share its charge with another neutral object.
  - <u>Induction</u>. Without contact! A charged object can cause the charges in a neutral object to shift to one side.
    - See p147

These notes are cover:

- p140 to p148 in the text
- P75 to p778 in the workbook

Write this in your notebook.

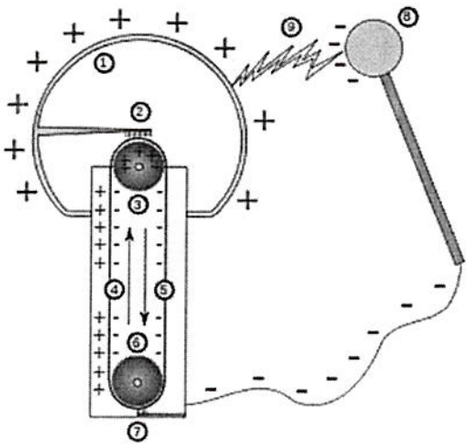
Calculations: How do you measure "charge"

- The unit of measure for electrical charge is the Coulomb (C). In equations it is symbolized by a "q"
  - Eg: q = 900C
- Ex. After charging a piece of fabric Kim determines that it has a charge of 9.1 C. How many electrons has it gained?

$$\frac{1C}{9.1C} = \frac{6.25 \times 10^{18} electrons}{?} \quad \text{or} \quad \frac{1\,electron}{?} = \frac{1.602 \times 10^{-19} C}{9.1C}$$

$? = \mathbf{5.7} \times 10^{19} electrons$ $\qquad ? = 5.7 \times 10^{19} electrons$

Robert J. Van de Graaf 1929



5.3 Dynamic Electricity

Write this in your notebook.

- There are 2 types of electricity

Static electricity: when electrical charges are at rest (as we have already covered).

Dynamic electricity: when electrical charges are in motion (in a wire) causing an electric current to flow.

Electric Current

Write this in your notebook.

- **Electric current** is the orderly flow of electrons (Fig. 5.19) through a conductor.
- **Electron flow**: the direction the electrons actually move (- to +)
- **Conventional current**: the direction positive particles would flow ***if*** they could move (+ to -). **BUT THEY DON'T MOVE!** Only the electrons move.

Important Points:

- Copper is an excellent conductor
- Wires that are:
  - SHORT
  - FAT
  - COLD

  } have a high conductance

  Write this in your notebook.
- Nichrome is an excellent insulator & a terrible conductor!

Current Intensity and Voltage

Write this in your notebook.

5.4 Current Intensity

Symbol: I
Units: Amperes, A

- ***Current***: the **amount of electrons** that flow through a wire
- *Example:* *0.7* amperes *is shown by* *I = 0.7 A*
- *An **ammeter** is the instrument used to measure current intensity. It has to be placed where the charge passes!*

Write this in your notebook.

Current Intensity

- The current intensity in a circuit can be determined using the formula:

$$I = \frac{q}{\Delta t}$$

I is the current intensity in amps (A)
q is the charge in coulombs (C)
t is time in **seconds** (s)

Write this in your notebook.

Ex #1

What is the current flowing through a car headlight if there are 900 C of charge used in 1 minute?

$$I = \frac{q}{\Delta t}$$

$$= \frac{900\ C}{60\ s} = 15\ A$$

Write this in your notebook.

Ex #2:

How much charge does it take to operate an MP3 player for 15 minutes if the current is 2A?

$$I = \frac{q}{\Delta t}$$

Write this in your notebook.

Ex #3:

A car headlight uses 15A. How long would it shine if it received a charge of 900 C?

$$I = \frac{q}{\Delta t}$$

5.5 Potential Difference (Voltage)

Write this in your notebook.

Symbol: V
Units:Volts, V

- ***Potential Difference*** **the amount of energy transferred** between two point of a circuit.
  - Provided by a battery or power supply
- Example: 12 volts = 12V

- A **voltmeter** is used to measure potential difference

Potential Difference (Voltage)

Write this in your notebook.

- The potential difference in a circuit can be determined using the formula:

$$V = \frac{E}{q}$$

V is potential difference in volts (V)
E is the energy in joules (J)
q is the electric charge in coulombs (C)

Ex #1 (same as the other one ☺)

Write this in your notebook.

- In a house, how much energy is provided by 120V service providing 200C of charge?

$$V = \frac{E}{q}$$

5.6 Resistance

Write this in your notebook.

- ***Resistance*** is how **difficult** it is for current to flow
- Resistance is the opposite of conductance!
- A resistor is used to **slow current down and convert electrical energy into heat energy (e.g. light bulb, stove element).**

Symbol: R
Units:Ohms, Ω

5.7 Ohm's Law

Write this in your notebook.

