Introduction to Vector and Forces -3

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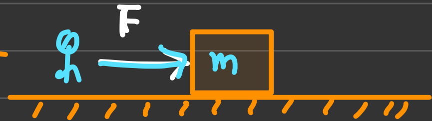
IIT JEE | MEDICAL | FOUNDATION

Weight ✓
Normal ✓
Tension ✓

" Contact force " (Push, pull)

Friction :



" it opposes slipping or slipping tendency "

$\mu_s \propto$ (roughness)

Case I

\# when block is not slipping
" block has slipping tendency "

(F_{net}) along the surface = ← frictional force

Static

Case II

when block is just about to slip

$f_s = \mu_s N$

Coefficient of static frictional force

Static

This is normal force between surface

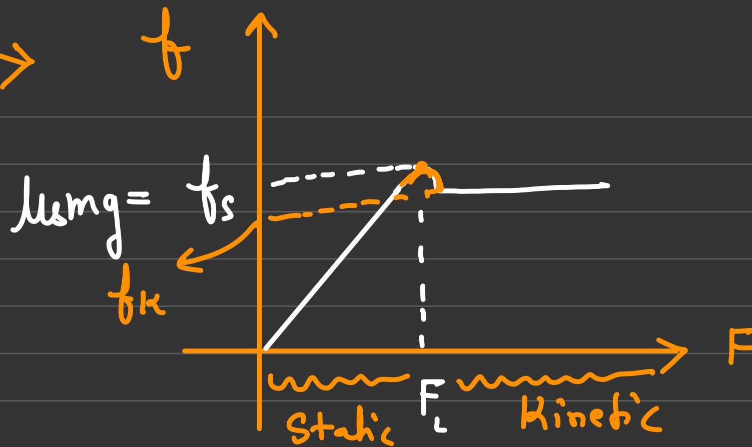
limiting frictional force

Case III

when block F (↑) is actually slipping

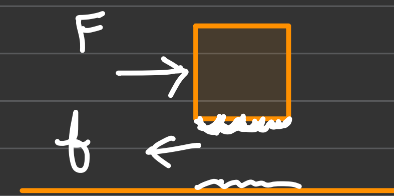
$f_k = \mu_k N$ "fixed"

coefficient of kinetic friction force

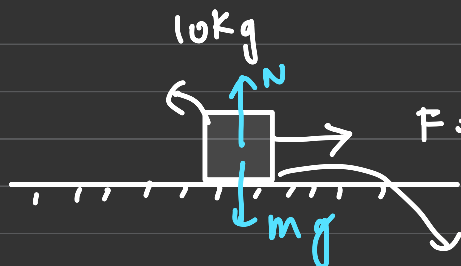


$f_s \geq f_K$

$\mu_s \geq \mu_K$



Q)



$F = 2t$ (N)

" t is in Sec "

$\mu_s = 0.3$
$\mu_K = 0.2$

$g = 10 m/s^2$

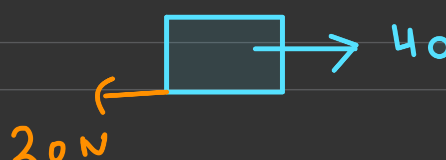
$f_s = 0.3 \times 10 \times 10$ = "30N"

$f_K = 0.2 \times 10 \times 10$ = 20N

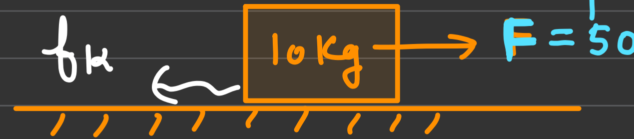
t = (sec)	F	Case	frictional force
0	0	1 ✓	0 (Static)
1	2N	1 ✓	2N (Static)

4	8N	1 ✓	8N
6	12N	1	12N Static
10	20N	1	20N
12	24N	1	24N
15	30N limiting	2	30N Static
20	40N	3	20N Kinetic
25	50N	3	20N

30.0001N → 20N friction (Kinetic)



"Remove"



{ if we remove force from here (50N) then ultimately, it is going to stop. }

① just befor stopping → what is frictional force?

