CLASS 11

SKC

PHYSICS CRUSH

Class Notes in Handwritten Format

A beautiful journey from basics to JEE Advanced via Mains/ NEET

By: Saleem Bhaiya

प्रयास है.....
Lakshya तक उड़ान भरने का
और Yakeen है.....
Arjuna की तरह Focus करने का

Pen tod kar dikhao

Contents

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Saleem.nitt

4 Newton's Laws of Motion & Friction

देख भाई इस chapter में mains or advance weightage ढूंढने की गलती मत करना Mains मे हर साल इससे question पूछे जाते है but advance मे बहुत ही कम question पूछे गए है but पूरी mechanics का ये fundamental chapter है जो पूरी physics मे use होगा, so इस chapter को हलके मे ना ले।

INERTIA

- It is the tendency to resist the change.
- It is the property due to which a body wants to be in state of rest or in uniform motion in a straight line.
- Mass is the measurement of inertia.

Momentum

It is the net motion contain in the system.

$\vec{P} = m\vec{v}$ $\quad$ $\overset{\vec{v}}{(m)}$ --------

देख भाई बाद मे हम यह देखेंगे kissi body या system का momentum निकालने का तरीका होता है।

$\vec{P}_{body} = M_{body}\ \vec{v}_{com\ of\ body}$

$\vec{P}_{system} = M_{syst.}\ \vec{v}_{com\ of\ syst.}$

Com में

Force ⟶ Push or Pull

Types of Force

1. Gravitational force ⟶ $mg, \frac{Gm_1 m_2}{r^2}$
2. Electromagnetic force
   - Tension force, Normal force, Friction, Electrostatic force, magnetic force etc.
3. Strong nuclear force
4. Weak nuclear force

} यह हम 12th class मे पढेंगे।

Newton 1st Law (Law of inertia)

- A body continue to be in state of rest or in state of uniform velocity (st. line) until or unless net external force acts on it.

Newton Second Law

$$\left(\vec{F}_{net}\right)_{ext} = \frac{d\vec{p}}{dt} \qquad \vec{P} = m\vec{v}$$

$$\left(\vec{F}_{net}\right)_{ext} = \frac{d(m\vec{v})}{dt} = m\frac{d\vec{v}}{dt} + \vec{v}\frac{dm}{dtv}$$

If m ⟶ Const

$$\left(\vec{F}_{net}\right)_{ext} = m\vec{a}$$

If mass of system is constant then

$$\left(\vec{F}_{net}\right)_{ext} = \frac{md\vec{v}}{dt} = m\vec{a}$$

अबे इसका मतलब है हर जगह F = ma मत लगा देना जैसे rocket propultion मे mass variable होता है तो वहाँ F = ma नही लगा सकते।

Newton Third law

- For every action there is equal and opposite reaction at the same time, simultaneously of the same nature.

★ Action and reaction simultaneously लगते है इसलिए we can't say की कौन action है और कौन reaction.

★ Two different body event.

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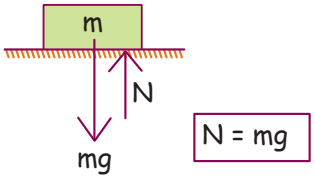
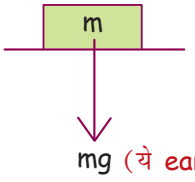
According to this law अगर A ने B पर force लगाएगा F ⇉ तो B भी A पर वापस force लगाएगा F, of same nature at same time
(इस लाईन को याद करलो बहुत काम आएगी)



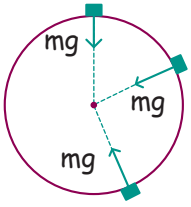
यहाँ normal और mg action reaction pair नही है।

चलो पहले mg, normal, tension force पढ़ लेते है।

GRAVITATIONAL FORCE



वैसे तो mg की direction towards the centre of earth है। जिसे हम gravitation में detail मे पढ़ेंगे



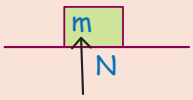
Block चाहे earth पर हो या हवा मे हो mg force तो लगेगा ही।

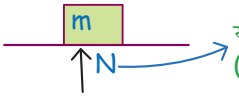
NORMAL FORCE

★ It act towards the body perpendicular to the surface.

★ Pushing nature.

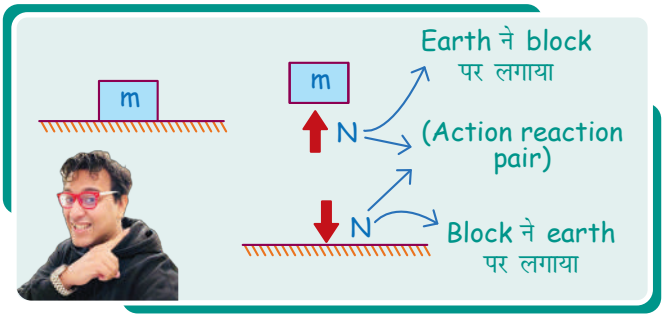
अगर कोई body kissi के साथ छुअन-छुआई कर रही है मतलब किसी surface के साथ contact/touch कर रही है तो उस body पर body की तरफ normal force लगेगा अब ये मत कहना mg क्यों नही लगाया Bcz अभी हम only normal force की बात कर रहे है।

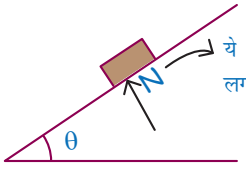


(a) 

यहाँ earth ने block पर N (normal force) लगाया

Block, earth के contact मे है तो earth भी तो block के contact मे है Hence, earth block को touch कर रही है तो earth पर भी normal लगेगा जो block लगाएगा।



(b) 

ये Block पर लगा incline plane ने लगाया।

(c) 

