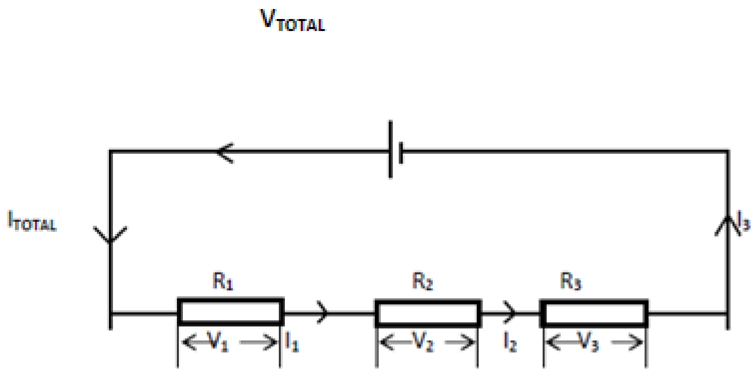
RATU NAVULA COLLEGE Y12 PHYSICS HOME LEARNING KIT 7

SERIES AND PARALLEL CIRCUITS
LESSON 93 LO: calculate total resistance in series circuit
SERIES CIRCUIT

Resistors in Series

When connected in series, the **total resistance**, R_T, is equal to

$$R_T = R_1 + R_2 + R_3 + \dots\dots\dots$$



- Current through each resistor is the same as charge has only one path to flow through

$$I_{TOTAL} = I_1 = I_2 = I_3$$

- Voltage – as charge passes through each resistor, it loses some energy called **voltage drop.**

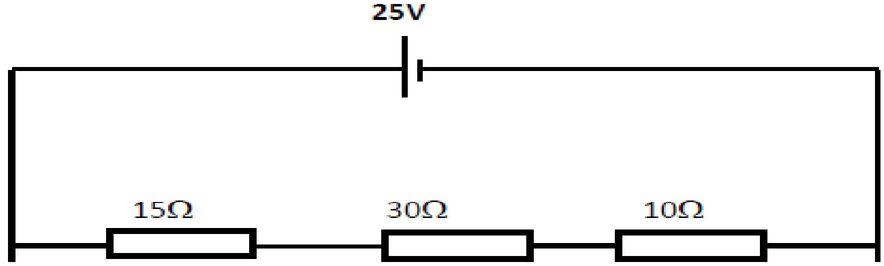
$$V_{TOTAL} = V_1 + V_2 + V_3$$

EXAMPLE
Find the total resistance of the three resistors connected in series.

$R_T = R_1 + R_2 + R_3 = 12\Omega + 4\Omega + 6\Omega = \underline{22\Omega}$.

EXAMPLE

Given the circuit diagram below.



Find the:

(i) total resistance of the circuit

(ii) total current of the circuit

(iii) voltage drop through the

a) 15Ω Resistor

b) 30Ω Resistor

c) 10Ω Resistor

(iv) power dissipated by the 30 Ω resistor

Soln:

(i) $R_{TOTAL} = R_1 + R_2 + R_3$

$R_T = 15\ \Omega + 30\ \Omega + 10\ \Omega =$ $55\ \Omega$

(ii) Total Current, from Ohm's Law: $I_T = \frac{V_T}{R_T} = \frac{25V}{55\Omega}$ $\Rightarrow$ $\underline{I_T = 0.455A}$

(iii) Voltage drop: since the current passing through each resistor in series is the same, therefore

a) $V_{drop}(15\ \Omega) = IR$ $\Rightarrow$ $V = (0.455A)(15\ \Omega)$ = **6.825 Volts**

b) $V_{drop}(30\ \Omega) = IR$ $\Rightarrow$ $V = (0.455A)(30\ \Omega)$ = **13.65 Volts**

c) $V_{drop}(10\ \Omega) = IR$ $\Rightarrow$ $V = (0.455A)(10\ \Omega)$ = **4.55 Volts**

(iv) Power dissipated, $P = VI$ $\Rightarrow$ $P = (13.65\ V)(0.455\ A) =$ **6.21 Watts**

Or use $P = I^2R$ $P = (0.455\ A)^2(30\ \Omega)$ = **6.21 Watts**

LESSON 94 LO: Calculate total resistance in PARALLEL CIRCUIT

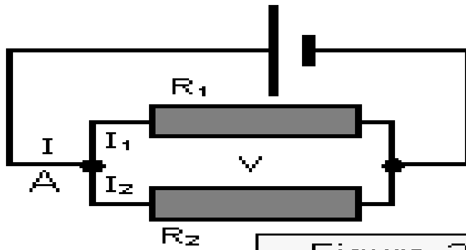


Figure 2

When connected in parallel, the total resistance, R_T, is equal to

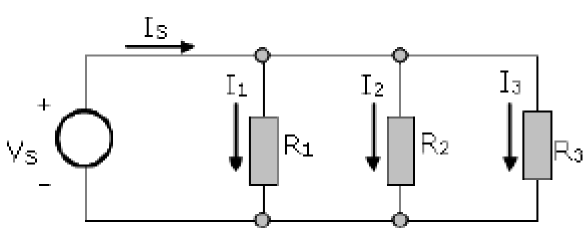
$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots\ldots$$

