friction

friction is a contact force which opposes the motion of a body when pulled on a horizontal surface.

The factors responsible for friction are -

(i) Interlocking of elevations and depressions of the surfaces.

(ii) force of attraction between molecules of the surfaces.

Characteristics

(i) It is a self-acting and self-adjusting force.

(ii) It has a limiting value (limiting friction) which is equal to the minimum force require to move a body at rest.

force of friction depends upon

(i) Nature of the surface in contact

(ii) Area of contact, or

(iii) Normal reaction.

Types of friction

(i) Static friction

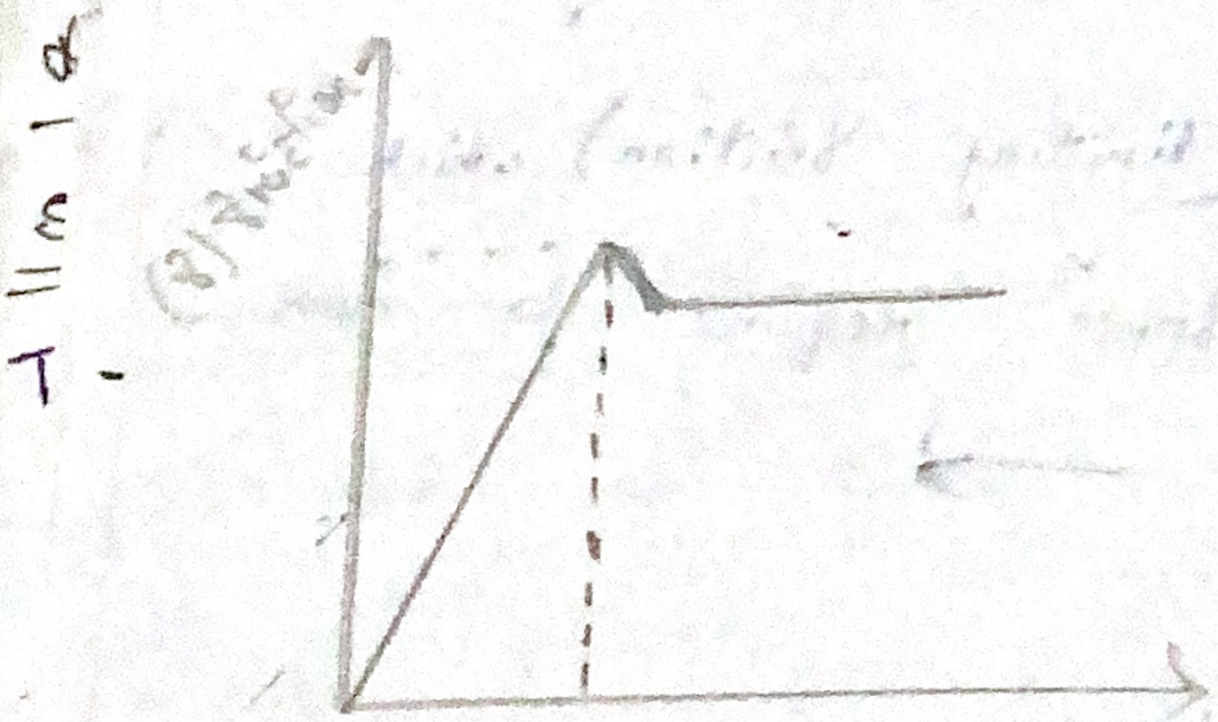
It is the friction acting on a body on rest. As applied force increases the force of friction also increases.

(ii) Limiting friction

The maximum value of static friction is called limiting friction.

(iii) Kinetic friction

It is the friction acting on a body in motion.



Kinetic friction is of two types Sliding friction & Rolling friction.

Laws of Limiting Friction

(i) The direction of friction is always opposite to direction of motion.

(ii) Limiting acts tangentially to the surfaces in contact.

(iii) Limiting friction is directly proportional to the normal reaction. $f \propto N$

(iv) Limiting friction is independent of the shapes and the area of contact of the surfaces.

(v) It depends on nature and material of the surfaces in contact.

Co-efficient of friction

We have,

$$f \propto N$$

$$f = \mu N$$

$$\mu = \frac{f}{N}$$

μ is called co-efficient of friction.