- This formula shows the relationship between Resistance (R), current intensity (I) and potential difference (V).

$$V = RI$$

# of ohms (Ω) **# of amps (A)**

5.8 Circuits:

Write this in your notebook.

- A circuit is made up of a **power supply**, **connecting wires** & **various <u>components</u>** that allow current to leave a power source, travel through the components & return back to the power source.

Write ★in your notebook.

Common Electric Symbols

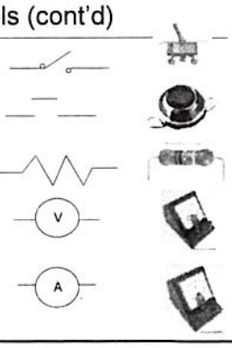
- Battery/Power Source

- Bulb

Write this in your notebook.

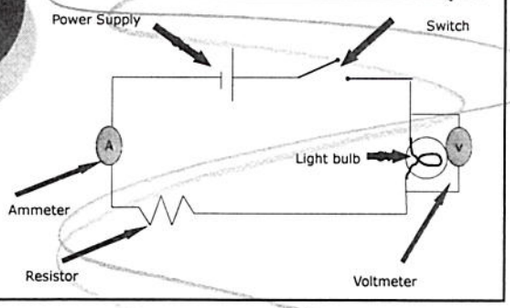
Common symbols (cont'd)

- **Switch**
- **Push-button Switch**
- **Resistor**
- **Voltmeter**
- **Ammeter**



Circuits

Write this in your notebook.



Series Circuits:

Write this in your notebook.

- Components are connected end to end
- Current only follows one path
- If one part of the circuit is broken, the entire circuit will stop functioning
- Eg: Some Christmas tree lights

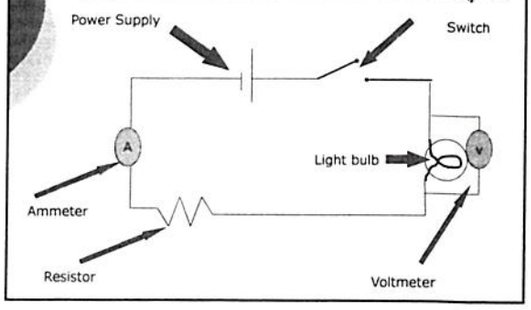
Parallel Circuits:

Write this in your notebook.

- Circuit that contains at least one branch
- Current can follow at least 2 different paths
- If part of the circuit is defective another part may still be able to operate.
- Eg: headlights on a car

Circuits

Write this in your notebook.



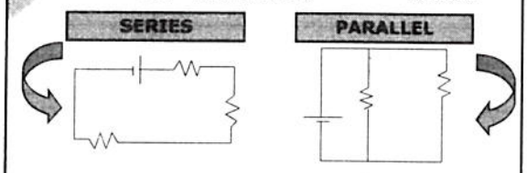
Trick to help identify type of circuit:

Series: Pen follows wire

Parallel: Pen can go in more than one direction

- There are 2 types of circuits:
  - 1. Series Circuit
  - 2. Parallel Circuit

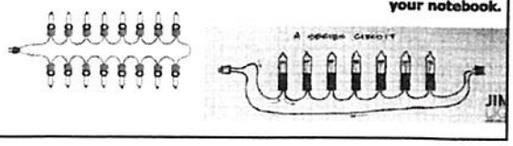
Write this in your notebook.



Series Circuits:

- Components are connected <u>end to end</u>
- Current only follows one path
- If one part of the circuit is broken, the entire circuit will stop functioning
- Eg: Some Christmas tree lights

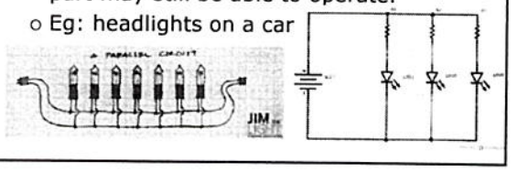
Write this in your notebook.



Parallel Circuits:

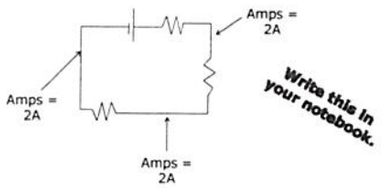
Write this in your notebook.