- Current divides itself according to the resistors. Smallest resistor will allow the most current through while largest resistor will allow the least current through.

$$I_{TOTAL} = I_1 + I_2 + I_3$$

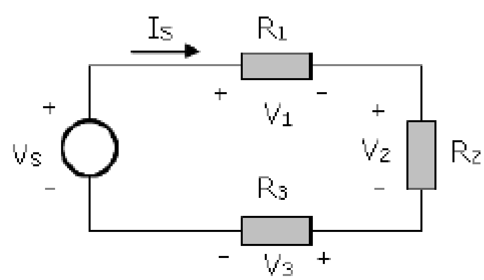
- Voltage is the same through each resistor

$$V_{TOTAL} = V_1 = V_2 = V_3$$



Parallel Circuit

$$I_S = I_1 + I_2 + I_3$$
$$= V_S/R_1 + V_S/R_2 + V_S/R_3$$



Series Circuit

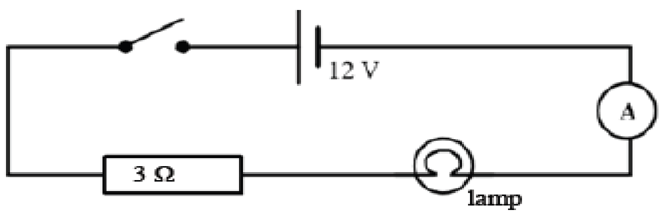
$$V_S = V_1 + V_2 + V_3$$
$$= I_S R_1 + I_S R_2 + I_S R_3$$

Current Electricity

1. $I = \frac{q}{t}$
2. $V = \frac{W}{q}$
3. $R_{T\,series} = R_1 + R_2 + R_3 + \dots$
4. $\frac{1}{R_{T\,parallel}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$
5. $V = IR$
6. $P = VI = I^2R = \frac{V^2}{R}$

<u>2019</u>

A lamp is connected in series as shown below. The ammeter reads 2 A when switch is closed.



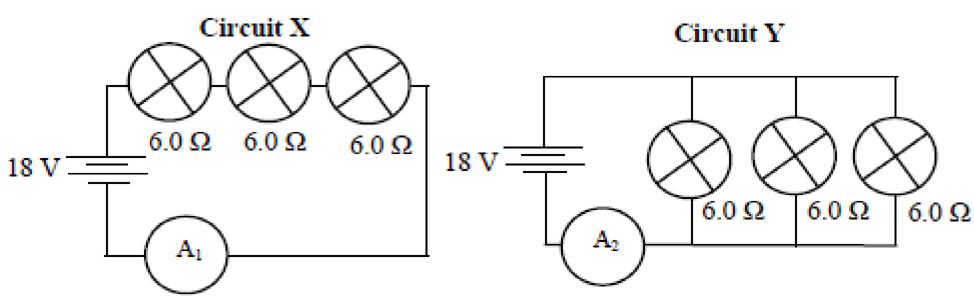
The current across the lamp when the switch is closed is

A 2 A
B. 3 A
C. 5 A
D. 12 A

2017

1.

Consider the circuit diagrams given below. **Circuit X** shows three bulbs of 6 Ω connected in series with an ammeter, A_1. **Circuit Y** shows the same three bulbs connected in parallel with ammeter A_2 in the position as shown.



(i) Calculate the total resistance of **Circuit X**. **(1 mark)**

(ii) Calculate the total resistance of **Circuit Y**. **(1 mark)**

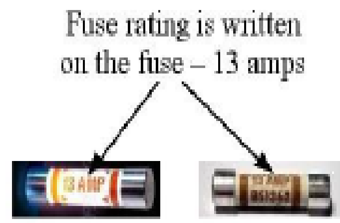
(iii) What would be the reading of ammeters A_1 and A_2? **(2 marks)**

(iv) Which of the two circuits is preferred to wire-up a small house? Give a reason. **(1 mark)**

LESSON 95 LO: Describe the functions of safety devices at home.

1. **FUSES**

- Is a small, thin conductor designed to melt and separate into two pieces.
- ***Removes electrical current from an electrical circuit when the current is too high.***



2. **CIRCUIT BREAKER**

- Has the same function as the fuse. If a surge of current is evident through a line, the circuit breaker breaks the line opening the flow of current.

