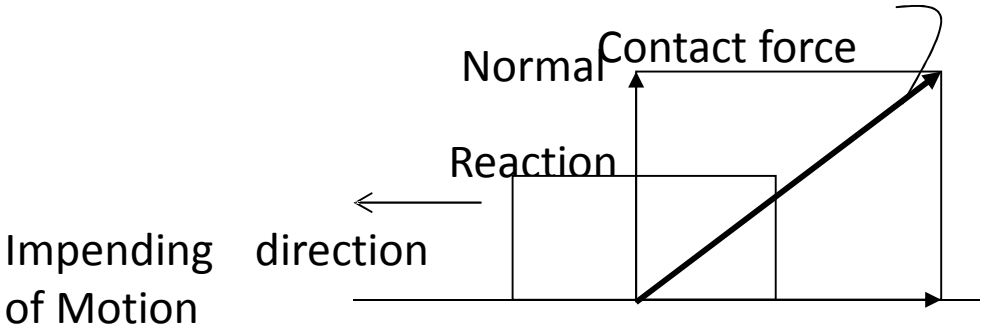
FRICTION

This PowerPoint Presentation is intended for Quick Revision

What is Friction?

1st Definition:-

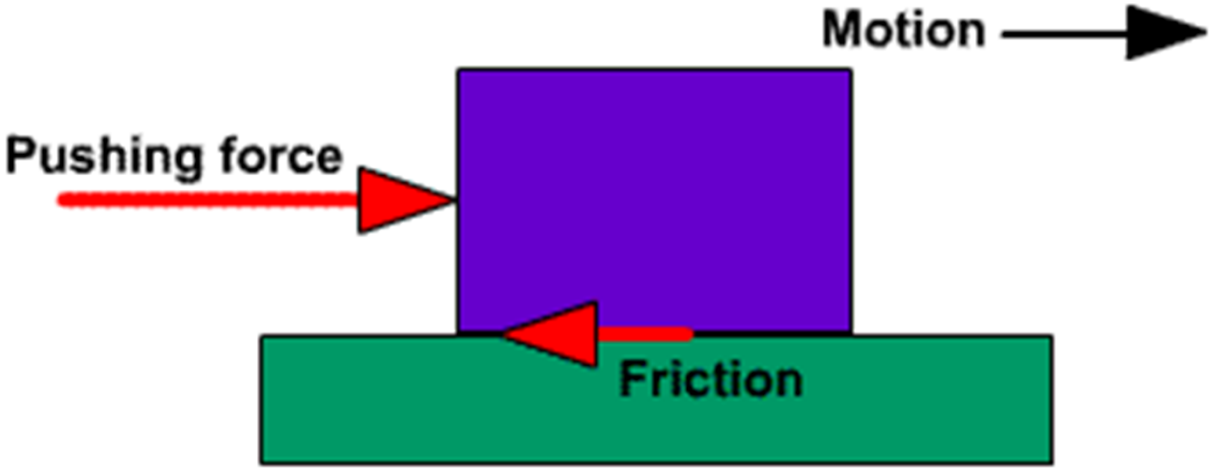
Friction is a type of contact force whose tangential component/ component along the surface is called friction.

