THE CONCEPT OF FORCE AND FRICTION

The agent that changes or tends to change the state of rest or of uniform motion in a straight line of a body is called force.

A force can move a body, change its direction of motion, make it to slow down or stop moving altogether, distort or change the shape of the body to which it is applied.

Formula and Unit of Force

Force is mathematically defined as the product of mass (m) and acceleration (a):

$$Force = mass \times acceleration = ma$$

$$F = ma$$

If the acceleration is due to gravity then the formula changes to

$$F = mg$$

where g is the acceleration due to gravity.

If mass is in Kg, and acceleration is in ms^{-2}, then Force would be in Newton, N ($kgms^{-2}$).

Types of Forces

There are two types of forces: contact force, and force fields.

a. **Contact Forces** are forces which are in contact or in touch with the body to which they are applied. Examples are forces of push, pull, tension, reaction and frictional forces.
b. **Fields Forces** are forces whose sources do not require contact with the body to which they are applied. Examples are gravitational force, electrical (electrostatic) force, magnetic force. Gravitational force is the force with which the earth attracts objects towards its centre. Electrostatic force is the force that exists around charged bodies. Magnetic force exist around a bar magnet. The effects of such forces are felt by bodies which are not in contact with them. Their actions are felt at a distance.

FRICTION

When a solid is in contact with another, the roughness of their surfaces prevents them from sliding freely over

one another. Such action is brought about by the effect of *friction*.

Friction is the force which acts at the surface of separation between two objects in contact and tends to *oppose* the motion of one over the other.

Frictional forces act tangential to the surface of separation between two bodies in contact. Friction is a force of opposition. It does not appear unless there is relative motion, or a force tending to produce motion. It always appears to oppose the motion or the force tending to produce motion. Some frictional forces have to be overcome before an object can move over another. When the force producing the motion is withdrawn, friction slows down the moving body until it eventually comes to rest.

Kinds of Friction

Static Friction (or limiting friction) is the maximum force that must be overcome before a body can just start to move over another.

Kinetic Friction (or dynamic friction) is the force that must be overcome so that a body can move with uniform speed over another body.

Laws of Solid Friction

1. Friction opposes the relative motion between two surfaces in contact. It acts in a direction opposite to that of the motion.
2. The force of friction increases to the same extent as the force which tends to start the motion.
3. Frictional force depends on the nature of the two surfaces in contact—the nature of the substance and the conditions of the surface such as rough, smooth, polished, wet, dry, etc.
4. It is independent of the area of the surface in contact.
5. It varies directly with the normal force pressing the surfaces together, i.e. it is proportional to the normal reaction (R).

$$F \propto R$$

$$F = \mu R$$

The constant, μ is the coefficient of friction

$$\mu = \frac{F}{R} = \frac{Frictional\ Force}{Normal\ Reaction}$$

Advantages of Friction and its Uses

i. Friction makes it possible of one to walk or move or stop. If the ground is slippery (i.e. little friction) and cannot provide enough friction, our feet will not experience the reaction force which moves us forward.

ii. Friction enables the automobile tyres to make a firm grip with the roadway, thus aiding their movement. It is the frictional force between the tyres and the road which enables a car to move forward.

iii. Friction is utilised in fan belts used for wheels or pulleys in machinery. The belting that drives the wheels in machines depends on friction to make the wheels to turn without slipping.

iv. Friction enables a screw or a nail to remain in place after being screwed or nailed into a position.

v. Friction is used in the grindstone to sharpen knives and chisels.

Disadvantages of Friction

1. Friction leads to much wear and tear on the moving parts of machines.
2. Friction causes loss of energy in machines and therefore reduces their efficiency.
3. Friction causes the heating of engines. This is because the energy which must be used to overcome friction is converted to heat. Sometimes the energy is partly converted to sound, hence the squeaks and groans we hear when we ride an old rusty bicycle.

Comparing Friction to Resistance

Just as friction opposes mechanical force, so does resistance opposes electrical force. Also, overcoming friction implies work in mechanics just as overcoming a resistance implies work in electrics.