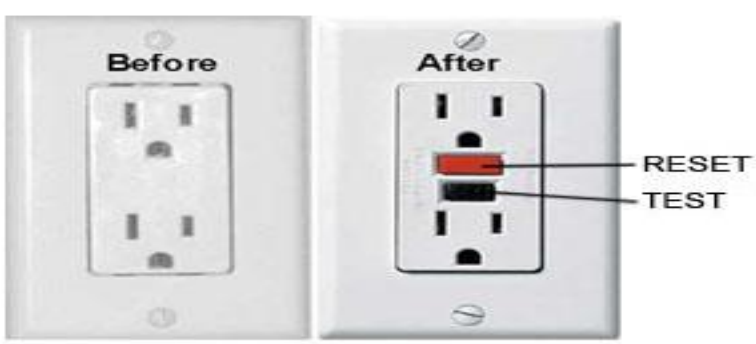
Residual Current circuit breaker

Mini Circuit Breaker

[http://www.made-in-china.com/showroom/meywon8/product-detaildMinfkrFbGhD/China-Mini-Circuit-Breaker-DZ47LE-63-.html]

3. **GROUND-FAULT INTERRUPTER (GFI)**

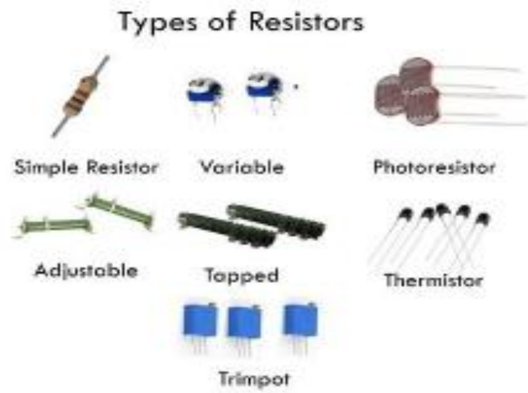
- ***Protects us from receiving electrical shocks from faults in devices. It contains an electronic circuit that detects small differences in current caused by an extra current path and opens the circuit.***



The GFI has a "Test" button which causes a small difference between "hot" and neutral currents to test the device.

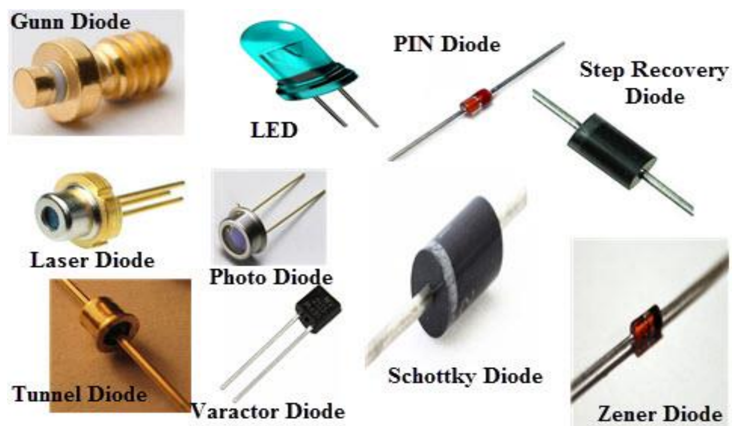
4. RESISTORS

- ***To control the flow of current to other components.(limits the current)***



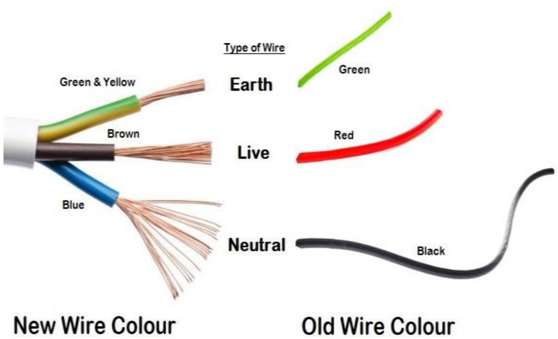
5. DIODE

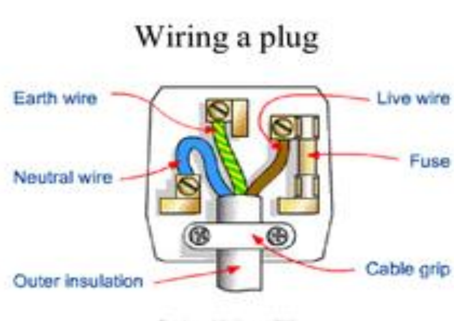
- ***To allow an electric current to pass in one direction(diode's forward direction), while blocking it in opposite direction.***
- ***Acts Like a check valve.***



6.EARTHING

- Many electrical appliances (washing machines, cookers, refrigerators) have metal cases. Creates **safe route** for the current to flow through if the live wire touches the casing.
- ***It prevents electrical shock by carrying excessive current/electricity to the ground.***