It is defined as the ratio between force of limiting friction between the surfaces and the normal

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reaction.

- It has no unit and dimension.

- It is of two types

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① Co-efficient of static friction. (μ_s)

- It is the ratio of maximum static friction and normal reaction.

$$\mu_s = \frac{(f_s)_{max}}{N}$$

② Co-efficient of kinetic friction (μ_k)

- It is the ratio of constant force of kinetic friction and normal reaction.

$$\mu_k = \frac{f_k}{N}$$

$T = mg$

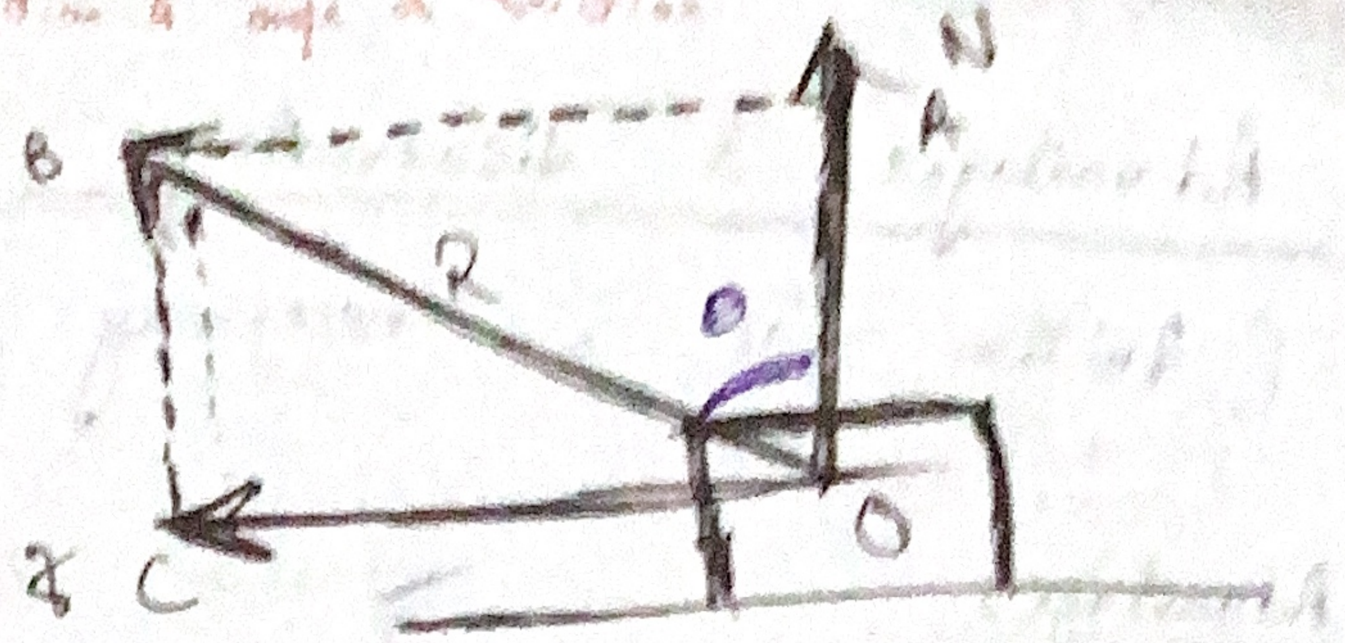
Angle of friction (θ)

- It is the angle made by the resultant of normal reaction and frictional force with the No. normal reaction.

