Classical Mechanics

First stage

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Lecture seven

Forces on the Body :

Dynamic :

This force is important when the body is moving and hitting another body. It appears on the body where acceleration or deceleration is involved .

The Newton's second law, force equals mass times acceleration :

F = ma

Newton said" force equals the change of momentum Δ(mv) over a short interval of time (Δt) :

$$F = \frac{\Delta(mv)}{\Delta t}$$

Example 1: A (60 kg) person walking at (1 m/sec) bumps into a wall and stops in a distance of (2.5 cm)in a about(0.05sec) .what is the force developed on impact ?

Sol :

Δ(mv) = (60 kg) (1m/sec) – (60 kg)(0 m/sec) = 60 kg m/sec

$$F = \frac{\Delta(mv)}{\Delta t} = \frac{60 \text{ kg m/sec}}{0.05 \text{ sec}} = 1200\ kg\ m/\ \text{sec}^2 \quad \text{or} \quad 1200 \text{ N}$$

Example 2: A person walking at (1 m/sec) . Assume him stops in (0.5 cm) in about (0.01 sec). If the mass of his is (4kg), what is the force developed ?

Sol:

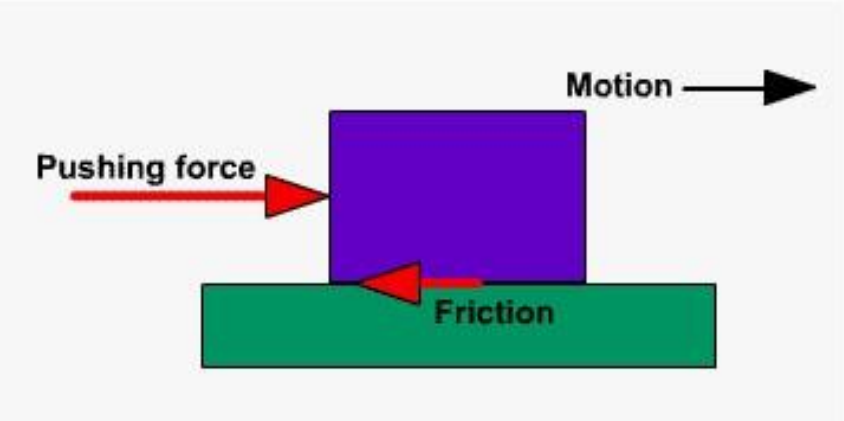
$$\Delta(mv) = (4 \text{ kg})(1\text{m/sec}) - (4 \text{ kg})(0 \text{ m/sec}) = 4 \text{ kg m/sec}$$

$$F = \frac{\Delta(mv)}{\Delta t} = \frac{4 \text{ kg m/sec}}{0.01 \text{ sec}} = 400\ kg\ m/\ \text{sec}^2 \quad \text{or} \quad 400 \text{ N}$$

Frictional Forces :

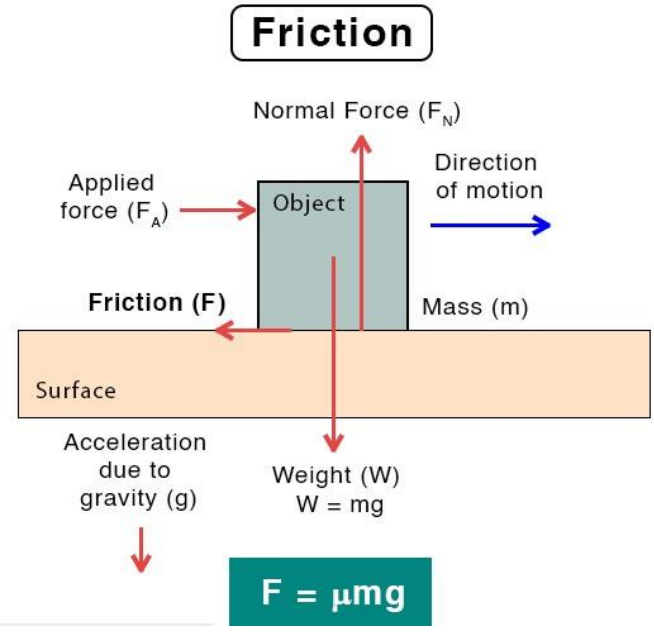
Frictional force refers to the force generated by two surfaces that contact and slide against each other.

Friction is the force that resists motion when the surface of one object comes in contact with the surface of another. The mechanical advantage of a machine is reduced by friction, or in other words, the ratio of output to input is reduced because of friction.



An automobile uses one-quarter of its energy on limiting friction. Yet, it is also friction in the tires that allows the car to stay on the road and friction in the clutch that makes it possible to drive.

From matches to machines to molecular structures, friction is one of the most significant phenomena in the physical world.



Factors Affecting on Frictional Force :

1- These forces are mainly affected by the surface texture and the amount of force impelling them together.

2- The angle and position of the object affect the amount of frictional force.

