A student walks 4 m East, 2 m South, 4 m West, and finally 2 m North.

Total distance = **12 m**

During the course of his motion, the total length of travel is **12 m.**

Total displacement = 0 m

When he is finished walking, **there is no change in his position.**

The 4 m east is "canceled by" the 4 m west; and the 2 m south is "canceled by" the 2 m north.

Speed

Speed can be defined as "how fast something moves" or it can be explained more scientifically as "the distance covered in a unit of time". In daily life we use the first definition and say the faster object has higher speed. Speed does not show us the direction of the motion it just gives the magnitude of what distance taken in a given time. In other words it is a scalar quantity.

- ✓ metric unit of speed: **m/s**
- ✓ English unit of speed: **ft/s**

We use a symbol v to show speed. Let me formulate what we talk above;

$$\text{speed (metre per second, m/s)} = \frac{\text{distance travelled (metre, m)}}{\text{time taken (second, s)}}$$

Average speed

The instantaneous speed of an object is not to be confused with the average speed. Average speed is a measure of the distance traveled in a given period of time; it is sometimes referred to as the distance *per* time ratio. Suppose that during your trip to school, you traveled a distance of 5 miles and the trip lasted 0.2 hours (12 minutes). The average speed of your car could be determined as

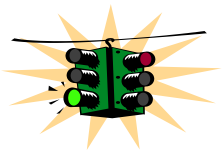
$$\text{Ave. Speed} = \frac{5 \text{ miles}}{0.2 \text{ hours}} = 25 \text{ miles/hour}$$

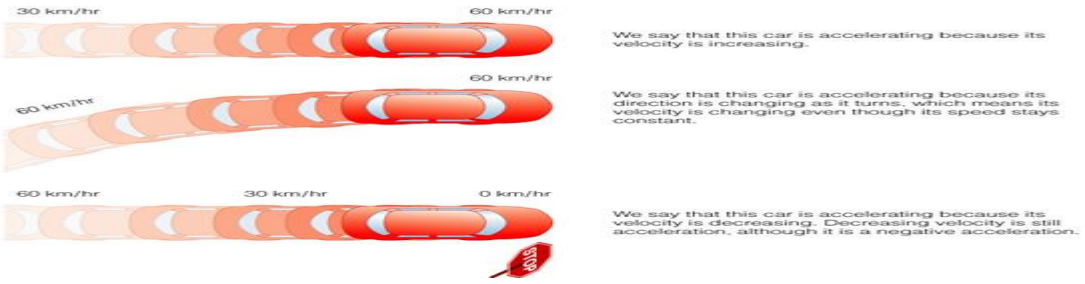
On the average, your car was moving with a speed of 25 miles per hour. During your trip, there may have been times that you were stopped and other times that your speedometer was reading 50 miles per hour. Yet, on average, you were moving with a speed of 25 miles per hour.

Instantaneous speed:

Instantaneous speed: is the speed at any instant

- Use speedometer to find instantaneous speed





The acceleration is given by

$$\text{Acceleration (m/s}^2\text{)} = \frac{\text{Change in velocity (m/s)}}{\text{Time taken for change (seconds)}}$$

$$a = \frac{\mathrm{v} - \mathrm{u}}{\mathrm{t}}$$

The units for acceleration can be implied from the definition to be meters/second divided by seconds, usually written (m/s^2)

Uniform acceleration

- ✓ **A body is said to move with uniform acceleration if its rate of change of velocity with time is constant.**

Notes

- ✓ **If velocity is constant throughout, there is no acceleration (a= 0)**
- ✓ **If the velocity is increasing, the object is said to be accelerating.**
- ✓ **if the velocity of a body decreases then the final velocity is less than the initial velocity in such cases the body is said to be decelerating(retardation) because the acceleration is negative**
- ✓ **if a body starts from rest its initial velocity is zero (v_i=0)**
- ✓ **if the body that was initial travelling comes to a stop, the final velocity is zero (v_f= 0)**

Example1

A skydiver accelerates from 20 m/s to 40 m/s in 2 seconds. What is the skydiver's average acceleration?

Solution

$(v - u)(v + u) = at \times \frac{2s}{t}$

$(v - u)(v + u) = 2as$

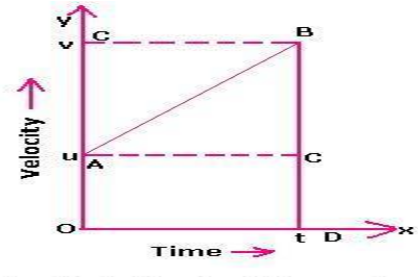
[We make use of the identity $a^2 - b^2 = (a + b)(a - b)$]

$v^2 - u^2 = 2as$..... Fourth equation of motion

Derivation of Equation of Motion (Graphically)

First Equation of Motion

Consider an object moving with a uniform velocity u in a straight line. Let it be, given a uniform acceleration at time, t = 0 when its initial velocity is u. As a result of the acceleration, its velocity increases to v (final velocity) in time t and s is the distance covered by the object in time t. The figure shows the velocity-time graph of the motion of the object.