- Circuit that contains <u>at least one branch</u>
- Current can follow <u>at least 2 different paths</u>
- If part of the circuit is defective another part may still be able to operate.
- Eg: headlights on a car



Volts, Ohm's and Amps in a Series Circuit

- In a series circuit, the Amps remain constant throughout the whole circuit

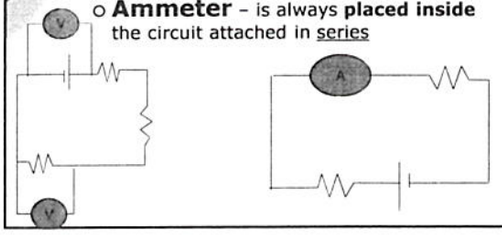


Write this in your notebook.

5.9 Where to place the meters.

Write this in your notebook.

- **Voltmeter** – always **placed outside** of the circuit attached in <u>parallel</u>
- **Ammeter** – is always **placed inside** the circuit attached in <u>series</u>



Write this in your notebook.

5.10 Energy and Power

- Energy= the ability to do work
  - Measured in Joules (J)
- Power = the amount of work that can be accomplished in a certain amount of time
  - Measures in Watts (W)

Write this formula in your notebook.

FORMULA

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

Energy Joules (J)

Time Seconds (s)

Power Watts (W)

Write this in your notebook.

Example #1

A stereo has a power rating of 200W & is used for 1800 seconds. How much energy is used?

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

$$\frac{200}{1} = \frac{E}{1800}$$

E = 360,000 J

360,000 Joules of energy were used to work the stereo

Write this in your notebook.

How do we pay for the energy we use?

- Energy is commonly measured in Joules (J), but can also be measured in kilowatt hours (kWh).
  - If we use 1000W in 1 hour, we consume 3 600 000J

1 kWh = 3 600 000 J

Write this formula in your notebook.

FORMULA

$$P = IV$$

Power Watts (W)

Current Amps (A)

Voltage Volts (V)

Write this in your notebook.
Tricky Question

Example #3

An appliance requires 120V & 12A to work. It is used for 900 seconds. How much energy is used?

~~1st- Solve Power~~

P = I•V

P = (12)•(120)

P = 1440 W

~~2nd- Solve Energy~~

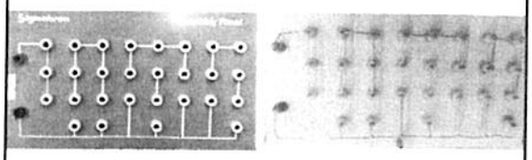
$$P = \frac{E}{\Delta t}$$

$$\frac{1440}{1} = \frac{E}{900}$$

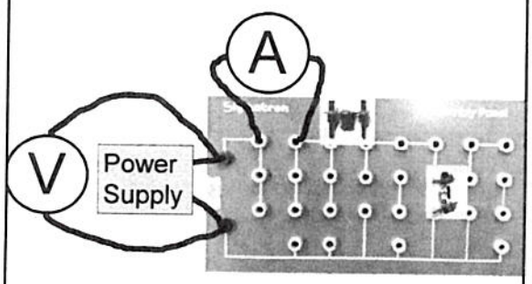
E =1,296,000 J

Sigmatron Circuit board

- Outside
- Inside



***TURN POWER ON! ***



5.11

Basic Procedure for circuit boards.

- P.A.R.V.
- Connect the:
  1. P = power supply
  2. A = ammeter
  3. R= resistors
     (Actual resistors, Lights, Anything that uses electrical energy!)
  4. V = voltmeter
- Turn on AFTER everything is connected!!!

Please Write this into your Notes

You will need:

One person	Another Person
1 ammeter	Power Supply
1 voltmeter	Ziplock bag of wires
Light bulb	
2 resistors	

What are you doing?

- You are learning how to use the circuits board.

- **Investigate the board....**
- **Follow the P.A.R.V. Order! To connect:**
  - **Power supply**
  - **Ammeter**
  - **Resistors and light bulb (in series)**
  - **Voltmeter.**
- **Turn on. Turn the black knob so that you get a reading.** 4V
- **If the bulb lights up you have made a circuit.**
- **Read the ammeter.**

Make sure everyone gets a turn ☺

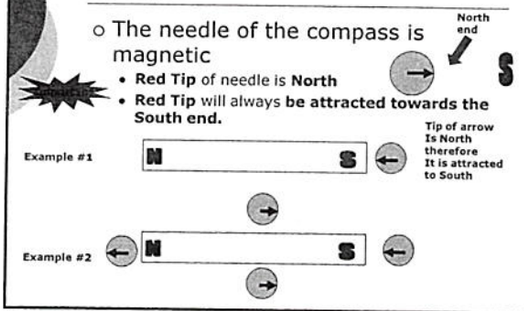
Write this in your notebook.