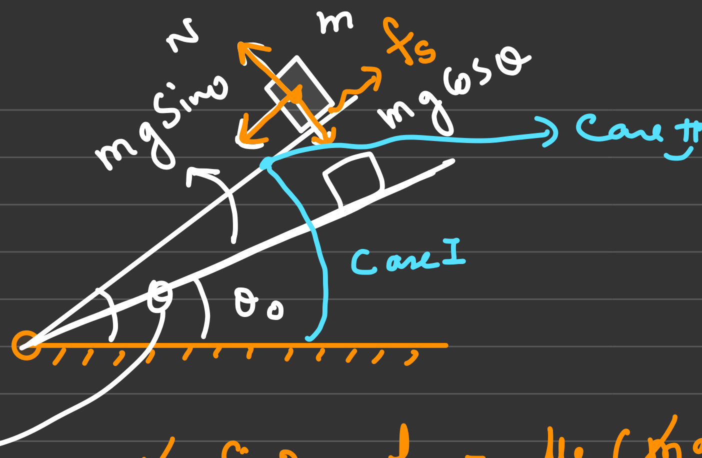
$f_k = 20N$

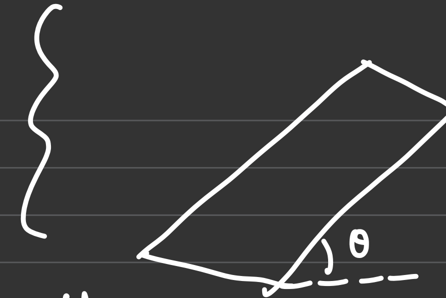
{ $\mu = [\mu_s = \mu_k]$ }

"Slipping more or less does not change any value of Kinetic frictional force"

② just after stopping :

Experiment:





Homework μ_s for [s diff]

Angle of Repose

$\Downarrow$

at this angle block is just about slip?

$$\cancel{m}g\sin\theta = f_s = \underline{\mu_s}\,\underline{(\cancel{m}g\cos\theta)}$$

$$\mu_s = \tan\theta$$

$$\tan\theta = \mu_s$$

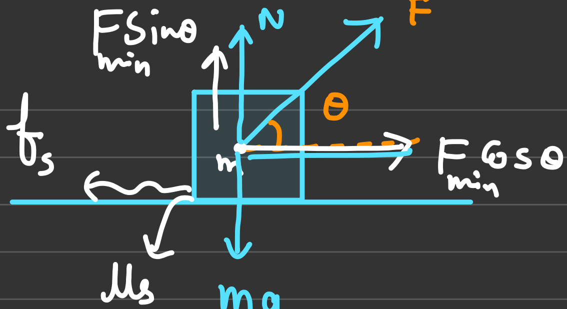
$$\theta = \tan^{-1}(\mu_s)$$

if $\theta = 30$ for this then $\mu_s = \tan 30$

$$\mu_s = \frac{1}{\sqrt{3}}$$

θ)

"for fixed θ"



find min force (F) for which block is just about to slip?

Just about to slip

$$F_{min}\cos\theta = f_s = \mu_s N$$

$$F_{min}\sin\theta + N = mg$$

$$N = mg - F_{min}\sin\theta$$

$$F_{min} = \frac{\mu_s}{\cos\theta}[N]$$

$$\cos\theta\, F_{min} = \mu_s[mg - F_{min}\sin\theta]$$

$$\cos\theta\, F_{min} = \mu_s mg - \mu_s F_{min}\sin\theta$$

$$F_{min}[\cos\theta + \mu_s\sin\theta] = \mu_s mg$$

$$F_{min} = \frac{\mu_s mg}{\cos\theta + \mu_s\sin\theta}$$

$\leftarrow$ $\rightarrow$ slip

$[F^+ = F^- = F]$

$\theta = 30 \rightarrow F_{min} \rightarrow \dfrac{\mu_s m g}{\frac{\sqrt{3}}{2} + \mu_s \frac{1}{2}}$