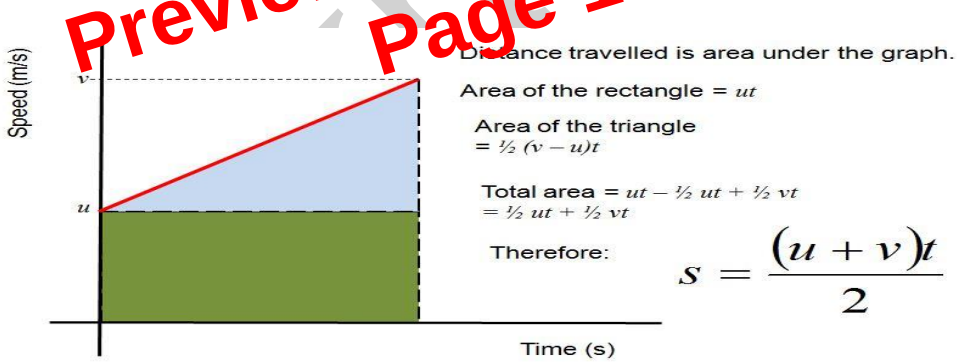
Slope of the v - t graph gives the acceleration of the moving object.

Thus, acceleration = slope = AB = $\frac{BC}{AC} = \frac{v-u}{t-0}$ =a = $\frac{v-u}{t}$

v - u = at

v = u + at..... 1)

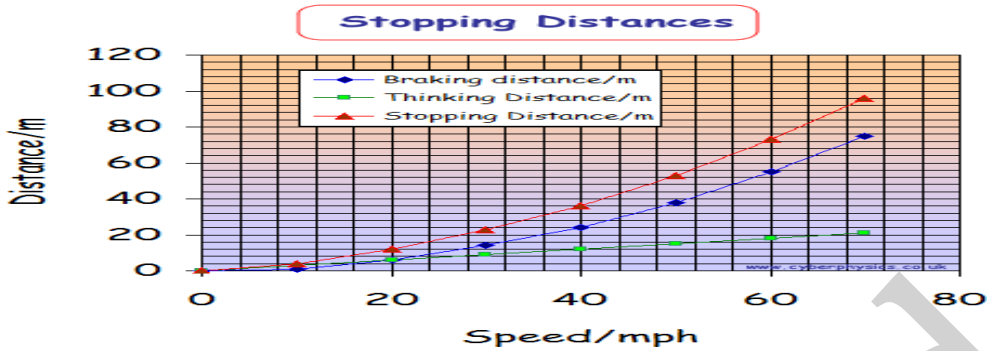
second equation



$s = \left(\frac{u+v}{2}\right) t$ .....second equation

When the brakes are applied, work is done by the friction force between the brakes and the wheels. This:

- Reduces the kinetic energy of the vehicle (because its speed decreases)
- Increases the temperature of the brakes

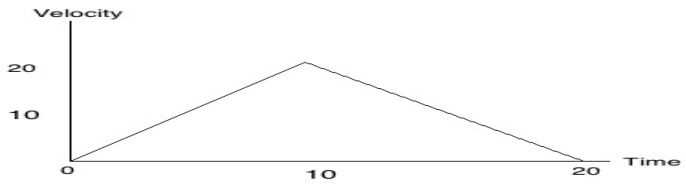


EXERCISE

1. A car accelerates uniformly from a speed of $20ms^{-1}$ to a speed of $25ms^{-1}$ in 2s. Calculate
   a. the average speed for this period of 2s
   b. the distance travelled during this period
   c. the acceleration

2. Describe the motion of the lorry over the following sections of graph along...
   a. PQ
   b. QR
   c. RS

3. a. How far has the object travelled during the first 5 seconds?
   b. What is the acceleration of the object
   c. For how long does the object move at uniform velocity?
   d. What is the average speed of the object during the first 15 seconds?



4. The figure below shows the velocity of a bus moving along a straight road over a period of time

   a. What does the portion of the graph between O and A indicate?
   b. What can you say about the motion of the bus between B and C?
   c. What is the deceleration of the bus between C and D?

b) i. On the graph, mark with 'Z' the point where the magnitude of acceleration of the child is maximum

ii. Mark with 'M' one point at which the acceleration is zero

c) Estimate the distance travelled by the child in 1.2s

d) Describe briefly the changes in acceleration during the period shown on the graph

10. When we say that an object is being accelerated, we mean that
    a. it is at rest,
    b. it is moving,
    c. it is either at a state of rest or a state of constant velocity,

motion part two

Dynamics

This is derived from the Greek word 'dynamis', meaning power. **Dynamics** involves the study of the cause of motion, which is force. When we relate motion of an object to the forces associated with it and to the properties of the moving objects, we are dealing with dynamics.