Draw the FBD of Block

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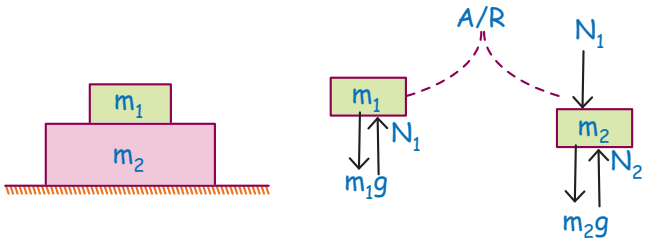
ध्यान से सुन लो FBD (Free Body Diagram) बनाने का मतलब है जिस body की हम FBD बना रहे है उस पर लगने वाले सारे external force दिखाने है मतलब वो body दूसरे लोगो पर कितना force लगा रही है हमे इससे कोई मतलब नही।

Q. Draw FBD of all the block in following cases.

(a)

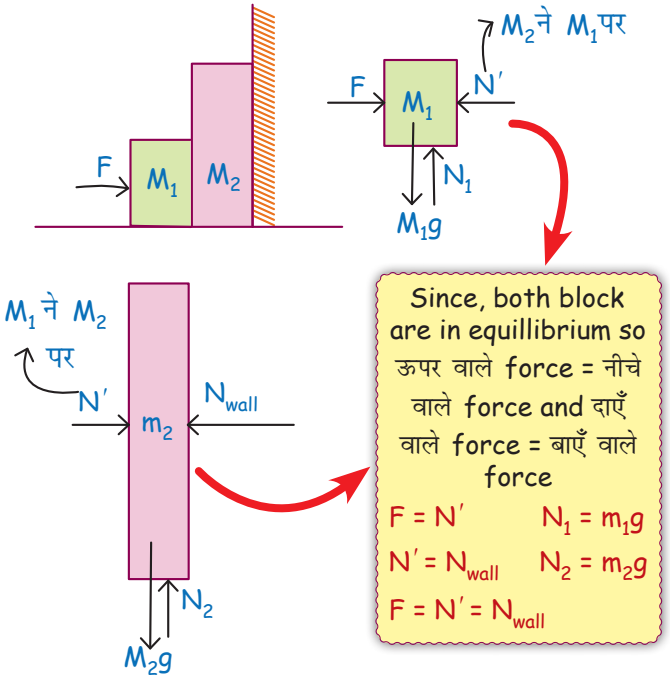


यहाँ दोनो block equillibrium मे है तो हर block पर we can say

net ऊपर वाला force = net नीचे वाला force

$N_1 = m_1g$ $\quad N_2 = N_1 + m_2g \Rightarrow N_2 = m_1g + m_2g$

(b)



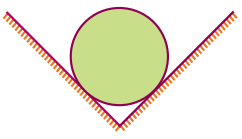
Since, both block are in equillibrium so ऊपर वाले force = नीचे वाले force and दाएँ वाले force = बाएँ वाले force

$F = N'$ $\quad N_1 = m_1g$

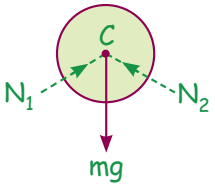
$N' = N_{wall}$ $\quad N_2 = m_2g$

$F = N' = N_{wall}$

Q. A cylinder of weight W is resting on a V-groove as shown in figure. Draw its free body diagram.



Sol.

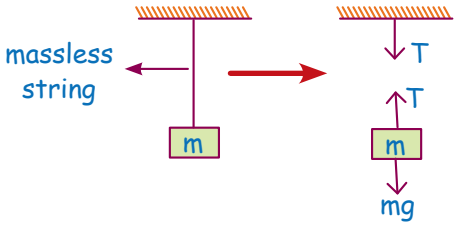


TENSION FORCE

- It act away from the body towards string.
- It is a pulling force.

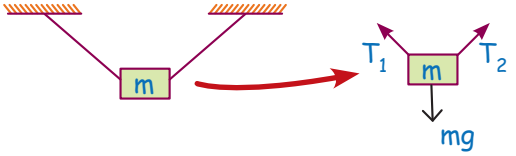
Q. Draw FBD of mass in following case.

(a)

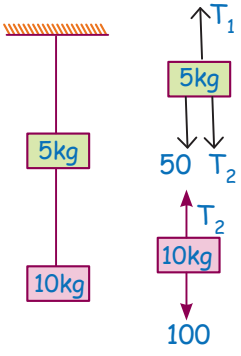


Here if string is massless then tension at every point is massless

(b)



Q. Find tension in each string if all string are mass less.



$T_1 = T_2 + 50$ ....(i)

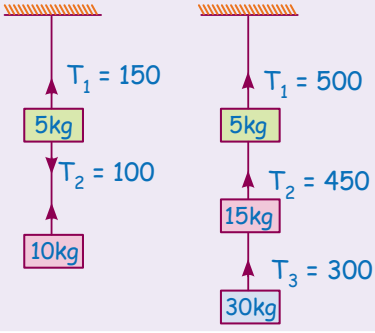
Both block are in equillibrium so ऊपर वाले force = नीचे वाले force

$T_2 = 100$ .....(ii)

Solve (i) and (ii)

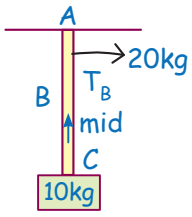
$T_1 = 150$

अबे ये detail मे तो मुझे मजबूरी मे लिखना पड़ रहा है भाई तू तो इसे direct कर, ऊपर वाली रस्सी को पकड़ देख नीचे कितना mass लटका है (15 kg so, $T_1 = 150$) similarly नीचे वाली रस्सी को पकड़ कर tension निकालो।



Q. 10 kg block is suspended through a string of mass 20 kg as shown in figure. Find T_A, T_B, T_C.

Sol. जिस जगह tension पूछी है देखो उसके नीचे total कितना mass है।

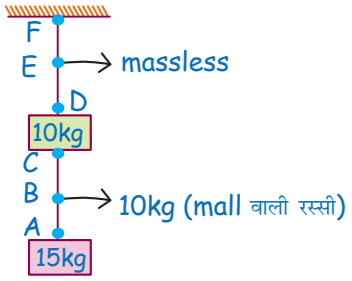


$T_c = 100$ N

$T_B = (10 + 10)g = 200$ N

$T_A = 300$ N

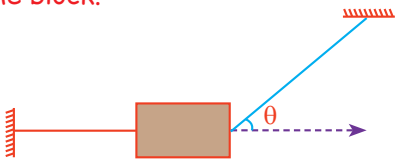
Q.