7.SWITCHES

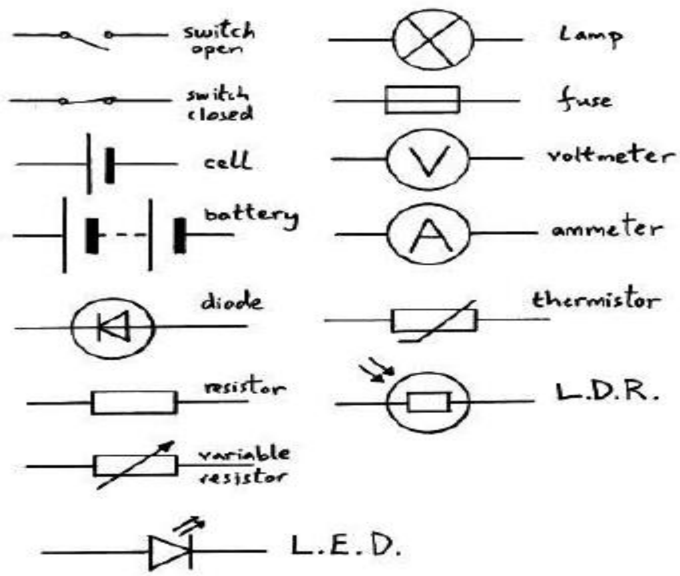
- ***A mechanical device used to connect and disconnect a circuit at will.***


8.JUNCTION BOX (jbox)

- ***Serves as communal meeting spot for electrical wires, where they connect before moving on.***
- ***Protects the electrical connections from the weather and prevents people from accidental electric shocks.***
- ***Protects hot(black), white(neutral) and grounding(green/copper) wires and may contain other color wires for secondary functions and lighting.***


ELECTRICAL SYMBOLS FOR DRAWING ELECTRICAL CIRCUIT DIAGRAMS

Below are some of the most common electrical symbols that you are likely to see when looking at diagrams of electrical circuits.



2018

The electrical safety device commonly found in households shown in the diagram given below is a

Source: http://technopow.com

A. fuse.
B. diode.
C. resistor.
D. circuit breaker.

2017

Draw the electrical symbol of the fuse

2016

State the function of the following safety devices in the electrical systems.

(i) Fuse **(1 mark)**

(ii) Earth wire **(1 mark)**

LESSON 96-97 EXP 11 VOLTAGE-CURRENT RELATION IN LIGHT BULB

S/S: 6.1 Motor Effect

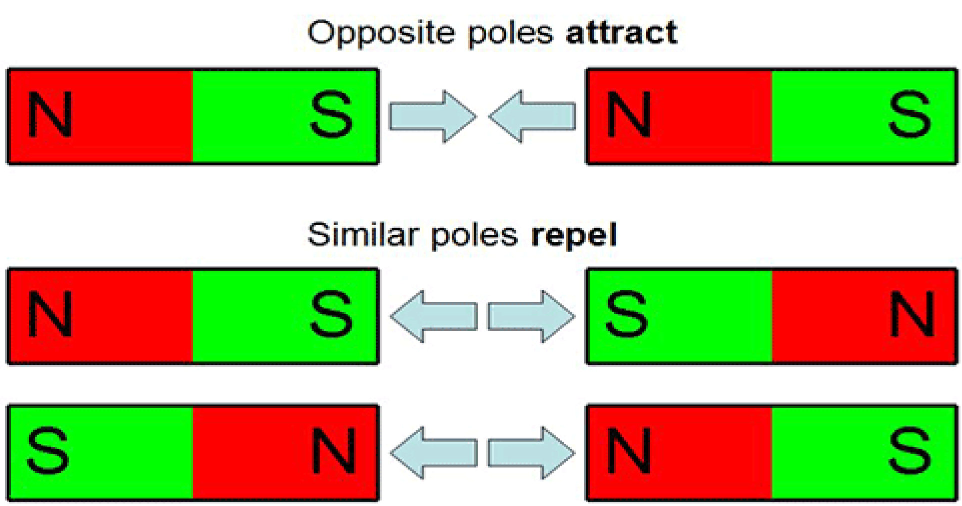
ELECTROMAGNETISM

LESSON 98 LO: calculate current and force in a current carrying conductor.

- Is the science of properties and relationship between electric current and magnetism.
- An electric current creates magnetic field which will create a flow of charge
- Is a property of certain materials that enables them to attract small pieces if iron.

