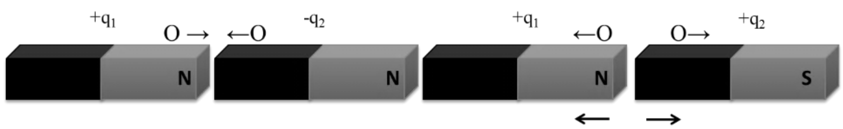
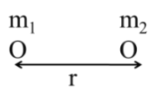
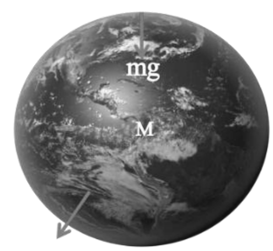
Chapter 8 Law of motion and friction

Day - 1

Force:- Any pull or push", $\vec{F} = m\vec{a}$ unit: kg met/sec^2 or Newton (N)
Types of forces:-
1- Field Forces:- No need of contact



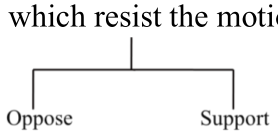




$\Rightarrow F = G\frac{m_1 m_2}{r^2}$ Always attraction type
$F = \frac{GMm}{R^2} = mg\left\{\text{here} g = \frac{Gm}{r^2}\right\}$
Direction:- Always along (-y) axis or straight vertically down ward.

(**2). Contact forces:** There must be some contact
(i) Normal force (N):- This force act when two surfaces of different object are in contact.
Direction:- perpendicular to contact surfaces.
(ii). Frictional force(*f*):- This force also act when two surfaces of different objects in contacts.
Direction:- Parallel to contact surfaces
Also F = μ N here μ is coefficient of friction.
Now
N → Perpendicular to contact surface
So $F \perp N$ $(F_{net})_{contact} = \sqrt{f^2 + N^2} = \sqrt{\mu^2 N^2 + N^2}$
$(F_{net})_{contact} = N\sqrt{1 + \mu^2}$

Understanding of frictional force
The force which resist the motion"

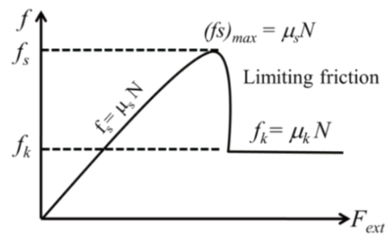


F = μ N
- $f_s = \mu_S N \Rightarrow$ static frictional force $\mu_s \rightarrow$ coefficient of static f_s Acts when body is at rest or tends to move.
- $f_k = \mu_k N \Rightarrow$ kinetic frictional force $\mu_k \rightarrow$ coefficient of kinetic friction f_k Acts when body is in motion.

