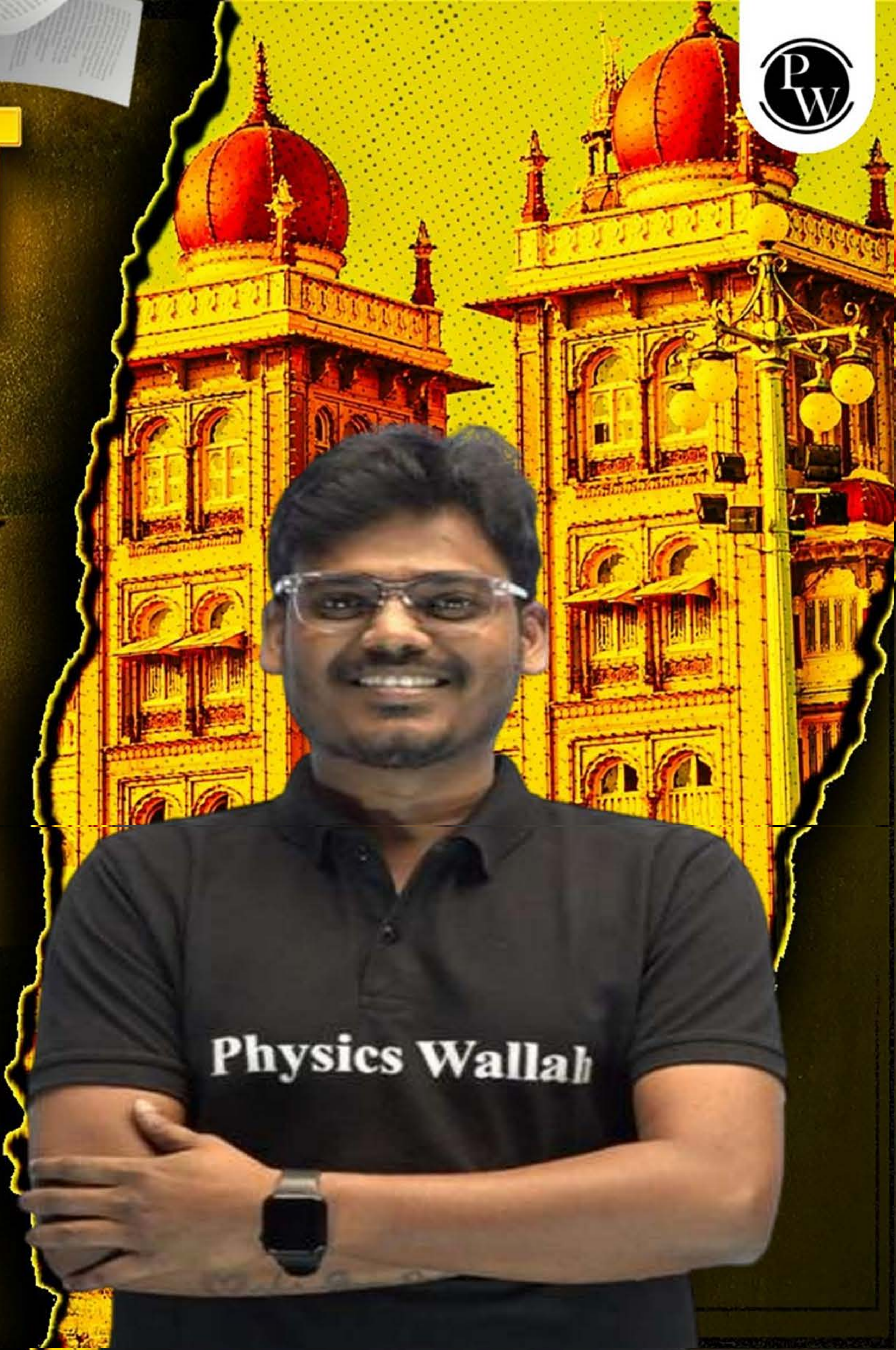
ULTIMATE KCET

CRASH COURSE 2026

Physics | Lecture :- 01

Law's of motion

By: AK Sir



Recap of previous lecture

1. QUESTIONS ON 1D MOTION
2. SCALARS AND VECTORS
3. PROJECTILE MOTION
4. PYQ's + MCQ's

Topics

to be covered

1. INERTIA AND LAWS OF MOTION
2. LINEAR MOMENTUM AND IMPULSE
3. MOTION OF CONNECTED BODIES
4. FRICTIONS AND TYPES OF FRICTION

CONCEPT OF FORCE

Force : It is the cause in the form of push or pull , which changes or tends to changes either the size or the shape or the state of rest or of motion of a body.

SI Unit – newton (N)

Measuring Device – spring balance

Quantity - vector.

Relation between SI & CGS unit - $\boxed{1N = 10^5 \text{ dyne}}$

THE LAW OF INERTIA

Law of Inertia : Its is the inability of a body to change its state (rest/motion) by itself.

Note : Inertia of body is directly proportional to the mass of the body

$$\boxed{\text{Inertia} \propto \text{Mass}}$$

TYPES OF INERTIA

Inertia

- Inertia of Rest
- Inertia of Motion
- Inertia of Direction

LAWS OF MOTION

Newton’s Laws of motion

LAWS OF MOTION

1^{ST} LAW

2^{ND} LAW

3^{RD} LAW

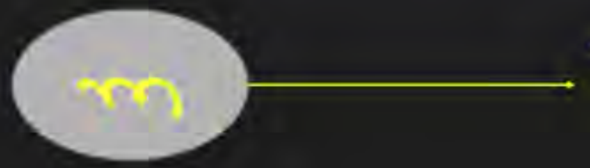
NEWTONS 1ST LAW

$\boxed{\textbf{It is Law of Inertia.}}$

Every body wants to keeps its state of rest/uniform motion until and unless it is acted upon by an external force.

LINEAR MOMENTUM [MASS IN MOTION]

Linear Momentum : Linear Momentum of a body is the property of moving body and It is given by the product of mass and velocity of the body.



$$\vec{P} = m\vec{V}$$

Formula : $P = mV$

Dimensional Formula : $[M^1 L^1 T^{-1}]$

Unit : $Kg\,m/s$

Quantity : Vector.

Direction - Along the motion of body

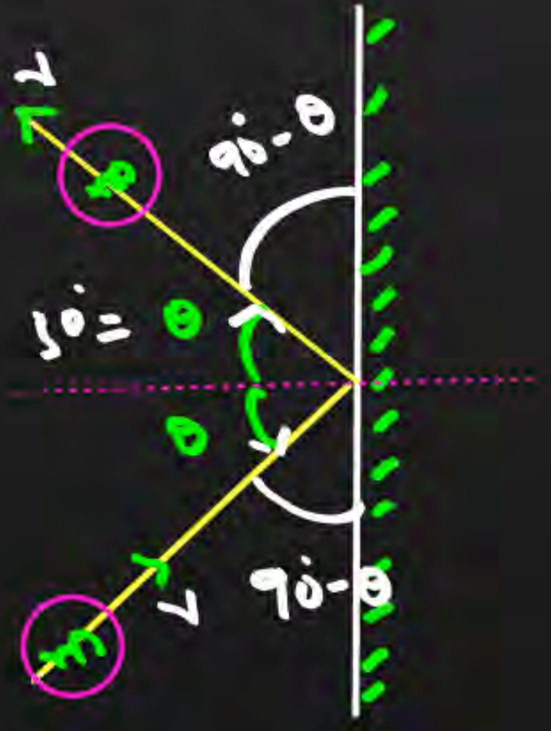
Change in Momentum $(\Delta\vec{P})$

$\Delta P = P_f - P_i$

$\Delta P = mV - mu$

* $\boxed{\Delta P = m(V-u) = m\Delta V}$

60°



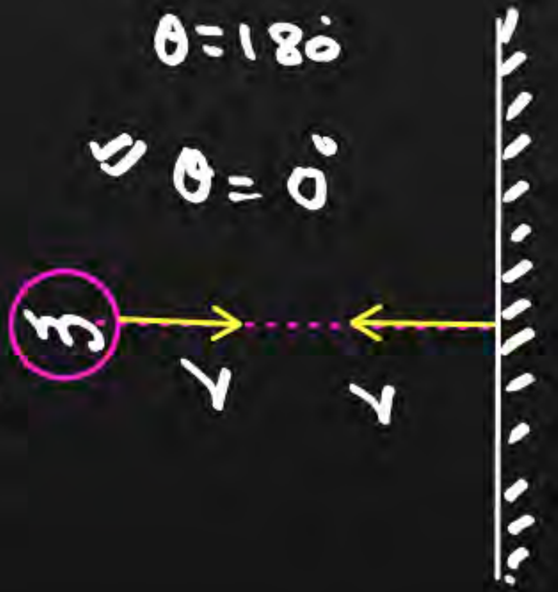
* $\boxed{\begin{array}{l}\Delta P = 2mV\cos\theta \\ \Delta P = 2mV\sin\theta\end{array}}$ → wrt wall

$\Delta P = 2mV\cos 0^\circ$

* $\boxed{\begin{array}{l}\Delta P = 2mV(1) \\ \Delta P = -2mV\end{array}}$
  → $\theta = 0^\circ$
  → $\theta = 180^\circ$

$\theta = 180^\circ$

$\theta = 0^\circ$



NEWTONS 2nd LAW

Statement:

"The rate of change of momentum of a body is directly proportional to the external force applied and takes place in the same direction in which the external force is acting".

$$\boxed{F = \frac{dp}{dt}}$$

$$F = \frac{d}{dt}(mv)$$

$$F = m\frac{dv}{dt} + v.\cancel{\frac{dm}{dt}}$$

$$F = m\frac{dv}{dt}$$

$$\boxed{F = ma}$$

$$\boxed{\vec{F} = m\vec{a}}$$

IMPULSIVE FORCE

Graph : $J = \Delta P = \int F \cdot dt$

The product of force and time that produces finite change in momentum of the body is called impulse.

OR

The force acting on a body for a short interval of time are called Impulse.

Ex:-Kicking of a ball ,Striking a cricket ball, Blow of a hammer on nail etc.

Formula : $\boxed{J = F \times \Delta t}$

$J = ma \times \Delta t$

$J = m \times \frac{\Delta v}{\Delta t} \times \Delta t$

$J = m\Delta v$

$\boxed{J = \Delta p}$

Dimensional formula :

$[M^1 L^1 T^{-1}]$

Unit : N-s or kg m/s

QUESTION

A 1 kg object strikes a wall with velocity 1 m/s 'at an angle of $\boxed{60^\circ \text{ with the wall}}$ and reflects at the same angle. If it remains in contact with wall for 0.1 s , then the force exerted on the wall is:

(A) $30\sqrt{3}$ N

(B) Zero

(C) $\boxed{10\sqrt{3} \text{ N}}$

(D) $20\sqrt{3}$ N

$$F = \frac{dP}{dt} = \frac{\Delta P}{\Delta t}$$

$$F = \frac{\sqrt{3}}{0.1} \times \frac{10}{10}$$

$$\boxed{F = 10\sqrt{3} \text{ N}}$$

M-1

$$\Delta P = 2mv\cos\theta$$

$$\Delta P = 2mv\cos 30^\circ$$

$$\Delta P = 2 \times 1 \times 1 \times \frac{\sqrt{3}}{2}$$

$$\Delta P = \sqrt{3} \text{ N-s}$$

M-2

$$\Delta P = 2mv\sin\theta$$

$$\Delta P = 2 \times 1 \times 1 \times \sin 60^\circ$$

$$\Delta P = 2 \times \frac{\sqrt{3}}{2} = \sqrt{3} \text{ N-s}$$

QUESTION

A rigid ball of mass m strikes a rigid wall at $\boxed{60^\circ}$ and gets reflected without loss of speed as shown in the figure below. The value of impulse imparted by the wall on the ball will be

(A) $\frac{mv}{2}$

(B) $\frac{mv}{3}$

(C) $\boxed{mv}$

(D) 2 mv

$J = \Delta p = 2mv\cos\theta$

$J = 2mv \times \cos 60$

$J = 2mv \times \frac{1}{2}$

$\boxed{J = mv}$

QUESTION

The distance covered by a body of mass 5 g having linear momentum 0.3 kg m/s in 5 s is:

A 0.3 m

B $\boxed{300 \text{ m}}$

C 30 m

D 3 m

$$\boxed{v = \frac{dist}{time}}$$

$$dist = v \times t$$
$$= 60 \times 5$$
$$\boxed{= 300 m}$$

$$p = mv$$
$$v = \frac{p}{m} = \frac{0.3}{5 \times 10^{-3}}$$
$$v = \frac{0.3 \times 10^{3}}{5} = \frac{300}{5}$$
$$\boxed{v = 60 m/s}$$

QUESTION

A body of mass m hits normally a rigid wall with velocity v and bounces back with the same velocity. The impulse experienced by the body is:

A mv

B 1.5 mv

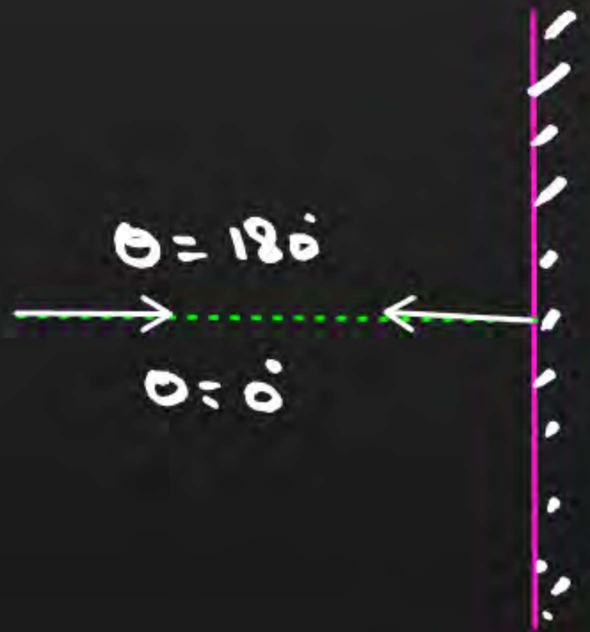
C $\boxed{2\ \text{mv}}$

D Zero

$J = \Delta p = 2mv\cos\theta$

$J = 2mv \quad \theta = 0^\circ$

$J = -2mv \quad \theta = 180^\circ$



QUESTION

$\phi_E = \vec{E}\cdot\vec{A}$ $\quad$ $\phi_B = \vec{B}\cdot\vec{A}$

The force 'F' acting on a particle of mass 'm' is indicated by the force-time graph shown below. The change in momentum of the particle over the time interval from zero to 8 s is

$J = F \times \Delta t = \Delta P$

(A) 24 Ns

(B) 20 Ns

(C) $\boxed{12 \text{ Ns}}$

(D) 6 Ns

$A_1 = \frac{1}{2} \times b \times h = \frac{1}{2} \times 2 \times 6 = 6$

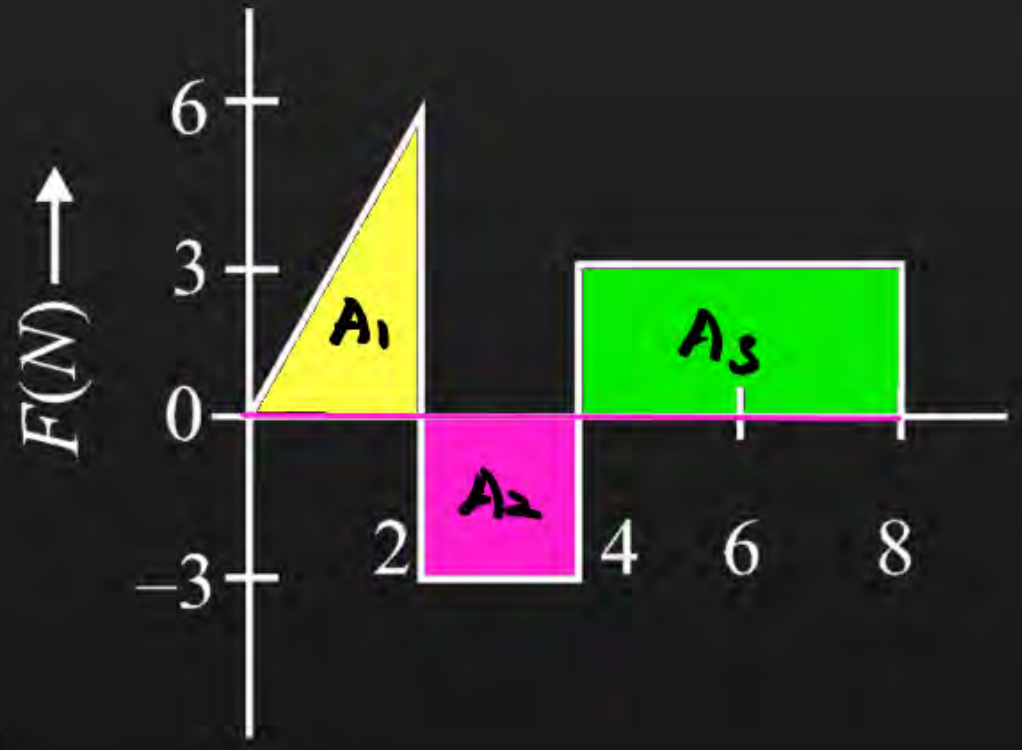
$A_2 = l \times b = 2 \times (-3) = -6$

$A_3 = l \times b = 4 \times 3 = 12$

ΔP = Area under F-t graph

$\Delta P = A_1 + A_2 + A_3 = 6 - 6 + 12$

$\boxed{\Delta P = 12 \text{ N-s}}$



QUESTION

If force $F = 500 - 100t$, then impulse as a function of time will be:

(A) $\boxed{500t - 50t^2}$

(B) $50t - 10$

(C) $50 - t^2$

(D) $100t^2$

$J = F \times \Delta t$

$J = \int (500 - 100t).dt$

$J = 500t - 100\frac{t^2}{2}$

$\boxed{J = 500t - 50t^2}$

QUESTION

A body, under the action of a force $\vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}$ acquires an acceleration of $1\ m/s^2$. The mass of this body must be:

(A) 10 kg

(B) 20 kg

(C) $\boxed{10\sqrt{2}\ \text{kg}}$

(D) $2\sqrt{10}$ kg

$F = ma$

$m = \frac{F}{a} = \frac{10\sqrt{2}}{1}$

$\boxed{m = 10\sqrt{2}\ Kg}$

$|\vec{F}| = F = \sqrt{(6)^2 + (-8)^2 + (10)^2}$

$F = \sqrt{36 + 64 + 100}$

$F = \sqrt{2 \times 100}$

$\boxed{F = 10\sqrt{2}\ N}$

QUESTION

$p = mv$

A cricketer catches a ball of mass 150 gm in 0.1 second moving with speed 20 ms^{-1}, then he experiences force of:

(A) 300 N

(B) $\boxed{30\ N}$

(C) 3 N

(D) 0.3 N

$$F = \frac{dp}{dt} = \frac{\Delta p}{\Delta t} = \frac{150 \times 10^{-3} \times 20}{0.1} = 30{,}000 \times 10^{-3}$$

$$\boxed{F = 30\ N}$$

QUESTION

A player catches a ball of 200 g moving with a speed of 20 m/s. If the time taken to complete the catch is 0.5 s, the force exerted on the player's hand is : [H.W]

A. 8 N

B. 4 N

C. 2 N

D. 0

QUESTION

A cricket ball of mass 250 g collides with a bat with velocity 10 m/s and returns with the same velocity within 0.01 second. The force acted on bat is [H.W]

(A) 25 N

(B) 50 N

(C) 250 N

(D) 500 N

QUESTION

A 10 N force is applied on a body produce in it an acceleration of 1 m/s^2. The mass of the body is:

(A) 15 kg

(B) 20 kg

(C) $\boxed{10 \text{ kg}}$

(D) 5 kg

$F = ma$

$m = \frac{F}{a} = \frac{10}{1}$

$\boxed{m = 10 \text{ kg}}$

QUESTION

Physical independence of force is a consequence of:

A. Third law of motion

B. Second law of motion

C. $\boxed{\text{First law of motion}}$

D. All of these laws

Rocket Propulsion

$$F = m\cancel{\frac{dv}{dt}} + v \cdot \frac{dm}{dt}$$

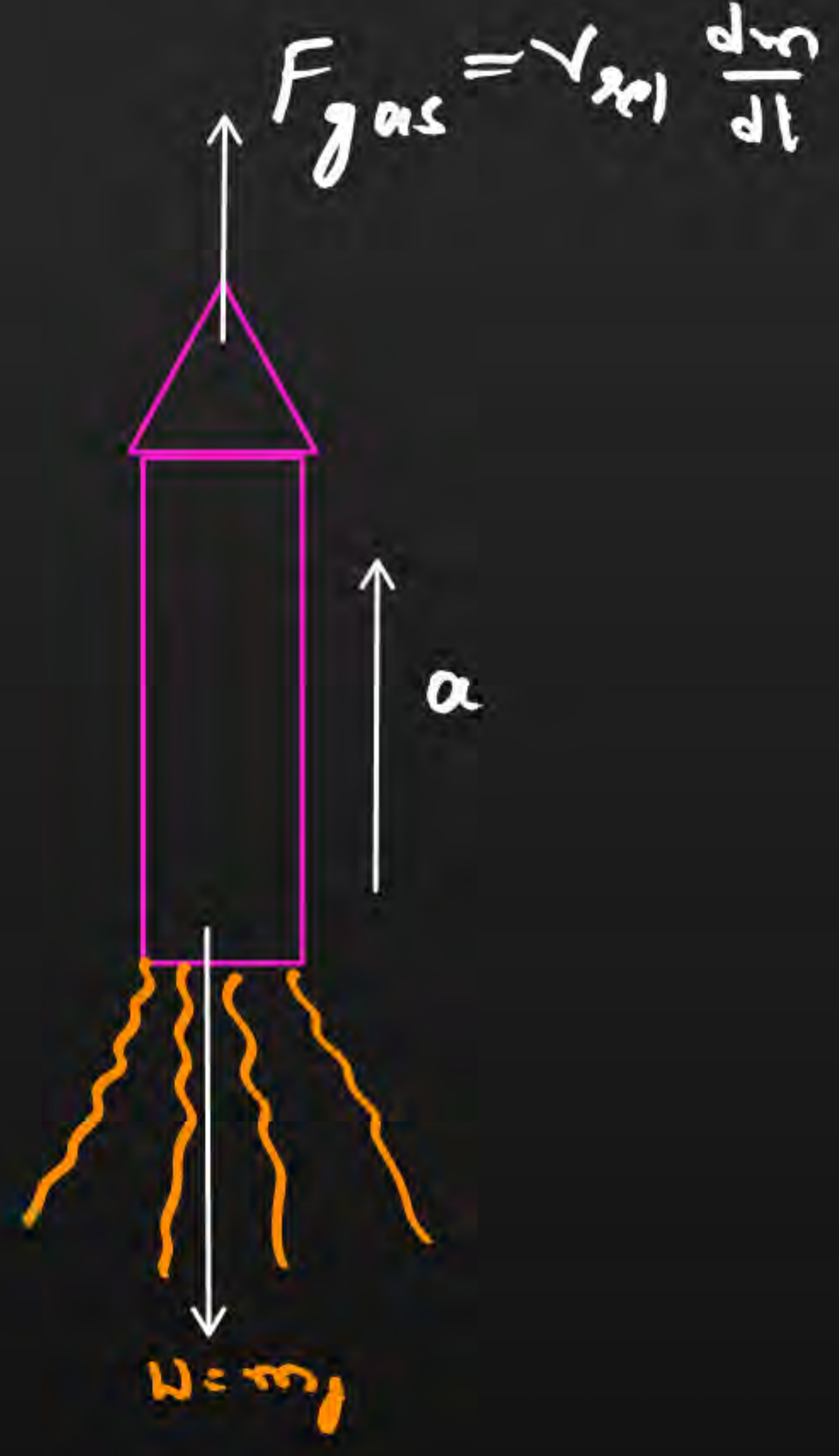
$$\boxed{F_{gas} = v_{rel} \cdot \frac{dm}{dt}} \Rightarrow v = \text{const}$$

$$F_{net} = ma$$

$$F_{gas} - W = ma$$

$$v_{rel}\frac{dm}{dt} - mg = ma$$

$$\boxed{a = \frac{v_{rel}\frac{dm}{dt} - mg}{m}} \quad v \neq \text{const}$$



QUESTION

v_{rel}

For a rocket propulsion velocity of exhaust gases relative to rocket is 2 km/s. If mass of rocket system is 1000 kg m, then the rate of fuel consumption for a rocket to rise up with acceleration 4.9 m/s^2 will be:

a

(A) 12.25 kg/s

(B) 7.35 kg/s

(C) 17.5 kg/s

(D) 5.2 kg/s

$$F_{gas} - w = ma$$

$$v_{rel}\frac{dm}{dt} - mg = ma$$

$$2000\frac{dm}{dt} - 1000 \times 10 = 1000 \times 4.9$$

$$2000\frac{dm}{dt} = 4900 + 10{,}000 = 14900$$

$$\boxed{\frac{dm}{dt} = \frac{14900}{2000} = 7.45 \text{ kg/s}}$$

QUESTION

A 600 kg rocket is set for a vertical firing. If the exhaust speed is 1000 $\mathrm{ms^{-1}}$, the mass of the gas ejected per second to supply the thrust needed to overcome the weight of rocket is:

(A) $117.6 \mathrm{kgs^{-1}}$

(B) $58.6 \mathrm{kgs^{-1}}$

(C) $\boxed{6 \mathrm{kgs^{-1}}}$

(D) $76.4 \mathrm{kgs^{-1}}$

$$F = v_{rel} \frac{dm}{dt}$$

$$mg = v_{rel} \frac{dm}{dt}$$

$$600 \times 10 = 1000 \frac{dm}{dt}$$

$$\boxed{\frac{dm}{dt} = 6 \text{ kg/s}}$$

QUESTION

For a rocket propulsion velocity of exhaust gases relative to rocket is 2 km/s. If mass of rocket system is 1000 kg, then the rate of fuel consumption for a rocket to rise up with an acceleration 4.9 m/s^2 will be: [H.W]

A. 12.25 kg/s

B. 17.5 kg/s

C. 7.35 kg/s

D. 5.2 kg/s

NEWTONS 3rd LAW

" To every action, there is always an equal and opposite reaction".