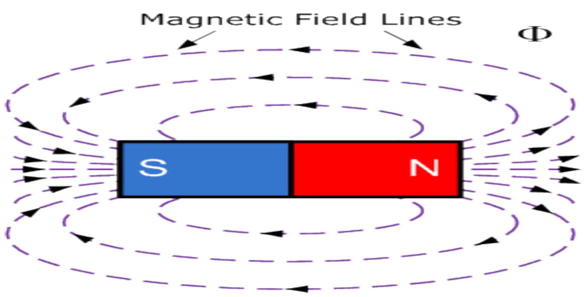
LAWS OF MAGNETISM

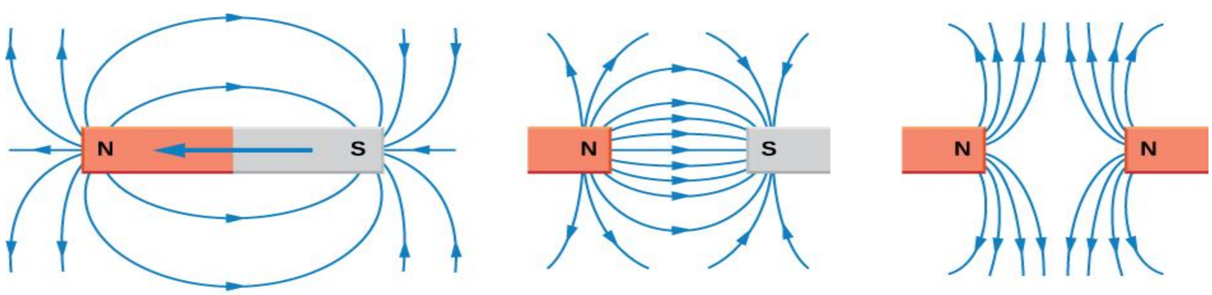
1. Like magnetic poles repel each other.
2. Unlike magnetic poles attract one another.



Magnetic Fields, B

-Is a region where magnetic (eg compass needle) and /or moving charge experiences a magnetic force. [any region of space that exerts a force on a compass needle]
-is represented by lines of magnetic force which points away from North pole of a magnet towards South Pole.

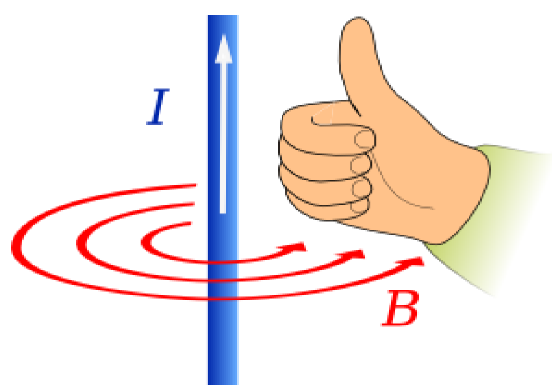




Magnetic field lines of a bar magnet (a) | Magnetic field lines between unlike poles (b) | Magnetic field lines between like poles (c)

RIGHT HAND GRIP RULE

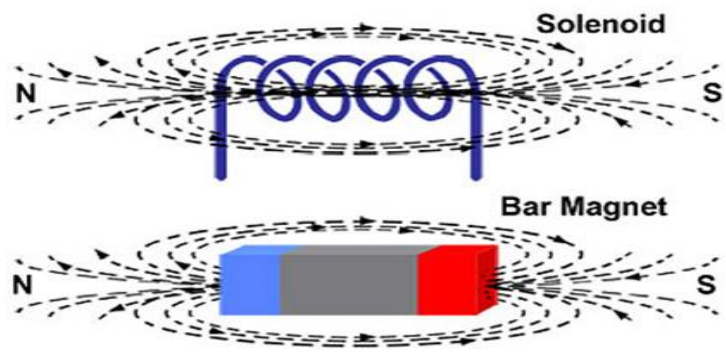
The shape of a magnetic field around a straight wire carrying a current is circular.