$\mu_S > \mu_k$ μ can be less than or greater than one

If $F_{ext} = 0$, $f = 0$

$$fs = \mu_s N = F_{ext}$$



Example:- 1

Now

$f_s = \mu_s$N

= μ_s mg

= 0.6 x 10 x 10

f_s = 60 N

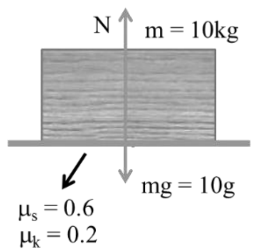
$f_k = \mu_k$N

= 0.2 x 10 x10

f_k = 20 N

Amount of frictional force = 0

Because $f_{ext} = 0$, = f = 0

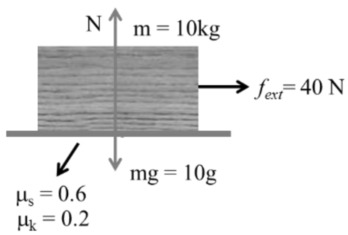


Example:- 2

m = 10 kg As in case (i) f_s = 60 N, f_k = 20 N

$f = f_s$ = 40 N

Body is at rest

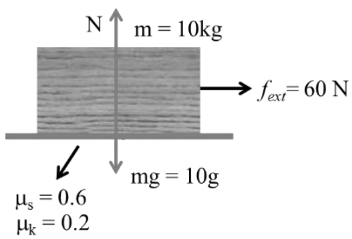


Example:- 3

As in case (i) f_s = 60N, f_k = 20 N

$f = f_s = 60 = F_{ext} \rightarrow$ limitation friction

Body is at rest but tends to move



Example:- 4

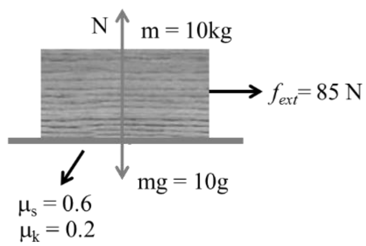
As in case = f_s = 60N, f_k = 20N

Body is in moving condition

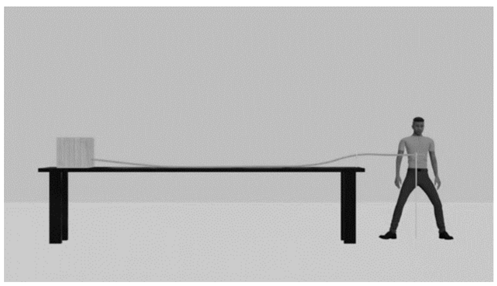
10a = 85 - 20

$$a = \frac{65}{10} = 6.5\ m/s^2$$

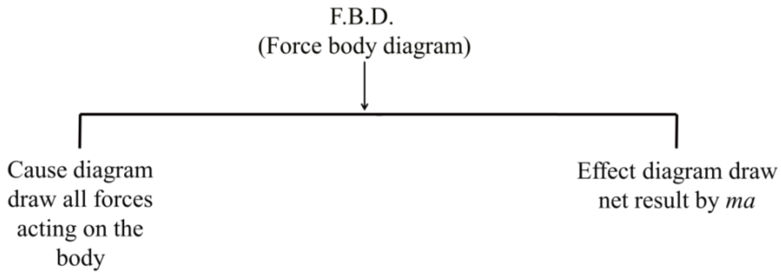
$f = f_k$ = 20 N



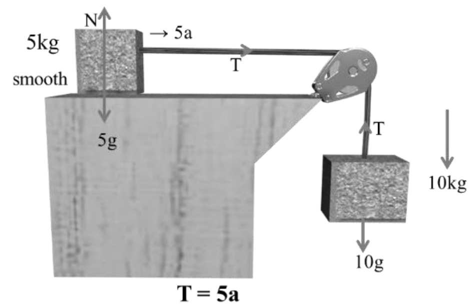
(3) Attachment forces indirect force



Direction: Direction of tension (T) is always away from the body.



Example:-



10 g –T = 10 a ---- (1)

N = 5 g ------(2)

T = 5a --------(3)

Solving 1& 3

10 g - 5a = 10a

15a = 10g

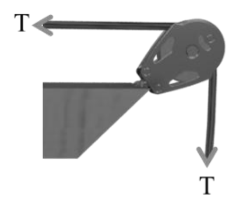
$= \frac{2g}{3} m/s^2$

$a = \frac{20}{3} m/s^2$

T = 5a

$T = \frac{100}{3} N$

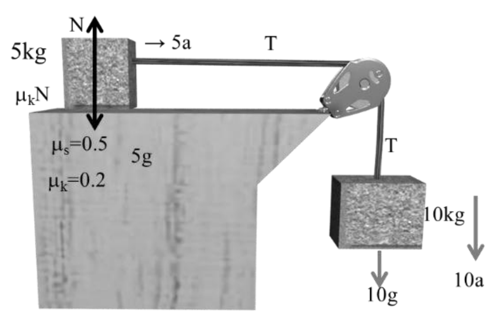
Net force on the pulley



$F_{net} = T\sqrt{2}$

$F_{net} = \frac{100\sqrt{2}}{3} N$

Example:-



$f_s = \mu_s N$

$= 0.5 \times 5g$

$f_s = 25$ N

$f_k = \mu_k N$

$= 0.2 \times 5g$

$f_k = 10$ N

Pulling force for 5 kg

10 g = 100 N

So both block will move

10 g –T = 10a -----(1)

T $-\mu_k$N = 5a ------(2)

T – 10 = 5a

N = 5g -----(3)

Solving (1) & (2)

10g –T = 10a

1-10 = 5a

90 = 15a ⇒ $a = \frac{90}{15} = 6\ m/s^2$

Similarly

T -10 = 5 x 6 T= 40N