Explanation: (Law of Action-Reaction)

Suppose a body 1 exerts a force on a body 2. This force is called action force, F_{12}.

Now body 2 exerts opposite force on body 1. This is called reaction Force F_{21}.

Here F_{12} = - F_{21}

Action and reaction will act on different bodies so they do not cancel with each other.

Examples

1. When a bullet is fired from a gun, bullet moves in forward direction and gun moves in backward direction.

2. A swimmer pushes the water in backward direction and water pushes the swimmer in forward direction.

3. Walking on the ground

4. Pulling a cart by horse

5. Flight of jet-planes and rockets

QUESTION

A rider on horse back falls when horse starts running all of a sudden because

A. Rider is taken back

B. Rider is suddenly afraid of falling

C. $\boxed{\text{Inertia of rest keeps the upper part of body at rest whereas lower part of the body moves forward with the horse}}$

D. None of the above

QUESTION

When a train stops suddenly, passengers in the running train feel an instant jerk in the forward direction because

A The back of seat suddenly pushes the passengers forward

B Inertia of rest stops the train and takes the body forward

C Upper part of the body continues to be in the state of motion whereas the lower part of the body in contact with seat remains at rest

D Nothing can be said due to insufficient data

QUESTION

A man getting down a running bus falls $\boxed{\text{forward}}$ because

(A) Due to inertia of rest, road is left behind and man reaches forward

(B) $\boxed{\text{Due to inertia of motion upper part of body continues to be in motion in forward direction while feet come to rest as soon as they touch the road}}$

(C) He leans forward as a matter of habit

(D) Of the combined effect of all the three factors stated in (1), (2) and (3)

QUESTION

Essential characteristic of $\boxed{\text{equilibrium}}$ is

$F_{net} = 0$ $F = ma$

$a_{net} = 0$ $F \propto a$.

(A) Momentum equals zero

(B) $\boxed{\text{Acceleration equals zero}}$ ✓

(C) K.E. equals zero

(D) Velocity equals zero

QUESTION

Action and reaction: (For a given system)

(a) Act on the two different objects (b) Have opposite directions

(c) Have equal magnitudes (d) Have zero resultant

A a, b, c

B b, c, d

C All of the above

D None of the above

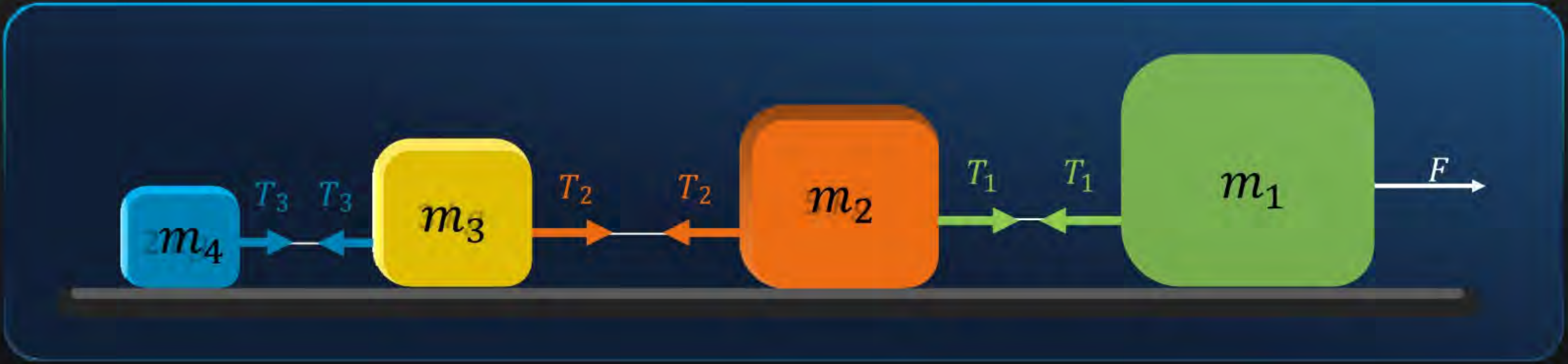
Blocks Connected by a String

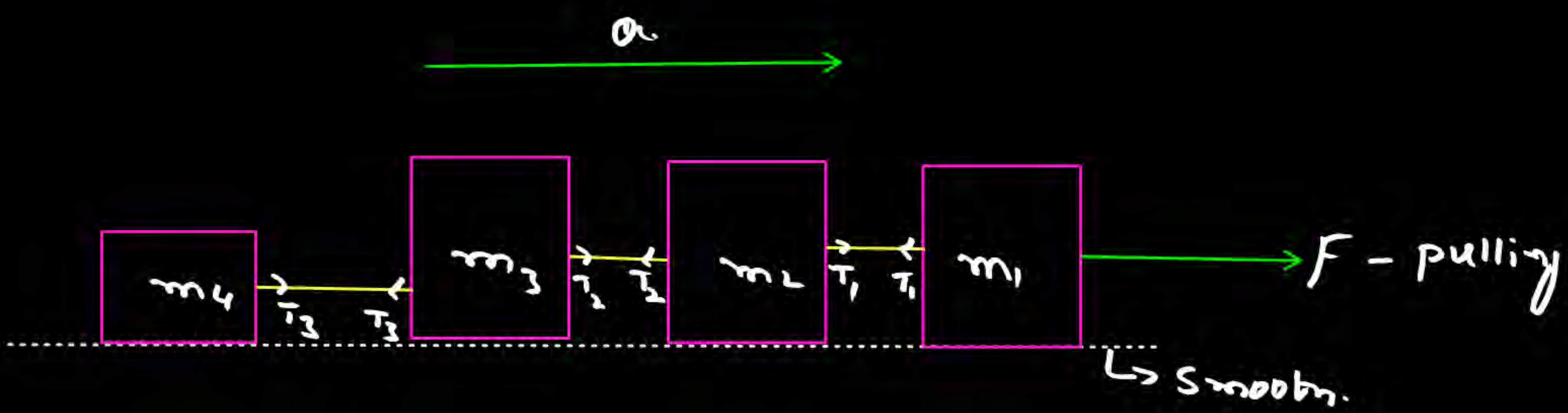
Trick: * $a = \frac{F_{net}}{M} = \frac{F}{m_1 + m_2 + m_3 + \cdots}$

- Mass of string is negligible.
- String is inextensible/inelastic.

* Tension, T = (masses pulled) x acceleration (a)

$T_1 = (m_2 + m_3 + m_4)a$, $T_2 = (m_3 + m_4)a$, $T_3 = m_4 a$.

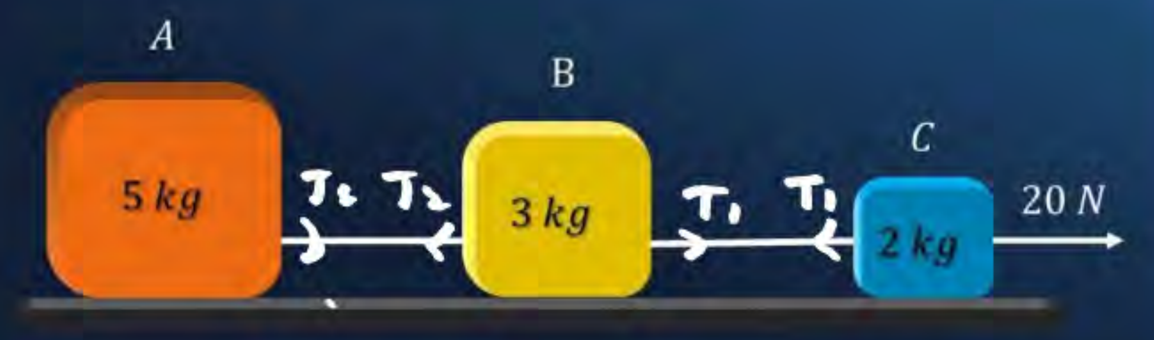




$\boxed{\text{Trick:}}$ $$a = \frac{F}{M} = \frac{F}{m_1 + m_2 + m_3 + m_4}$$

$$\text{Tension, } T = \left(\begin{matrix}\text{masses}\\ \text{pulled}\end{matrix}\right) \times a.$$

Figure shows three blocks connected by a light inextensible string. A pulling force of $20\ N$ is applied on the block of $2\ kg$ horizontally. Find the tension in the string connecting the three blocks.



$$a = \frac{F}{m} = \frac{F}{m_A + m_B + m_C} = \frac{20}{5+3+2}$$

$$\boxed{a = \frac{20}{10} = 2\ m/s^2}$$

$$T_1 = (m_B + m_A)\,a$$

$$T_1 = (3+5) \times 2$$

$$T_1 = 8 \times 2$$

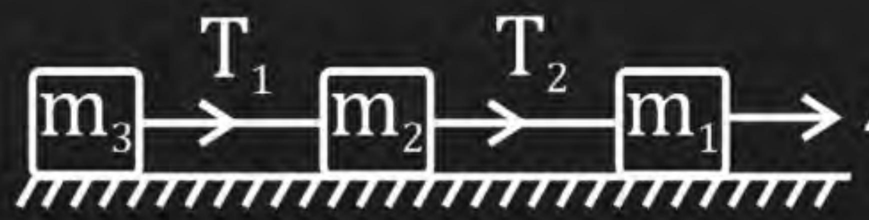
$$\boxed{T_1 = 16\ N}$$

$$T_2 = m_A a = 5 \times 2$$

$$\boxed{T_2 = 10\ N}$$

QUESTION

Three block of masses m_1, m_2 and m_3 are connected by massless strings as shown in the figure on a frictionless table. They are pulled with a force of 40 N. If $m_1 = 10$ kg, $m_2 = 6$ kg and $m_3 = 4$ kg, then tension T_2 will be:



A) 10 N

B) $\boxed{20\text{ N}}$

C) 32 N

D) 40 N

$T_2 = (m_2 + m_3)a$

$T_2 = (6+4) \times 2$

$T_2 = 10 \times 2$

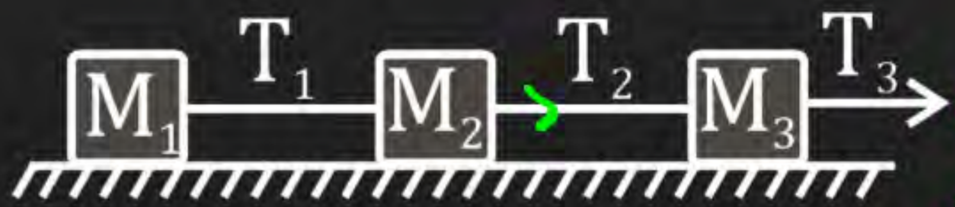
$\boxed{T_2 = 20\text{N}}$

$a = \frac{F}{m} = \frac{40}{10+6+4} = \frac{40}{20} = 2\text{m/s}^2$

$\boxed{a = 2\text{m/s}^2}$

QUESTION

Three blocks are connected as shown in figure. on a horizontal frictional frictionless table if $m_1 = 1$ kg, $m_2 = 8$ kg, $m_3 = 27$ kg and $T_3 = 36$ N, T_2 will be:



$F = T_3$

$F = 36N$

$a = \frac{F}{m} = \frac{36}{1+8+27} = \frac{36}{36}$

$\boxed{a = 1 m/s^2}$

$T_2 = (m_1 + m_2)a$

$T_2 = (1+8)1$

$\boxed{T_2 = 9N}$

(A) 18 N

(B) $\boxed{9 \text{ N}}$

(C) 3.375 N

(D) 1.75 N

Blocks are in contact

Trick: $\boxed{a = \frac{F}{m}}$ *

$T = N$

$T = \left(\begin{matrix}\text{masses}\\ \text{pulled}\end{matrix}\right) \times a$

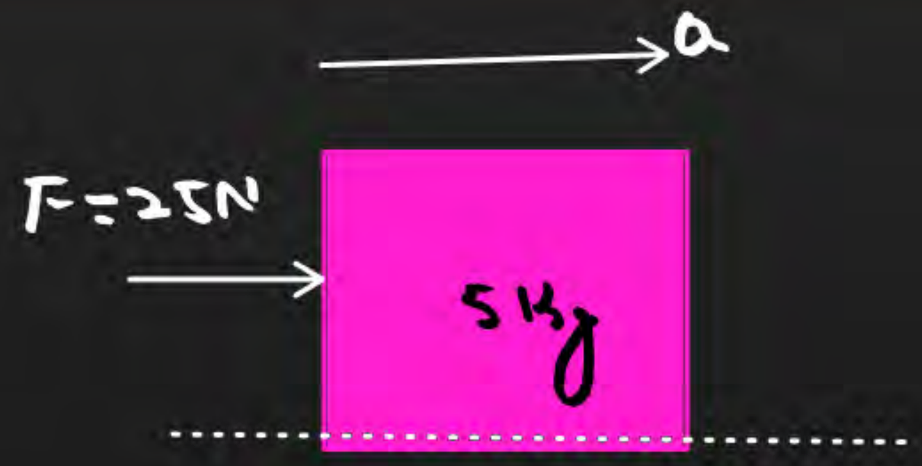
Normal, * $\boxed{N = \left(\begin{matrix}\text{masses}\\ \text{pushed}\end{matrix}\right) a}$

A block of mass $5\ kg$ is kept on a smooth surface. A force of $25\ N$ is applied. Find the acceleration of the block.