5.12 Magnetism

- **Magnetism**
  - is a property that makes certain material attract or repel.
- **Magnet**
  - is always magnetic
  - creates a magnetic field
- **Ferromagnetic**
  - Attracted by a magnet,
  - can become magnetized
  - Must contain Fe, Ni, Co
- **Nonmagnetic**
  - Not attracted by a magnet

Compass

- The needle of the compass is magnetic
  - **Red Tip** of needle is **North**
  - **Red Tip** will always **be attracted towards the South end.**

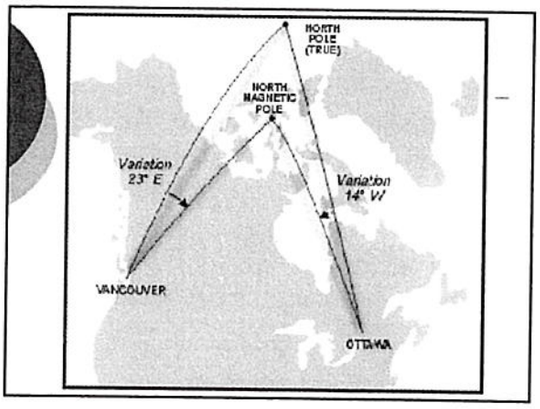


Write this in your notebook.

5.12 continued

- **Opposites attract** (i.e **N & S**)
- **Likes Repel** (i.e. **S & S** or **N & N**)
- **Magnetic Field**
  - Arrows always go from north t (outside magnet)
  - Lines of force never cro
  - The closer the lines, the field
- **Compass**
  - Red portion of compass needle is **North** and is always attracted to South





Write this in your notebook.

5.13 How to Magnetize an Object

- Bring the ferromagnetic substance in **contact with another magnet**.
- **Bang** the ferromagnetic substance (example: striking a nail repeatedly).
- **Heat up** the substance and cause the domains to align.
- **Run electric current** through the ferromagnetic substance.
- ***Please note that all of these methods can also de-magnetize a magnet.***

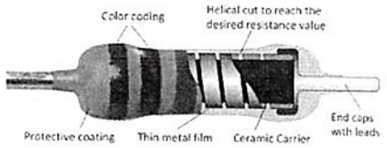



Resistance

How to read the strength of a resistor

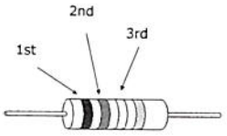
Colour coding on resistors

- Resistors are coated with ceramic.



They have colour coded bands to indicate the resistance strength!

Resistor →



1st colour = 1st #
2nd colour = 2nd #
3rd colour = # of zeros

Black	0
Brown	1
Red	2
Orange	3
Yellow	4
Green	5
Blue	6
Violet	7
Grey	8
White	9

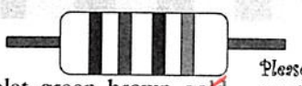
23 **Ω**

Resistor Tolerance

- The last band is gold or silver in colour.
- They give the accuracy range.
  - The last example had silver → 10%
  - 230 000 Ω ± 10 %
  - **The resistor can be off by 10%**

Digit	0	1	2	3	4	5	6	7	8	9		
Colour	Black	Brown	Red	Orange	Yellow	Green	Blue	Violet	Grey	White	Gold	Silver
Tolerance											±5%	±10%

Digit	0	1	2	3	4	5	6	7	8	9		
Colour	Black	Brown	Red	Orange	Yellow	Green	Blue	Violet	Grey	White	Gold	Silver
Tolerance											±5%	±10%



- Violet, green, brown, gold
- 750 Ω ± ~~5%~~ 10%. silver
- ~~5%~~ of 750 = 75 Ω
- 750 – 75 = 675 750 + 75 = 825
- **Range = 675 Ω – 825 Ω**

10% →

Please tape/glue table & write into notebook.

Activity to practice reading resistors

Names:

Resistor #	Strength	Range
example	750 Ω ± 10%	675 Ω - 825 Ω
#1		
#2		
#3		
…		

Your paper should look like this.

Write this in your notebook.

5.14 MAGNETIC FIELDS AND ELECTRIC CURRENT

Electromagnetism:
when an electric current flows through a wire, a magnetic field is created.

1

Write this in your notebook.

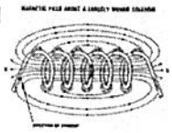
- A magnetic field is created whenever an electric current flows through a conductor.
- The conductor can be a:
  - "straight-line conductor" (uncoiled wire) or
  - coiled wire (a.k.a solenoid)

2

Write this in your notebook.

