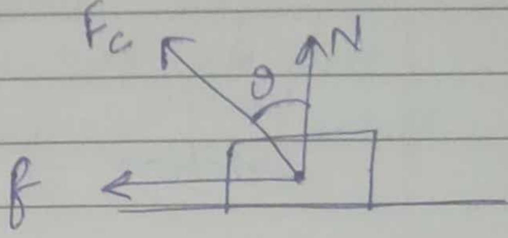
Friction

L-2

Friction is a contact force
Friction & Normal force are not different
means If friction exist, then normal too or
vice-versa

Contact Force
- Normal
- Friction



F_C → contact forc
its directⁿ is neithe
⊥ar nor ∥el to surfac

N → Normal force act ⊥ar to contact surface
f → Friction act along the contact surface

$$F_C = \sqrt{N^2+f^2} \quad — (1)$$

$$\tan\theta = \frac{N}{f} \quad — (2)$$

Friction is necessary evil

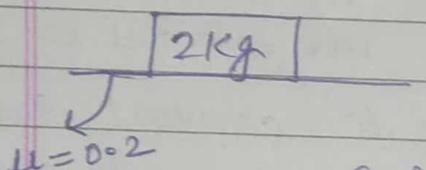
→ Friction is NECESSARY
If friction does not EXIST, then I can't write it with pen now, we are playing, walking everywhere friction exist. Life is not possible without FRICTION

→ NOW WHY It is EVIL
∵ Due to friction, there will some energy losses. For ex 1) If u rub your hand heat will generate
2) Tyre get heated when applying break to vehicle

In friction energy does not conserve as some energy get loss in process

FRICTION

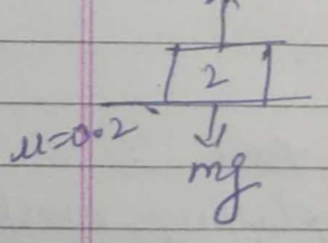
- Kinetic friction
- Static friction
- Rolling friction [Study when talk about rigid body]

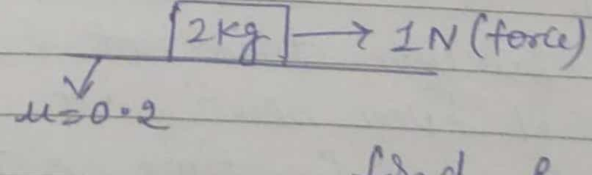
1.) 

find friction (f)

Friction is zero ∵ It is a contact force. ~~but also kind of~~ Its motive is to bring two bodies incontact. When there is no other force or external agent to go against its motive. It (friction) will remain calm. So $f = 0$

In this case f is static



2.) 

find friction

$f_c = \mu \times$ ~~mg~~ N

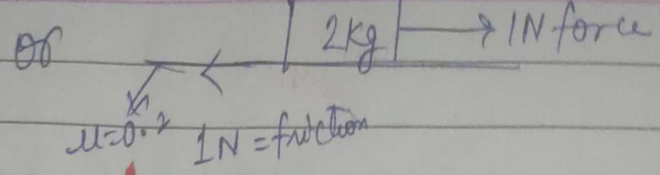
(Limiting friction) $f_c = 0.2 \times 20 = 4N$ — f is (static)

~~(f = 0)~~

∴ Limiting friction dominate 1N

~~ff~~

Or

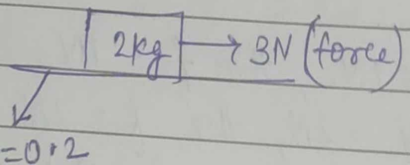


$f_c = 4N$

Now friction = 1N (allowed) will act against 1N force (external) so that block & surface can remain in contact.

