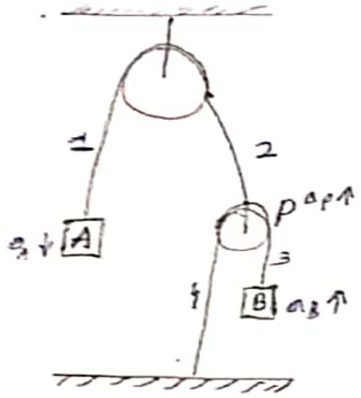
!! Chapter - 4 !!

Newton's Laws of Motion & Friction

Constraint Motions :-

→ The equations showing the relation of motion of bodies in which motion of one body is ~~con~~ constrained by the other are called constraint relations.

1. Pulley Constraint



Relation between acceleration of blocks

Δl_1 (change in length of rope 1) $= +x_A$
(जितना Block A निचे जाएगा)

$\Delta l_2 = -x_p$
(जितना pulley upar जाएगा)

$\Delta l_1 + \Delta l_2 = 0$
(rope length remains same)

$$+x_A - x_p = 0$$

$$\boxed{x_A = x_p}$$

$\Delta l_3 = + x_p - x_B$
(जितना Pulley upar जाएगा − जितना Block नीचे जाएगा)

$\Delta l_4 = x_p$

$$\Delta l_3 + \Delta l_4 = 0$$

$$x_p + x_p - x_B = 0$$

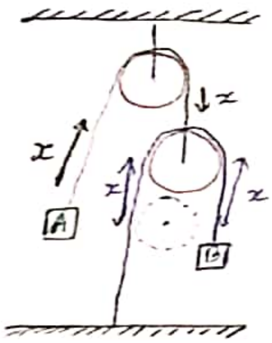
$$2x_p = x_p$$

$$2x_A = x_B$$

$$2V_A = \cancel{x_q}\, V_B$$

$$\boxed{2a_A = a_B}$$

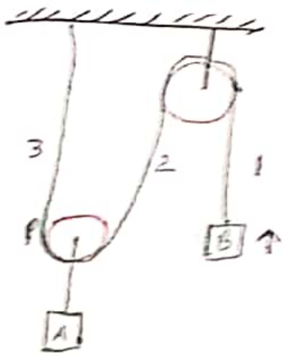
Method II



Displacement of the block B will be $2x$
A will be x.

$$\boxed{2a_A = a_B}$$

Q Find relation between movement of blocks



$\cancel{\Delta l_1 = x_B}$

$\cancel{\Delta l_2} = \cancel{x_1}$

$$\Delta l_3 = +x_A$$
$$\Delta l_2 = +x_A$$
$$\Delta l_1 = -x_B$$

$$\Delta l_1 + \Delta l_2 + \Delta l_3 = 0$$

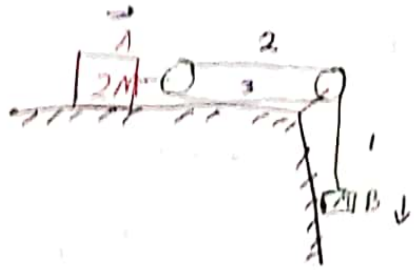
$$2x_A - x_B = 0$$

$$2x_A = x_B$$

$$2V_A = V_B$$

$$\boxed{2a_A = a_B}$$

Q find constraint relation between acceleration of A & B



$\Delta l_1 = x_B$

$\Delta l_2 = -x_A$

$\cancel{\Delta l_1 + \Delta l_2 = 0}$

$\cancel{x_B = x_A}$

$\Delta l_3 = -x_A$

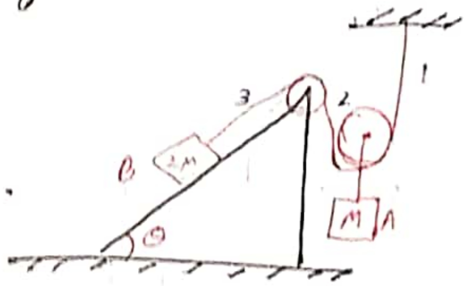
$\Delta l_1 + \Delta l_2 + \Delta l_3 = 0$

$x_B - 2x_A = 0$

$\boxed{2x_A = x_B}$

$\boxed{2a_A = a_B}$

Q find constraint relation between acceleration of A and B.