$$\tan\theta = \frac{AB}{AO}$$

$$= \frac{S}{N}$$

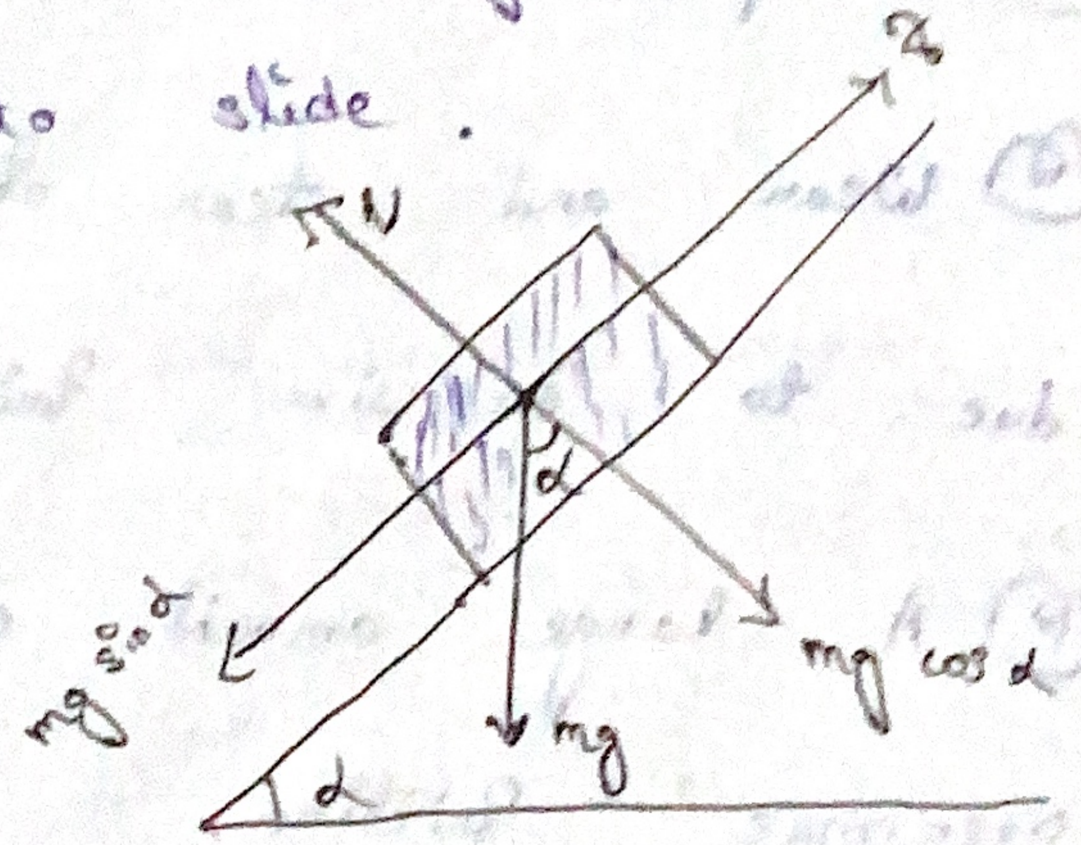
$$\tan\theta = \mu$$



Therefore, tanget of angle of friction is equal to co-efficient of friction

Angle of Repose (α):

It is the angle made by inclime plane with horizontal surface so that a body placed over it just starts to slide.



At equilibrium,

$$S = mg\sin\alpha \quad \text{—— (i)}$$

$$N = mg\cos\alpha \quad \text{—— (ii)}$$

$$\frac{\text{(i)}}{\text{(ii)}} \Rightarrow \frac{mg\sin\alpha}{mg\cos\alpha} = \frac{S}{N}$$

$$\Rightarrow \tan\alpha = \frac{S}{N}$$

$$\Rightarrow \tan\alpha = \mu$$

• Advantages & disadvantages of friction

(Friction is a necessary evil)

Advantages

(i) Friction is very necessary for our day to day life activities like holding a pen, reading a book, walking, application of brakes in automobiles. Thus friction is a necessity.

Disadvantages

(i) It produces excessive heat causing damage.

(ii) Wear and tear of machinery is due to excessive friction.

(iii) A large amount of power is wasted to overcome friction.

Thus friction is called a necessary evil.

* It is easier to pull a body than to push it.