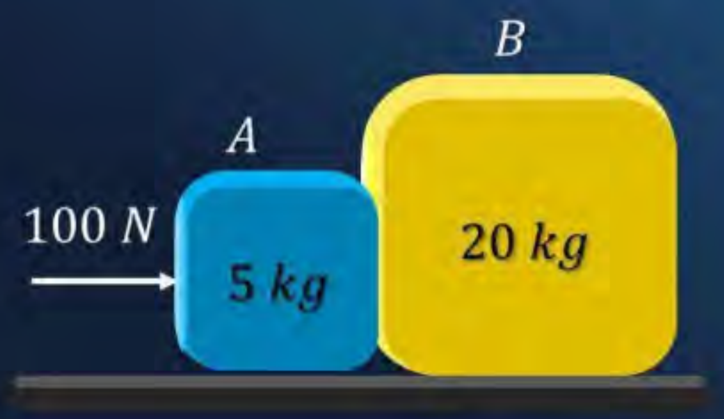
$F = ma$

$a = \frac{F}{m} = \frac{25}{5} = 5$

$\boxed{a = 5\ m/s^2}$



Two blocks kept in contact experience $100\ N$ force as shown. Find the acceleration of the $5\ kg$ block and the normal force between the blocks.

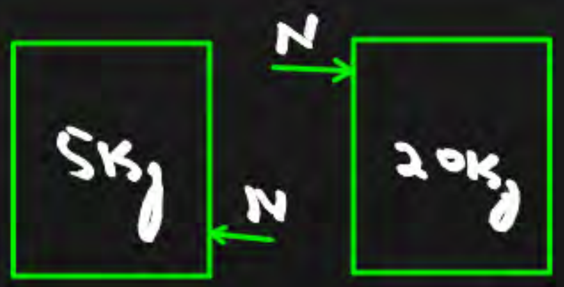


$$a = \frac{F}{m} = \frac{100}{5+20} = \frac{100}{25} = 4$$

$$\boxed{a = 4\ m/s^2}$$

$$N = 20 \times 4$$

$$\boxed{N = 80\ N}$$



QUESTION

A horizontal force 10 N is applied to a block A as shown in figure. The mass of blocks A and B are 2 kg and 3 kg respectively. The blocks slide over a frictionless surface. The force exerted by block A on block B is:

A $\boxed{6\text{ N}}$

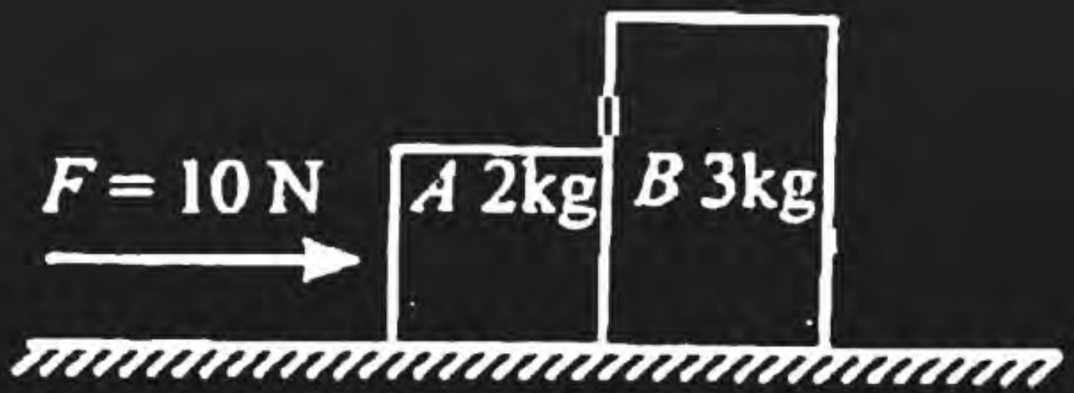
B 10 N

C Zero

D 4 N

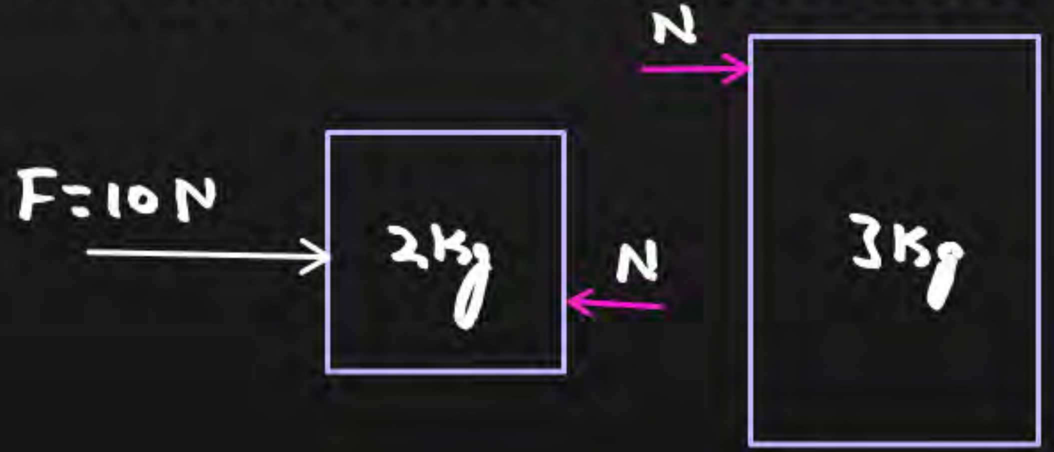
$a = \frac{F}{m} = \frac{10}{2+3} = \frac{10}{5}$

$\boxed{a = 2\,m/s^2}$



$N = 3 \times 2$

$\boxed{N = 6N}$



QUESTION

Three blocks A, B and C of masses 4 kg, 2 kg and 1 kg respectively, are in contact on a friction less surface, a shown. If a force of 14 N is applied on the 4 kg block, the contact force between A and B is:

(A) $\boxed{6\text{ N}}$

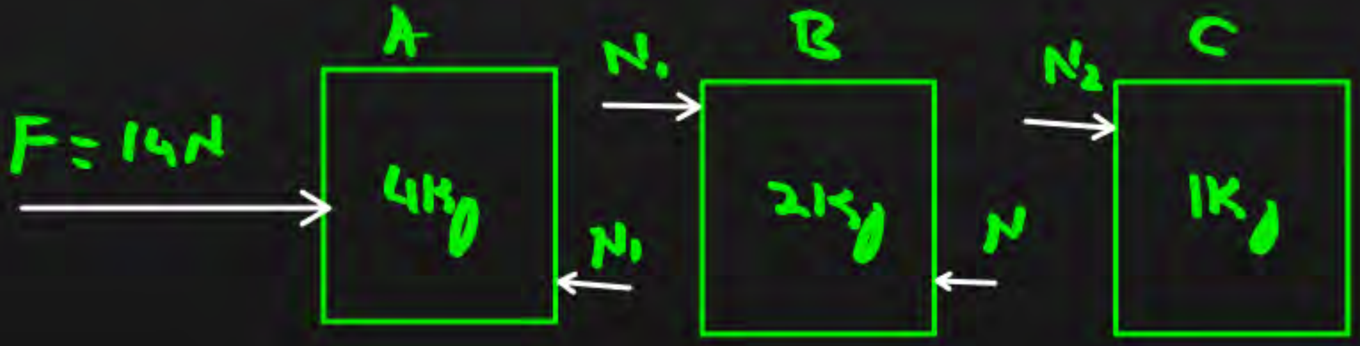
(B) 8 N

(C) 18 N

(D) 2 N

$a = \frac{F}{m} = \frac{14}{4+2+1} = \frac{14}{7}$

$\boxed{a = 2\,m/s^2}$



$N = (2+1) \times 2$

$N = 3 \times 2$

$\boxed{N = 6N}$

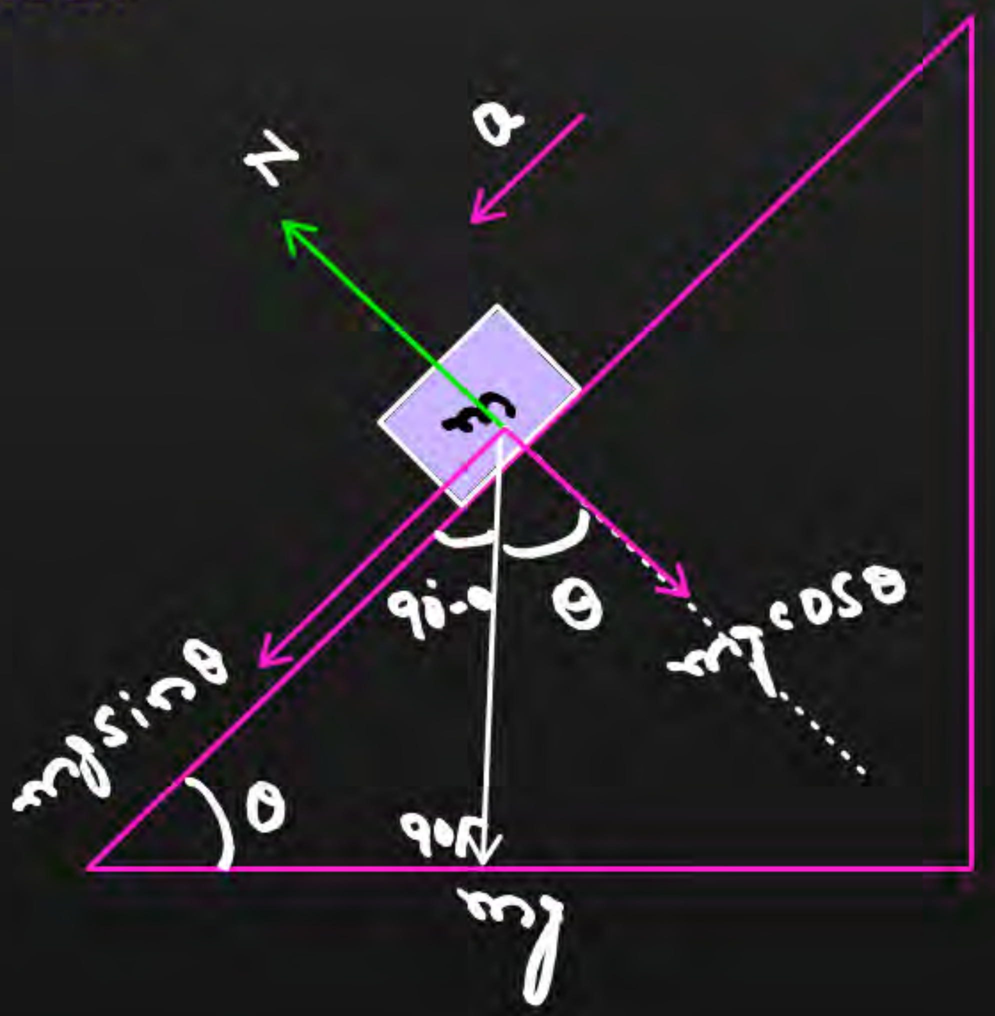
Blocks on an Inclined Plane

- Case 1 : No external force is applied on the block

$$F_{net} = ma$$

$$mg\sin\theta - 0 = \cancel{m}a$$

$$\boxed{a = g\sin\theta}$$



Blocks on an Inclined Plane

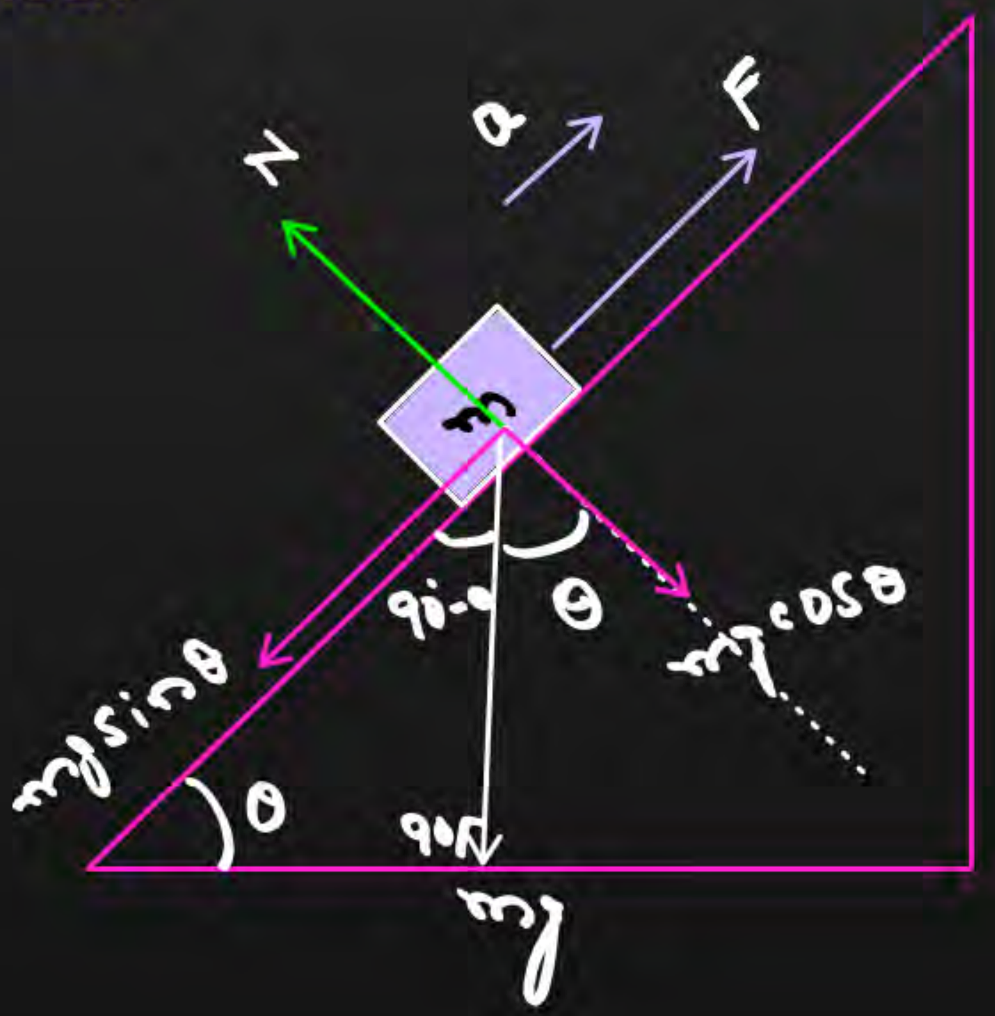
- Case 2 : ~~No external~~ upward force is applied on the block