$\cancel{\Delta l_1} = \Delta l_1 = x_B$

$\Delta l_2 = -x_A$

$\Delta l_3 = -x_A$

$\Delta l_1 + \Delta l_2 + \Delta l_3 = 0$

$x_B - x_A - x_A = 0$

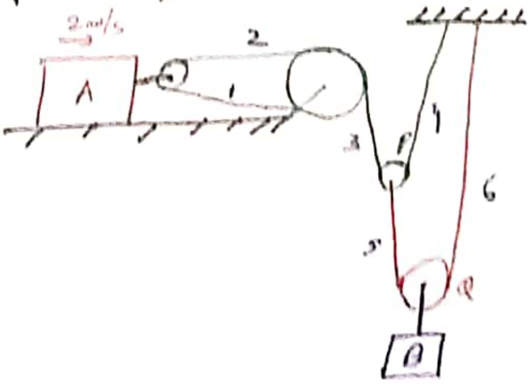
$x_B = 2x_A$

$2x_A = x_B$

$2V_A = V_B$

$\boxed{2a_A = a_B}$

Q find acceleration of block B, Pulley P & Q. If acceleration of A is given



$\Delta l_1 = -x_A$

$\Delta l_2 = -x_A$

$\Delta l_3 = x_P$

$\Delta l_4 = x_P$

$\Delta l_1 + \Delta l_2 + \Delta l_3 + \Delta l_4 = 0$

$-2x_A + 2x_P = 0$

$\boxed{x_P = x_A}$

$\Delta l_5 = +x_B \mp x_p$

$\Delta l_6 = +x_B$

$\Delta l_5 + \Delta l_6 = 0$

$+2x_B \mp x_p = 0$

$+x_p = +2x_B$

$x_A = 2x_p$

$V_A = 2V_B$

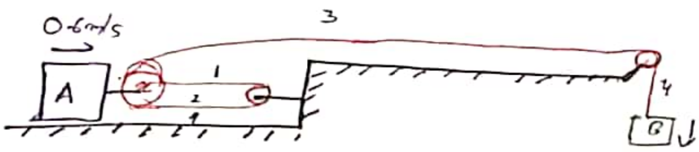
$\boxed{a_A = 2a_B}$

$a_A = 2 m/s$

$2 = 2a_B$

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

Q Block A vel = 0.6 m/s to right, find V_B.



$\Delta l_1 = -x_A$

$\Delta l_2 = -x_{BA}$

$\Delta l_3 = -x_A$

$\Delta l_4 = x_B$

$\Delta l_1 + \Delta l_2 + \Delta l_3 + \Delta l_3 = 0$

$-3x_A + x_B = 0$

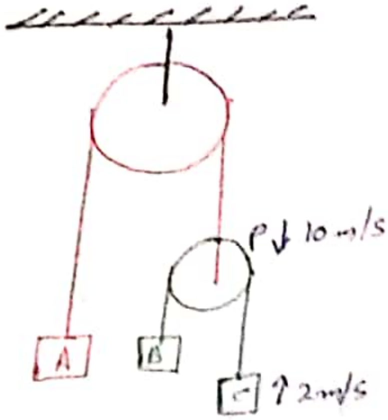
$x_B = 3x_A$

$V_B = 3V_A$

$V_B = 3(0.6)$

$\boxed{V_B = 1.8 \ m/s}$

Q find velocities of A & B if velocity of P is 10 m/s downwards and velocity of C is 2 m/s upwards.



$V_A = -V_P$

$V_P = -10\hat{j}$

$\boxed{V_A = +10\hat{j}}$

$V_C = 2\hat{j}$

$V_B = ?$

$\boxed{\vec{V}_{B,P} = -\vec{V}_{C,P}}$

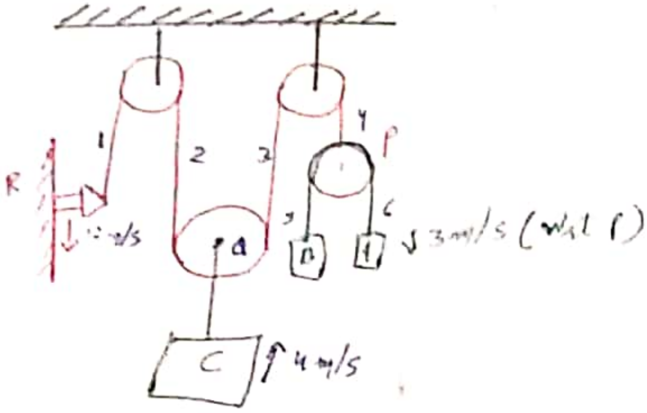
$\vec{V_B} - \vec{V_P} = -(\vec{V_C} - \vec{V_P})$

$2\vec{V_P} = \vec{V_B} + \vec{V_C}$

$2(-10\hat{j}) = \vec{V_B} + 2\hat{j}$

$\boxed{-22\hat{j} = \vec{V_B}}$

Q ~~At an instant~~ Determine motion of B with ground



$\Delta l_1 = x_R$

$\Delta l_2 = -x_c$

$\Delta l_3 = -x_c$

$\Delta l_4 = x_p$

$x_R + x_p = 2x_c$

$x_p = 2(4) \mp 12$

$= 8 \mp 12$

$\boxed{x_p = \cancel{20}\,{-4}\ m/s}$

$\cancel{x_{A,P} = x_A - x_P}$

$\cancel{-3 - 20}$

$\cancel{= -23}$

$\cancel{x_{B,P} =}$

$x_{A,P} = -3$

$x_{B,P} = x_B - x_P = (-3)$

$\cancel{x_B = +3 + 20}$

$\boxed{\cancel{x_B = 23\ m/s}}$

$-x_B = -3 - 4$

$\boxed{x_B = -7\ m/s}$

Q2 Method II (P mirroring the board)

$\cancel{\vec{V}_R = -12\hat{j}}$

$\cancel{\vec{V}_C = -4\hat{j}}$

$\vec{V}_{A,P} = -3\hat{j}$

$\vec{V}_{B,P} = -\vec{V}_{A,P}$

$\vec{V}_B - \vec{V}_P = 3\hat{j}$

$\vec{V}_B = 3\hat{j} + \vec{V}_P$

$\vec{V}_B = 3\hat{j} + 20\hat{j}$

$\boxed{= 23\hat{j} \text{ m/s}}$

Q find B acc.

