AP Physics x TIK Content

Grade 7 - Momentum

A. Definition

Momentum is the product of a particle's mass and its velocity, it's a measure of how difficult it is to stop a moving object possessed by masses in motion.

Momentum, p (kg m/s) = mass, m (kg) x velocity, v (m/s)

$p = mv$

B. Momentum & Acceleration

Newton discovered that the rate of change of momentum is proportional to the force applied. An unbalanced force that is applied to a moving object causes acceleration, the change in velocity.

Initial momentum = mu
Final momentum = mv
Change in momentum = (mv - mu)

$$\text{Force, F, rate of increase of p} = \frac{\text{change in p, (mv - mu)}}{\text{time taken, t (s)}}$$

$$F = \frac{(mv - mu)}{t}$$

→ How this formula aligns with Newton's 2nd Law of Motion:

$$F = \frac{(mv - mu)}{t}$$
$$= \frac{m (v - u)}{t}$$
$$F = ma$$

C. Law of Conservation of Momentum

Momentum is always conserved in both elastic and inelastic collisions. After 2 objects collide, the total momentum remains the same. Elastic collisions are when the momentum and kinetic energy is conserved. After 2 objects collide, it moves to the opposite direction. Inelastic collisions are when the momentum is conserved but the kinetic energy isn't. After 2 objects collide, it moves in the same direction.

total p before collision = total p after collision

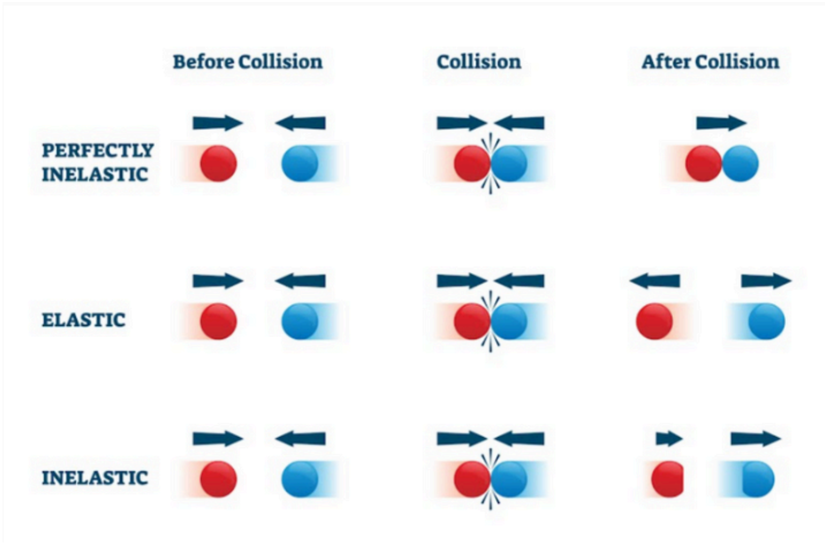
(m1 x u1) + (m2 x u2) = (m1 x v1) + (m2 x v2)

→ Velocity exchange after collision happens based on mass differences, with lighter objects generally moving faster after impact.

For perfectly inelastic collisions ('sticky'):

(m1 x u1) + (m2 x u2) = (m1 + m2) x v

→ Since it moves in the same direction at equal velocity.



→ Velocity exchange after collision happens based on mass differences, with lighter objects generally moving faster after impact.

Momentum can also be conserved by explosions. The momentum before and after collision is the same, but there will be an increase in kinetic energy. When a rocket takes off, the momentum of the fast-moving gases (explosion) is equal and opposite (downward & upward) to the momentum of the rocket's movement.

The law of conservation of momentum aligns with Newton's 3rd Law of Motion:

For every action, there is an equal and opposite reaction.