Effects of Force

A force is **push or pull** exerted on an object.

Force is a vector quantity that has magnitude and direction.

The unit of force is Newton (or $kgms^{-2}$). ($1N=1kgm/s^2$)

Unbalanced Force/ Resultant Force

When the forces acting on an object are not balanced, there must be a **net force** acting on it. The net force is known as the unbalanced force or the resultant force.

When a force acts on an object, the effect can change the

size,

shape,

stationary state,

speed and

Direction of the object.

Formula of Force

$$F = ma$$

F = Net force

m = mass

a = acceleration

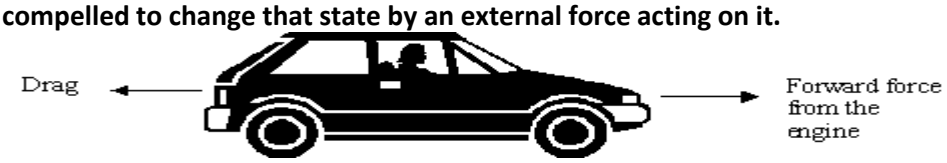
from Newton's Second Law, we can derived the equation

(IMPORTANT: F Must be the net force)

Newton I

Newton's First Law states:

Every object continues in its state of rest or uniform motion in a straight line, unless it is compelled to change that state by an external force acting on it.



A **car** will maintain a constant speed if the drive force and the drag are balanced. **The total force is zero**.

Newton's First Law Example

Example1
A man fires a rifle which has mass of 2.5 kg. If the mass of the bullet is 10 g and it reaches a velocity of 250 m/s after shooting, what is the recoil velocity of the pistol?
Answer:
This is a typical question of explosion.

$m_1 = 2.5$ kg
$m_2 = 0.01$ kg
$u_1 = 0$ ms^{-1}
$u_2 = 0$ ms^{-1}
$v_1 = ?$
$v_2 = 250$ ms^{-1}

By using the equation of conservation of momentum principle
$0 = m_1v_1 + m_2v_2$
$0 = (2.5)v_1 + (0.01)(250)$
$(2.5)v_1 = -2.5v_1 = -1$ ms^{-1}

Impulse
As you can see, momentum can change, and a change in momentum is known as an **impulse**.
Is a vector quantity
The impulse is represented by a capital **J**, and since it's a change in momentum, its units are the same as those for momentum, [kgm/s], and can also be written as a Newton-second [N×s].
$J = \Delta p$
Example2
A body having 3 kg weight is traveling at 2m/s is subjected to Velocity of 10m/s.
Find:
(a) Initial momentum
(b) Final momentum
(c) Change in momentum
(d) Impulse
Solution
Given mass, m = 3kg,
Initial Velocity $V_i = 2m/s$,
Final Velocity $V_f = 10m/s$
(a) Initial momentum, $pi = mv_i = 3 \times 2 = 6$ kg m/s.
(b) Final momentum, $pf = mv_f = 3 \times 10 = 30$ kg m/s.
(c) Change in momentum, $\Delta p = p_f - p_i = 30 - 6 = 24$kgm/s.
(d) Impulse, $J = Ft = \Delta p$
$= 24$Ns.

Impulsive Force

1. Impulsive force is defined as the rate of change of momentum in a reaction. Mathematically, we write

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

2. It is a force which acts on an object for a very short interval during a collision or explosion.

Effects of impulse vs Force

b). final kinetic energy = work done (because the initial kinetic energy is zero)

example3

a car of a mass 800kg is increases is kinetic energy from 20m/s t0 30m/s.

a). calculate the initial kinetic energy o the car ?

b). calculate the final kinetic energy of the car ?

c) Calculate the change in kinetic energy?

Solution

a) $kE_1=\frac{1}{2}mu^2=\frac{1}{2}(800)(20)=160000j$

b) $KE_2=\frac{1}{2}mv^2=\frac{1}{2}(800)(30)=360000j$

c). $\Delta kE=kE_2-kE_1=360000j-160000j=200{,}000j$

Example4

A trolley of 5 kg **mass moving** against friction of 5 N Its velocity at A is 4ms-1 and it stops at B after 4 seconds. What is the work done to overcome the friction?

Solution

In this case, kinetic energy is converted into **heat** energy due to the friction. The work done to overcome the friction is equal to the amount of kinetic energy converted into heat energy, hence

$$\boldsymbol{WorkDone = Kinetic\ Energy\ Loss}$$

$$= \frac{1}{2}mv_1^2 - \frac{1}{2}mv_2^2$$
$$= \frac{1}{2}(5)(4)^2 - \frac{1}{2}(5)(0)^2$$
$$= 40J$$

Power

Power is the rate at which work is done, which means how fast a work is done.

Formula:

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

P = Power
W = Work done
t = Time taken

Example1

An **electric motor** takes 20 s to lift a box of mass 20kg to a height of 1.5 m. Find the amount of work done by the machine and hence find the power of the electric motor.