$$F_{net} = ma$$

$$F - mg\sin\theta = ma$$

$$* \boxed{a = \frac{F - mg\sin\theta}{m}}$$

$$* \boxed{a = \frac{S.F - O.F}{mass}} *$$



Blocks on an Inclined Plane

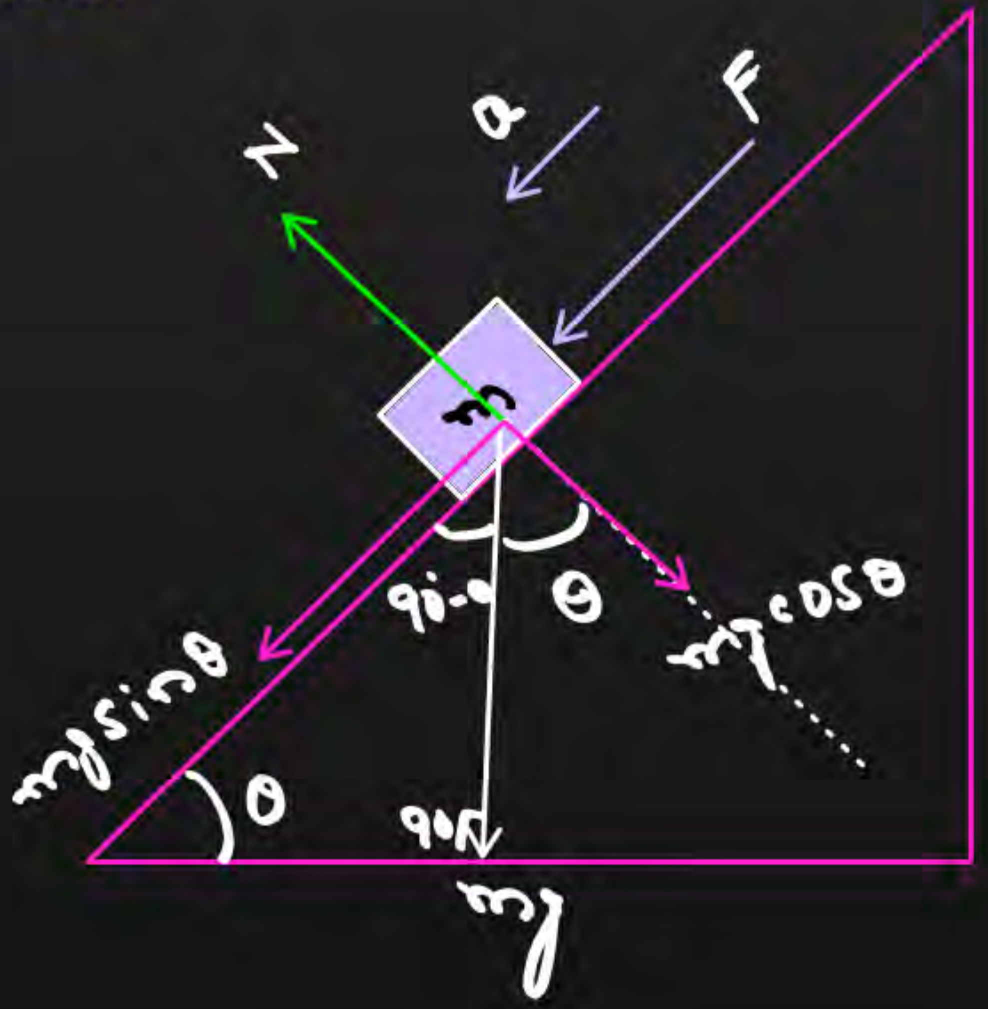
- Case ~~1~~ 3 : ~~No external~~ Downward force is applied on the block

$$F_{net} = ma$$

$$F + mg\sin\theta = ma$$

$$\boxed{a = \frac{F + mg\sin\theta}{m}}$$

$$\boxed{a = \frac{S.F + O.F}{mass}}$$



QUESTION

θ

A box of mass 5 kg is pulled by a cord, $\boxed{\text{up along}}$ a frictionless plane inclined at 30° with the horizontal. The tension in the cord is 30 N . The acceleration of the box is (Take $g = 10\ \mathrm{ms}^{-2}$)

F

(A) $2\ \mathrm{m\ s}^{-2}$

(B) Zero

(C) $0.1\ \mathrm{m\ s}^{-2}$

(D) $\boxed{1\ \mathrm{m\ s}^{-2}}$

$$a = \frac{F - mg\sin\theta}{m} = \frac{30 - 5\times10\times\sin30^\circ}{5}$$

$$a = \frac{30-25}{5} = \frac{5}{5}$$

$$\boxed{a = 1\ \mathrm{m/s^2}}$$

QUESTION

Down

θ

A box of mass 5 kg is pulled by a cord, $\boxed{\cancel{\text{up}}\text{ along}}$ a frictionless plane inclined at 30° with the horizontal. The tension in the cord is 30 N . The acceptation of the box is (Take $g = 10\ \mathrm{ms^{-2}}$)

F

A $2\ \mathrm{m\ s^{-2}}$

B Zero

C $0.1\ \mathrm{m\ s^{-2}}$

D $\boxed{11\ \mathrm{m\ s^{-2}}}$

$$a = \frac{F + mg\sin\theta}{m} = \frac{30 + 5\times 10\times \sin 30^\circ}{5}$$

$$a = \frac{30+25}{5} = \frac{55}{5}$$

$$\boxed{a = 11\ \mathrm{m/s^2}}$$

QUESTION

placed at rest on θ

A box of mass 5 kg is ~~pulled by a cord,~~ $\boxed{\text{~~up~~}}$ ~~along a~~ frictionless plane inclined at 30° with the horizontal. ~~The tension in the cord is 30 N~~ . The acceleration of the box is (Take $g=10 \mathrm{~ms}^{-2}$)

(A) $2 \mathrm{~m} \mathrm{~s}^{-2}$

(B) ~~Zero~~ $\boxed{5 \mathrm{~m/s}^{2}}$

(C) $0.1 \mathrm{~m} \mathrm{~s}^{-2}$

(D) $1 \mathrm{~m} \mathrm{~s}^{-2}$

$a = g \sin\theta$

$a = 10 \times \sin 30^{\circ}$

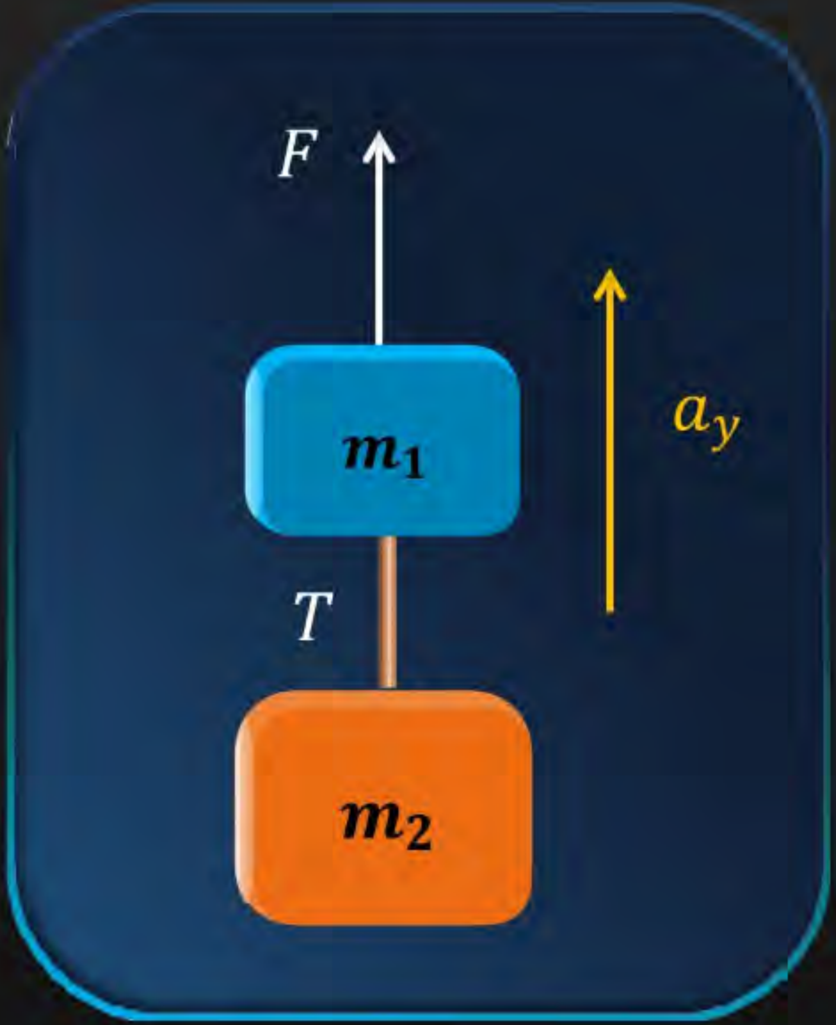
$a = 10 \times \frac{1}{2}$

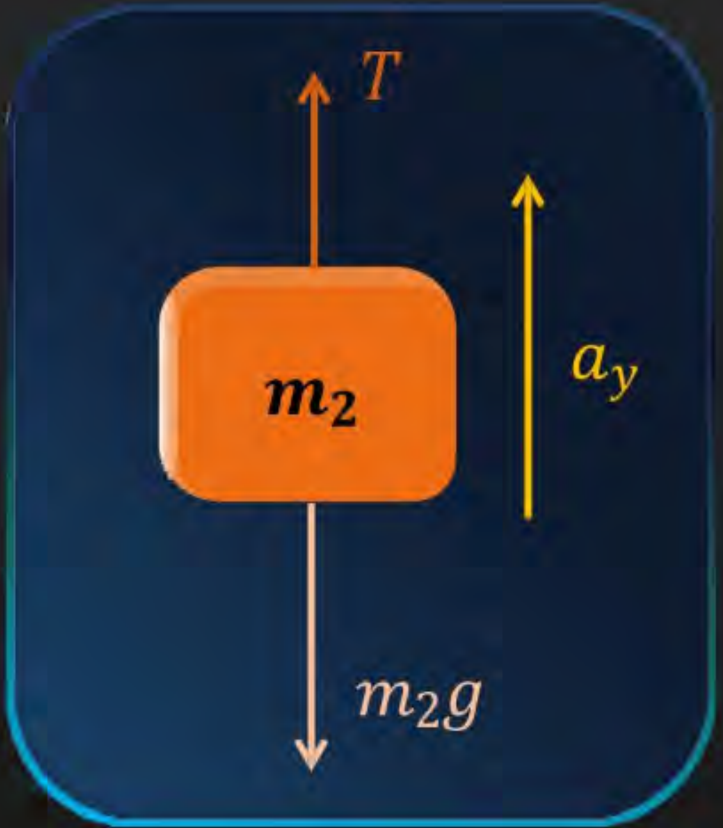
$\boxed{a = 5 \mathrm{~m/s}^{2}}$

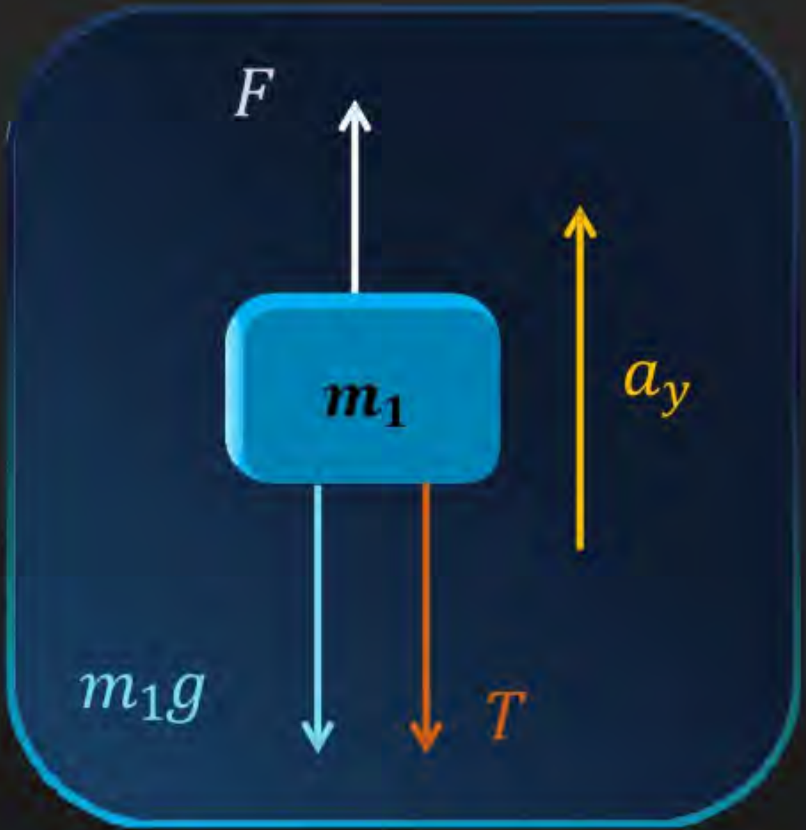
Vertical motion of the block

$a = \frac{F}{m}$

In Upward Direction:







Tension, $T = \left(\begin{matrix}\text{masses} \\ \text{pushed/} \\ \text{pulled}\end{matrix}\right) a$

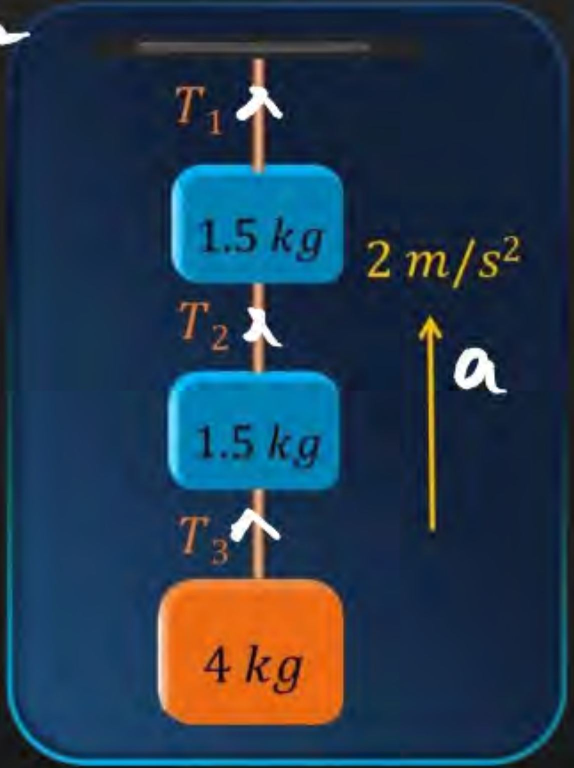
$T = (\text{Masses pulled}) \times g_{eff}$

$g_{eff} = g + a \rightarrow$ Upward

$g_{eff} = g - a \rightarrow$ Downward

Three blocks are suspended by a light string as shown in the figure below. What is the value of T_1, T_2 and T_3 if the whole system is moving up with an acceleration $2\ m/s^2$? (Take $g = 10\ m/s^2$)

$g_{eff} = g + a = 10 + 2 = 12\ m/s^2$



$T_1 = (1.5 + 1.5 + 4) \times 12 = 84\ N$

$T_2 = (1.5 + 4) \times 12 = 66\ N$

$T_3 = 4 \times 12 = 48\ N$

Three blocks are suspended by a light string as shown in the figure below. What is the value of T_1, T_2 and T_3 if the whole system is $\boxed{\text{moving up}}$ with an acceleration $2\ m/s^2$? (Take $g = 10\ m/s^2$)

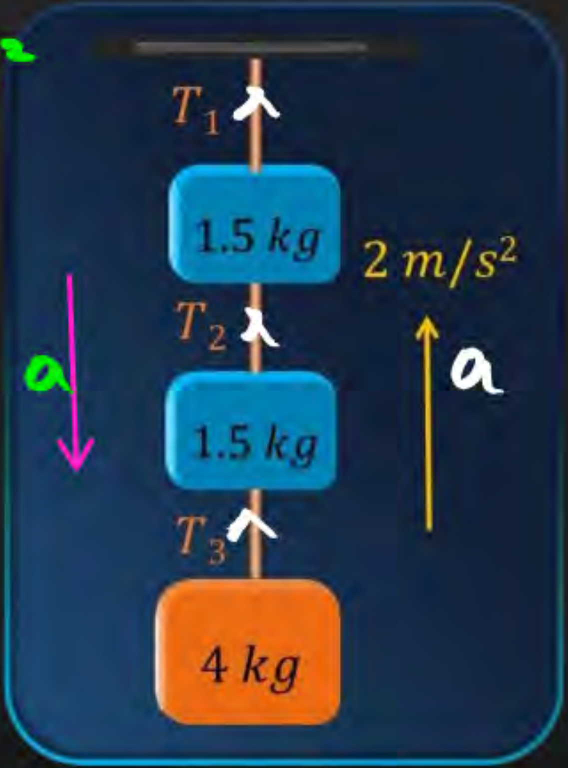
moving Down

$g_{eff} = g - a = 10 - 2 = 8\ m/s^2$

$T_1 = (1.5 + 1.5 + 4) \times 8 = 56\ N$

$T_2 = (1.5 + 4) \times 8 = 44\ N$

$T_3 = 4 \times 8 = 32\ N$



QUESTION

Find the tension T_2 for the system shown in fig.

(A) 1g N

(B) 2g N

(C) $\boxed{5g\ N}$

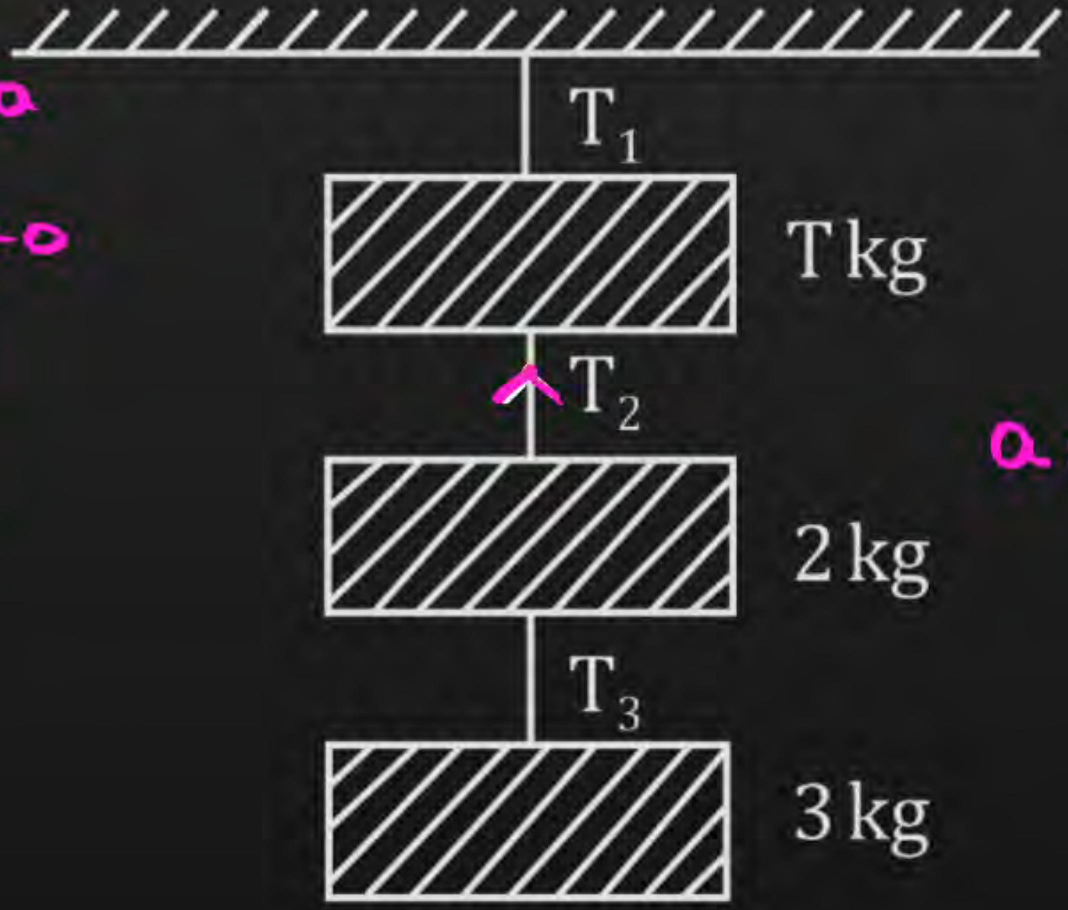
(D) 6g N

$g_{eff} = g + a$

$= g + 0$

$\boxed{g_{eff} = g}$

$a = 0$



$T_2 = (2+3)g$

$\boxed{T_2 = 5g}$ N

Pulley

$\mapsto$ Atwood machine (Atwood) ↳ Air.

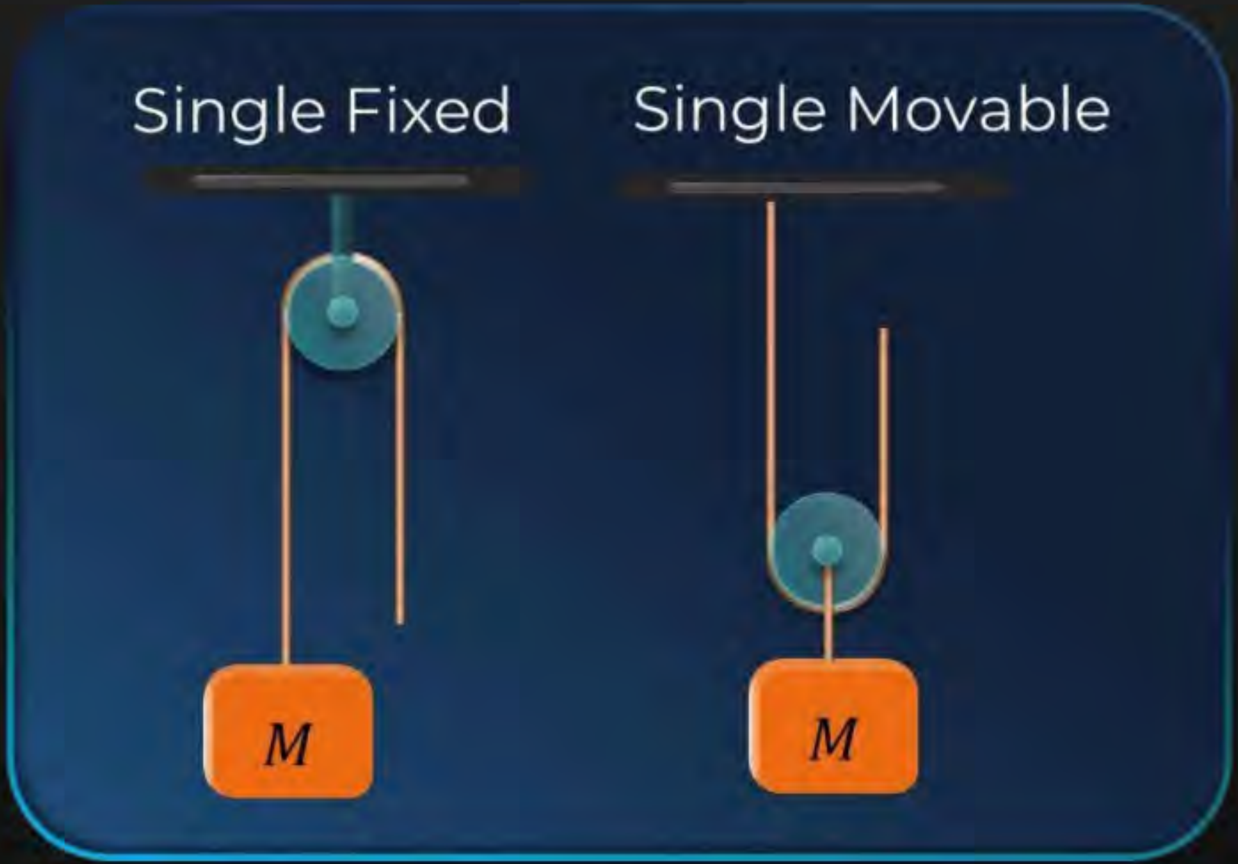
* $a = \left(\frac{\text{Diff in masses}}{\text{Sum of masses}}\right) g$