Grade 8 - Thermal Physics

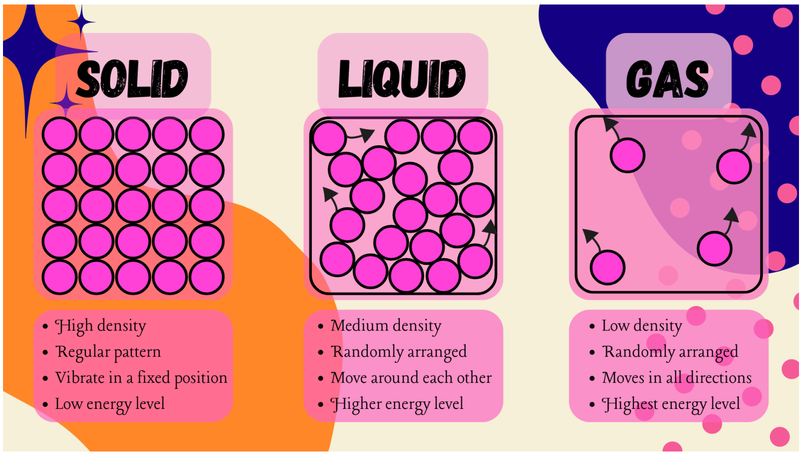
A. Definition

Thermal physics is the relationship between heat, temperature, and energy, and their interactions with matter.

B. States of Matter & Factors of Thermal Expansion

There are three states of matter:

- Solid
- Liquid
- Gases



Thermal expansion can be caused by:

- Extreme temperature difference
- The material of the object
- The size of the object

Cold air is more dense, therefore it has a higher pressure, whereas warm air is less dense and has a lower pressure.

C. Particle Movement

Particles can move faster or slower depending on the temperature. When an object is heated, it gains an increase in its internal energy. The higher the temperature, the higher the average of the internal energy. With more energy, molecules will vibrate faster to the point that they would collide and move further among each other. In solids, molecules vibrate faster and take up more space, which causes expansion.

- The size of the molecules are still the same.
- The number of the molecules didn’t change.

D. Specific Heat Capacity

The specific heat capacity or SHC of an object or substance is the amount of energy needed to heat 1 kg of a substance by 1°C.

Heat energy = Q
Mass = m (kg)
SHC = c
Change in temperature = ΔT

$$Q = mc\Delta T$$

For example, water has a specific heat capacity of 4200J/kg°C. This means that to heat 1 kg of water by 1°C, 4200 Joules of energy is required.

E. Coefficient of Thermal Expansion

The coefficient of thermal expansion or CTE describes how the size of an object (material) changes in temperature. The higher an object's CTE, the larger the object will expand when heated.

Change in length = ΔL (m)
Original length = L_o
CTE (/°C)
Change in temperature = ΔT

$$\Delta L = L_o. a. \Delta T$$

F. Specific Latent Heat

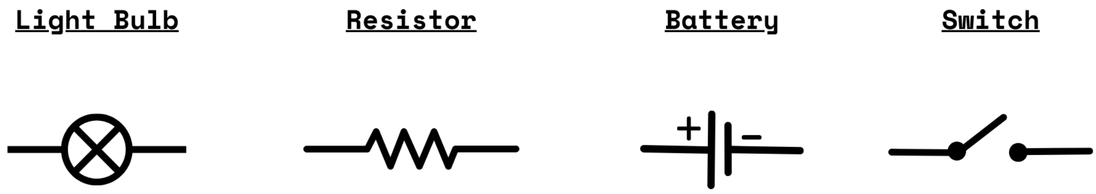
Specific latent heat or SLH is the amount of energy required to change 1 kg of a substance from a particular state to another. The specific latent heat of **fusion** is one of the 2 types of SLH. It's the energy change when a substance changes between solid and liquid (melting/freezing). On the other hand, the specific latent heat of **vaporization** is the energy change when a substance changes between liquid and gas (vaporisation/condensation).
Energy required/released = E (J)
Mass = m (kg)
SLH = L (J/kg)

$$E = L. m$$

Grade 9 Semester 1 - Dynamic Electricity

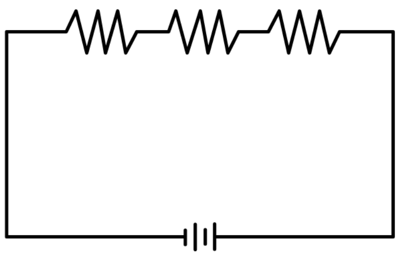
A. Introduction

Dynamic electricity is the flow of electric charges through a conductor, in other words an electric current.

