Fricition Force

Friction force is the force resisting the relative motion of two surfaces in contact

Symbol is F_f

Units are Newton (it's a force!)

Depends on

•Weight of object (normal force)

•Nature of the surfaces between the moving object and the supporting surface

There are two types of friction :

1-Static friction

Static friction is friction between two objects that are not moving relative to each othe For example, static friction can prevent an object from sliding down a sloped surface. The coefficient of static friction, typically denoted as μ_s, is usually higher than the coefficient of kinetic friction

2-Kinetic friction

Kinetic (or dynamic) friction occurs when two objects are moving relative to each other. and rub together (like a sled on the ground). The coefficient of kinetic friction is typically denoted as μ_k, and is usually less than the coefficient of static friction.

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The coefficient of friction:

(also known as the frictional coefficient) is a dimensionless scalar value which describes the ratio of the force of friction between two bodies and the force pressing them together. The coefficient of friction depends on the materials used; for example, ice on steel has a low coefficient of friction (the two materials slide past each other easily), while rubber on pavement has a high coefficient of friction (the materials do not slide past each other easily). Coefficients of friction range from near zero to greater than one – under good conditions.

The coefficient of friction is a dimensionless quantity symbolized by the Greek letter(

μ) and is used to approximate the force of friction. Friction can be viewed, again as an approximation, as being of two primary types, static or kinetic.

The coefficient of *static* friction is defined as the ratio of the *maximum static friction* force (F) between the surfaces in contact to the *normal* (N) force. The coefficient of *kinetic* friction is defined as the ratio of the *kinetic friction* force (F) between the surfaces in contact to the normal force:

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

μ : coefficient of friction

Ff : Friction force

N : Normal force

Both static and kinetic coefficients of friction depend on the pair of surfaces in contact;

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Both static and kinetic coefficients of friction depend on the pair of surfaces in contact;

their values are usually approximately determined experimentally. For a given pair of surfaces, the coefficient of static friction is *usually* larger than that of kinetic friction; in some sets the two coefficients are equal, such as Teflon-on-Teflon.

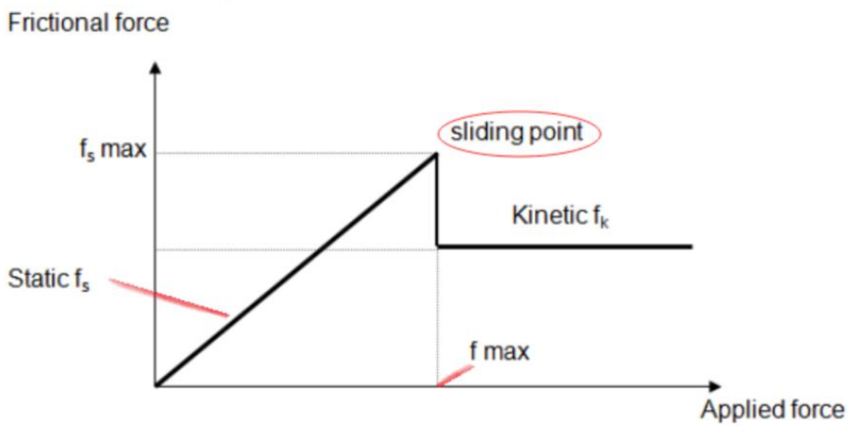
Angle of friction (α)

The angle of friction for two surfaces in contact is defined as the angle that the maximum contact force makes with the direction of normal force.

