Laws of Static Friction:

(1) The maximum value of static frictional force fs between two given surfaces is independent of the surface area of contact over large areas.

(2) The maximum value of static frictional force is proportional to the normal reaction.

(3) The maximum value of static frictional force depends upon the two surface of contact

Experimental Determination of Coefficient of Static Friction:

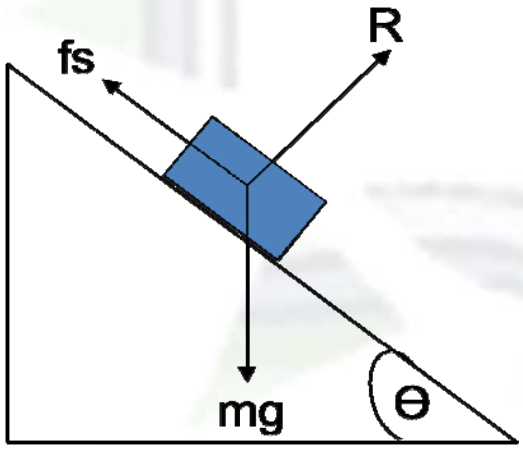
There are two methods to determine the coefficient of static friction.

(1) Inclined plane method

(2) Horizontal plane method

(1) Inclined plane method:

A block is kept on the surface and between these two surfaces of contact the coefficient of static friction is to be measured.



Experiment: The inclination of the plane with the vertical gradually increased till the block just start to slide down the inclined plane. The angle of the inclined plane with the horizontal is measured.

Given: m = mass of the block

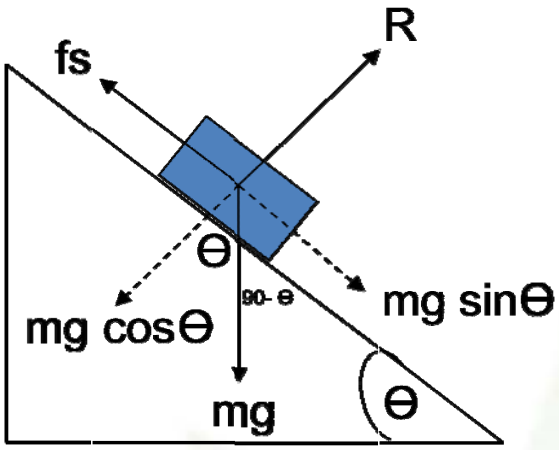
Θ = angle of inclination of the plane at which the block is just to slide down.

Force acting on the block:

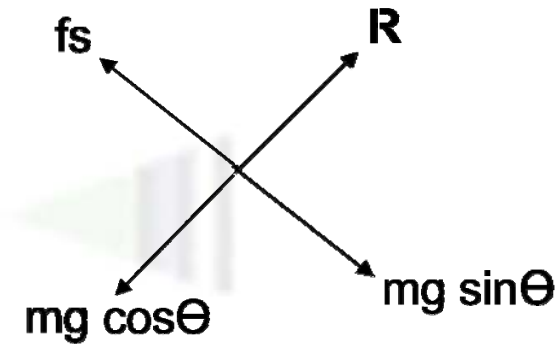
(1) Gravitational force mg along vertically downward direction.

(2) The normal reaction R of the plane of the support on the block as shown.

(3) The maximum value of the static frictional force parallel to the plane along upward direction.



Resolving weight mg into two mutually perpendicular components the free body diagram is as shown.



The component along the plane = mgsinΘ

The component along perpendicular to the plane = mgcosΘ

Since the block is in equilibrium:

Total perpendicular force acting on the body = 0

R- mgcosΘ = 0

The total parallel force acting on the body = 0

fs - mgsinΘ = 0

$$\mu_s = \frac{f_s}{R} = \frac{mg\sin\theta}{mg\cos\theta} = \tan\theta$$

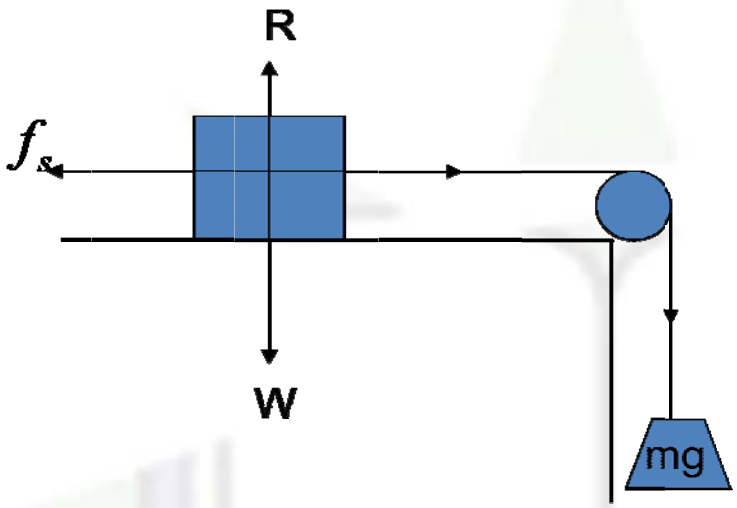
$$\mu_s = \tan\theta$$

Where Θ is the inclination of the plane at which the block is just to slide.

Horizontal Plane Method:

The block is kept on the given horizontal surface. A string is tied with the block passes through a frictionless pulley and carries a hanger at its free end.

Experiment: Load is put on the hanger then gradually increased till the block is just in a position to move. The load put in the hanger is noted. The weight of the hanger is also measured. The weight of the block is taken.



W = Weight of the block

m_0g = Weight of the hanger

mg = Load put on the hanger.

The force acting on the block:

(1) The weight W along vertically downward direction.

(2) The normal reaction R along vertically upward direction

(3) The applied force (m_0g + mg) along the string vertically downward direction.

(4) The maximum value of static frictional force opposite to the direction of the applied force.

Since the block is in equilibrium:

Force along X axis i.e. Parallel to the surface

$$\sum f_x = 0$$
$$\therefore f_s - P = 0$$
$$f_s = P$$
$$f_s = m_0 g + mg \longrightarrow \quad (1)$$

Force along Y axis i.e. the force perpendicular to the surface

$$\sum f_y = 0$$
$$\therefore R - W = 0$$
$$R = W \longrightarrow \quad (2)$$

Since the coefficient of static friction is defined as the ratio of the maximum frictional force to the normal reaction.

$$\mu_s = \frac{f_s}{R}$$

$$\mu_s = \frac{m_0 g + mg}{mg}$$