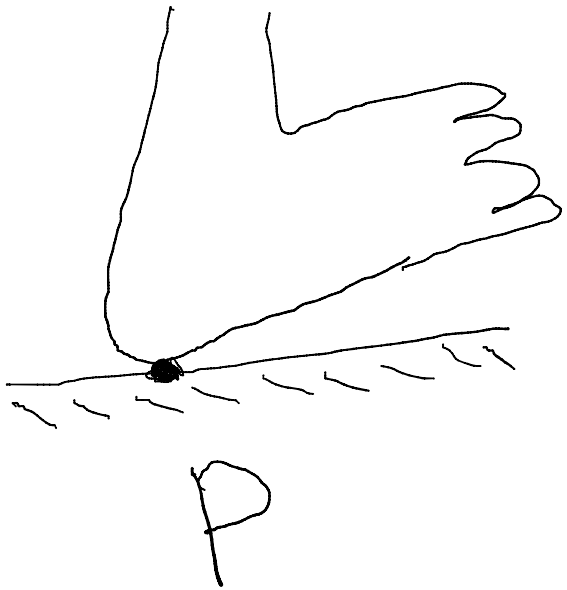


Friction

2nd Definition

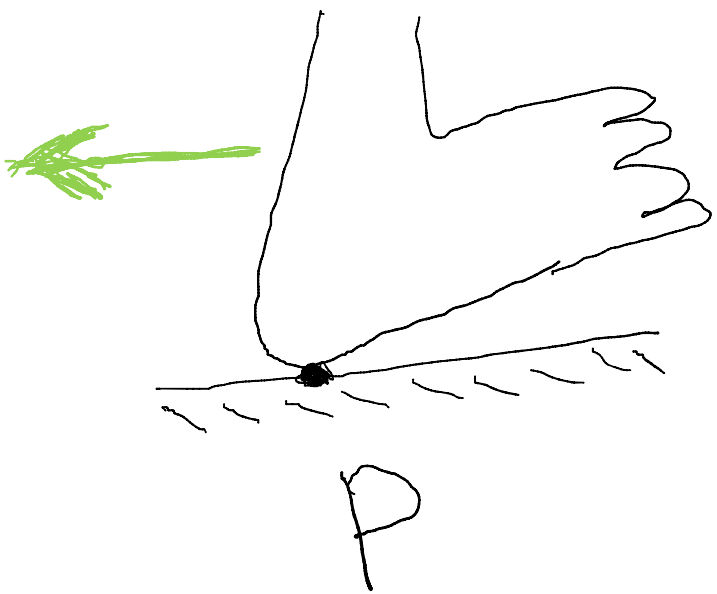
It is force which opposes relative motion between two surfaces in contact





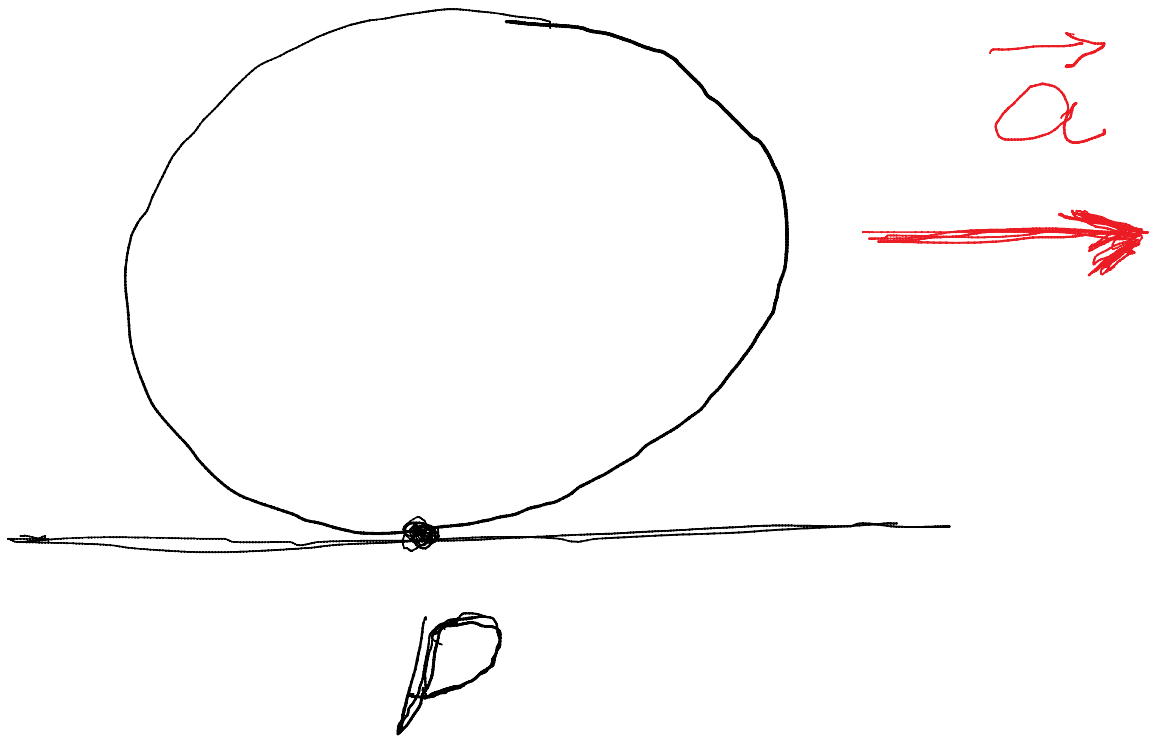
You want to move forward?

To move forward we move the foot in the direction of arrow.