Solution

Work done

$$W = mgh = (20)(10)(1.5) = 300J$$

Power,

$P=\frac{w}{t}=\frac{300}{20}=15J$

example2

John is having mass 60 kg runs up to 12m high in 40 seconds. Calculate his power.

Solution:

Given: mass m = 60 kg,

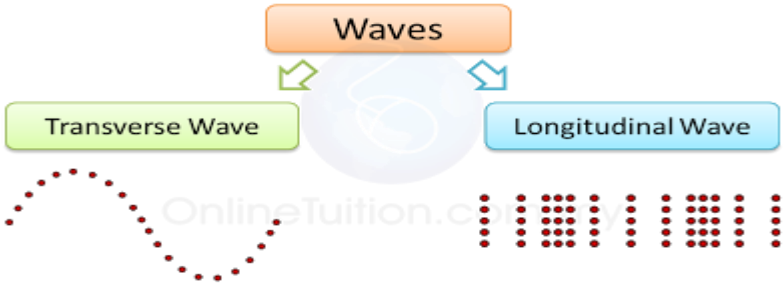
Height h = 12 m,

time taken t = 40 seconds.

Power is given by P = w/t

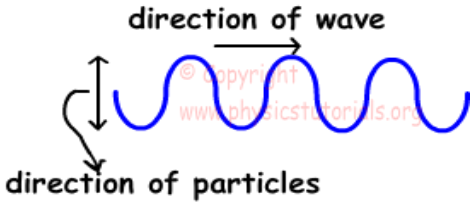
$= \frac{12\times60}{40}$

= 588 Watts.



Transverse Wave

A transverse wave is a wave where the particles of the medium vibrate in a direction that is perpendicular to the direction of the wave motion.



Example:

Light wave, ripple, radio wave

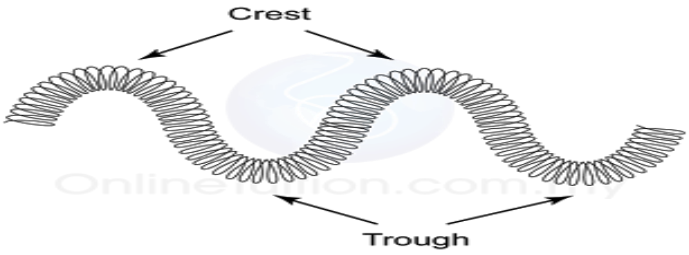
Longitudinal Wave

A longitudinal wave is a wave where the particles of the medium vibrate in a direction that is parallel to the direction of the wave motion.

Example:

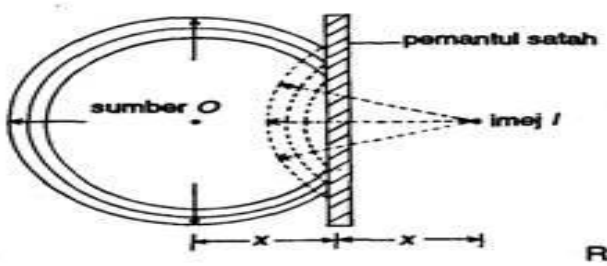
Sound Wave

Transverse Wave – Crest and Trough



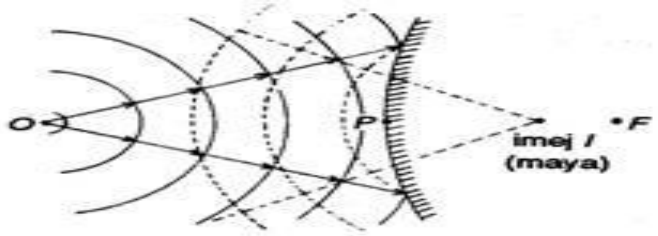
- When discussing wave, it's important to know what is meant by the crest and trough of a wave.
- The point at which the displacement of the water from its normal level is highest called the crest of the wave

✓ Circular water wave strikes plane barrier. The reflected wave reversed circular.



Rajah 64

✓ Circular wave reflection from a convex barrier/obstacle, the reflected wave are circular



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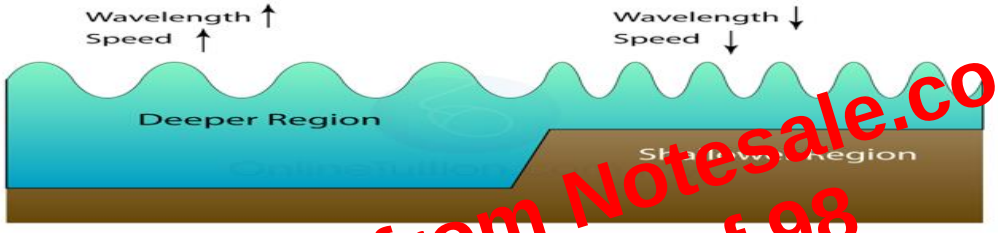
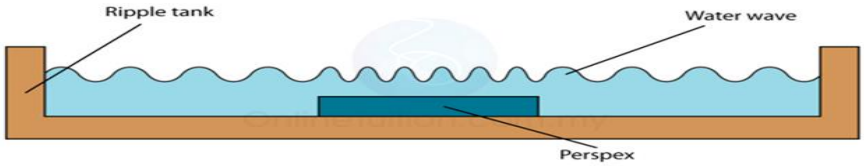
Refractions