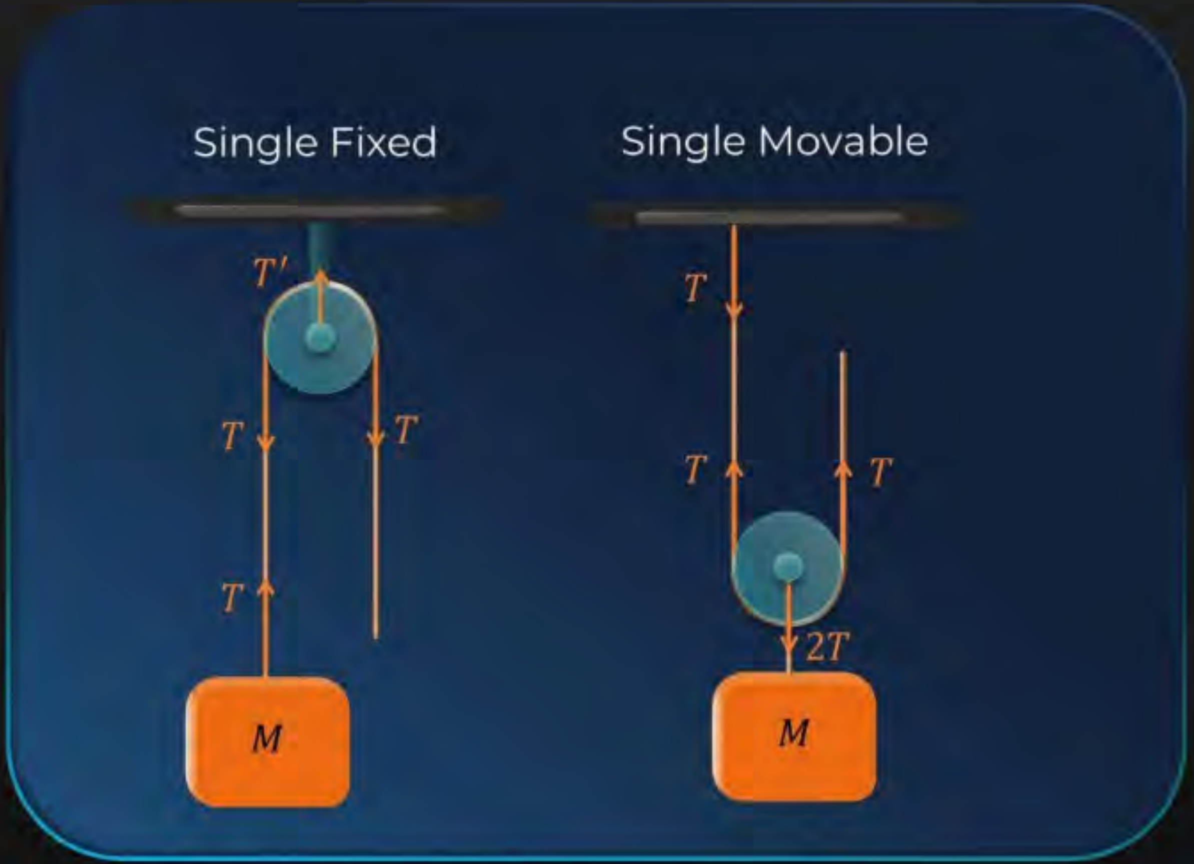
↳ Anywhere

2 pulley: * $T = \left(\frac{2\ \text{product of masses}}{\text{Sum of masses}}\right) g$

Assumption:

1. The rope is massless and inextensible.
2. The pulley is light, massless and frictionless.





After the blocks are released from rest, calculate the acceleration of the system and the amount of tension in the string.
(Take $g = 10\ m/s^2$)

$$a = \frac{1}{5} \times 10 = 2\ m/s^2$$

$$\boxed{a = 2\ m/s^2}$$

$$a = \left(\frac{\text{Diff in mass}}{\text{sum of mass}}\right) g$$

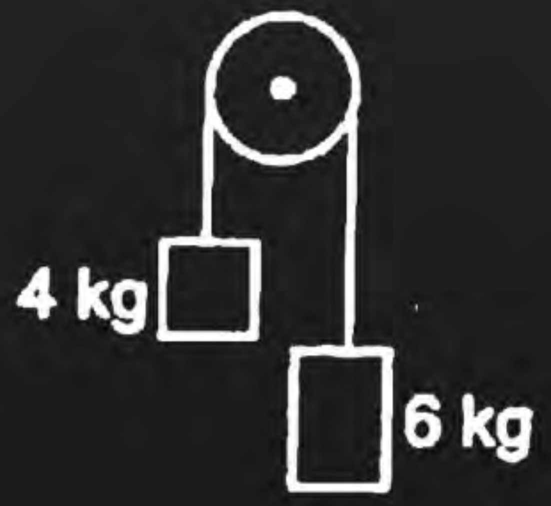
$$T = \left(\frac{2 \times 2 \times 3}{2+3}\right) \times 10$$

$$T = \frac{12}{\cancel{5}} \times \cancel{10}^{2}$$

$$\boxed{T = 24 N}$$

QUESTION

Two bodies of mass 4 kg and 6 kg are tied to the ends of a massless string. The string passes over a pulley which is frictionless (see figure). The acceleration of the system in terms of acceleration due to gravity (g) is:



(A) $g/2$

(B) $\boxed{g/5}$

(C) $g/10$

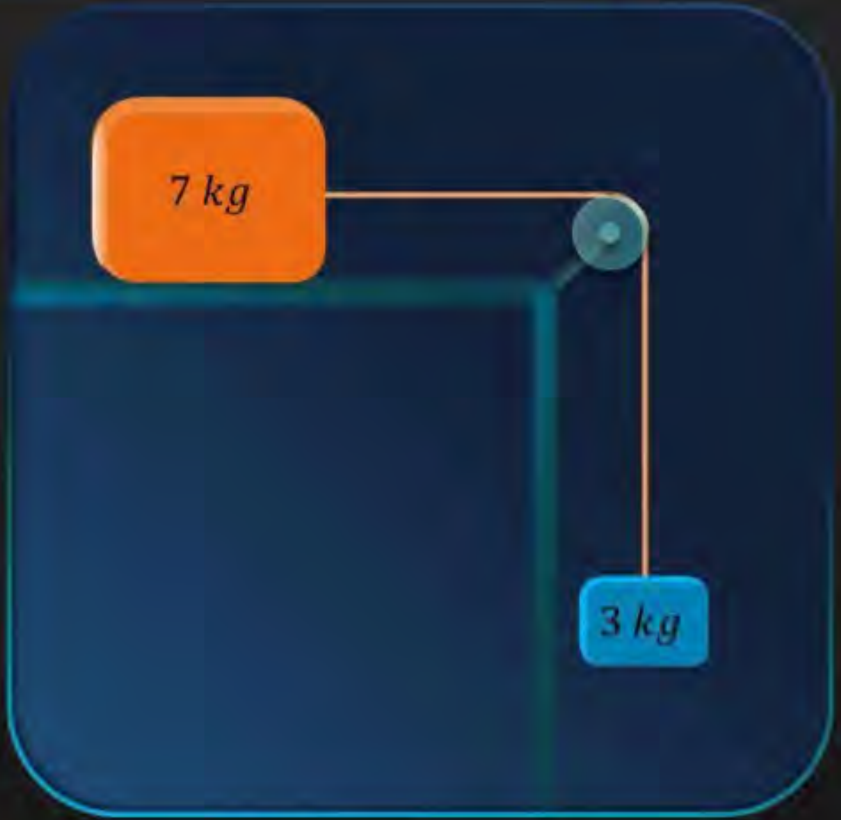
(D) g

$$a = \left(\frac{6-4}{6+4}\right)g = \frac{2}{10} \times g$$

$$\boxed{a = \frac{g}{5}}$$

A block A of mass $7\ kg$ is placed on a frictionless table. A thread tied to it passes over a frictionless pulley and carries a body B of mass $3\ kg$ at the other end. The acceleration of the system is (Assume table to be smooth and take
$g = 10\ m/s^2$)

$$a = \left[\frac{\text{Diff in masses (Air)}}{\text{Sum of masses (Anywhere)}}\right] g$$

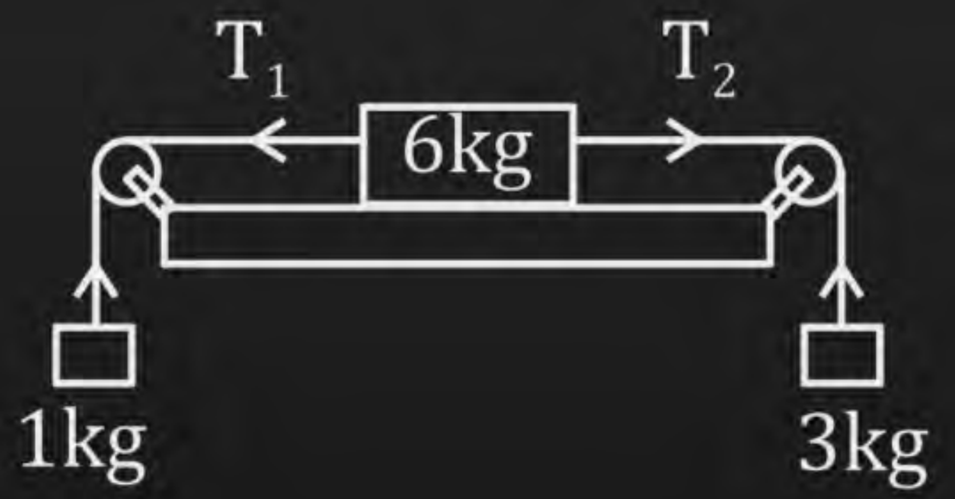


$$a = \frac{3}{3+7} \times 10$$

$$a = \frac{3}{10} \times 10 \Rightarrow \boxed{a = 3\ m/s^2}$$

QUESTION

Three masses of 1 kg, 6 kg and 3 kg are connected to each other with threads and are placed on table as shown in figure. What is the acceleration with which the system is moving? (Take $g = 10\ m/s^2$)



(A) Zero

(B) $\boxed{2\ m/s^2}$

(C) $4\ m/s^2$

(D) $3\ m/s^2$

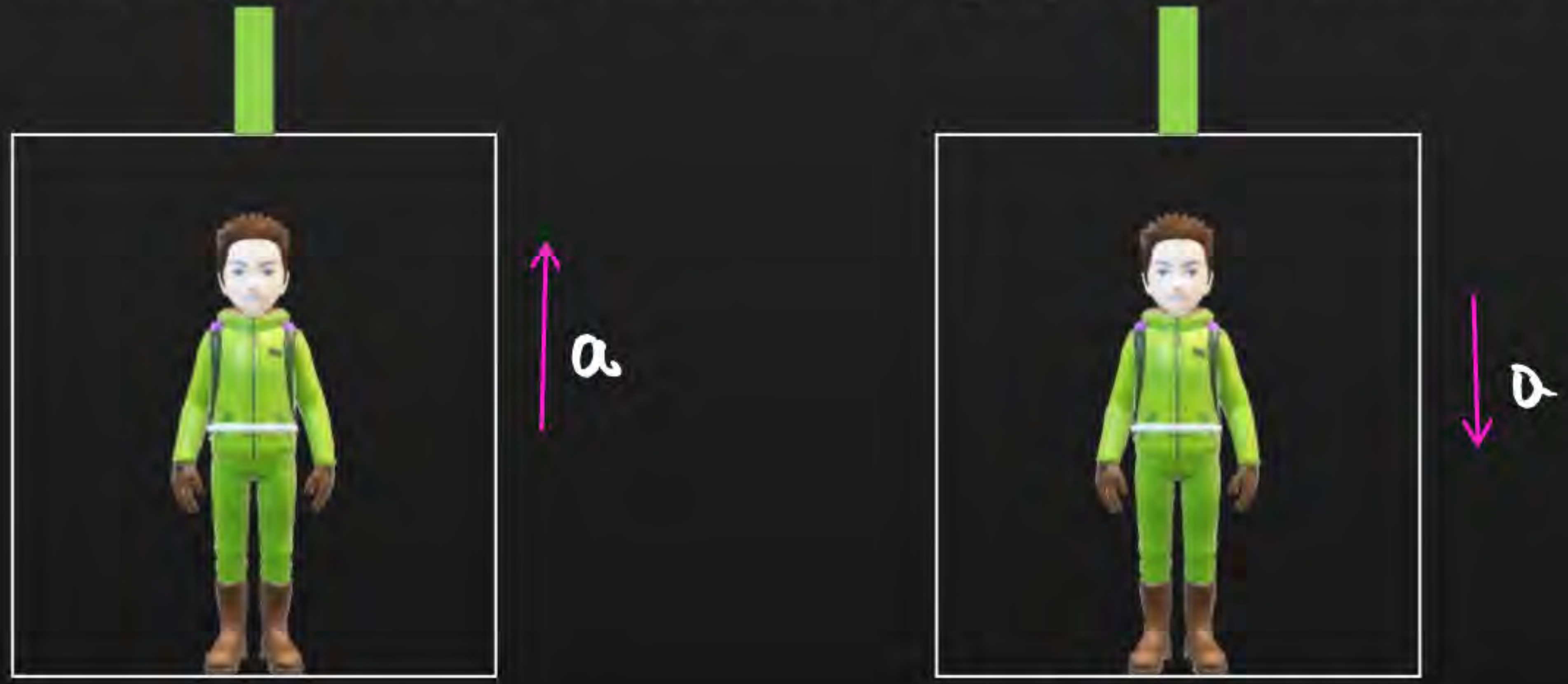
$$a = \left(\frac{3-1}{1+6+3}\right) \times 10$$

$$a = \frac{2}{10} \times 10$$

$$\boxed{a = 2\ m/s^2}$$

APPARENT WEIGHT OF A BODY IN A LIFT

Apparent weight : The weight that a person feels when moving up or down in the lift.