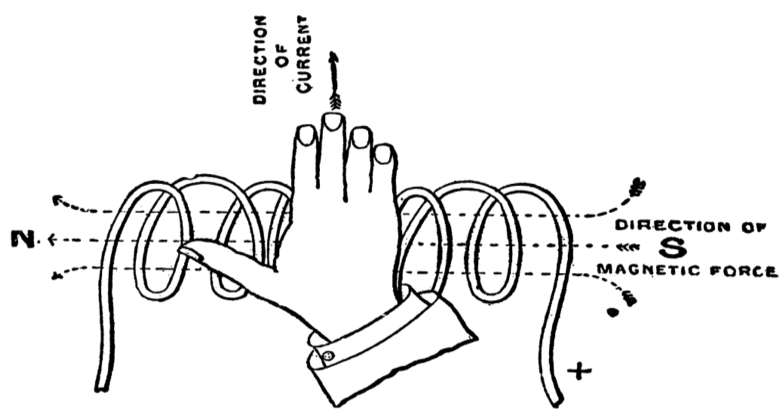


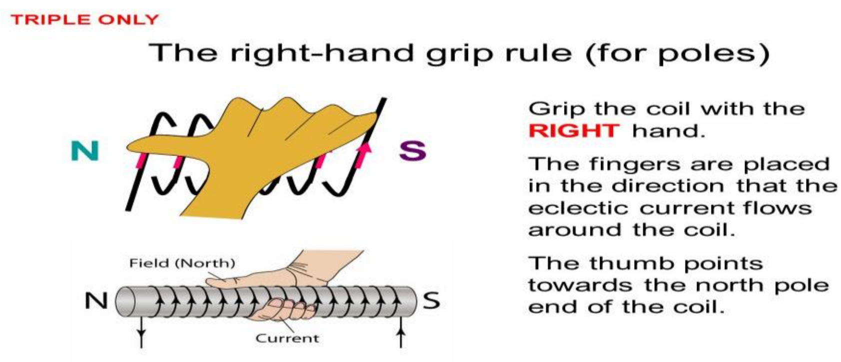
A SOLENOID

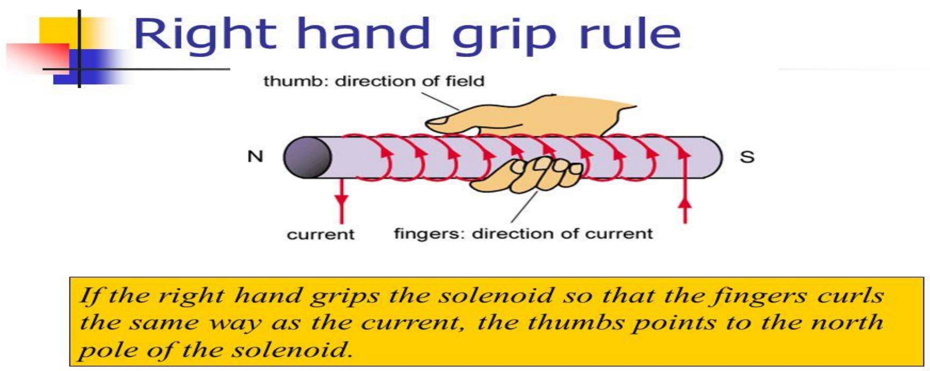
-thumb: points North

-Fingers: direction of conventional (positive to negative) current









What is the advantage of using an electromagnet over permanent magnet?

-Magnetic Field Strenth can be turned on or off/Magnetic Field Strength can be controlled
-easy to magnetise and easy to demagnetise

*Steel is used in permanent magnets.
* Soft iron is used in temporary magnets.

*Induced magnetism: occurs when a non-magnetic substance behaves like a magnet under the influence of a magnet.(e.g North Poles and iron nails)

ACTIVITY

2013

Which of the following properties makes materials suitable for use as a core in an electromagnet?

A. easy to magnetise and easy to demagnetise
B. difficult to magnetise and easy to demagnetise
C. easy to magnetise and retains magnetic strength
D. difficult to magnetise and retains magnetic strength

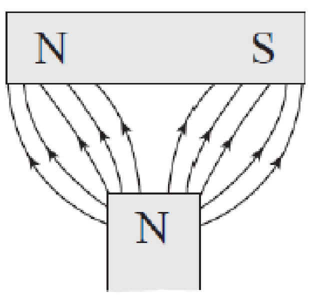
2011

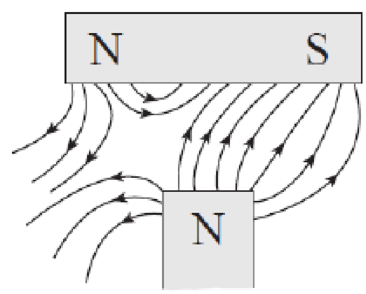
Which of the following is an example of induced magnetism?

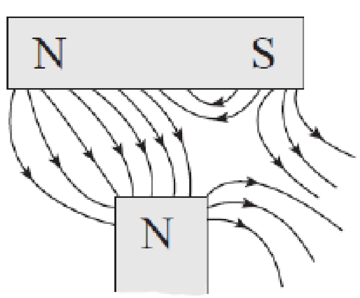
A. the coil of a motor turning in a magnetic field
B. a north pole repelling a north pole
C. a compass needle pointing north
D. a north pole attracting iron nails

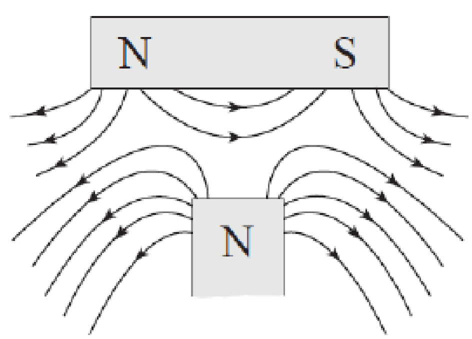
2010

Which of the following diagrams best represents the magnetic field in the region between the two permanent magnets?

A.