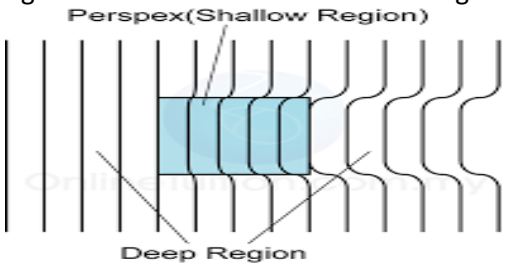
Speed of Water Waves



1. When straight waves pass from deep to shallow water, their
   a. wave-length becomes shorter
   b. speed decreases
   c. frequency remain unchanged
2. This can be illustrated by placing a piece of rectangular Perspex of suitable thickness in the tank to reduce the local water depth.



3. Figure below shows the wavefront diagram of the wave formed.



4. We can see that the wavelength above the Perspex is shallower.

Refraction of Waves at a Boundary

(Diffraction happen when waves encounter an obstacle)

✓ Characteristics of Diffracted Wave

a. Wavelength does not change.
b. Frequency does not change.
c. Speed of diffracted does not change.
d. The amplitude of the wave decreases after diffraction.

Must know:
After diffraction,
Frequency
Wavelength
Speed
} Remain unchanged

Amplitude - Decreases

✓ **Factors Affecting the Magnitude of Diffraction**

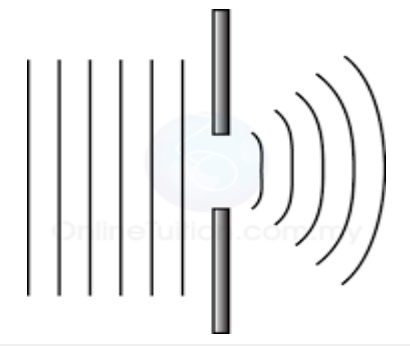
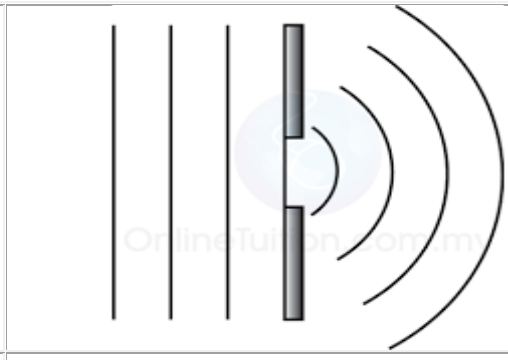
The magnitude of diffraction (or angle of diffraction) depends on

a) The wavelength
b) The size of the opening

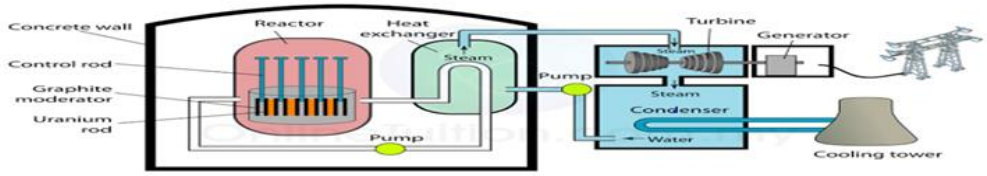
Experiment 1

	
Shorter wavelength - The wave spreads to a smaller area	Longer wavelength - The wave spreads to a wider area
Conclusion: Diffraction is affected by the **wavelength**. The longer the wavelength, the **greater** the effect of diffraction	

Experiment 2

	
Bigger opening - The wave spreads to a smaller area	Smaller opening - The wave spreads to a wider area
Conclusion: Diffraction is affected by the **size** of the opening. The **smaller** the size of the opening, the **greater**the	