$\Delta l_1 + \Delta l_2 = 0$

$\cancel{x_A - x_Q = 0}$ $\quad x_A - x_Q - x_Q = 0$

$\cancel{x_Q = 12 \text{ m/s}^2}$ $\quad x_A = 2x_Q$

$\boxed{6 = x_Q}$

$\Delta l_3 + \Delta l_4 + \Delta l_5 + \Delta l_6 = 0$

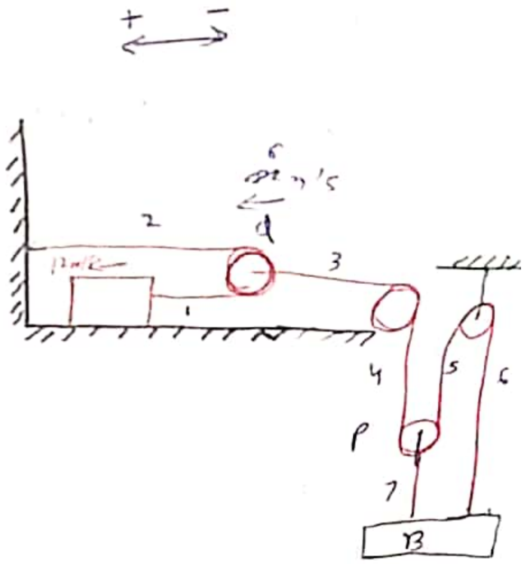
$x_Q - x_P - x_P - x_P = 0$

$x_Q = 3x_P$

$6 = 3x_P$

$x_P = \frac{6}{3}$

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

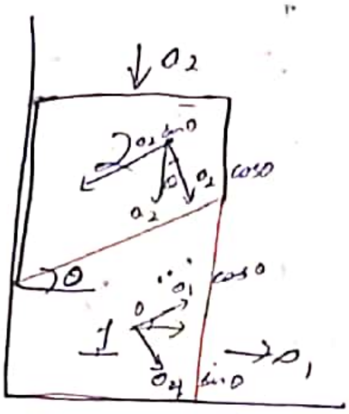


HW 01-28 (0) 04-06-2024

Wedge Constraint

→ Contact between the wedges is intact

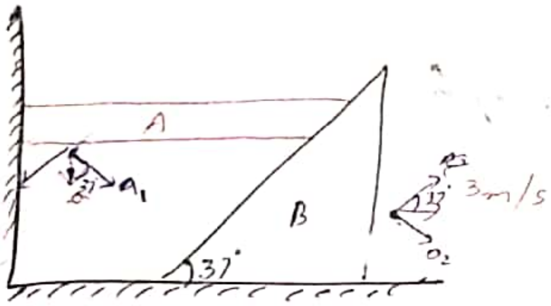
→ component of acceleration perpendicular to surface in contact is same for both.