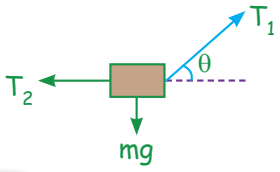
$T_A = 150$
$T_B = 200$
$T_C = 250$
$T_D = 350$
$T_E = 350$
$T_F = 350$

Mall वाली रस्सी अबे मतलब mass वाली रस्सी

Q. A block of mass m is attached with two strings as shown in figure. Draw the free body diagram of the block.



Sol.



EQUILIBRIUM वाले सवाल

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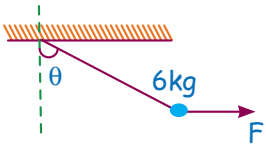
अगर body equil मे है तो सबसे पहले उसकी FBD बनाओ सारे forces को X-Y axis मे तोड़लो और फिर $F_{net} = 0$ करदो मतलब ऊपर वाले force = नीचे वाले force, left वाले force = right वाले force

If body is in equil

$\Rightarrow \vec{F}_{net} = 0$ (Translational equil.)

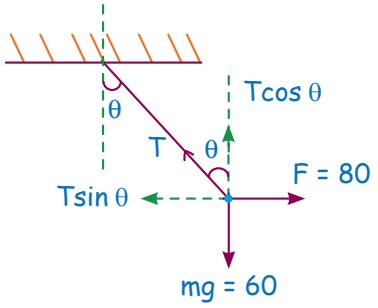
$\Sigma \vec{F}_x = 0, \quad \Sigma \vec{F}_y = 0, \quad \Sigma \vec{F}_y = 0$

Q. Body is in equilibrium find θ = ?



भाई हसना मत ये ques. पिछले 5 साल में 4 बार mains ने पूछा है।

Sol.



$T\sin\theta = 80$

$T\cos\theta = 60$

$\tan\theta = \frac{80}{60} = \frac{4}{3}$

$\theta = 53$

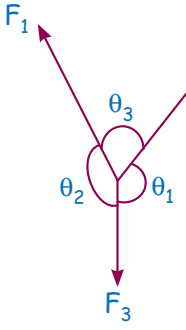
$T\sin 53° = 80$

$T = 100$

or after solving we got $T = \sqrt{F^2 + (mg)^2}$

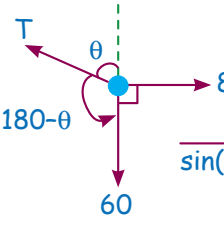
M-2 Lami theorem

If $\vec{F}_1 + \vec{F}_2 + \vec{F}_3 = 0$, in following case.



$$\frac{F_1}{\sin\theta_1} = \frac{F_2}{\sin\theta_2} = \frac{F_3}{\sin\theta_3}$$

Let's solve last ques from lami theorem



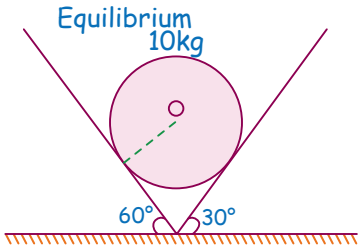
$$\frac{80}{\sin(180-\theta)} = \frac{T}{\sin 90} = \frac{60}{\sin(90+\theta)}$$

$$\frac{80}{\sin\theta} = \frac{60}{\cos\theta}$$

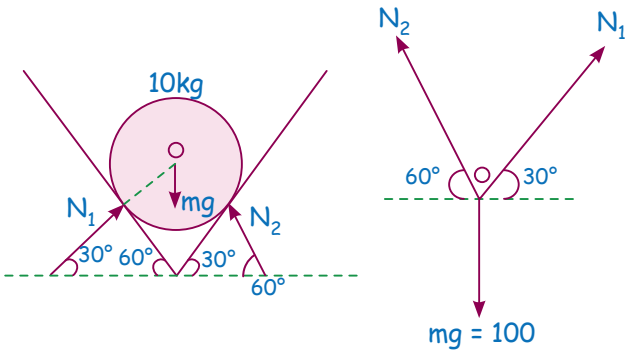
$$\tan\theta = \frac{80}{60} \Rightarrow \theta = 53$$

भाई मुझे तो ये lami theorem घटिया method लगता है bcz ना तो इससे feel आती है और time उतना ही लगेगा मेने यहाँ बता दिया है कहीं तू बाद मे बोले बताया नही। So, i will suggest की component लेके, force equate करके solve करो।

Q. Sphere is in equil find force applied by inclined plane in following figure.



Sol.