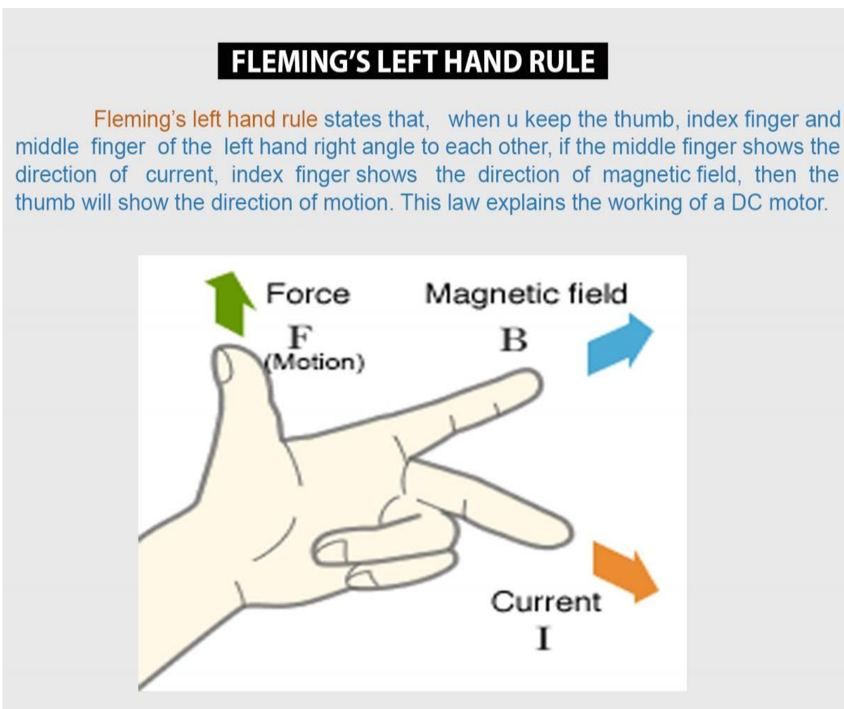
B.


C.


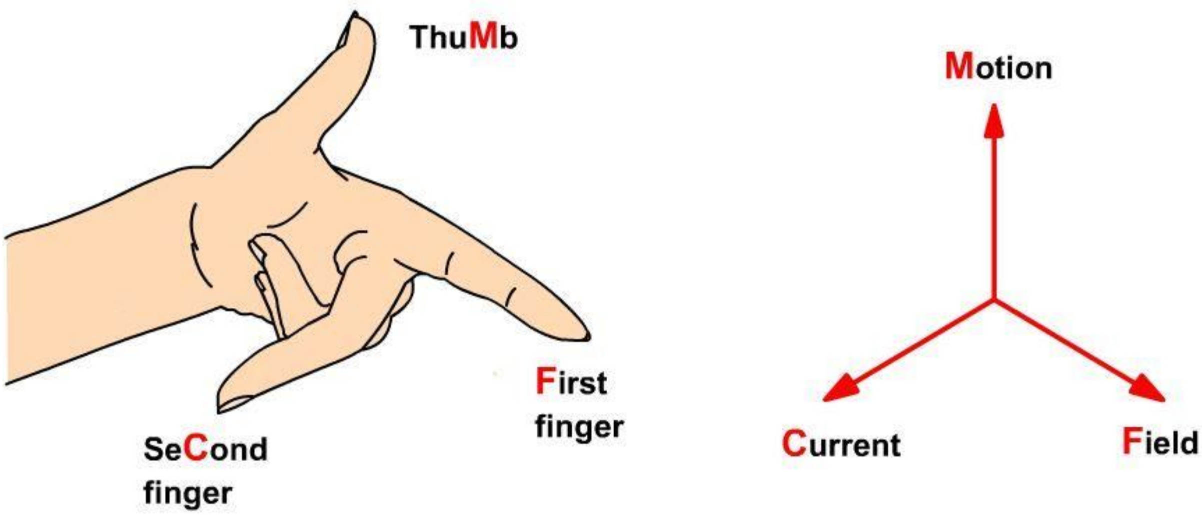
D.


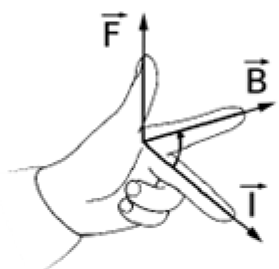
LESSON 99 LO: STUDY MOTOR EFFECT

- When two magnets are close together they produce a force
- When a wire carrying current is placed in a magnetic field, a force is produced
- An electric motor is an electric machine that converts electrical energy to mechanical energy.
- The direction of movement is determined by using **Flemings Left Hand Rule.**
- The first finger represents the direction of the magnetic field (N to S)
- The second finger represents the direction of the current (positive to negative)
- The thumb represents the direction of the force



Fleming's left-hand rule





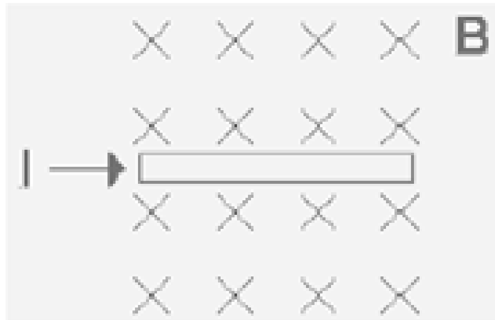
NOTE:

1. When the wire is perpendicular(90^0) to the field, force is maximum.(Sin 90=1) F=BIL
2. If the wire is parallel to the field, then the force is zero.