So $f = 1N$

3)

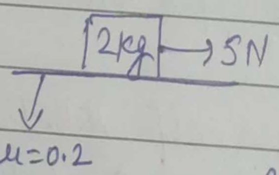


(Static)

$f_c = 4N$

Now, f = 3N (allowed) will act against 3N so that block & surface can remain in contact

4)



f is (Kinetic)

$f_c = 4N$

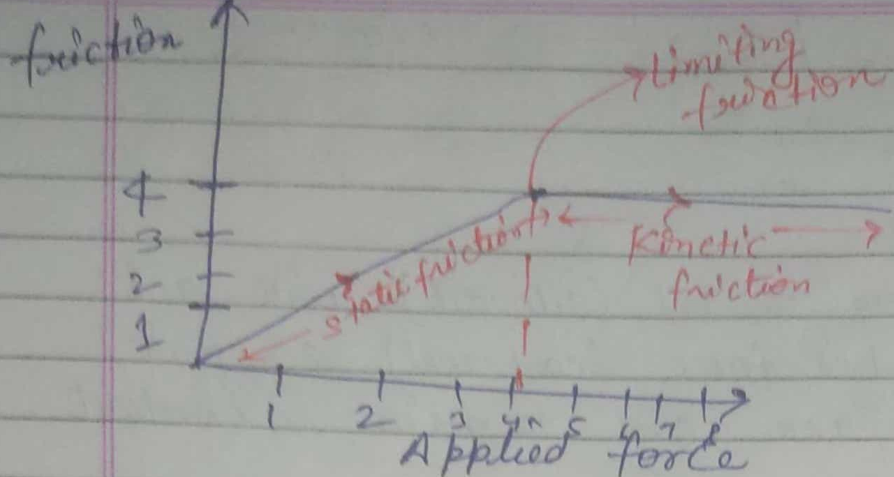
Now its limited power is upto 4N So it can't win against 5N

So $f = 4N$.

Kinetic friction is also = 4N
Limiting " " " = 4N

When two bodies in contact have relative motion It is case of Kinetic friction
When two bodies in contact are at rest then friction is Static friction

Max value of static friction is called limiting friction



(graph-1)

When Applied force = 0, friction will also be = 0

When A·f = 1N, then f = 1N

~~When~~ If A·f = 2N, the f = 2N

If A·f = 3N, then f = 3N

If A·f = 4N, then f = 4N

If A·f = 5N, then f = 4N [∵ f_c = 4N]

|

| Af = 10N, then f = 4N

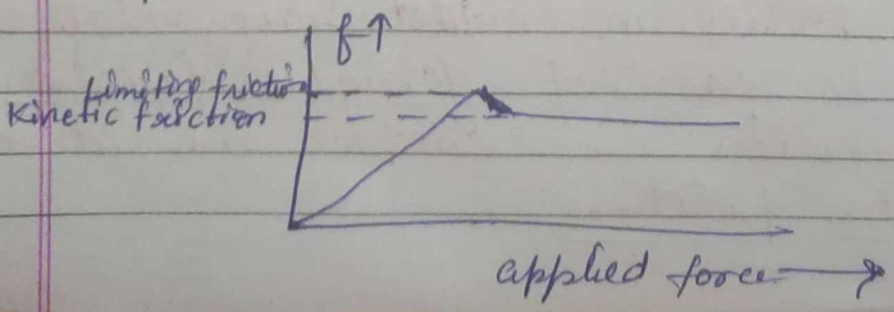
Static friction is self ADJUSTABLE.

When applied force is zero, friction will ~~ab~~ also be zero

When some Af is applied, according to that friction will also change or adjust itself

Kinetic friction is CONSTANT

Experimentally Graph



(graph-2)

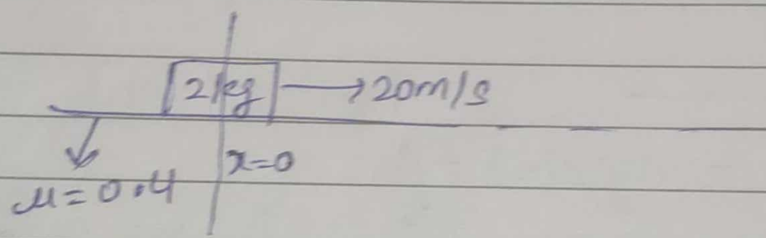
In graph-1

f_C (limiting friction) & kinetic friction are same.