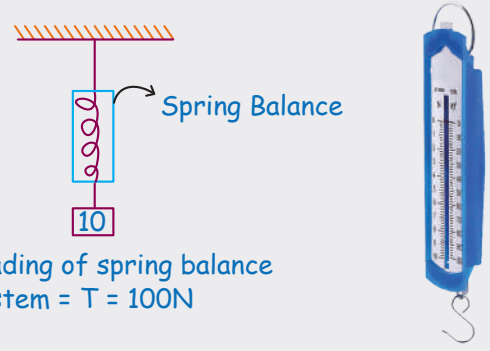
$N_1 \cos 30 = N_2 \cos 60$

$N_2 \sin 60 + N_1 \sin 30 = mg = 100$

Now you can solve and get N_1 and N_2 और मन करे तो lami theorem से answer verify कर लेना।

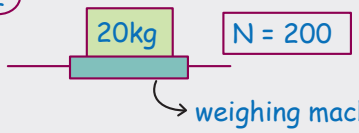
देख भाई ques. मे string मे tension पूछने का एक तरीका होता है reading of spring balance similarly normal पूछने का एक तरीका होता है reading of weighing machine

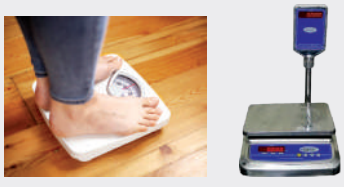
(1)



Reading of spring balance
System = T = 100N

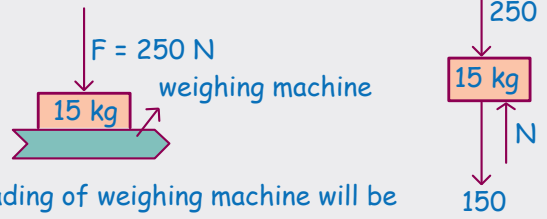
(2)





Reading of weighing machine = N = 200 newton

Q. Reading of weighing machine in following.

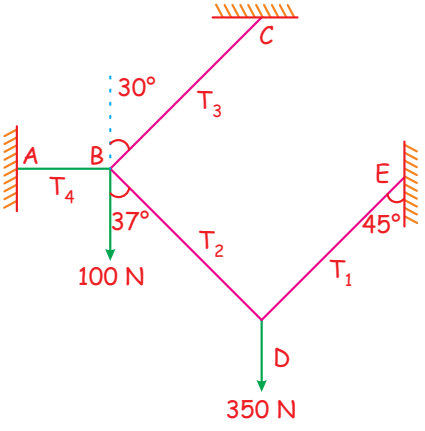


Reading of weighing machine will be

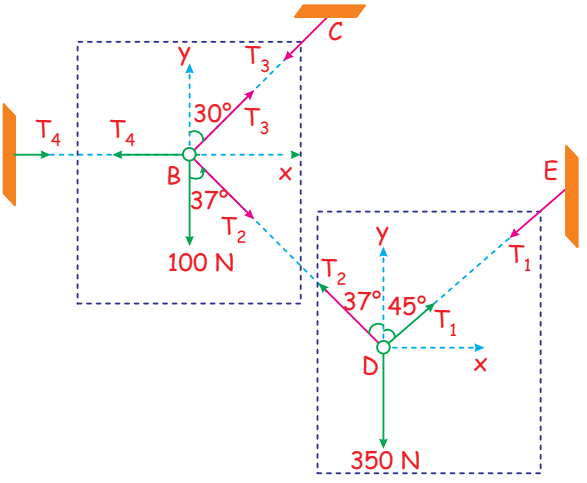
$N = 250 + 150 = 400N$

(1) 25 kg (2) 20 kg (3) 40 kg (4) 50 kg

Q. Two particles of masses 10 kg and 35 kg are connected with four strings at points B and D as shown in figure. Find T_1, T_2, T_3



Sol.



Analysing the equilibrium of point D:

$\sum F_x = 0$ or $T_1 \sin 45° - T_2 \sin 37° = 0$ ... (i)

and $\sum F_y = 0$ or $T_1 \cos 45° + T_2 \cos 37° = 350$ ... (ii)

Solve both eqn. and get

$\Rightarrow T_1 = 150\sqrt{2}\,N$ and $T_2 = 250\ N$

Similarly for equil of point B

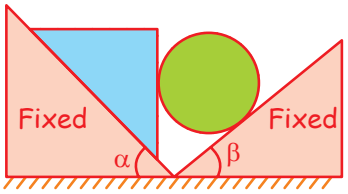
$T_3 \cos 30° = 100 + T_2 \cos 37°$

$T_3 \sin 30° + T_2 \sin 37° = T_4$

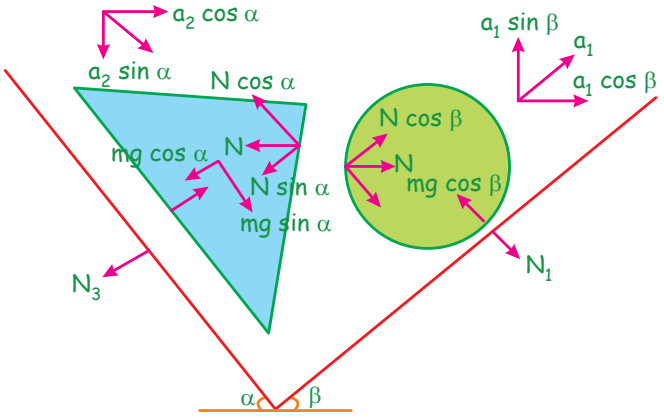
Put value of T_2 = 250, & solve both eqn get the ans.

अबे क्यों रो रहा है मुझे पता calculation मुश्किल है लेकिन advance के point of view से आदत डाल ले। ये ले दो सवाल और ले।

Q. A cylinder and a wedge of same masses with a vertical face, touching each other, move along two smooth inclined planes forming the same angle α and β respectively with the horizontal. Determine the force of normal N exerted by the wedge on the cylinder, neglecting the friction between them.



Sol.



It is obvious that acceleration of cylinder is parallel to the wedge I and acceleration of triangular block is parallel to the wedge 2.