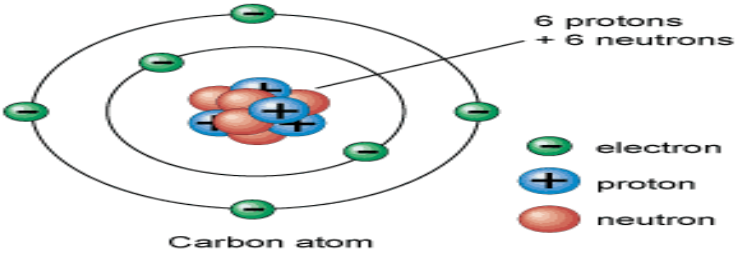
chapter three: radioactive



Introduction

The structure of an atom

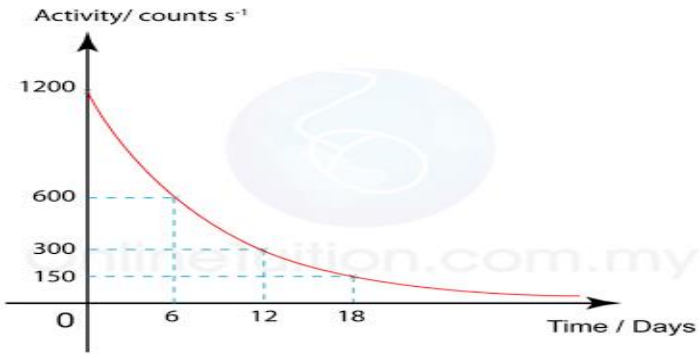
Although the word 'atom' comes from the Greek for *indivisible*, we now know that atoms are not the smallest particles of matter. Atoms are made from smaller



Describe the composition of the nucleus of an atom in terms of protons and neutrons

- ✓ Matter is made up of very small particles called atoms.
- ✓ Each atom has a very small and very dense core called nucleus. Most of the mass of atom is contained in the nucleus
- ✓ The electrons move in orbits around the nucleus.
- ✓ There are a lot of empty space within atom
- ✓ A nucleus consists of a number of protons and neutrons.
- ✓ Protons and neutrons also known as nucleons.
- ✓ A proton has a unit positive charge.
- ✓ A neutron is an uncharged particle of about the same mass as the proton.
- ✓ An atom is neutral because it contains an equal number of negatively charged electrons. So the net charge is zero.
- ✓ Proton number,(**Z),** is defined as the number of protons in a nucleus
- ✓ **The number of electrons = the number of protons**
- ✓ An element is identified by its proton number
- ✓ Nucleon number, (A) is defined as the total number of protons and neutrons in a nucleus.
- ✓ Number of neutrons, N = A - Z
- ✓ A nuclide is an atom of a particular structure. Each element has nucleus with a specific number of protons.

Nuclide notation ${}^{A}_{Z}X$	${}^{A}_{Z}X$ A = nucleon number, Z = proton number, X = chemical symbol of the element
Proton ${}^{1}_{1}p$	Example ${}^{12}_{6}C$
Neutron ${}^{1}_{0}n$	Proton number of carbon = 6, carbon nucleus has 6 protons. The nucleon number of carbon is 12. So the number of neutrons in carbon nucleus is 12 – 6 = 6
Electron ${}^{0}_{-1}e$	



The diagram shows the graph of the activity of a radioisotope, X, against time. What is the half-life of the radioactive substance?

solution

The half-life is the time taken for the activity to decrease to become half of the initial value.
From the graph we can see that the radioisotope take 6 days for the activity to become half. Therefore Half-life = 6 days

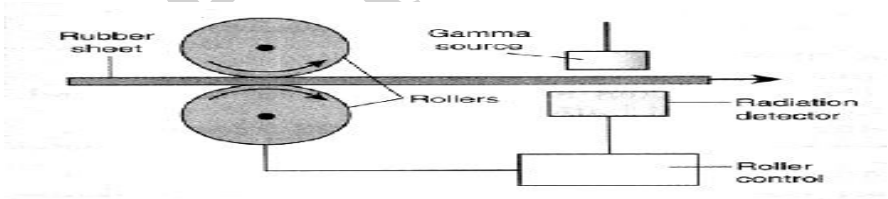
Exercise

An alien radioactive isotope has a half-life of 238years. If you start with a sample of 8 kg, how much will be left in 100 years?

Uses of radioactive

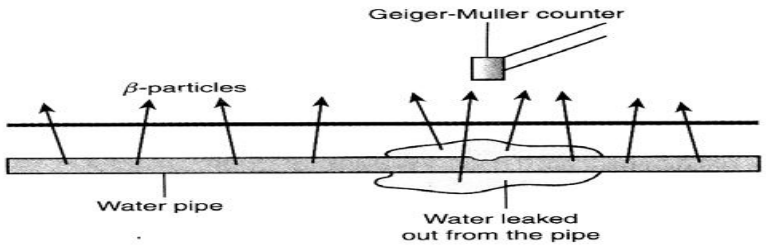
Thickness control

- A radioactive sends radiation through the sheet material as it comes off the production line. Beta radiation is used for thin sheets. A radiation detector on the other side of the sheet measures the intensity of the radiation passing through the sheet.
- The amount of radiation received by the detector depends on the thickness of the rubber sheet
- If the sheet is too thin, the reading of the detector increases.
- A signal is sent from the roller control to the rollers so that the pressure on the sheets can be reduced.



detecting leaks in underground water pipes.

- A radioactive substance which emits beta particles is added to a fluid in a pipeline to measure the flow rate in the pipeline and to find leaks.
- The radiation produced by the radioactive substance can be detected with a GM tube counter placed above ground.
- A larger increase in the count rate will indicate that there is leak in that area.