$g_{eff} = g + a$

$g_{eff} = g - a$

QUESTION

A man weighs 80 kg . He stands on a weighing scale in a lift which is moving upwards with a uniform acceleration of $5 \mathrm{~m/s^2}$. What would be the reading on the scale? $(g = 10 \mathrm{~m/s^2})$:

(A) Zero

(B) 400 N

(C) 800 N

(D) 1200 N

$W = mg$

$W = mg_{eff}$

$g_{eff} = g + a$

$= 10 + 5 = 15 \mathrm{~m/s^2}$

$W = 80 \times 15$

$\boxed{W = 1200 N}$

QUESTION

A person of mass 60 kg is inside a lift of mass 940 kg and presses the button on control panel. The lift starts moving $\boxed{\text{upwards}}$ with an acceleration $1.0\ \text{m/s}^2$. If $g = 10\ \text{ms}^{-2}$, the tension in the supporting cable is

a

(A) 8600 N

(B) 9680 N

(C) $\boxed{11000\ \text{N}}$

(D) 1200 N

$T = M(g + a)$

$T = (60 + 940)(10 + 1)$

$T = 1000 \times 11$

$\boxed{T = 11000\ \text{N}}$

FRICTION

The property by virtue of which two surfaces in contact opposes the relative motion of the surfaces is known friction.

The force that always opposes the motion of one body over the other body in contact with it is known as force of friction.

TYPES OF FRICTION

→ f_{lim} find ✓

→ $F_{app} > f_{lim} \Rightarrow f_k$ ✓ a ✓

↳ motion

TYPES OF FRICTION

→ $F_{app} < f_{lim} \Rightarrow$ Rest, $a = 0$

↳ $\boxed{f_s = F_{app}}$

self adjusting force

STATIC FRICTION

$N = mg$

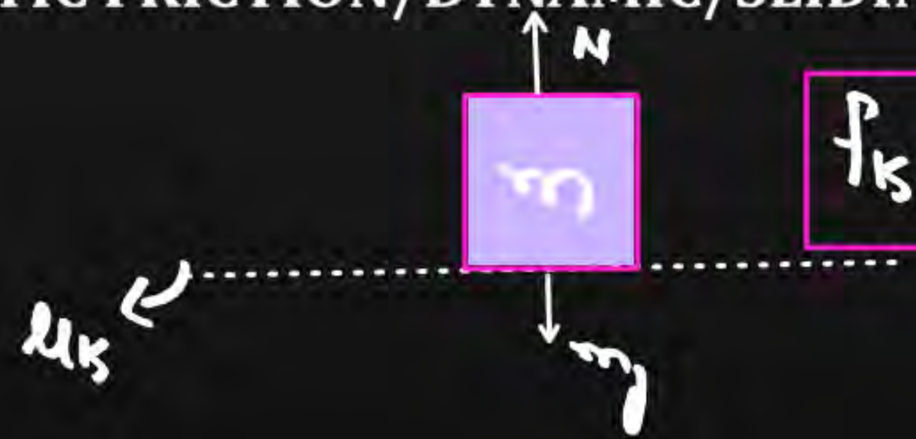
↳ μ_s

$$\boxed{F_{lim} = \mu_s N = \mu_s mg}$$

$$0 \le f_s \le f_{lim}$$

KINETIC FRICTION

KINETIC FRICTION/DYNAMIC/SLIDING FRICTION



$$\boxed{f_k = \mu_k N = \mu_k mg}$$

HOW TO SOLVE PROBLEMS

1. Check if there is relative motion or not?

2. Calculate $F_{lim} = \mu_s N = \mu_s mg$

3. If $F_{app} \leq F_{lim}$- The body is at rest, $\boxed{F_s = F_{app}}$

4. If $F_{app} > F_{lim}$- The body is in motion, $\boxed{F_K = \mu_K N}$

QUESTION

Maximum force of friction is called

A $\boxed{\text{Limiting friction}}$

B Static friction

C Sliding friction

D Rolling friction

QUESTION

The limiting friction between two bodies in contact is independent of

A. Nature of the surface in contact ✓

B. $\boxed{\text{The area of surfaces in contact}}$ ✗

C. Normal reaction between the surfaces ✓

D. The materials of the bodies ✓

$F_{lim} = \mu_s mg = \mu_s N$

QUESTION

A block of mass 2 kg is kept on the floor. The coefficient of static friction is 0.4. If a force F of 2.5 Newton's is applied on the block as shown in the figure, the frictional force between the block and the floor will be:

(A) $\boxed{2.5\text{ N}}$

(B) 5 N

(C) 7.84 N

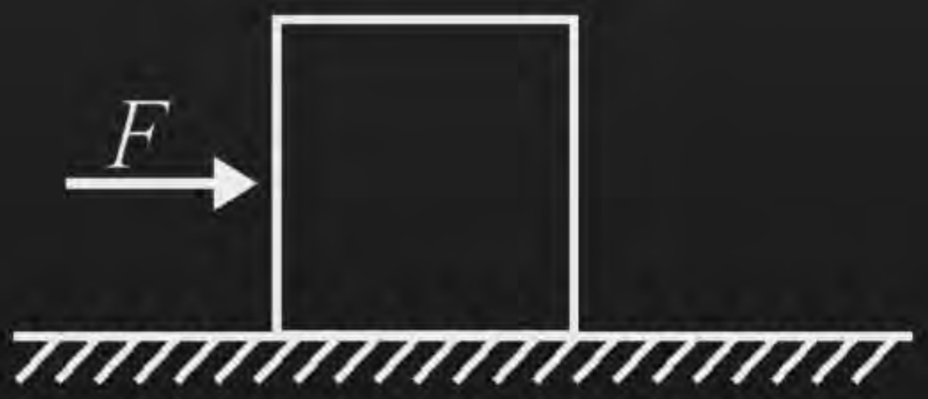
(D) 10 N

$F_{lim} = \mu_s N = \mu_s mg$

$= 0.4 \times 2 \times 10$

$\boxed{F_{lim} = 8\text{N}}$

$F_{app} < F_{lim} \Rightarrow$ Rest



$\boxed{\begin{array}{l} F_s = F_{app} \\ F_s = 2.5\text{N} \end{array}}$

QUESTION

A body of mass 2 kg is kept by pressing to a vertical wall by a force of 100 N. The coefficient of friction between wall and body is 0.3. Then the frictional force is equal to:

A. 6 N

B. 20 N

C. 600 N

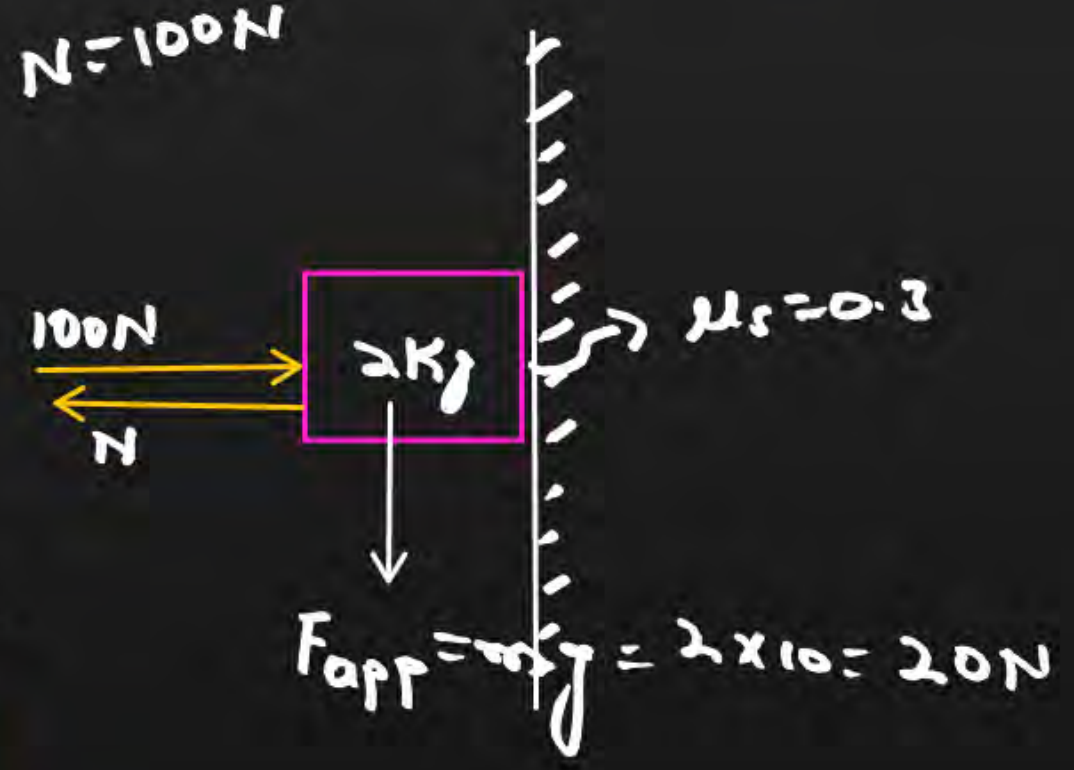
D. 700 N

$F_{lim} = \mu_s N = 0.3 \times 100$

$\boxed{F_{lim} = 30N}$

$F_{app} < F_{lim}$, Rest, $F_s = F_{app}$

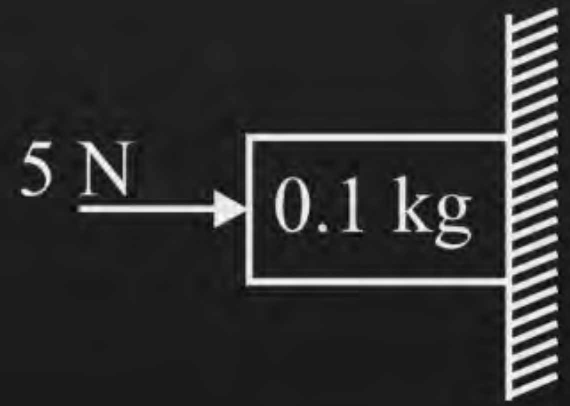
$\boxed{F_s = 20N}$



QUESTION

H.W

A block of mass 0.1 kg. is pressed against a wall with a horizontal force of 5N as shown in the figure. If the coefficient of friction between the wall and the block is 0.5 then the frictional force acting on the block will be ($g = 9.8\ m/s^2$):-



(A) 9.8 N

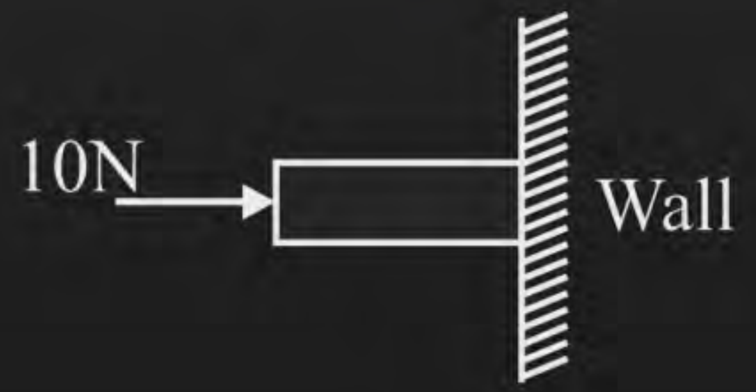
(B) 2.5 N

(C) 0.98 N

(D) 0.49 N

QUESTION

A horizontal force of 10 N is necessary to just hold a block stationary against a wall. The coefficient of friction between the block and wall is 0.2. The weight of the block is :-



(A) 20 N

(B) 50 N

(C) 100 N

(D) 2 N

Banking of Road

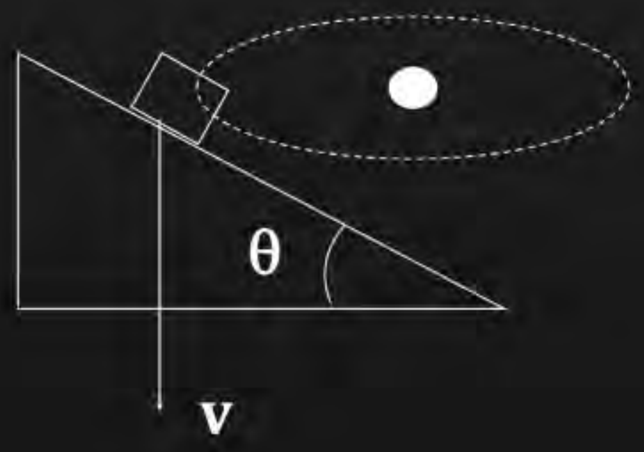
Banking of Road

With friction

Without Friction

$$\tan\theta = \frac{v^2}{Rg}$$

$$V = \sqrt{Rg\tan\theta}$$



$$V_{min} = \sqrt{Rg\left(\frac{\tan\theta - \mu}{1 + \mu\tan\theta}\right)}$$

$$V_{max} = \sqrt{Rg\left(\frac{\tan\theta + \mu}{1 - \mu\tan\theta}\right)}$$

QUESTION

A car is negotiating a curved road of radius R. The road is banked at an angle θ. the coefficient of friction between the tyres of the car and the road is μ_s · The maximum safe velocity on this road is

(A) $\sqrt{gR^2\frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}}$ ✗

(B) $\boxed{\sqrt{gR\frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}}}$

(C) $\sqrt{\frac{g}{R}\frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}}$ ✗

(D) $\sqrt{\frac{g}{R^2}\frac{\mu_s+\tan\theta}{1-\mu_s\tan\theta}}$ ✗

Thank

You