$a_2 \cos \alpha = a_1 \cos \beta$ ... (i)

[constrained relation between the contact surface of block and cylinder]

$N \cos \beta - m_1 g \sin \beta = m_1 a_1$ ... (ii)

[Newton's II law for cylinder along the direction parallel to the wedge1]

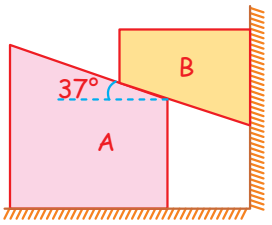
$m_2 g \sin \alpha - N \cos \alpha = m_2 a_2$ ... (iii)

[Newton's II law for block along the direction parallel to the wedge 2]

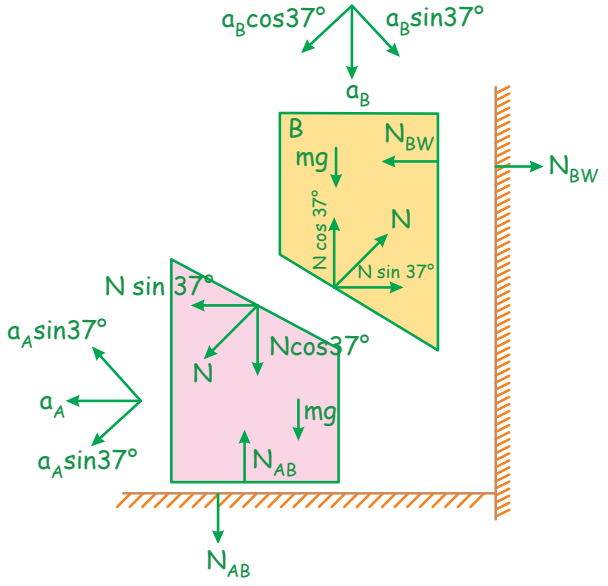
By solving equation (*i*), (*ii*) and (*iii*) we get

$$N = mg\left(\frac{\sin\alpha\cos\alpha + \sin\beta\cos\beta}{\cos^2\alpha + \cos^2\beta}\right)$$

Q. The masses of blocks A and B are same and equal to m. Friction is absent everywhere. Find the magnitude of normal force with which block B presses on the wall and accelerations of the blocks A and B.



Sol.



$mg - N \cos 37 = ma_B$

[Newton's II law for block B in vertical direction]

$N \sin 37 = ma_A$

[Newton's II law for block A in horizontal direction]

$a_B \cos 37 = a_A \sin 37$

[constrained relation for contact surface between block A and B]

By solving above three equations we get

$$a_A = \frac{12g}{25} \quad a_B = \frac{9g}{25} \quad N = \frac{4mg}{5}$$

$N_{BW} = N \sin 37$

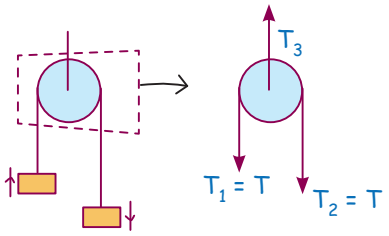
[Equilibrium of block B in horizontal direction]

$$\Rightarrow N_{BW} = \frac{12mg}{25}$$

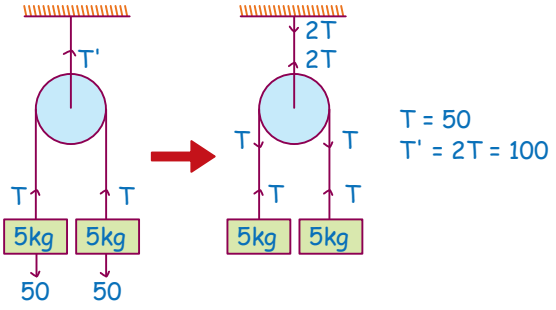
PULLEY SYSTEM / ATWOOD MACHINE

Real Pulley

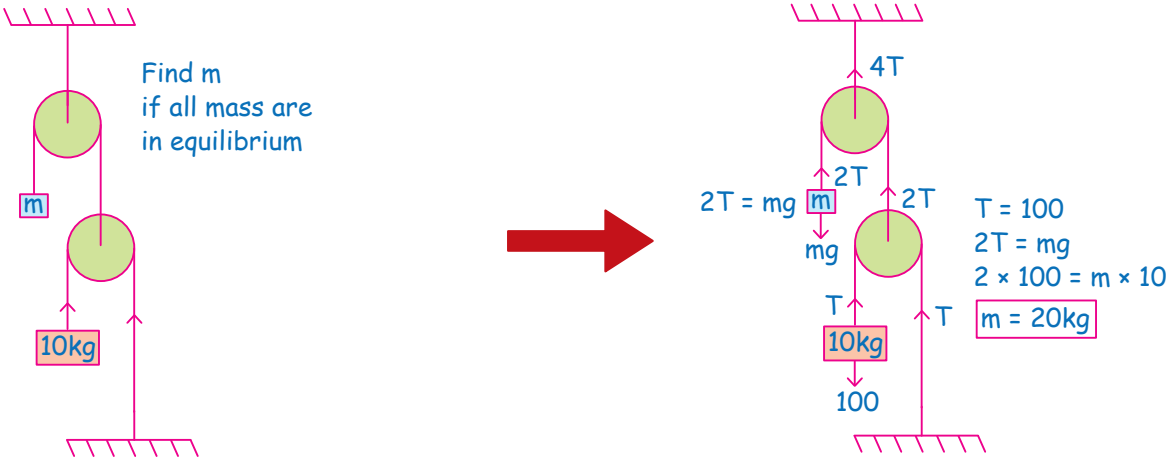
Ideal Pulley → massless, no friction between string and pulley.