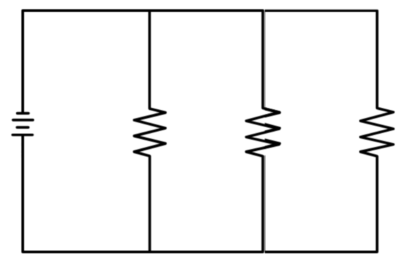


A battery provides electrical potential energy
A battery supplies (v) joule of energy for each coulomb of charge

Series Circuit
A series circuit is where the components are connected one after another.



Parallel Circuit
A parallel circuit is where the components are side by side.



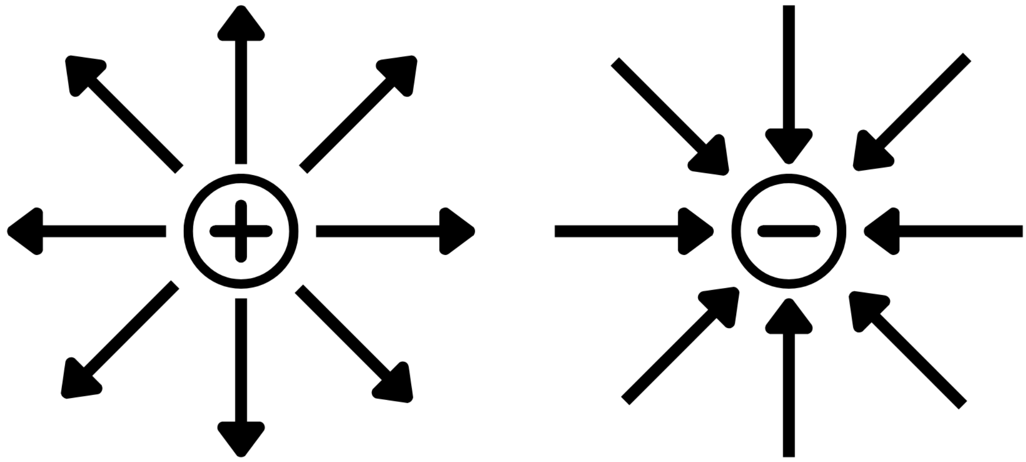
B. Voltmeter

The voltmeter is a measurement device used to measure voltage in electrical circuits or electronic devices. It is commonly employed to measure the voltage across a circuit or component, typically expressed in volts.

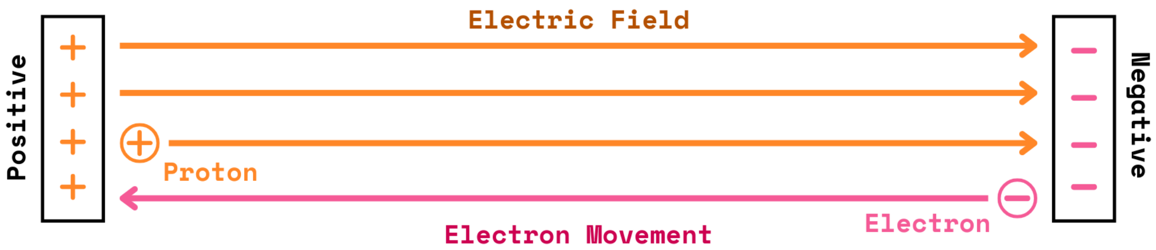
C. Ammeter

An ammeter is a measuring instrument used in electrical circuits. Its primary purpose is to measure electric current and express the intensity of the current. Electric current represents the speed of charged particles passing through a circuit and is typically measured in amperes (A).