$\theta = 45 \rightarrow F_{min} \rightarrow (\quad)$

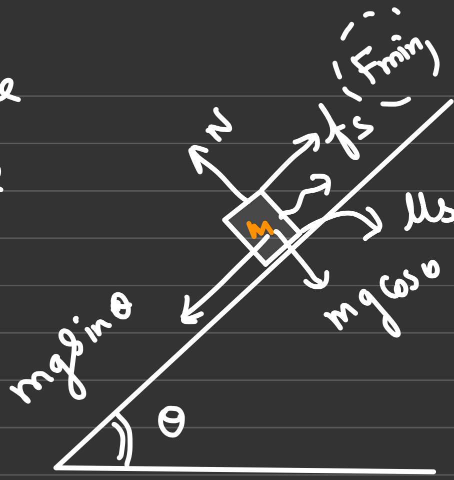
$\theta = 60 \rightarrow F_{min} \rightarrow (\quad)$

Q)

frictional force is adjustable force

" $0 \rightarrow \mu_s N$ "

also can change the direction



find F_{min} and F_{max} for which block is at equilibrium?

$mg\sin\theta > f = \mu_s mg\cos\theta$

$F_{min} = mg\sin\theta - \mu_s mg\cos\theta$

block is stationary

if $F \uparrow$

1) $F < F_{min}$ slipping downward

II) $F = F_{min}$ Equilibrium

III) $F > F_{min}$ Equilibrium

Equilibrium

iv) $F = mg\sin\theta$ $\quad f = 0$

v) $F > mg\sin\theta$ $\quad f \neq 0$

vi) $F_{max} = f_s + mg\sin\theta$

$= \mu_s mg\cos\theta + mg\sin\theta$

"maximum force for which block is equilibrium"

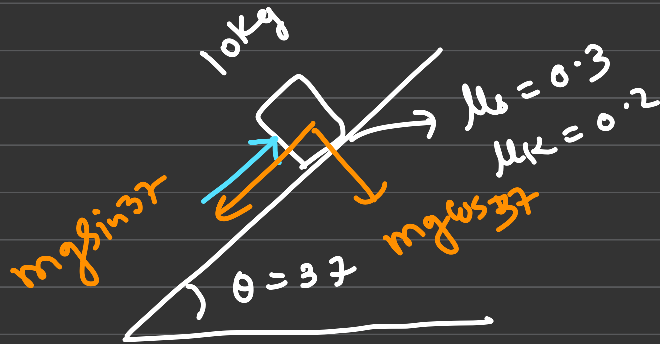
vii) $F > F_{max}$ → slipping upwards

Advanced

$$\boxed{mg\sin\theta - \mu_s mg\cos\theta \le F \le mg\sin\theta + \mu_s mg\cos\theta}$$

Q)

find min and max value of F for which block is in equilibrium?



$mg\sin 37$

$10 \times 10 \times \frac{3}{5} = 60$

$\mu_s mg\cos 37$

$0.3 \times 10 \times 10 \times \frac{4}{5}$

24

$F_{min} = mg\sin 37 - \mu_s mg\cos 37$

$60 - 24$ N

$F_{min} = 36N$

$F_{max} = 60 + 24 = 84$ N

$36 \leq F \leq 84$

frictional force :

F

$10 \rightarrow \mu_k mg \cos 37 = 0.2 \times 10 \times 10 \times \frac{4}{5} = 16N \uparrow$ Kinetic

