Force, Motion and Energy

Motion and Rest

- Motion is the change in the position of object with respect to its surroundings.
- An object which do not change their position is said to be at rest.
- Motion is a relative phenomenon

An object appearing to be in motion to one person can appear to be at rest as viewed by another person.

Example: Trees on road side

- Force is a push or pull.

Newton's law of motion:

This law states that a body continues to be in its state of rest or the state of uniform motion along a straight line unless it is acted upon by some external force.

It gives the definition of force and inertia

Inertia

The inherent property of a body to resist any change in its state of rest or state of Uniform motion unless it is influenced upon by an external unbalanced force is known as inertia.

2nd law of motion:

The force acting on a body is directly proportional to the rate of change of linear momentum of the body and change in momentum tooks place in the direction of force

Force = Mass × acceleration

Linear Momentum:

The impact of force is more of the velocity and mass of the body is more to quantity the impact of a force a physical quantity linear momentum is defined.

APPOLO STUDY CENTRE PH: 044-24339436, 42867555, 9840226187

P = Mass × Velocity

P = M × V

Unit is Kg m/s

Impulse:

A large force acting for a very short interval of time is called impulsive force.

$$J = F \times t$$

3rd law of motion:

For every action there is as equal and opposite reaction. They always act on two different bodies.

$$F_B = -F_A$$

Principle of Linear Momentum

There is no change in the linear momentum of a system of bodies as long as not net external force acts on them.

Rocket Propulsion:

- Newton's third law of motion
- Principle of linear momentum

While in motion, the mass of the rocket gradually decreases until the fuel is completely burnt out. Since, there is no net external force acting on it, the linear momentum of the system is conserved. The mass of the rocket decreases with the attitude which increases velocity of the rocket and at one stage it just escapes from the gravitational pull of the earth. This velocity is called escape velocity.

$$V_e = \sqrt{\frac{2GM}{r}}$$

1. Which of the following law undergoes rocket propulsion?
   a. Newton 1st law of motion
   b. Newton 2nd law of motion
   c. Newton 3rd law of motion
   d. None of these

(Group 2, 2013)

2. Inertia of a body depends upon
   a. weight of the object
   b. Acceleration due to gravity of planet
   c. mass of the object
   d. Both a & b

3. Newton's III law is applicable
   a. for a body is at rest
   b. for a body is motion
   c. Both a & b
   d. only for bodies with equal masses

Distance and Displacement

The actual length of the path travelled by a moving body irrespective of the direction is called distance travelled by the body.

S.I Unit is meter

Displacement is defined as the change in position of a moving body in a particular direction. It is a vector quantity.

S.I Unit is meter

Speed, Velocity and Acceleration:

i) $\text{Speed} = \dfrac{\text{Distance}}{\text{Time}}$
   SI Unit is ms^{-1}

ii) Velocity is the rate of change of displacement.
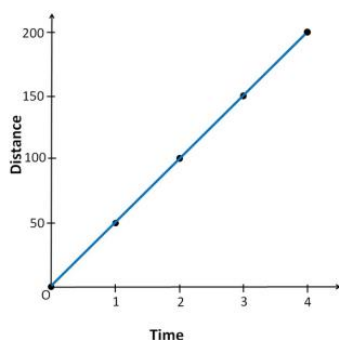 $$\text{Velocity} = \dfrac{\text{Displacement}}{\text{Time Taken}}$$

iii) Acceleration is the rate of change of velocity.
   $$\text{Acceleration} = \text{Change in velocity}$$
   $$a = \dfrac{\text{final velocity - initial velocity}}{\text{Time Taken}}$$
   SI Unit – ms^{-2}

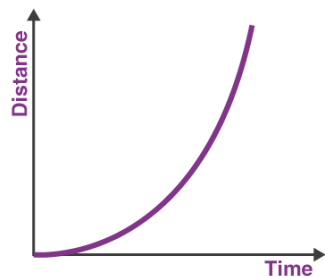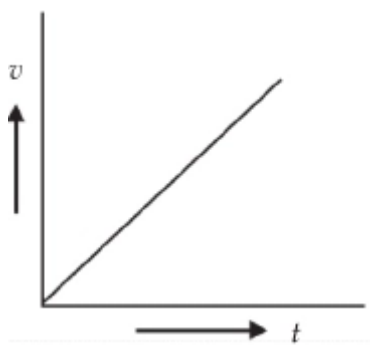## Distance – Time graph for uniform motion

equal distance in equal intervals at time, it is a straight line.
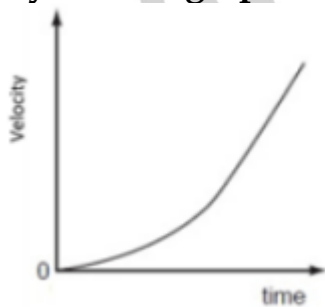
Distance – Time graph for non- uniform motion

Non-linear variation

Velocity – Time graph for Uniform acceleration

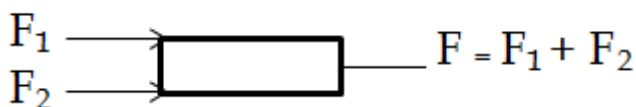(i) It is a straight line

Velocity – Time graph for Non-Uniform acceleration

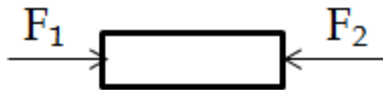- There is no shape. It can have any shape.

Types of Forces:

(i) Parallel Force

$F = F_1 + F_2$

(ii) Unlike Parallel Force

$$F = F_1 - F_2 \ (F_1 > F_2)$$

$$F = F_2 - F_1 \ (F_2 > F_1)$$
$$F = 0 \ (F_1 = F_2)$$

(iii) Rotational effect of force.