P Direction of force of friction on foot

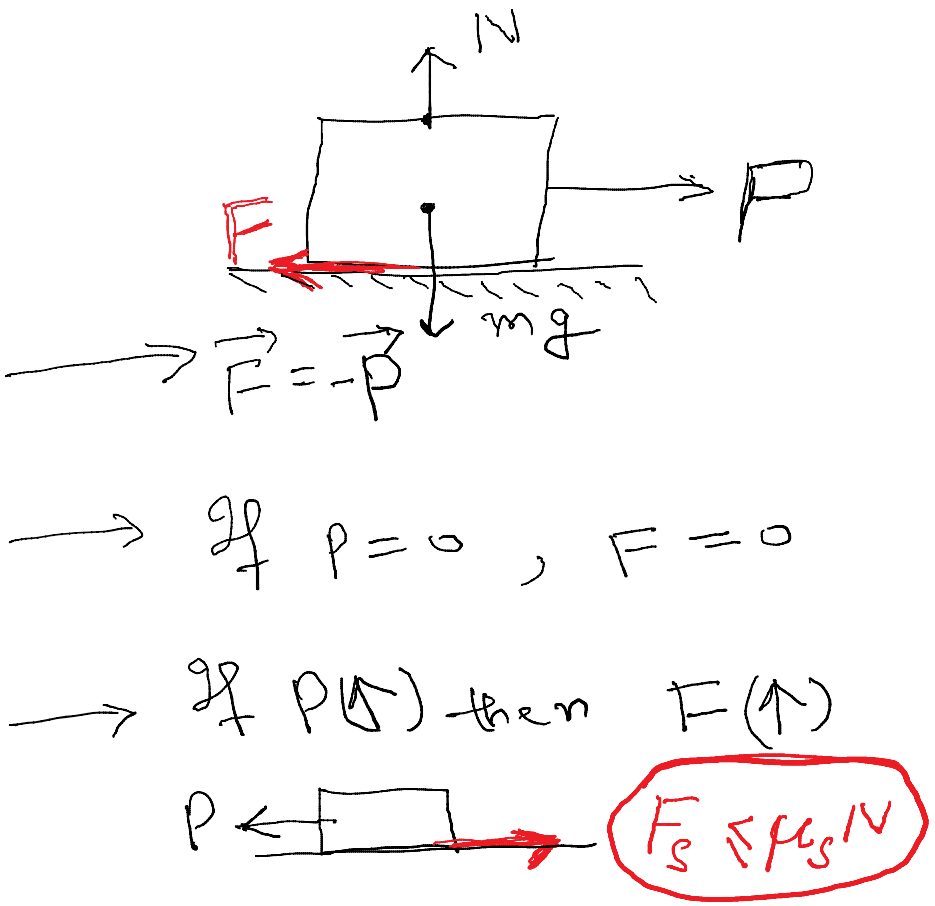
Rear wheel of cycle.




$\vec{a}$
P
$\vec{F}$

Types of Friction

- **Static friction :** The opposing force that comes into play when one body tends to move over the surface of another, but the actual motion has yet not started is called static friction.
- (i) If applied force is P and the body remains at rest then static friction F = P.
- (ii) If a body is at rest and no pulling force is acting on it, force of friction on it is zero.
- (iii) Static friction is a self-adjusting force because it changes itself in accordance with the applied force and is always equal to net external force.



Limiting friction : If the applied force is increased, the force of static friction also increases. If the applied force exceeds a certain (maximum) value, the body starts moving. This maximum value of static friction upto which body does not move is called limiting friction.

(i) The magnitude of limiting friction between any two bodies in contact is directly proportional to the normal reaction between them.

or $F_l = \mu_s N$

(ii) Direction of the force of limiting friction is always opposite to the direction in which one body is at the verge of moving over the other

(iii) Coefficient of static friction : μ_s is called coefficient of static friction and is defined as the ratio of force of limiting friction and normal reaction

(iv) Value of depends on material and nature of surfaces in contact that means whether dry or wet ; rough or smooth polished or non-polished.

(e) Value of does not depend upon apparent area of contact.

Kinetic or dynamic friction : If the applied force is increased further and sets the body in motion, the friction opposing the motion is called kinetic friction.

(i) Kinetic friction depends upon the normal reaction.