$\mu = \tan \propto$

$\alpha = \tan^{-1} \mu$

- Plot of applied force vs friction force



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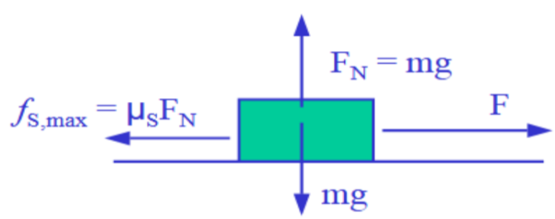
Example for μ

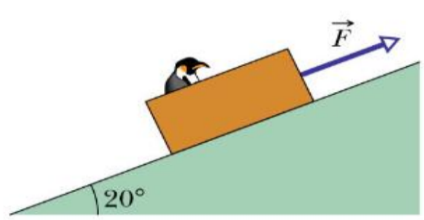
Surfaces	Static	Sliding
Hardwood on hardwood	0.5	0.25
Rubber on dry concrete	1.0	0.75
Rubber on wet concrete	0.75	0.5
Steel on steel	0.74	0.6
Steel on steel (lub'd)	0.15	0.06
Human joints	0.01	0.003

$$F_{max} = \mu_s N$$

$$F_k = \mu_k N$$

$$\mu_k < \mu_s$$





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Ex1: In fig. shown , a = 12 cm , b = 18 cm , h = 15 cm , W = 100 N , μ = 0.24 , P = 24 N Is the body sliding or turning over or stay at rest ?

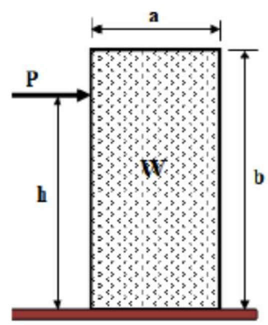
Solution:

$$h_{max} = \frac{W.a}{2*P}\frac{100(12)}{2(24)} = 2.5cm$$

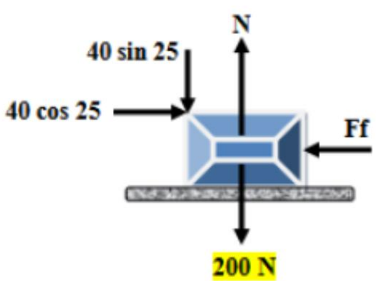
When $h_{max} > b$ then the force doesn't effect on the body , therefore , the body is not turnover .

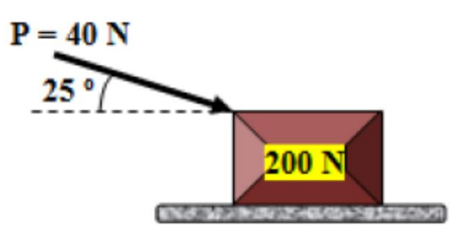
$F_{max} = \mu.W = 0.24(100) = 24$, $F_{max} = P$

Then the body tends to slide and doesn't turnover



Ex2: A block with (200 N) weight rests on a rough horizontal plane , is subjected to the force (P = 40 N) which inclined (25 o) . Determine the coefficient of friction.

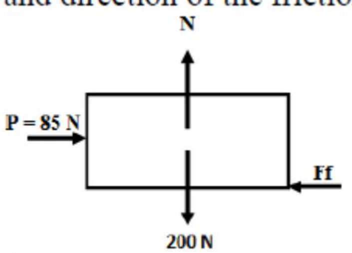


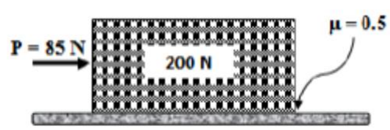


Solution:

$$\sum F_x = 0$$
$$F_f = 40\cos 25$$
$$\sum F_y = 0$$
$$N - 40\sin 25 - 200 = 0$$
$$N = 40\sin 25 + 200 = 217N$$
$$F_f = \mu.N$$
$$36.25 = \mu(217)$$
$$\mu = \frac{36.25}{217} = 0.17$$

Ex3: The (85 N) force (P) is applied to the (200N) crate. Determine the magnitude and direction of the friction force exerted by the horizontal surface on the crate .





Solution:

Assume equilibrium
$$\sum F_x = 0$$
$$F_f = P = 85N$$
$$\sum F_y = 0$$
$$N = 200N$$
$$F_{f\ max} = \mu.N = 0.5(200) = 100N$$
$$F < F_f \text{, assumption volid , F = 85 N}$$

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