In graph - 2

f_C & kinetic friction are distinguishable when object begin to slip or start ~~d~~ moving wRT surface then ~~limiting~~ kinetic friction 4N का फर्क है 3.9N – हमारी जो थोड़ी सी घट जाती।

N-1



After what distance particle will stop.

$$f = \mu N$$

$$f = 8N$$

(deacceleration) $a = \frac{f}{m} = \frac{8}{2} = 4\ m/sec^2$

$$v = u - at$$

$$0 = 20 - 4(t)$$

$$\frac{20}{4} = t$$

$$t = 5\ sec$$

$$v^2 = u^2 - 2as$$

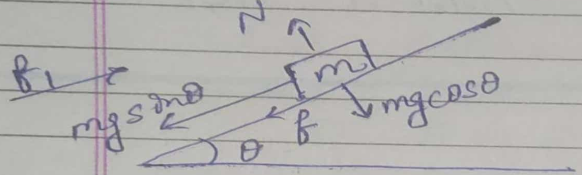
$$0 = (20)^2 - 2 \times 4 \times s$$

$$\frac{400}{8} = s$$

$$s = 50m$$

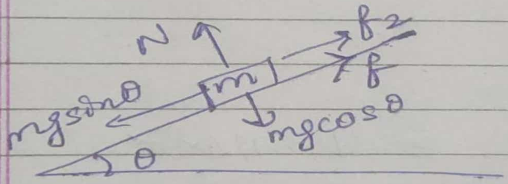
N-2 The minimum force required to start pushing a body up a rough inclined plane (μ) is F_1 while minimum force needed to prevent it from sliding down is f_2. If inclined plane makes an angle θ with the horizontal such that $\tan\theta = 2\mu$

$$\frac{f_1}{f_2} = ?$$



$$f_1 = mg\sin\theta + f$$

$$f_1 = mg\sin\theta + \mu mg\cos\theta \quad \text{—(1)}$$



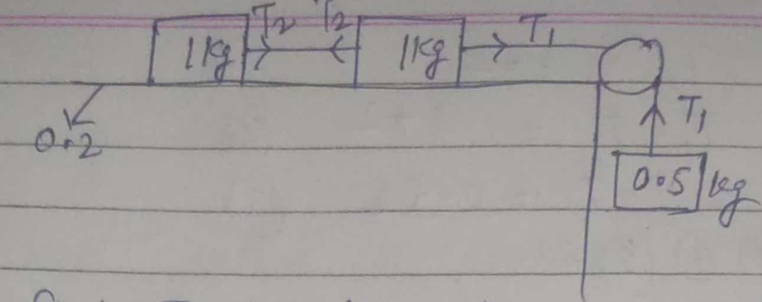
$$f_2 = mg\sin\theta - \mu mg\cos\theta \quad (2)$$

$$\frac{f_1}{f_2} = \frac{mg\sin\theta + \mu mg\sin\theta}{mg\sin\theta - \mu mg\cos\theta}$$

$$\frac{f_1}{f_2} = \frac{\tan\theta + \mu}{\tan\theta - \mu} = \frac{2\mu + \mu}{2\mu - \mu}$$

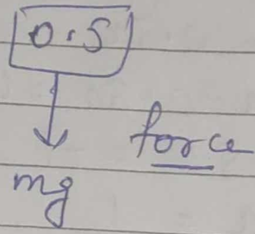
$$\frac{f_1}{f_2} = 3$$

N-3

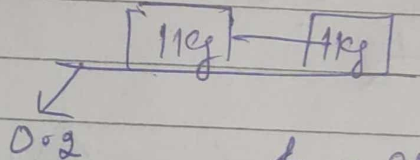


Find Tension in string connecting 1 kg block

Ans first find out system will fall down or not.