D. Electric Field



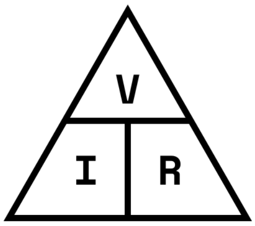
The direction of the electric field moves from positive to negative
The direction of electron movement moves from negative to positive.
Positive charge will move with the electric field
Negative charge will move against the electric field



E. Ohm's Law

Ohm's law states the relationship between electric current and potential difference.
The current that flows through most conductors is directly proportional to the voltage applied to it.

V = voltage (V)
I = current (A)
R = resistance (Ω)



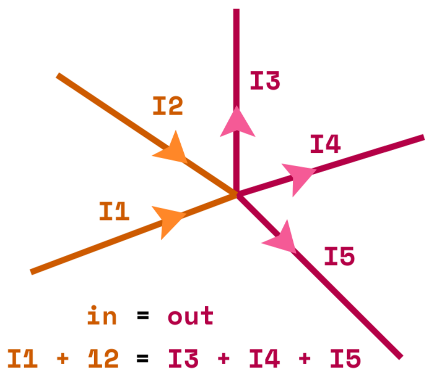
F. Kircchoff's Law

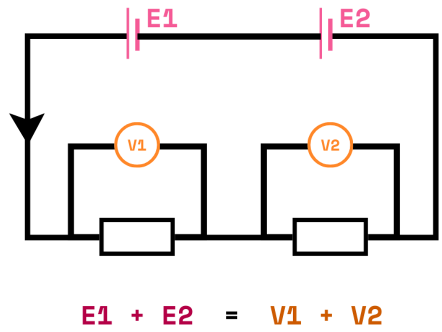
Kirchhoff's Current Law (KCL)

The total current entering the junction
=
the total current leaving the junction.

Kirchhoff's Voltage Law (KVL)

The total electromotive force (emf) in a closed circuit is equal to the sum of the potential differences in the circuit


I1
I2
I3
I4
I5
in = out
I1 + I2 = I3 + I4 + I5

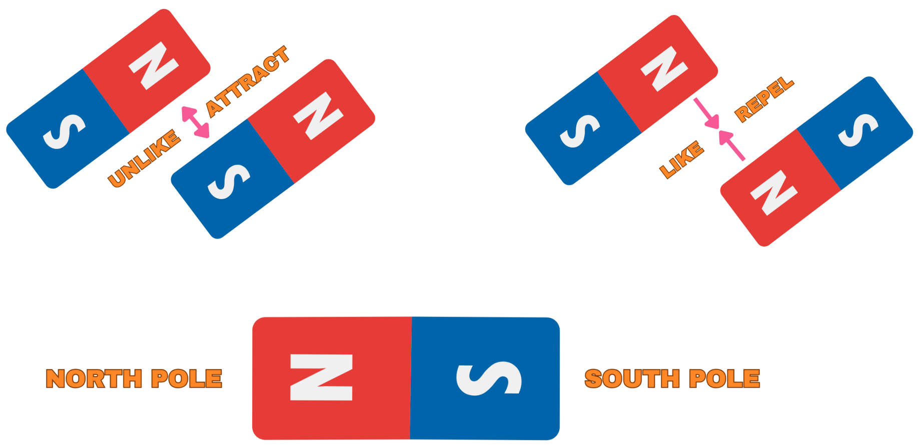

E1
E2
V1
V2
E1 + E2 = V1 + V2

Grade 9 Semester 2 - Magnetism

A. Introduction

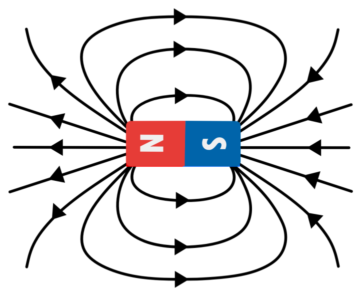
Magnetism is the force exerted by magnets when they attract or repel each other. The strongest parts of magnets are called poles, consisting of a north pole and a south pole.

Permanent magnets are made from magnetically hard materials such as steel. A magnetically hard material keeps its magnetism once it has been magnetized. Permanent magnets take longer to magnetize and demagnetize. While temporary magnets are made from magnetically soft materials such as iron. A magnetically soft material loses its magnetism easily and is therefore useful as temporary magnets. Temporary magnets are easier to magnetize and demagnetize.