Let a body of mass M be pulled on a horizontal surface by a force f

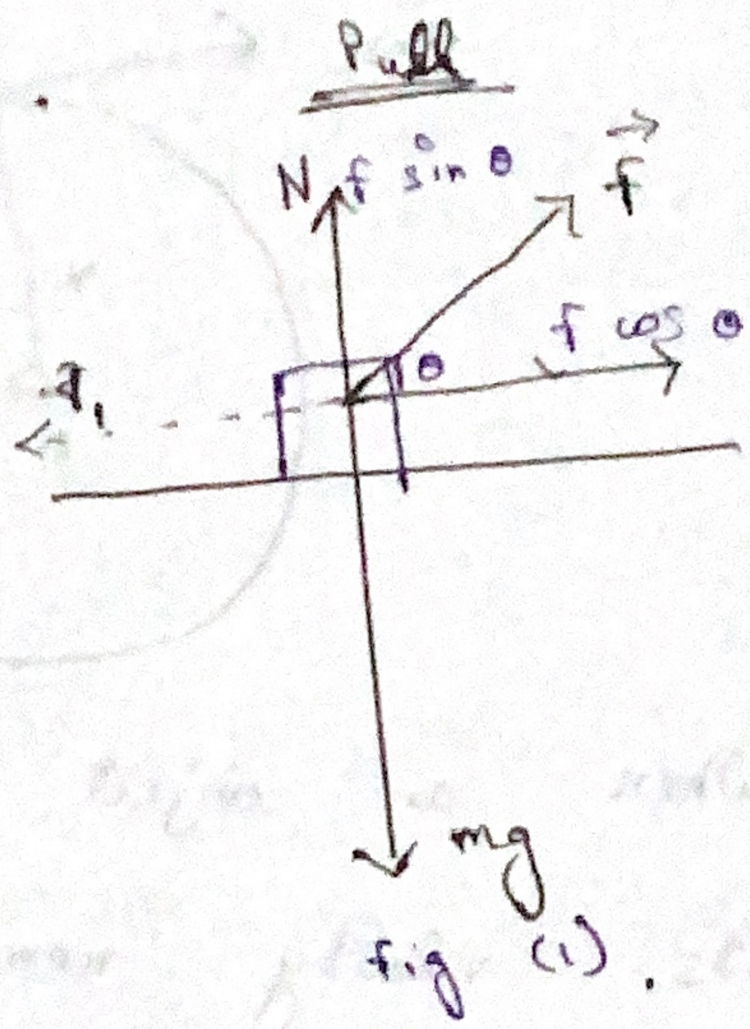


fig (1).

We have, from the figure (1).

$N + f \sin\theta = mg$

$\Rightarrow N = mg - f \sin\theta$

∴ The frictional force,

$f_1 = \mu N$ ($\mu \rightarrow$ co-efficient of friction).

$\Rightarrow f_1 = \mu (mg - f \sin\theta)$

Thus, the friction is decreased and motion becomes easier.

We have, from the figure (2)

$N = mg + f \sin\theta$

∴ frictional force,

$f_2 = \mu N$

$\Rightarrow f_2 = \mu (mg + f \sin\theta)$

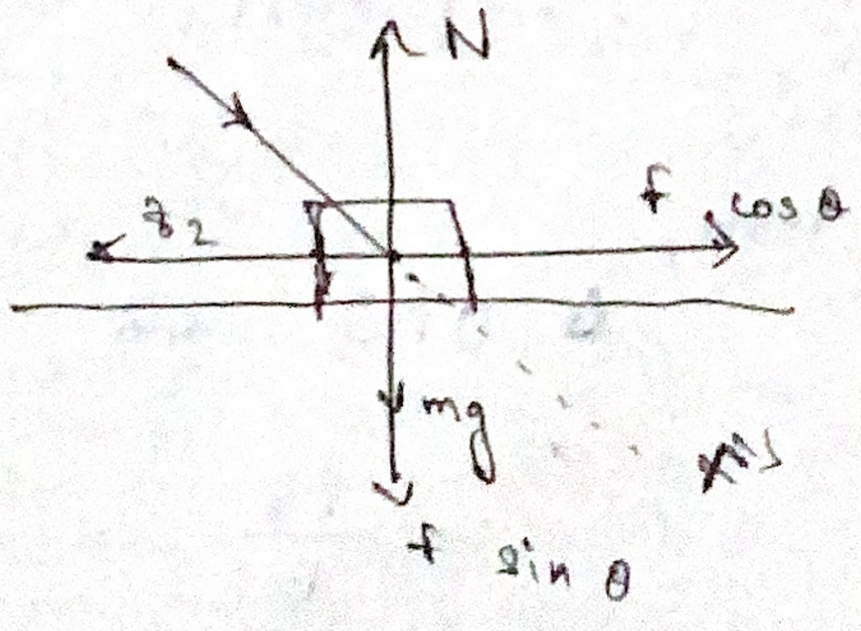


fig (2)

Thus a large force is required to push a body. Hence it is said that it is easier to pull a body than to push a body.