Medicine

Radioactive tracers

• Nuclear medicine is a branch of medicine that uses radiation to provide information about the function of the specific organs of a patient or to treat disease.

A radioisotope is taken in by a patient through the digestive system, by inhalation or through the blood vessels by injection.

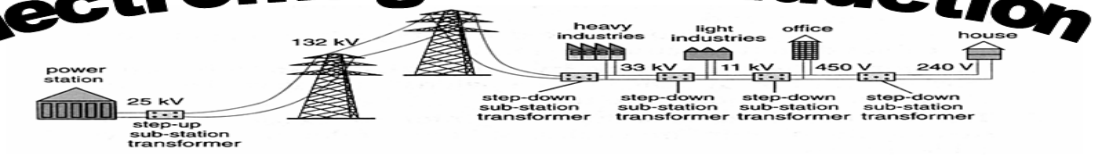
• The radiation emitted enables organs such as thyroid, bones, heart, liver to be easily imaged by imaging equipment. Disorders can then be detected.

In archaeology radioisotope carbon-14

a) In archaeology radioisotope carbon-14 is used to study and estimate the age of ancient artifacts. This method is named as the radiocarbon dating.
b) Radiocarbon dating can be used to estimate the age of organic materials, such as wood and leather, up to about 58,000 to 62,000 years.

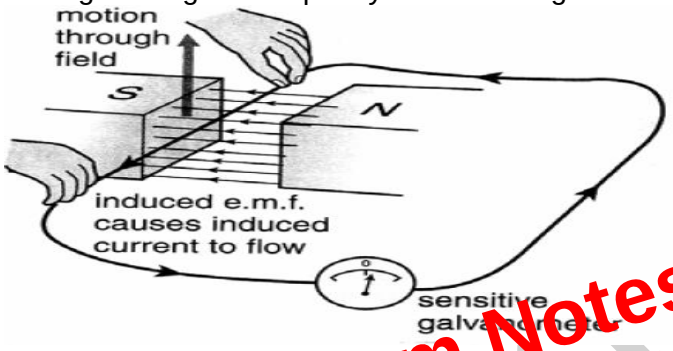
chapter 4

electromagnetic induction

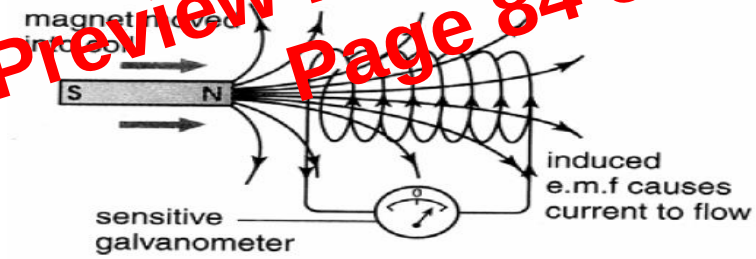


Electromagnetic induction is the production of an electric current by a changing magnetic field. The induced current is produced only when there is relative motion between the conductor / coil and the magnetic field lines.
The relative motion of a conductor across a magnetic field can be produced by:

a) Moving a straight wire quickly across a magnetic field between two flat magnets.



b) Moving a permanent magnet towards one end of a solenoid.



Each time the straight wire cuts across the magnetic field, or the permanent magnet moves towards the solenoid, a current is induced in the coil and a deflection is observed in the sensitive galvanometer.
This current is called induced current. The electromotive force that is produced is called the induced e.m.f.

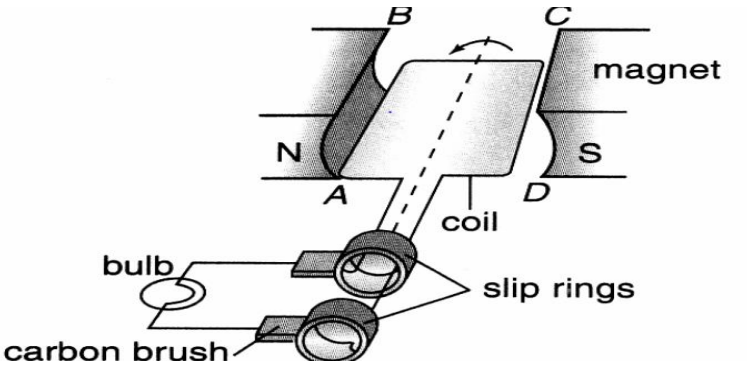
<u>This can be achieved in two ways:</u>

I. a conductor can be moved in a magnetic field
II. a magnet can be moved in a coil of wire Induction does not happen. if the conductor moves in the same direction as the magnetic field.