$a_1 \sin\theta = a_2 \cos\theta$

$\boxed{a_2 = a_1 \tan\theta}$

Q find acceleration of A.? $(\theta = 37°)$



~~$a_A \tan\theta = a_B$~~

~~$a_A \times \frac{3}{4} = 3$~~

~~$a_A = 3 \times \frac{4}{3}$~~

~~$\boxed{a_A = 4 \text{ m/s}^2}$~~

Or

$a_1 = \cos 37° \times a$

$a_2 = \sin 37° \times 3$

$= \cancel{4} \times 3 \times \frac{3}{5}$

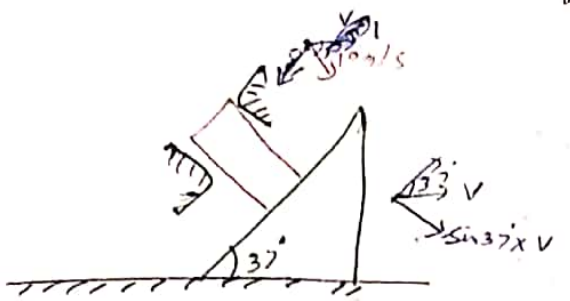
$= \cancel{\frac{9}{4}} = \frac{9}{5}$

$a_1 = a_2$

$a \times \frac{4}{5} = \frac{9}{5}$

$\boxed{a = \frac{9}{4} \text{ m/s}^2}$

Q A rod is moving with speed 10m/s . find V



$V_{01} = 10\cos 37$ ∴ $V\sin 37° = 10$

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

$= 8$ m/s

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

$$\boxed{V = \frac{50}{3} \text{ m/s}}$$

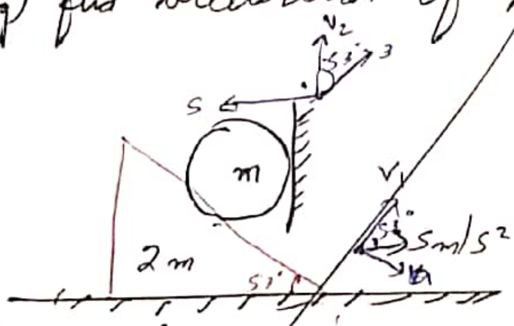
$V_2 = V \times \frac{3}{5}$

$V_2 = \frac{3V}{5}$

$V_1 = V_2$

$8 = \frac{3V}{5}$

Q (m=1kg) find acceleration of sphere



$V_1 = 5 \times \sin 53$

$= 5 \times \frac{4}{5}$

$= 4$ m/s

$V_1 = \cos 53° \times 5$

$= 3$ m/s²

$V = \sqrt{9 + 25 - 30 \times \frac{4}{5}}$

$V = \sqrt{34 - 24}$

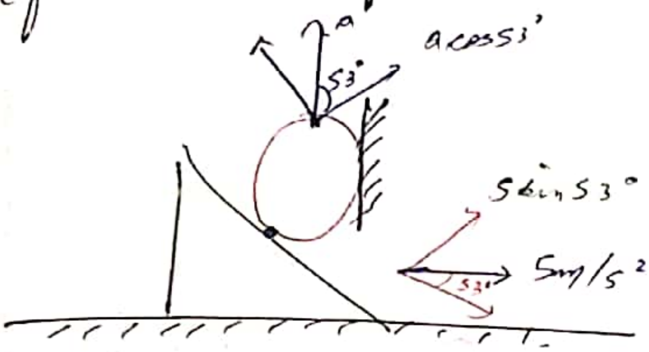
$V = \sqrt{10}$

$V_2 = 3\cos 53°$

$V_2 = 3 \times \frac{4}{5}$

$V_2 = \frac{12}{5}$

Q (find acceleration of sphere



$a \cos 53° = 5 \sin 53°$

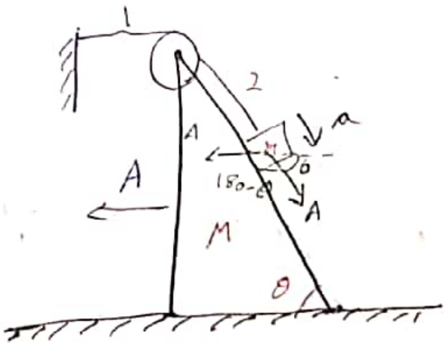
$a \times \frac{3}{5} = 5 \times \frac{4}{5}$

$a = \frac{4 \times 5}{3}$

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

Pulley & Wedge constraint

Q Determine block acceleration w.r.t wedge.



$\Delta l_1 = -x_m$

$\Delta l_2 = x_m$

$x_M = x_m$

$a_M = a_A$

$\boxed{a_m = A \text{ (wrt wedge)}}$

$A_{wrt\,ground} = \sqrt{A^2 + A^2 + 2A^2 \cos(180-\theta)}$

$= \sqrt{2A^2 - 2A^2 \cos\theta}$

$= \sqrt{2A^2 (1 - \cos\theta)}$

$= \sqrt{2A^2 \times 2\sin^2\frac{\theta}{2}}$

$\boxed{= 2A \sin\frac{\theta}{2}}$

Q. vel B w.r.t. ground

$x_A = x_B$

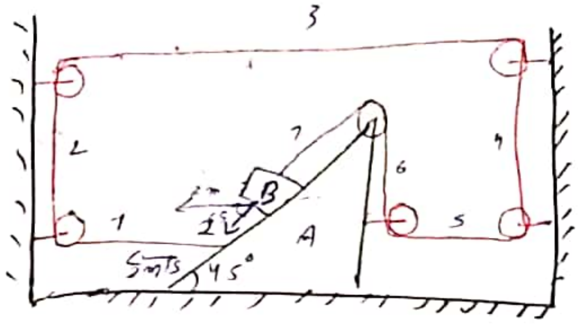
$V_A = V_B$

$V_{B\,wrt\,(A)} = 2\,m/s$

$V = \sqrt{v^2 + v^2 + 2v^2 \cos 45^\circ}$

$= \sqrt{8 + 8 \times \frac{1}{\sqrt{2}}}$

$= \sqrt{8 + 4\sqrt{2}}$



$\Delta l_1 + \Delta l_2 + \Delta l_3 + \Delta l_4 + \Delta l_5 + \Delta l_6 + \Delta l_7$

$-x_A + x_A + x_B = 0$

$x_B = 0$

v_B (wrt wedge) $= 0$

wrt ground

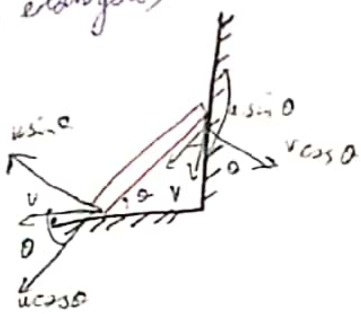
$\boxed{v_B = 2\,m/s}$

A General Constraint

Q Find vel of end B when rod makes an angle θ with horizontal

$v \sin\theta = u \cos\theta$ (so rod dont compress or elongate)

$\boxed{V = u \cot\theta}$

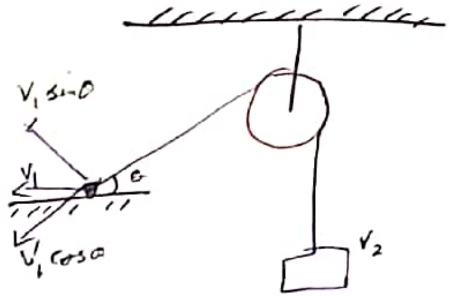


→ Component of velocity along the rod or string is equal for both ends.

Q find relation b/w v_1 & V_2

(the component along string to remain same.

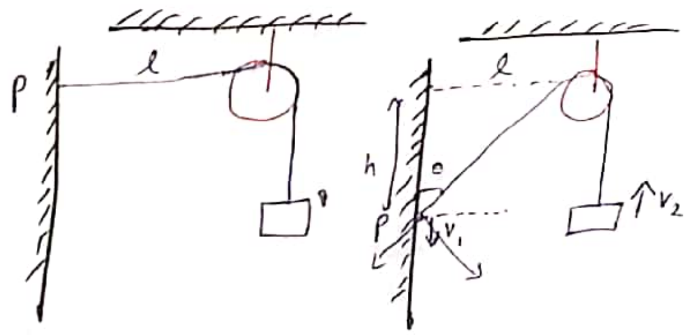
$$\boxed{V_1 \cos\theta = V_2}$$



Q2. find relation b/w v_1 & V_2 if distance moved by P is h.

$V_1 \cos\theta = V_2$

$$\boxed{\frac{v_1 h}{\sqrt{h^2+l^2}} = V_2}$$



Newton's Laws of Motion

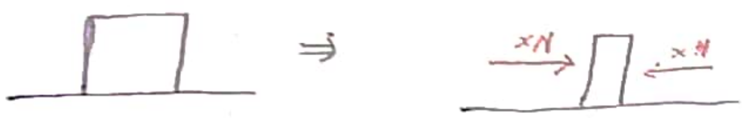
→ cause of motion :- forces → Dynamics

Balanced Forces – Net Force = 0

If body at rest
↓
Remains at rest

Body is in motion
↓
Continues in motion with same speed & direction.