A Solenoid:

- Is a wire wrapped around a core
- Has a current flowing through it
- Has a magnetic field
  - Similar to that of a bar magnet.



Electromagnet

3

Write this in your notebook.

Cores:

- A ***Core*** is the object that is inserted into the solenoid, creating an electromagnet.
- Different metals can be used for the core: iron, steel, nickel or cobalt.
  - Iron is most commonly used because when you turn off the electricity it demagnetizes!
  - You would NOT use steel because it is a permanent magnet (stays magnetized).

4

Write this in your notebook.

5.15 The Left Hand Rules

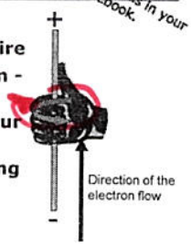
- The left hand rule will help you determine the direction of the magnetic fields created by an electric currents.
  - **The 1st Left Hand Rule** is used with a straight wire (uncoiled).
  - **The 2nd Left Hand Rule** is used with a solenoid (or coil)
  - Remember electrons flow from – to + !!!!

7

Straight Line Conductors (Uncoiled)

Write this in your notebook.

1. **Find the positive and negative ends of the wire**
2. **The electrons flow from - to +**
3. **Point your thumb of your left hand towards +**
4. **Your fingers are pointing in the direction of the field**

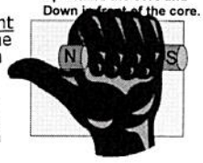


8

Write this in your notebook.

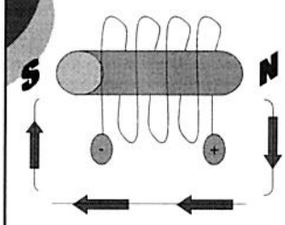
Solenoids (or coils)

1. Find the +and - ends of the wire
2. Draw arrows on the front of the coil pointing in the direction of the electron flow (towards +).
3. Place your hand on the page with your fingers pointing in the direction of the electron flow.
4. Your thumb will point towards the **north** end of the solenoid.



9

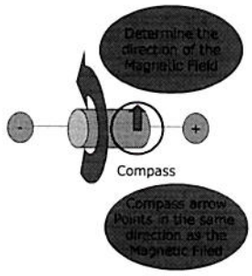
Solenoid Example - # 1



1. Find the positive and negative ends of the wire
2. Determine the direction of the electric current
3. Wrap your fingers around the coil pointing in the same direction as the current
4. Thumb points "N". Other end is "S".
5. Lines of Magnetic force run **N** to **S** .

17

Effects of a Straight Line Conductor on a Compass



20

Write this in your notebook.

5.15 continued

- Hand Rule for Straight Line Conductors:
  - Your **thumb** points in the direction of the electric current
  - Your **fingers** will point in the direction of the magnetic field
  - There is no North or South Pole.
  - The magnetic field flows in a continuous circle around the wire.
  - The magnetic field flows in the same direction as the compass points.

23

Write this in your notebook.

5.16 Electromagnetic Induction

- Is the process where you use a moving magnetic field to produce an electrical current. (p171)

24

Write this in your notebook.

- This is achieved by:
  - Moving a conductor inside the magnetic field
  - Moving a magnet around a conductor
    - eg. Hydro electricity
    - Electric generators

5.17 Factors that affect the Magnetic field of an Electromagnet

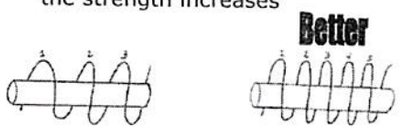
Write this in your notebook.

1. **The core material**
   - The denser the material the stronger the field
   - Made of ferromagnetic material
2. **The current intensity**
   - Higher the current stronger the magnetic field
3. **Number of loops** (number of turns)
   - More turns gives a stronger field.

Number of Loops

Write this in your notebook.

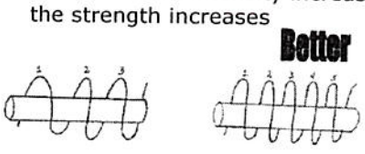
- As the number of loops increases, the strength increases



Current Intensity

Write this in your notebook.

- As the current intensity increases, the strength increases



5.18 Mathematical Relationship

Write this in your notebook.

- To find the strength of the electromagnet scientists use the following equation: ***F = IN***
  - ***F*** is force or strength of the electromagnet
  - ***I*** is the current intensity traveling through the wire
  - ***N*** is the number of loops around the core

Which Electromagnet has the Strongest Magnetic Field