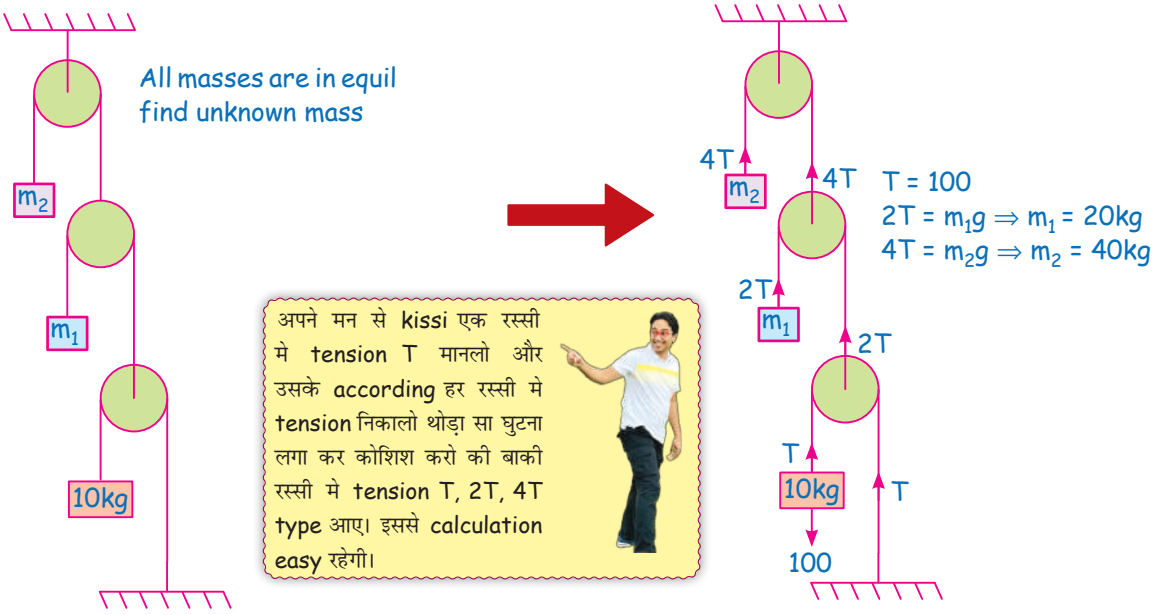
If pulley is ideal then $T_3 = T_1 + T_2 = 2T$



Q. Find m if all mass are in equilibrium

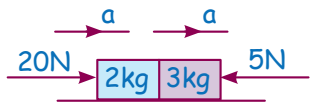


Q. All masses are in equil find unknown mass



अपने मन से kissi एक रस्सी मे tension T मानलो और उसके according हर रस्सी मे tension निकालो थोड़ा सा घुटना लगा कर कोशिश करो की बाकी रस्सी मे tension T, 2T, 4T type आए। इससे calculation easy रहेगी।

Q. Find acc and normal between blocks.



Sol.

$20 - N = 2a$ $\quad$ $N - 5 = 3a$

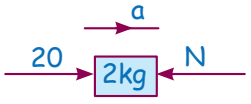
Solve and get a = 3, N = 14

Method-2:

$(\vec{F}_{net})_{ext} = 20 - 5 = (2 + 3)\,a$

$15 = 5a$

$a = 3$

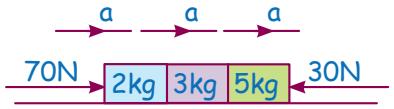


$20 - N = 2 \times 3$

$N = 14$

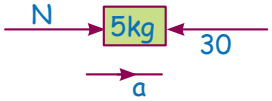
SKC

Q. Find acc and normal between blocks.



$a = \dfrac{70 - 30}{10} = 4$

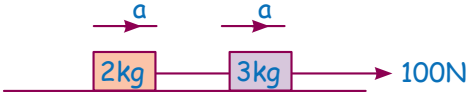
force applied by 3kg on 5kg



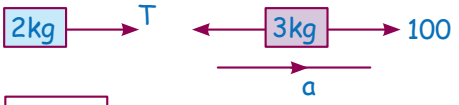
$N - 30 = 5a$

$N = 30 + 20 = 50$

Q. Find acc of each block and tension in string.



Sol.

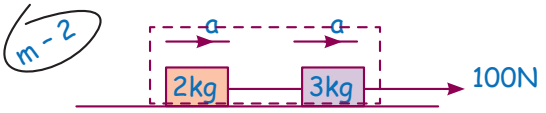


$T = 2a$ $\quad$ $100 - T = 3a$

Solve and get a = 20 and T = 40

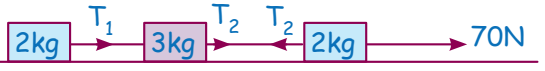
$a = 20$

$T = 40$



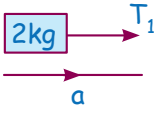
$a = \dfrac{100 - 0}{2 + 3} = 20$

Q.

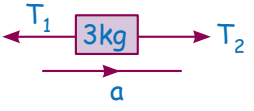


Sol.

$a = \dfrac{70 - 0}{2 + 3 + 2} = 10$



$T_1 = 2 \times a = 2 \times 10 = 20$

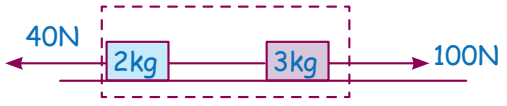


$T_2 - T_1 = 3a$

$T_2 - 20 = 3 \times 10$

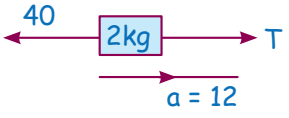
$T_2 = 50\ N$

Q.



Sol.