$20 \rightarrow \;=\; = 16N \uparrow$

$30 \rightarrow \;=\; = 16N \uparrow$ Jaraf upar ki

$40 \rightarrow \;=\; = 20$ Static

equb

$60N \rightarrow \;=\; \Rightarrow 0$

$80 \rightarrow \;=\;$ 20 Static Niche

Slip

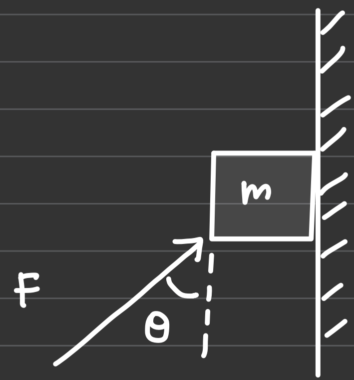
$90 \rightarrow \;=\;$ Slipping upwards

$16N \downarrow$

Q)

μ_s

find min and max for for which block is at rest?



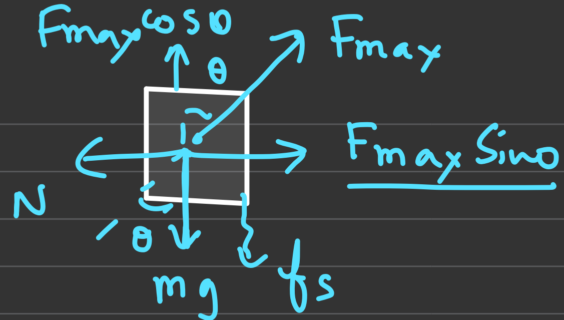
$\left\{\right.$ if block is just about to slip upwards then that will be max force to keep block in equilibrium. ($f_s = \mu_s N \downarrow$)

" if block is just about to slip downwards then force will min to keep in Equilibrium "

$\underline{\underline{f_s}}$ ↑

maximum: (Force)

for which block is in equilibrium



$$F_{max}\cos\theta = mg + f_s$$

$$F_{max}\cos\theta = mg + \mu_s (N)$$

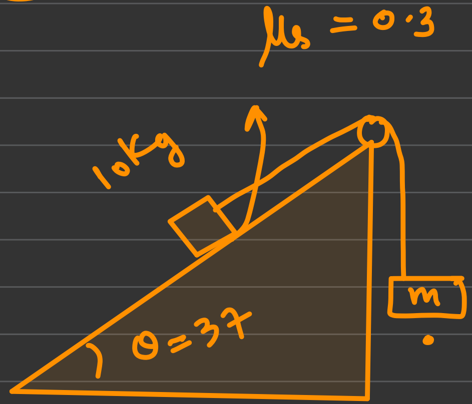
$$F_{max}\cos\theta = mg + \mu_s (F_{max}\sin\theta)$$

$$F_{max} = \frac{mg}{\cos\theta - \mu_s\sin\theta}$$ Ans

min:

$$\left\{ F_{min} = \frac{mg}{\cos\theta + \mu_s\sin\theta} \right\}$$

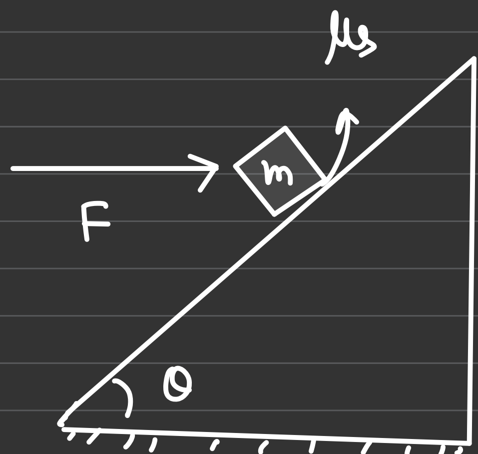
Homework :



find m_{min} and m_{max} for which block is in equilibrium ?

Q)

Find F_{max} and F_{min} to keep this block in equilibrium?



work book · Level 1 (module) ⇒ Q.45 {
Level 2: ⇒ 30 {

module: Section # 7 Solve Everything

Pre-class: { Section (Vector Subtraction) + Relative }