→ Balanced Forces may lead to change in size or shape of the object.



Unbalanced Forces – Net Force ≠ 0

Body is at rest
↓
Body will start moving in the direction of resultant force

Body is in motion

Direction of net force is same as motion of the body
↓
Body will speed up

Direction of net force opp. to motion of the body
↓
Body will slow down & finally stop

~~Notes~~ Newton's First Law & Inertial Frame & non Inertial Frame.

→ Newton's First law / law of Inertia – defines a set of reference frames called inertial frames.

→ ~~Index~~ Inertial Frame – Frames which do not have any acceleration.

→ Either the ~~Ro~~ frame is at rest or moving with a uniform velocity.

→ Newton's laws can be directly applied in such frames and $\boxed{\text{dynamic equations}}$ can be written for objects in this frame. $\Sigma \vec{F} = m\vec{a}$

→ First Law – In the absence of external forces, when viewed from an inertial reference frame, every object continues to be in its state of rest or uniform motion.

Friction does not oppose the motion, It opposes the relative motion between two surfaces.

→ Inertial frames are also called as ~~Gali~~ 'Galilean Frames'.

→ Any reference frame that moves with a relative constant velocity to an inertial frame is itself an inertial frame.

→ First law is a qualitative law. (does not talk about the quantity of forces)

→ Non-Inertial Frame – A Frame of reference which is in accelerated motion with respect to a Inertial frame.

→ Newton's Laws cannot be ~~used~~ directly ~~applied~~, ~~same as~~ applicable

→ Tendency of an object to resist any attempt to change its velocity is called Inertia.

→ Depends on mass,

more mass ↑ more Inertia ↑

Linear Momentum & Newton's second Law.

Linear Momentum (P) – The quantity of motion contained in the body.

$$\boxed{\vec{P} = m\vec{v}}$$

SI unit :- kg m/s or Ns

It is a vector quantity

Q Two identical bodies are allowed to fall from two different heights h_1 & h_2. find the ratio of momentum just before striking the ground.

$v^2 = u^2 + 2as$

$v_1^2 = 2gh_1$

$v_1 = \sqrt{2gh_1}$

$v_2 = \sqrt{2gh_2}$

$P_1 = mv_1$
$P_2 = mv_2$ [same mass]

$\frac{P_1}{P_2} = \frac{\cancel{m}v_1}{\cancel{m}v_2}$

$= \frac{\sqrt{2gh_1}}{\sqrt{2gh_2}}$

$= \frac{\sqrt{gh_1}}{\sqrt{gh_2}}$

$= \sqrt{\frac{h_1}{h_2}}$

$P_1 : P_2$

$\sqrt{h_1} : \sqrt{h_2}$

Q A ball of mass m is dropped from a height h on a smooth elastic floor, ~~such~~ such that it rebounds with same speed what is the change in momentum of ball before & after striking the floor is : (take vertically downward as positive)

$v^2 = u^2 + 2as$

$v^2 = 2gh$

$v = \sqrt{2gh}$

$P_1 = m\sqrt{2gh}$

$v_2 = (-\sqrt{2gh})$

$P_2 = -m\sqrt{2gh}$

$|P_1| = m\sqrt{2gh}$

$|P_2| = m\sqrt{2gh}$

$$\boxed{|P_2| - |P_1| = 0}$$

b) find magnitude of change in momentum

$P_2 - P_1$

$-m\sqrt{2gh} - m\sqrt{2gh}$

$-2m\sqrt{2gh}$

$$\boxed{|P_2 - P_1| = 2m\sqrt{2gh}}$$

Newton's Second Law

→ When viewed from an inertial frame of reference, the acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass.

$a \propto \frac{1}{m}$ $\quad a \propto F$

→ Rate of change of momentum is directly proportional to net unbalanced force acting on it.

$P_i = mu$

$P_f = mv$

$\Delta P = mv - mu$

$$\boxed{\frac{\Delta P}{t} \propto F}$$

$F \propto \frac{m(v-u)}{t}$

$F \propto ma$

$F = kma \quad (k=1)$

$$\boxed{F = ma}$$

$$\boxed{\vec{F} = \frac{dP}{dt}} \rightarrow \text{Slope of } P\text{-}t \text{ graph}$$

$$\int_{p_i}^{p_f} dp = \underbrace{\int_0^t F\,dt}_{\text{area under } F\text{-}t \text{ graph}}$$

change in momentum

Impulse (J) :- It is the change in momentum of a body.

$J = \Delta P = mv - mu = Ft$

SI unit :- Ns or kg m/s

Q A machine gun has mass 5 kg. It fires 50 g bullets at the rate of 30 bullets per minute at a speed 400 m/s. What force is required to keep gun in position.

$$F = m\frac{(v-u)}{t}$$

$$= \frac{50}{1000}\left[\frac{400-0}{2}\right]$$

$$= \frac{5}{100} \times 200$$

$$= 5 \times 2$$

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

Q A dish of mass 10 g is kept horizontally in air by firing 5 g bullets 10/s. If bullets rebound with same speed, ~~what~~ with what speed are bullets fired ($g = 9.8/s^2$)

Force to keep dish in air $= \frac{10}{1000} \times 9.8$

$= \frac{98}{1000}\ N$

$$\cancel{F = m\frac{(v-u)}{t}}$$

$$\cancel{= 5 \times \frac{(-u)}{1} \times 10}$$

$$\cancel{\frac{98}{1000} = -50u}$$

$$F = m\frac{(v-u)}{t}$$

$$\frac{98}{1000} = \frac{5(v-(-v))}{1000} \times 10$$

$$\frac{98}{1000} = 50 \times 2v$$

$$\frac{98}{1000} = \frac{100v}{1000}$$

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$V = \frac{98}{100}$

$\boxed{V = 0.98 \, m/s}$

Q A body of mass 4 kg moving on horizontal surface with initial velocity 6 m/s comes to rest after 3 s. If one wants to keep moving the body with same speed of 6 on same surface. find required force.