$F_k = \mu_k N$

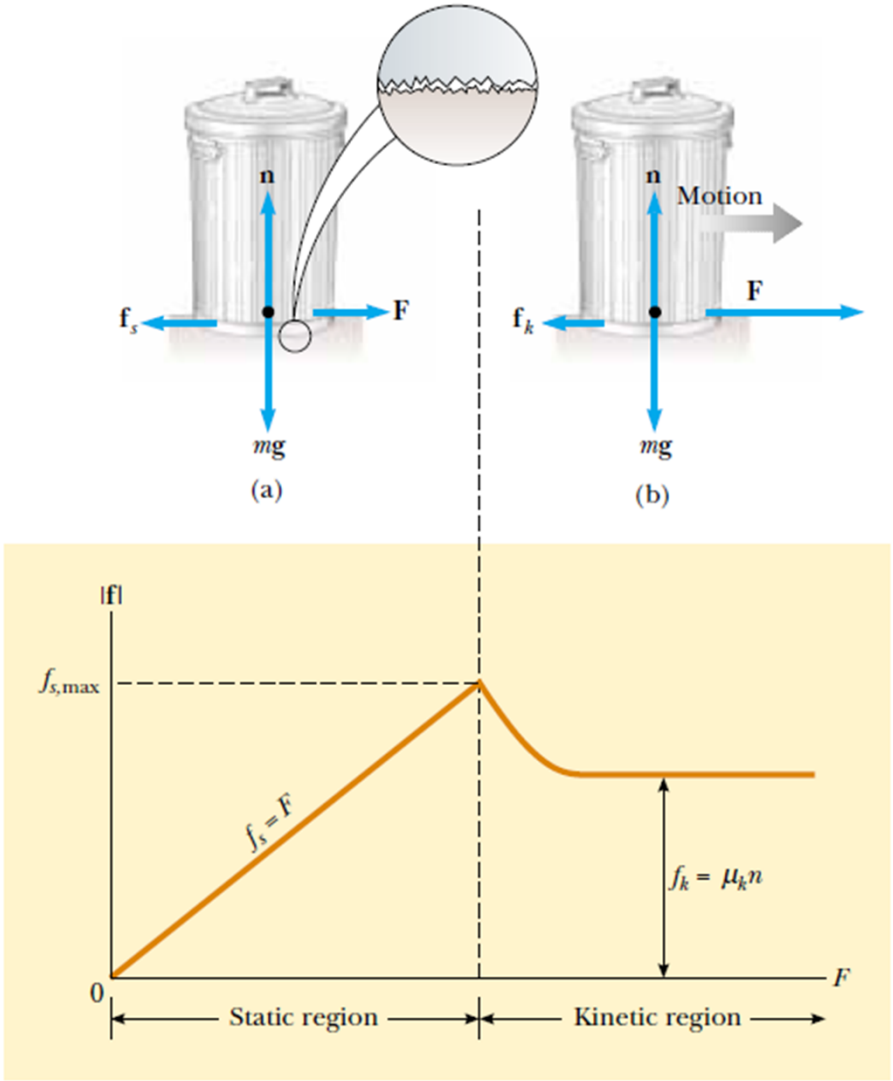
or where is called the coefficient of kinetic friction

(ii) Value of depends upon the nature of surface in contact.

(iii) Kinetic friction is always lesser than limiting friction ∴ coefficient of kinetic friction is always less than coefficient of static friction. Thus we require more force to start a motion than to maintain it against friction. This is because once the motion starts actually ; inertia of rest has been overcome.

Also when motion has actually started, irregularities of one surface have little time to get locked again into the irregularities of the other surface.

(iv) Kinetic friction does not depend upon the velocity of the body.


n
f_s
F
mg
(a)
n
Motion
F
f_k
mg
(b)
|f|
$f_{s,\max}$
$f_s = F$
$f_k = \mu_k n$
0
F
Static region
Kinetic region

For a given body and surface μ_s= 0.4 and μ_k= 0.2, Calculate the acceleration of the body of mass 15 kg, if the applied force is

(a)30N (b)80N

Most Imp pt. to consider while solving numericals :—

Calculate f_{ms} or f_l

this decides whether object will move or not.

As $f_{ms} = \mu_s N, = \mu_s mg$

here $f_{ms} = 0.4 \times 15 \times 10 = 60$ N

Case (a) $F_{app.} = 30$ N

$\Rightarrow$ force of friction is 30N

object is not moving

So acceleration $= 0$

Case (b) $F_{app} = 80\,N > F_{ms}$

So object will move.