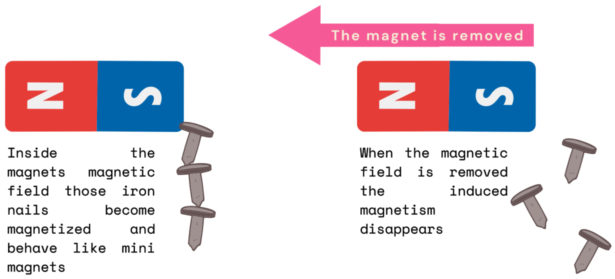
B. Magnetic Field

The volume of space around a magnet is called a magnetic field.
→ Field lines closer to each other -> stronger magnetic field
→ Magnetic fields "travel" from N(north) -> S(south)
(x) -> inwards direction
(.) -> outwards direction



C. Induced Magnetism

If we place an object made from magnetic materials (ex. iron nail) inside a magnetic field it becomes a magnet. In magnetically soft materials, induced magnetism is temporary and disappears if the permanent magnet is removed. Whereas for magnetically hard materials, itt will retain some of its magnetism after the magnet is removed.



D. Electromagnetism

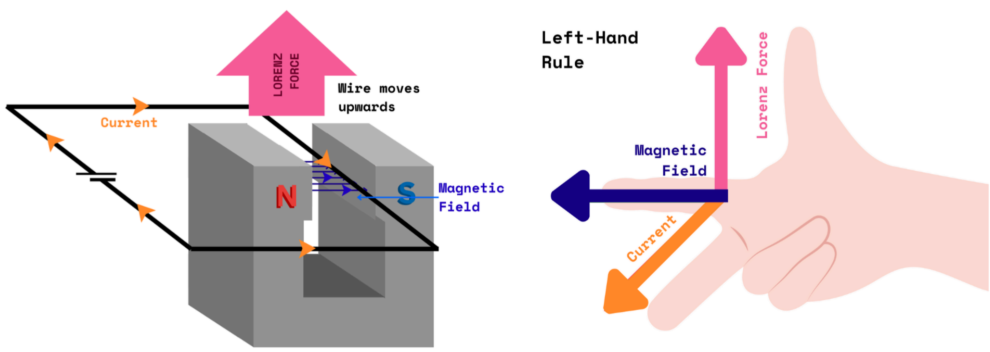
When there is a current in a wire, a magnetic field is created around it. This is called electromagnetism. The field around the wire is quite weak and circular in shape.

1) The Electric Bell

When the bell is pushed the circuit is complete and the current flows through the circuit. As a result the soft iron core becomes magnetized and attracts the iron armature that is attached to the hammer, the hammer strikes the bell. At the same time a gap is created at the contact screw. The circuit is now incomplete and the current stops. The electromagnet is now turned off so the springy metal strip pulls the armature up to it's original position. The circuit is again complete and the whole process repeats again.

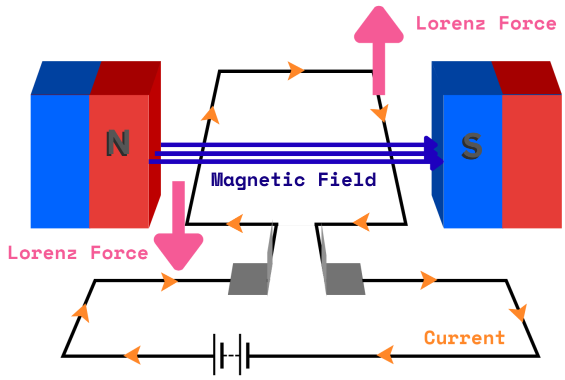
2) Lorenz Force

When a charged particle moves through a magnetic field it experiences a force called Lorentz Force.



3) DC Electric Motor

When there's current in the loops of wire, one side of it will experience a force pushing it upwards. The other side will feel a force pushing it downwards, causing the loop to rotate.


Lorenz Force
N
S
Magnetic Field
Lorenz Force
Current