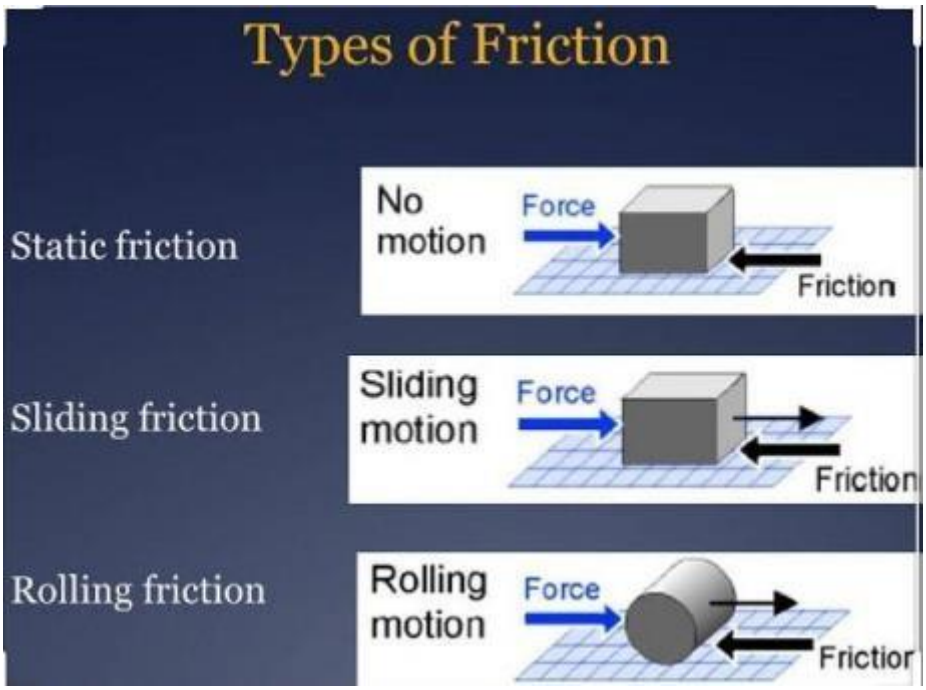
3- If an object is placed flat against an object, then the frictional force will be equal to the weight of the object.

4- If an object is pushed against the surface, then the frictional force will be increased and becomes more than the weight of the object.

Type of Frictional :

there are different types of frictional forces. The friction that takes place between solid surfaces is classified as Static, Kinetic, Rolling, and Sliding Friction. The friction that takes place between fluids and gases is termed as fluid friction. Hence, friction is broadly classified as:

- Dry Friction .
- Static Friction .
- Kinetic Friction .
- Rolling Friction .
- Sliding Friction .
- Fluid Friction .



Frictional Force Equation :

The maximum amount of friction force that a surface can apply upon an object can be easily calculated with the use of the given formula:

$$F_{frict} = \mu . F_{norm}$$

μ : Coefficient of friction .

The co-efficient that you would choose depends on the object and the specific situation. If the object isn't moving across the surface, you use the coefficient of static friction**,** but if the object under consideration is moving you use the coefficient of sliding friction

The normal force is the support force exerted upon an object that is in contact with another stable object. The normal force can be simply described in most cases by the following formula:

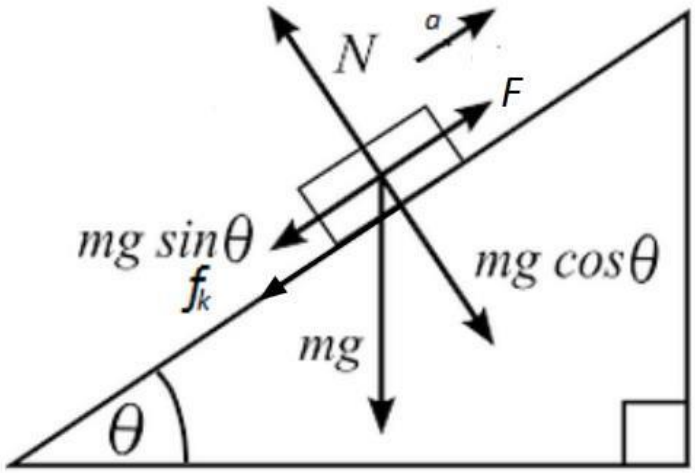
$$F_{norm} = \mathbf{m\ g}\ \text{m:}$$

mass g: acceleration of

gravity

In this formula, m describes the mass of the object, and g stands for the acceleration due to gravity. In the case of an inclined surface, the strength of the normal surface is reduced the more the surface is inclined, hence the formula becomes:

$$F_{norm} = \mathbf{m\ g\ cos\ (\theta)}$$



Example 1 : A large block of ice is being pulled across a frozen lake. The block of ice has a mass of 300 kg. The coefficient of friction between two ice surfaces is small: μk = 0.05. What is the force of friction that is acting on the block of ice?

Sol:

$F_{frict} = \mu . F_{norm}$ ⟶ $F_{norm} = m\,g$

$F_{frict} = \mu . m\,g$ ⟶ $F_{frict} = 0.05 * 300\ kg * 9.8\ m/s^2$

$F_{frict} = 147\ kg.m/s^2$ or 147 N .

Example 2 : A man has to push his boat on the shore across the mud to get to the water. The coefficient of friction between the boat and the mud is given by (μ = 0.4). If the boat has a mass of (40000 g) calculate the magnitude of the force of friction acting on the boat ?

Sol :

m = 40000 / 1000 = 40 kg .

$F_{frict} = \mu . F_n$ ⟶ $F_N = m\,g$

$F_{frict} = 0.4 * 40\ kg * 9.8\ m/s^2$

$F_{frict} = 156.8\ kg.m/s^2$ or 156.8 N.

H.W : A force of 5000N pulls an object of mass (150kg) and overcomes a frictional force of (270N). find the acceleration of the object ?