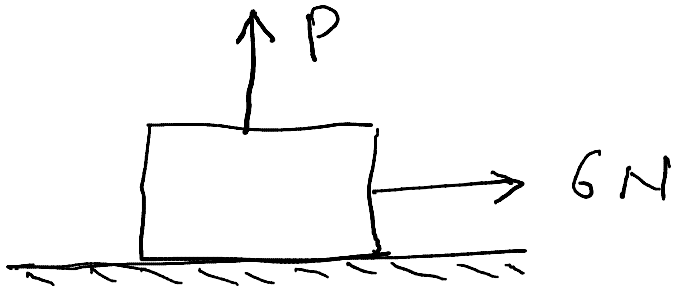
and acc. $a = \frac{F_{net}}{m} = \frac{F_{app} - F_K}{m}$

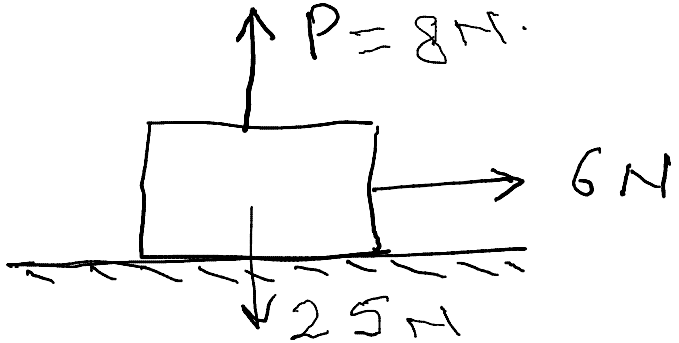
here force of friction $F_K = \mu_K N = 30\,N$

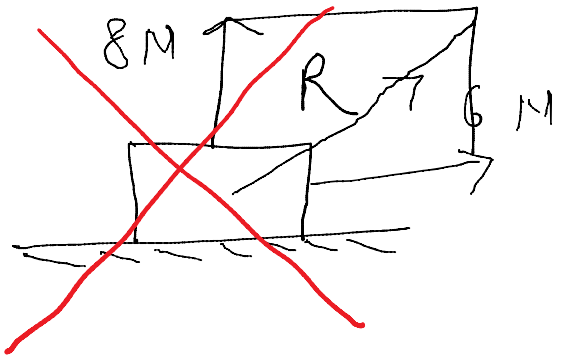
So $a = \frac{80-30}{15} = \frac{50}{15} = 3.33\,m/s^2$

A 2.5 kg block is initially at rest on a horizontal surface. A 6N horizontal force and a vertical force **P** are applied to the block as shown in figure. The coefficients of friction for the block and the surface are μ_s=0.4 and μ_k=0.25. Determine the magnitude and direction of the frictional force acting on the block if **P** is

(a) 8N (b)10 N (c) 12N





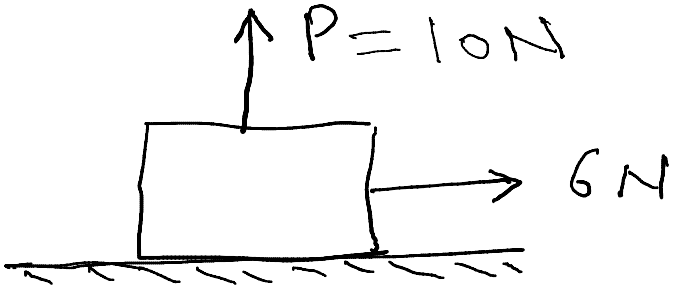


Actually P changes Normal Reaction.

$\therefore$ ~~F_m~~ $= (17)(0.4) = 6.8\,N$

So force of friction is 6N (←)

Object is at rest.



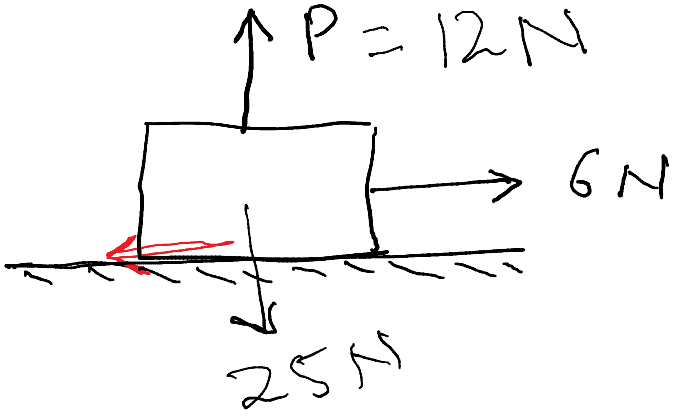
$N = 15\,N$

So $f_{ms} = 6N$

So frictional force

$= 6N$ (←)

object is still not moving



$N = 13$ Newton

$\therefore f_{rs} = 13 \times 0.4$

$= 5.2\,N$

object now moves in the direction of applied force.

force of friction $= \mu_K N = 0.25 \times 13$

$= 3.25\,N\ (\leftarrow)$

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