X : B(magnetic field going into the mage)

- : B(magnetic field coming out of page)

Current + *Field* = *Force* (motion)



The magnitude of the fore is given by :

$$F = B I L \sin \Theta$$

where:

F= force

B = magnetic field strength (T)

I = current flowing (A)

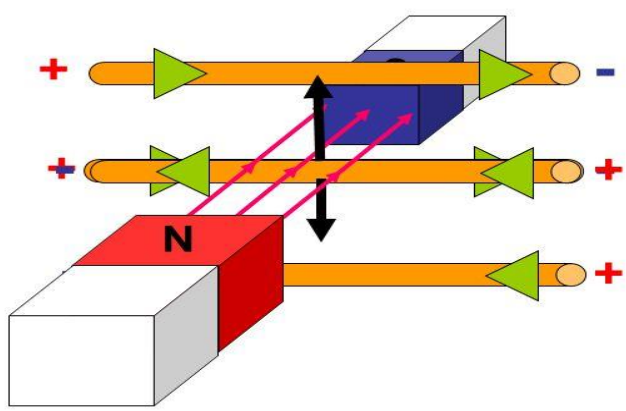
L = Length of conductor (wire) in the field (m).

Θ = angle the conductor makes with the direction of the magnetic field

The motor effect

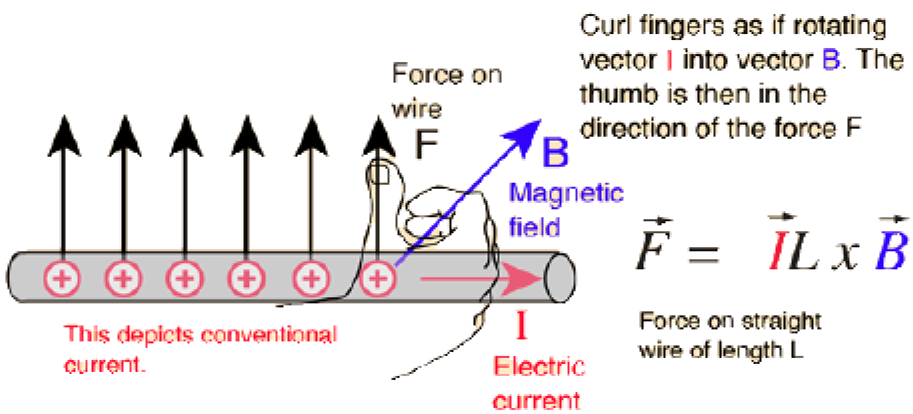
When a current carrying conductor carrying an electric current is placed in a magnetic field, it will experience a force provided that the conductor is not placed parallel to the field lines.

This is called the **motor effect**.



Motor effect - Fendt

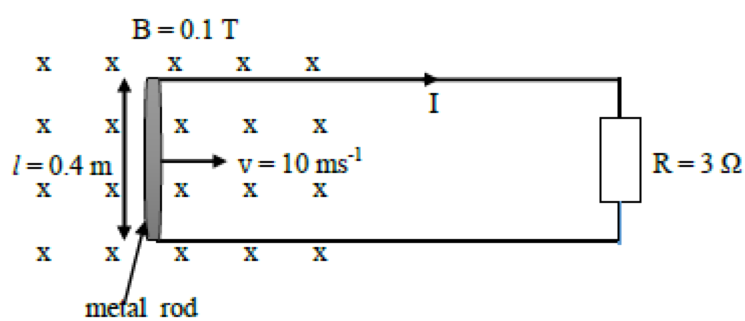
- An electric motor converts electrical energy to mechanical energy



ACTIVITY

2019

A metal rod is pushed in a uniform magnetic field along contacts which are connected to a 3 Ω resistor. The length, l of rod in the magnetic field is 0.4 m. The rod moves at 10 ms^{-1}. The strength of the magnetic field, B is 0.1 T.



Calculate the

(i) induced voltage across the rod.

(ii) current, I.

2018

Which of the following devices prove that a current carrying coil placed in a magnetic field will experience a force?

A. DC Motor
B. Transformer
C. DC generator
D. AC generator

2017

When a current carrying conductor is placed in a magnetic field, a force is produced. This phenomenon is known as

A. motor effect.
B. generator effect.
C. photovoltaic effect.
D. photoelectric effect.

2016

Which of the following energy conversion takes place in an electric motor?

A. Electrical to sound
B. Mechanical to light
C. Electrical to mechanical
D. Mechanical to electrical

2015

A current-carrying wire located in a magnetic field will experience

A. electric force .
B. magnetic force.
C. centripetal force.
D. gravitational force.

2014

A magnetic field is **best** described as a region in space where a magnetic pole experiences a

A. force.
B. current.
C. velocity.
D. resistance.