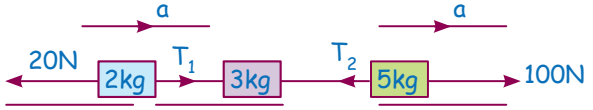
$a = \dfrac{100 - 40}{2 + 3} = 12$



$T - 40 = 2 \times 12$

$T = 64$

Q.



find T_1 & T_2

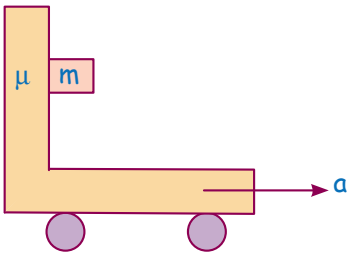
Sol. $a = \dfrac{100 - 20}{2 + 3 + 5} = 8$

$T_1 - 20 = 2 \times 8$

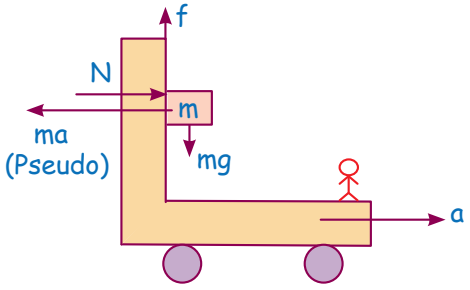
$T_1 = 36$

$100 - T_2 = 5 \times 8$

$T_2 = 60$



Sol.



सही $\Rightarrow$ $mg \le (f_s)_{max}$

$mg \le \mu N$

$mg \le \mu ma$

$$\frac{g}{\mu} \le a$$

$N = ma$ ...(1)

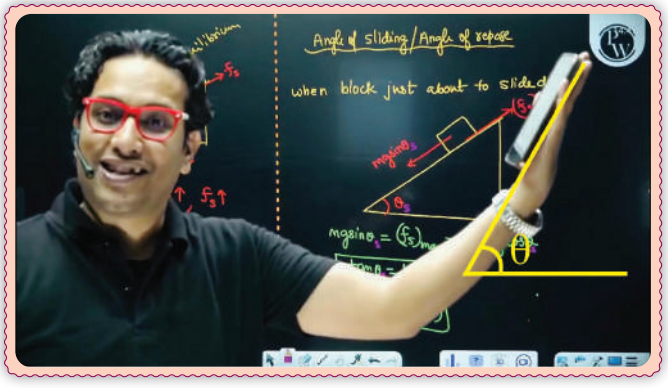
$mg = (f_s)_{max} = \mu N$

$mg = \mu ma$

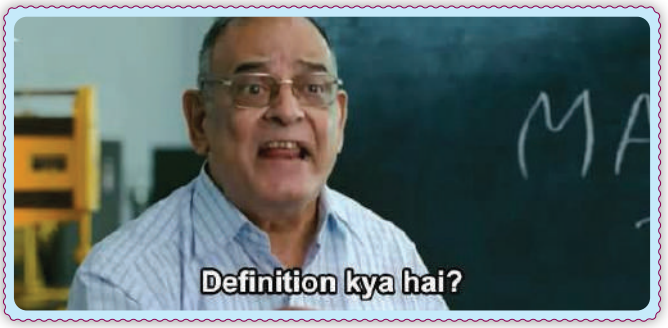
$$a = \frac{g}{\mu}$$

Answer for both the (a) and (b) is same and equal to $\frac{g}{\mu}$

Angle of Repose/Angle of Sliding

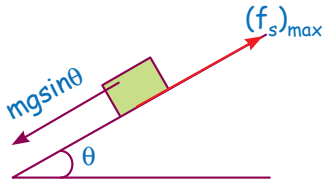


अगर मै ऊपर वाली image मे अपने हाथ को ऊपर उठाता जाऊँ मतलब θ increase करता जाऊँ तो जिस angle पर ये mobile just नीचे फिसलना start हो जाएगा उस angle को हम फिसलने वाला angle कहते है बोले तो angle of sliding.



A block of mass m is at rest on a rough incline plane making angle θ with horizontal. The angle θ at wedge block is just about to slide down is called angle of repose.

When block is just about to slide



$mg\sin\theta = (f_s)_{max} = \mu_s mg\cos\theta$

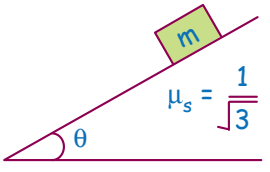
$\mu_s = \tan\theta$

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

If $\theta \le \theta_s$ = Rest

$\theta > \theta_s$ = Slide down

★



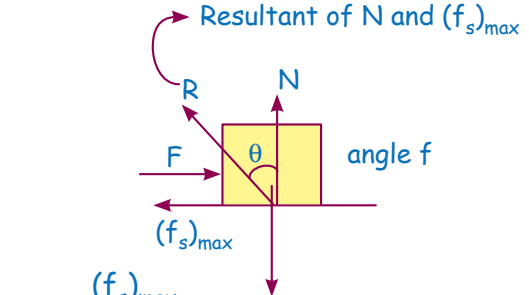
$\tan\theta = \mu_s = \frac{1}{\sqrt{3}}$

$\theta_s = 30$

$\theta \le 30 \Rightarrow$ Block Rest

$\theta > 30 \Rightarrow$ Block Move

Angle of Friction



$\tan\theta = \frac{(f_s)_{max}}{N}$

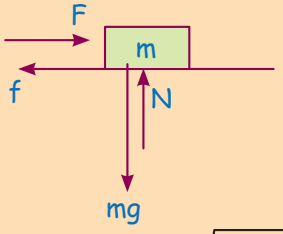
$\tan\theta = \frac{\mu_s N}{N}$

$\tan\theta = \mu_s$

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

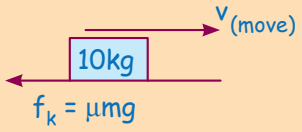
काम का डब्बा

★



Netcontact force = $\sqrt{N^2 + f^2}$

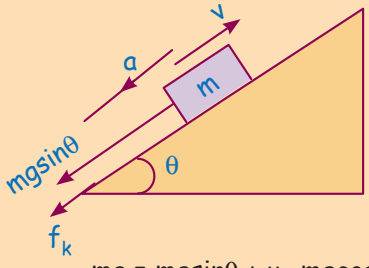
★



$a = \frac{f_k}{m} = \frac{\mu mg}{m} = \mu g$ (पीछे)