$u = 6$

$v = 0$

$t = 3s$

$a = \frac{v-u}{t}$

$= \frac{-6}{3}$

$= -2$

• to keep moving, a = 2 to be applied

$F = ma$

$F = 4 \times 2$

$\boxed{F = 8N}$

Newton's Third Law

→ To Every Action there is a equal & opposite reaction.

→ Action & Reaction are equal in magnitude, opposite in direction and acts on two different bodies

→ if two forces are acting on the same object, even if they are equal in magnitude and opposite in direction, cannot be an action - reaction pair.

Free Body Diagram

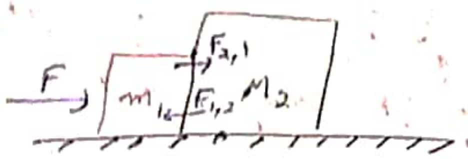
→ diagram of a body showing all the forces on it along with direction & magnitude.

→ consider only ~~sth~~ the forces applied on that body & not the forces the body applies on any other body.

Types of Forces

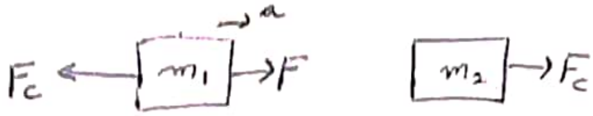
1. Contact forces - The force which acts between two bodies in contact are called contact forces.

$|F_{2,1}| = |F_{1,2}| = F_c$



$F = (m_1 + m_2)\, a$

$a = \frac{F}{(m_1 + m_2)}$



for m_2,

$F_c = m_2 a$

$$\boxed{F_c = \frac{m_2 F}{m_1 + m_2}}$$

for m_1,

$F - F_c = m_1 a$

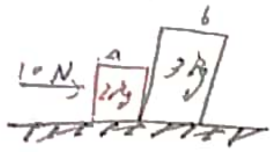
$F - F_c = \frac{m_1 F}{m_1 + m_2}$

$F_c = F\left[1 - \frac{m_1}{m_1 + m_2}\right]$

$$\boxed{F_c = \frac{m_2 F}{m_1 + m_2}}$$

$\boxed{\Sigma \vec{F} = m\vec{a}} \rightarrow$ Dynamic Equation.

Q ~~ff~~ find acceleration & contact force b/w A & B.



$F = ma$

$10 = 5 \times a$

$a = \frac{10}{5}$

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

for, b

$F_c = 3 \times 2$

$\boxed{F_c = 6\ N}$

for, a

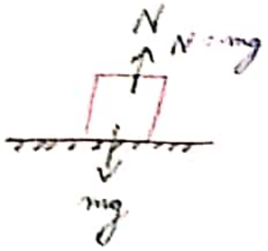
$F - F_c = 2 \times 2$

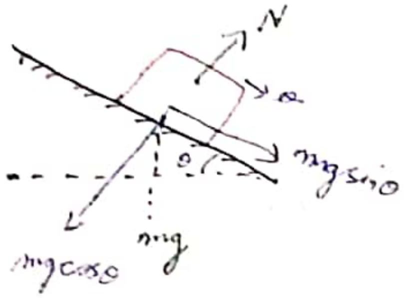
$10 - F_c = 4$

$F_c = 10 - 4$

$\boxed{F_c = 6\ N}$

2. Normal Force & Weight of body - Normal force is a special type of contact force which always act ⊥ to surface in contact





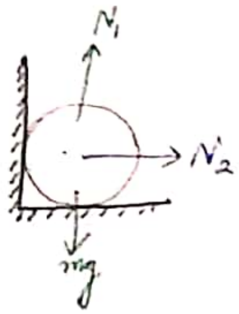
$N = mg\cos\theta$

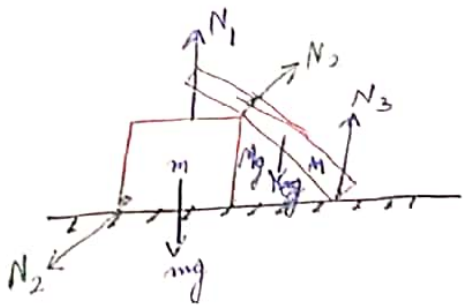
~~mg cos~~

$mg\sin\theta = ma$

$\boxed{g\sin\theta = a}$ (along incline)

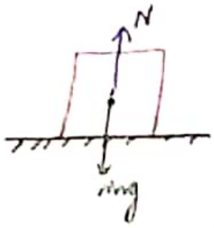
Eg

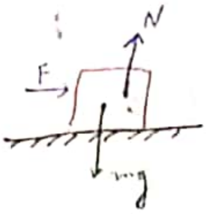


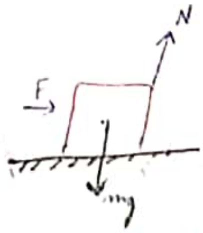


$N_1 = mg$

Note







→ when external force is applied on a object, the normal force shifts towards the direction of applied force.

→ on the verge of toppling, normal reaction passes through edge of the block.