(iv) Torque: The turning (or) rotating effect of a force about a fixed point (or) Fixed axis is called Torque.

$$\boxed{l = F \times d}$$ It is a vector quantity

(v) Couple: two equal and unlike parallel forces applied simultaneously at two distinct points constitute a couple.

$$\boxed{M = F \times s}$$ Nm → Unit

Factors affecting Force

- Value
- Area of contact

Thrust

It is a force acting perpendicular to an object.

Pressure

The Force per unit area acting on an object concerned is called pressure.

$$\boxed{Pressure = \frac{Force}{Area}}$$

S.I Unit Pressure is Pascal.
1 Pascal = 1 Nm^{-2}

Pressure exerted by a force depends on the magnitude of the force and the area of content.

Atmosphere Pressure:

The amount of force or weight of the atmosphere air that acts downwards on unit surface area of the earth is known as Atmospheric Pressure.

It is measured by using barometer device. It is invented by 'Torvicelli'. S.I Unit Nm^{-2} (or) Pascal

$$1 \text{ atomic Pressure} = 1.01 \times 10^{-5} \text{ Nm}^{-2}$$

Factors affecting pressure exerted by liquids:

(i) Depth (h)
(ii) Density
(iii) It will exerts in all direction

PASCAL'S LAW:

Pressure applied at any point of a liquid at rest, in a closed system will be distributed equally through all regions of the liquid

Application:

- Hydraulic lift (in service station, JCB)
- Brake system (Car, Bus, Lorry etc)
- Hydraulic press (a large word, steel, sugarcane machine)

Surface Tension:

It is the property of a liquid where the molecules of a liquid experience a force, which contracts the extent of surface area so as to have the minimum value.

The amount of force acting per unit – length on the surface of the liquid. Unit is Nm^{-1}

Applications:

- Rains are spherical in shape
- In plants water from the grounds are absorbed through the xylem tissues.
- Water strides insects slides on the water easily.
- During a heavy storm sailors pour soap powder or oil into the sea to decrease the surface tension of sea water.

Viscosity:

Frictional force between successive layers of liquids to oppose relative motion of layer.

SI unit is Nsm^{-2}

CGS $\rightarrow$ kgm^{-1}s^{-1}

Friction:

- When two or more bodies in contact tends to move relative to each other frictional forces arises.
- It is produced due to the geometrical dissimilarities of the surface of the bodies.
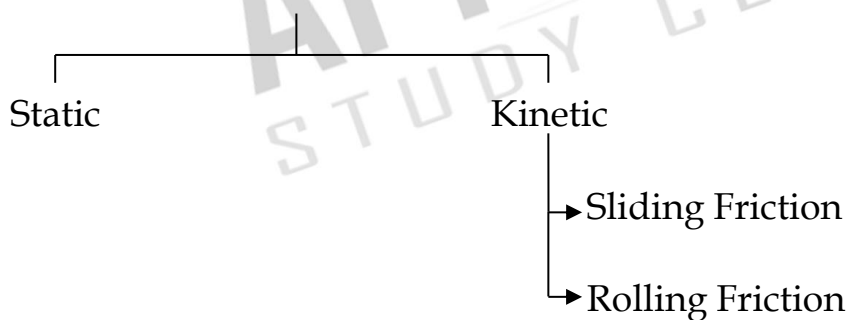
Effects:

- Opposes motion
- It causes wear and tear of the surface in contact.
- It produces heat.

Factors affecting Friction:

i) Area of contact
ii) Nature of a surface
iii) Weight of the body.

Types of Friction:

```
                    |
        ┌───────────┴───────────┐
      Static                  Kinetic
                                  │
                                  ├──► Sliding Friction
                                  │
                                  └──► Rolling Friction
```

- Static – Friction experience by the bodies which are at rest.
- Kinetic – Friction existing during the motion of bodies.
- Sliding Friction – Friction between the surfaces in contact when a body slides over the surface of another body.

- Rolling Friction – Friction acting between the surfaces, when a body rolls over the surfaces.

  Sliding Friction > Rolling Friction

Increasing and decreasing of Friction:

APPOLO STUDY CENTRE PH: 044-24339436, 42867555, 9840226187

- Area of contact
- Using lubricants (oil)
- Using ball bearing

ARCHIMEDES PRINCIPLE:

It states that "a body immersed in a field experiences a vertical upward buoyant force equal to the weight of the fluid it displaces".

Laws of Flotation:

1. The weight of a floating body in a fluid is equal to the weight of the fluid displaced by the body.

2. The centre of gravity of the floating body and the centre of buoyancy are in the same vertical line.

Practice Questions

1. A man has to exert a force of 20N at the edge of a door to push it open. How much force will the man have to exert if he pushes the centre of the door?
   a. 30N   b. 20N   c. 40N   d. 50N

2. An athlete completes one round of a circular track of diameter 200m in 40 seconds. What is the distance covered at the end of 2m and 20s?
   a. 2300m   b. 2200m   c. 2500m   d. 2000m

3. When a body is thrown vertically upwards in space, at the highest point. What will be velocity and acceleration?
   a. Finite velocity and finite acceleration
   b. Zero velocity and finite acceleration
   c. Zero velocity and Infinite acceleration
   d. Infinite velocity and infinite acceleration

4. An object travels 16m in 4 seconds and then another 16m in 2 s. What is the average speed of the object?
   a. 5.33 m/s   b. 6.33 m/s   c. 7.14 m/s   d. 7m/s

5. A door is pushed, at a point whose distance from the hinges is 90cm, with a force of 40N. Calculate the moment of the force about the hinges?
   a. 34 Nm   b. 35 Nm   c. 36 Nm   d. 38 Nm