Stopping distance निकालने के लिए 3rd eqn of motion लगाओ $0^2 = v^2 - 2(\mu g)x$

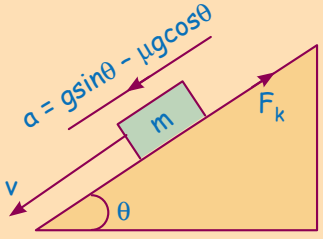
★ When block is moving up along the inclined



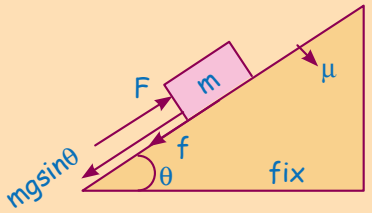
$ma = mg\sin\theta + \mu_k mg\cos\theta$

$a = g\sin\theta + \mu g\cos\theta$
पीछे

★ When block is moving down along the inclined



★

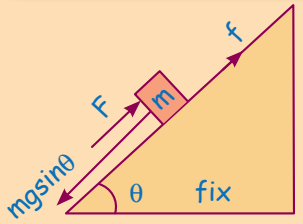


min value of F so that block slide up.

$F_{min} = mg\sin\theta + (f_s)_{max}$

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

★



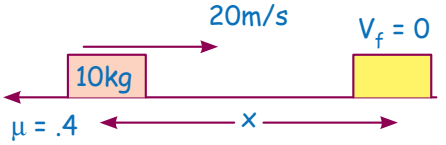
min value of F to prevent the block sliding down

$F + (f_s)_{max} = mg\sin\theta$

$F = mg\sin\theta - \mu mg\cos\theta$

Q. In following fig. Find distance travel by block before coming to rest.

Sol.

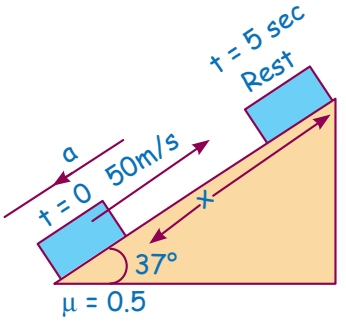


$a = \mu g = 4$ (पीछे) = cost.

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

$x = 50$ m

Q. In the given fig. block is projected along the rough incline ($\mu = 0.5$) with speed 50 m/s. Find distance travel by block before coming to rest.



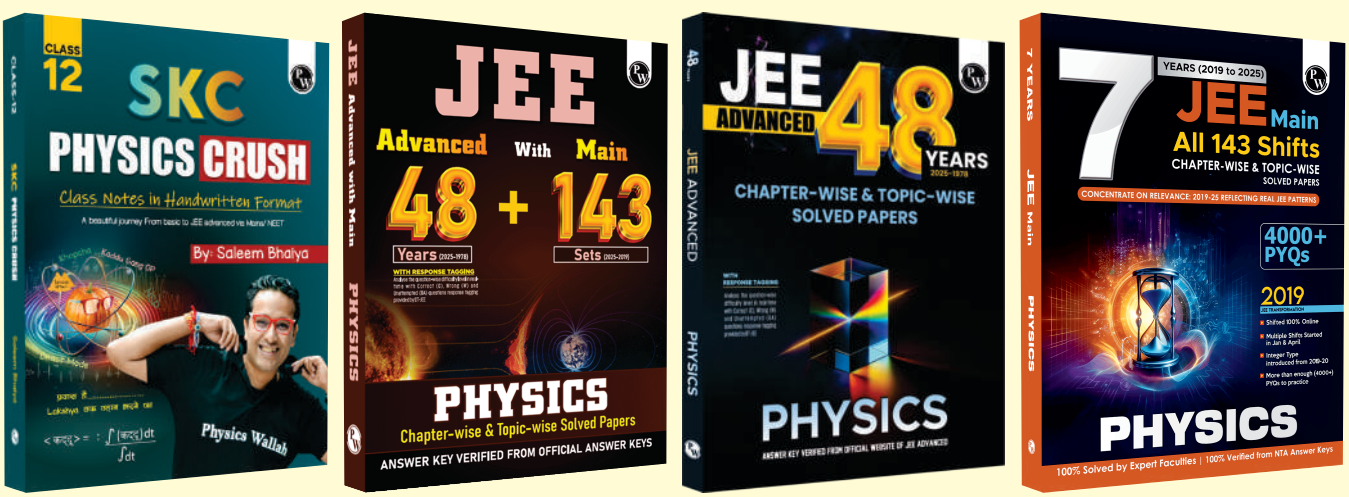
About the Author

Saleem Ahmed, an alumnus of **NIT Trichy** with a **B.Tech in Electronics and Communication Engineering (ECE),** is a highly respected Physics educator with experience of **12+ Years** known for his **engaging teaching style** and **student-centric approach.**

With over 8 **years of experience** as a **Senior and Star Faculty** at **Allen Career Institute, Kota,** he has **mentored lakhs of students,** including many with **top ranks under 100 and under 50** in JEE. Currently, he is a core member of **Physics Wallah,** continuing to guide students with **conceptual clarity** and **problem-solving expertise.**

Affectionately called **"Saleem Bhaiya",** his classes focus on **building concepts from basic to advanced,** helping students unlock their potential. His non stop **17-hours** in 2023, non stop **19-hours** and non stop **20 hours** in 2024 **marathon sessions** on the **PW JEE Wallah / PW Alakh Pandey YouTube channels** reflect his dedication to student success. Saleem Ahmed's commitment has left a lasting impact on JEE aspirants across the country.

Other Helpful Books



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