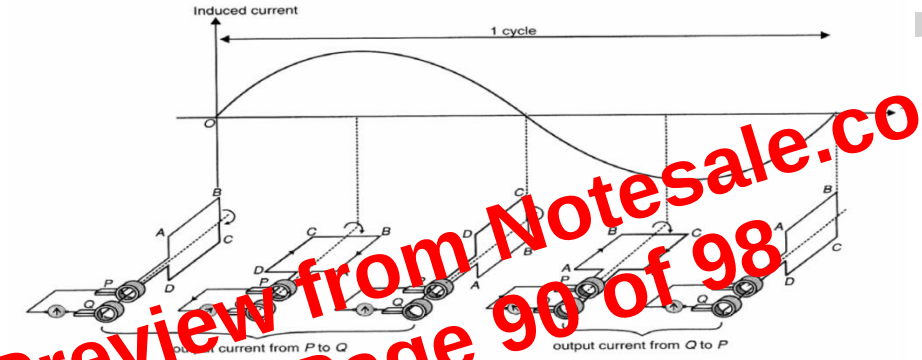
<u>Law of Electromagnetic Induction</u>

There are two principal laws of electromagnetic induction:

- ✓ Alternating current is an electric current in which the direction of flow of the electrons reverses periodically

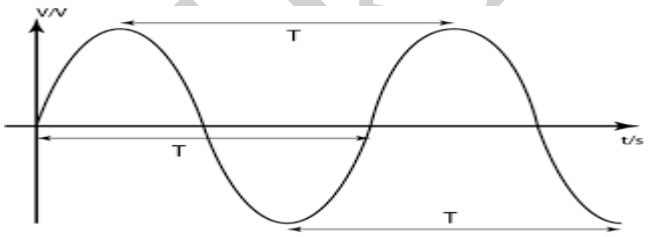


- ✓ The two ends of the coil are connected to two slip rings which rotate with the coil.
- ✓ Each slip ring is always in contact with the same carbon brush.
- ✓ Alternating current changes direction 50 times every second. Its magnitude also changes with time.



- ✓ The output current generated is an alternating current because the current changes direction in the external circuit each time the coil passes the vertical position.

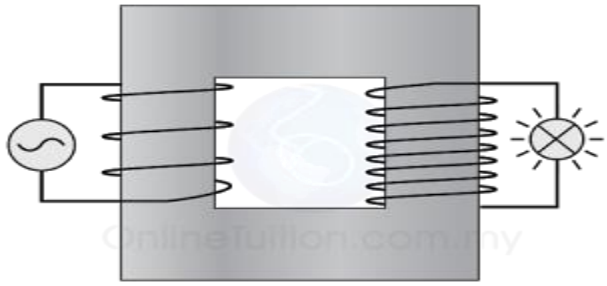
Period And Frequency



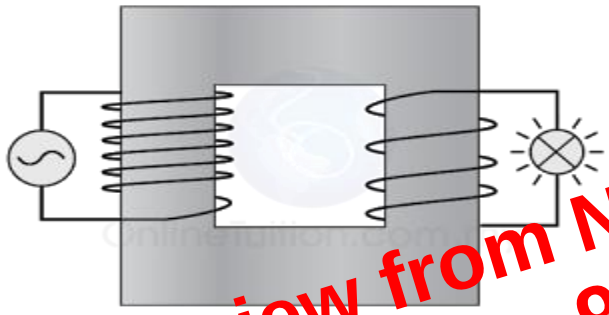
- ✓ The time taken for one complete cycle is known as the period, T.
- ✓ The frequency f is defined as the number of complete cycles in 1 second.
- ✓ The relationship between the frequency and the period is:
- ✓ f=1/T
- ✓ we need to know the effect of both the direct current and alternating current on
  - a bulb
  - a capacitor
  - a moving coil loudspeaker

2. the step down transformer

Step-up Transformer



- ✓ A step-up transformer is one where the e.m.f. in the secondary coil is greater than the e.m.f. in the primary coil. It is used to increases the potential difference.
- ✓ The number of windings in the secondary winding is greater than the number of windings in the primary coil.
- ✓ The current in the primary coil is greater than the current in the secondary coil.



Step-down transformer

- ✓ Conversely, a step-down transformer is one where the e.m.f. in the secondary coil is less than the e.m.f. in the primary coil. It is used to reduce the potential difference.
- ✓ The number of windings in the primary winding is greater than the number of windings in the secondary coil.
- ✓ The current in the primary coil is lesser than the current in the secondary coil.

Transformer Equations

Vp is the potential, Ip is the current, Np is the turn on the primary coil and Vs is the potential, Is is the current, Ns is the turn on the secondary coil. We use following equations to find potential, current or number of turns of any coil;

$$\frac{N_p}{N_s} = \frac{V_p}{V_p} = \frac{I_s}{I_p}$$

N_p = number of turns in primary coil
N_s = number of turns in secondary coil
Vp = input (primary) potential difference
Vs = output (secondary) potential difference
Ip = input (primary) current
Is = output (secondary) current

Example1

A 16.5:1, 50 Hz single-phase transformer has 100 turns on the secondary coil.