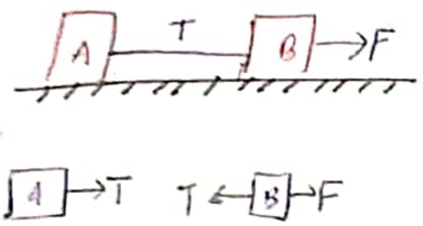
3. **Tension Force** – ~~The~~ The force with which elements of a string pull each other is called tension force.

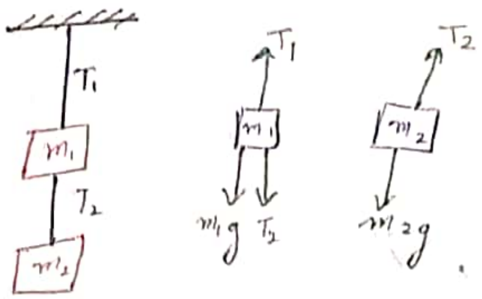
→ An Ideal string is considered to be massless, inextensible, pulls at any point on the string can pull but not push.

→ An Ideal pulley is assumed to be massless, frictionless. Action of pulley is to change the direction of force. Tension is same in the pulley on both sides of it.

→ Tension force is always directed away from point of contact.

Eg





$T_2 = m_2 g$ (for body at rest)

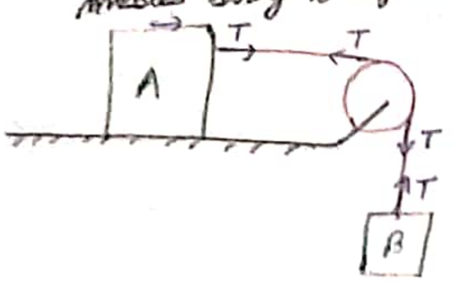
$T_2 = m_2 g$

$T_1 = m_1 g + T_2$

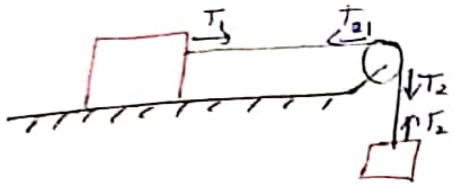
$T_1 = m_1 g + m_2 g$

$\boxed{T_1 = (m_1 + m_2) g}$

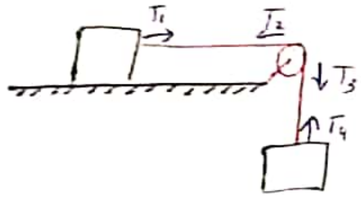
massless string and frictionless pulley & String



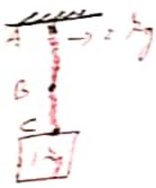
Massless String & pully is not frictionless



Massive String & Pulley is not frictionless



Eg



$g = 10\, m/s^2$

find ~~total~~ tension at A, B, C
↳ midpoint

at A, $T = mg$

$T = (2+1) \times 10$

$= 3 \times 10$

$\boxed{T_A = 30N}$

$T_B = mg$

$= (1+1) \times 10$

$\boxed{T_B = 20N}$

$T_C = mg$

$= 1 \times 10$

$\boxed{T_C = 10N}$

Q A rope of uniform mass distribution of mass m & length l, find ~~bottom~~ ~~at~~ tension at distance x from bottom,

length till $x = x$

$$mass = \cancel{\frac{m}{l}(l-x)} = \frac{mx}{l}$$

$$T = mg$$

$$= \cancel{\frac{m(l-x)}{l}g}$$

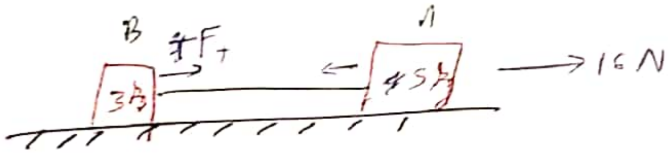
$$\boxed{T = \frac{mxg}{l}}$$

H.W.

Ch - 3

S - 1 (1-20)

Q Find acceleration of blocks & Tension in string connecting A . B.



$$\cancel{F = ma}$$
$$\cancel{16 = 18 \times a}$$
$$\cancel{a = \frac{8}{9}}$$

$$F = ma$$
$$16 = 8a$$
$$a = \frac{16}{8}$$
$$\boxed{a = 2}\ m/s^2$$

$$F_T = 3 \times 2$$
$$\boxed{F_T = 6N}$$

Q with what min acceleration can a fireman slide down a rope whose breaking strength is of his $\frac{2}{3}$ weight.

$$w - F_t = ma$$

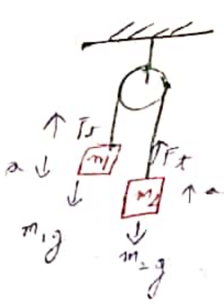
$$W - \frac{2}{3}W = \frac{W}{g} \times a$$

$$1 - \frac{2}{3} = \frac{a}{g}$$

$$\frac{1}{3} = \frac{a}{g}$$

$$\boxed{\frac{g}{3} = a}$$

Q Find acc & Tension $(m_1 > m_2)$



Atwood machine

~~acc = g~~

$$m_1 g - F_t = m_1 a \quad \text{--- (1)}$$

$$F_t - m_2 g = m_2 a \quad \text{--- (2)}$$

(1) + (2)

$$m_1 g - m_2 g = m_1 a + m_2 a$$

$$\boxed{\frac{(m_1 - m_2)g}{m_1 + m_2} = a}$$

$$F_t = m_2 a + m_2 g$$

$$= m_2 [a + g]$$

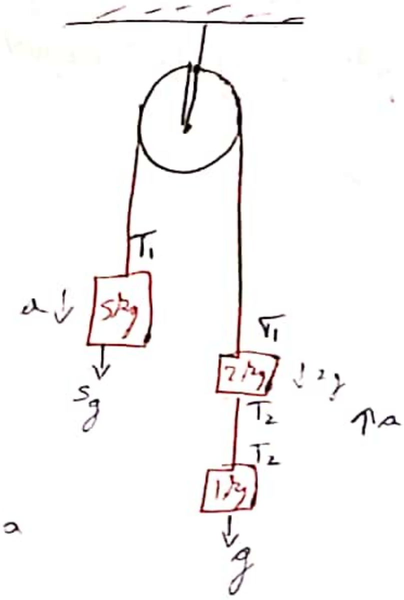
$$= m_2 \left[\frac{(m_1 - m_2)g}{m_1 + m_2} + g \right]$$