5N force is acting downward under gravity



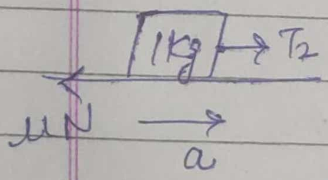
$f_c = 2N$

Total $f_c = 4N$

$5N > 4N$

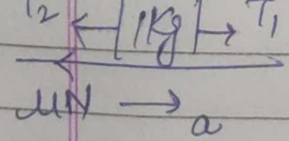
~~So~~

NOTE → The whole system will have same acc^n Mind it If not then string will break



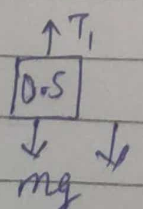
$-\mu_N + T_2 = m_1 a$

$T_2 = a + 2$ ①



$T_1 - T_2 = m_2 a$

$-\mu N + T_1 - T_2 = a \Rightarrow T_1 - T_2 = a + 2$ — ②



$0.5 \times 10 - T_1 = m_3 a$

$\Rightarrow 5 - T_1 = 0.5 a$

③

$T_2 = a + 2$ ... (1)

$T_1 - T_2 = a + 2$ ... (2)

$5 - T_1 = 0.5a$ ... (3)

(1) + (2)

$T_1 = 2a + 4$

Putting in (3)

$5 - 2a - 4 = 0.5a$

$1 - 2a = 0.5a$

$1 - 2a - 0.5a = 0$

$-2.5a = -1$

$a = \frac{1}{2.5}$

From (1) $T_2 = \frac{1}{2.5} + 2$

$T_2 = \frac{1+5}{2.5} = \frac{6}{2.5} = \frac{6 \times 10}{25} = \frac{12}{5}$

From (2) $T_1 - \frac{12}{5} = \frac{1}{2.5} + 2$

$T_1 - \frac{12}{5} = \frac{1+5}{2.5}$

$T_1 - \frac{12}{5} = \frac{6 \times 10}{25}$

$T_1 - \frac{12}{5} = \frac{12}{5}$

$T_1 = \frac{24}{5}$

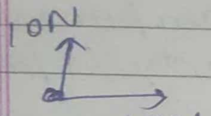
Work Power Energy

$\overset{\bullet}{m} \longrightarrow v$ $\qquad K.E = \frac{1}{2}mv^2$

For system of particle

$K.E = \sum K_i$

Kinetic Energy is Scalar or zero order Tensor
vector → 1st order Tensor
Moment of Inertia → 2nd order Tensor



Total = 20N ✗ , Total = $10\sqrt{2}$

Suppose a particle of mass m is moving and we want to ↑ its vel., then we need to apply force but in what directn ans is ∥el to directn of vel.

$\vec{F} \parallel \vec{v}$ ⟶ Kinetic Energy ↑

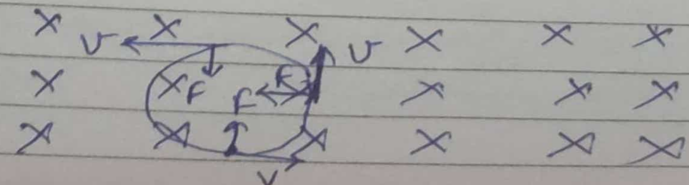
$\vec{F}$ anti∥ $\vec{v}$ ⟶ K.E ↓es

when $\vec{F} = 0$ ⟶ K.E remain same

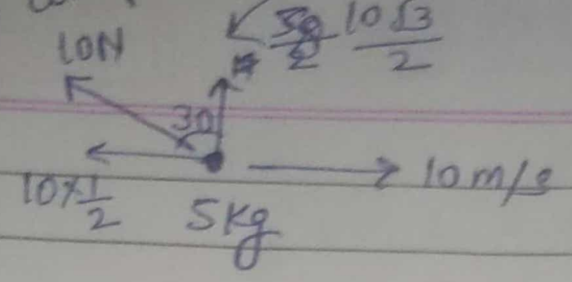
$\vec{F} \perp \vec{v}$ ⟶ K.E remain same

If force on particle is always ⊥ar to velocity

For ex → charge in MF



Resolve 10N into two components i.e $10\cos\theta$ & $10\sin\theta$



Suppose a particle is moving with 10m/s speed & 10N force is applied at angle 30°

Now tell me first speed will ↑ or ↓

Ans → ↓

Will whole 10N force is resposible for ↓ing speed

Ans → NO

Then ? only $10\sin 30°$ component is responsible for ↓ing velocity/speed i.e 5N force

$5\sqrt{3}$ force is doing nothing at this instance further may be it will change trajectory.