~~$= m_2 g$~~

$$= m_2 g \left[\frac{m_1 - m_2 + m_1 + m_2}{m_1 + m_2} \right]$$

$$\boxed{F_t = \frac{2 m_1 m_2 g}{m_1 + m_2}}$$

Q first acc & Tension



$5g - T_1 = 5a$ ---(1)

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

$T_2 - g = a$ ---(3)

(3) − (2)

$-g + 2g - T_1 = 0$

$\boxed{T_1 = g}$

$g + T_2 = a$

$T_2 - g = a$

$2g + 2T_2 = 2a$

$5g - g = a$

$\boxed{a = 4g}$

$T_2 = a + g$

$= 4g + g$

$\boxed{T_2 = 5g}$

$T_2 = a + g$

$T_2 = 10 + 2.5$

$\boxed{T_2 = 12.5\,N}$

(3) + (2)

$T_1 - 2g - g = 3a$

$T_1 - 3g = 3a$

$5g - T_1 = 5a$

$2g = 8a$

$a = \frac{g}{4}$

$a = \frac{10}{4}$

$\boxed{a = 2.5\,m/s^2}$

$5g - T_1 = 5a$

$T_1 = 5g - 5a$

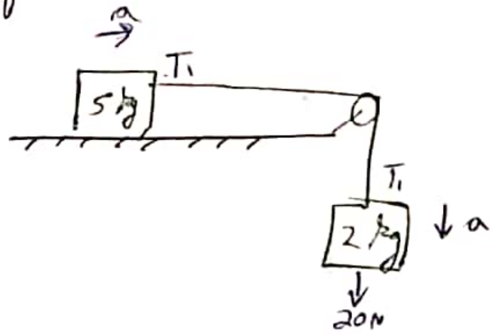
$T_1 = 5g - \frac{5g}{4}$

$T_1 = \frac{15g}{4}$

$T_1 = \frac{150}{4}$

$\boxed{T_1 = \frac{75}{2}\,N}$

Q find acc & Tension.



$T_1 = 5a$ --- ①

$\cancel{T_1 - 20 = 2a}$ --- ②

$\cancel{20 = 3a}$

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

$20 - T_1 = 2a$

$20 = 7a$

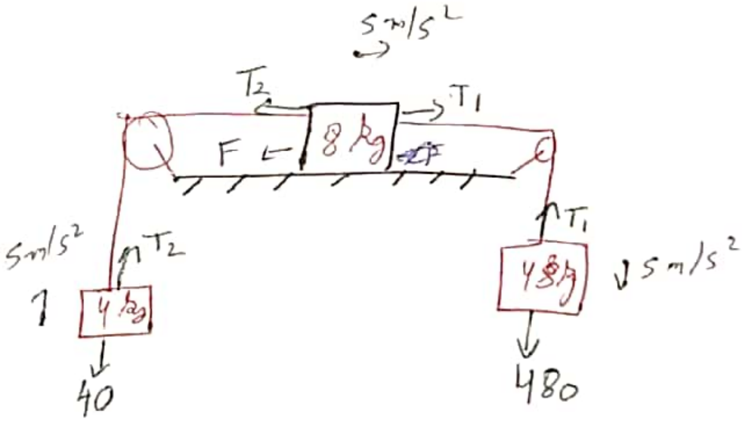
$\boxed{a = \frac{20}{7} m/s^2}$

$T = 5a$

$T = 5 \times \frac{20}{7}$

$\boxed{T = \frac{100}{7} N}$

Q. $a = 5 m/s^2$
find friction of 8 kg block



for 48 kg

$480 - T_1 = 5 \times 48$

$480 - T_1 = 240$

$T_1 = 480 - 240$

$\boxed{T_1 = 240 N}$

for 4 kg

$T_2 - 40 = 5 \times 4$

$\cancel{T_2 = 45N}$

$T_2 - 40 = 20$

$\boxed{T_2 = 60 N}$

for 8 kg

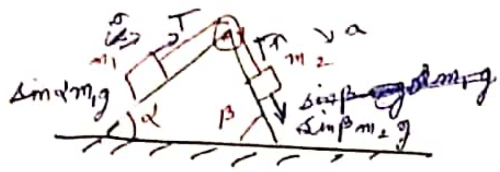
$T_1 - T_2 - F = 8 \times 5$

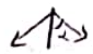
$240 - 60 - F = 40$

$F = 240 - 100$

$\boxed{F = 140 N}$

Q find acc.





$$\sin\beta\, m_2 g - T = m_2 a \quad \text{---} (1)$$

$$T - \sin\alpha\, m_1 g = m_1 a \quad \text{---} (2)$$

$$\sin\beta\, m_2 g - \sin\alpha\, m_1 g = m_2 a + m_1 a$$

$$\boxed{\frac{g\,(\sin\beta\, m_2 - \sin\alpha\, m_1)}{(m_2 + m_1)} = a}$$