Frictional force:

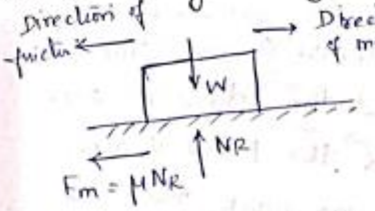
When 2 bodies are in contact with one another, the property of two bodies by virtue of which a force is exerted between them at their point of contact to prevent one body from sliding on the other called "Frictional Force" or simply "Friction".

$$\text{Coefficient of Friction} = \frac{\text{Limiting Friction}}{\text{Normal reaction}}$$

$$\mu = \frac{F_m}{N_R}$$

$$\boxed{F_m = \mu N_R}$$

Case ① : Body moving on rough horizontal Range



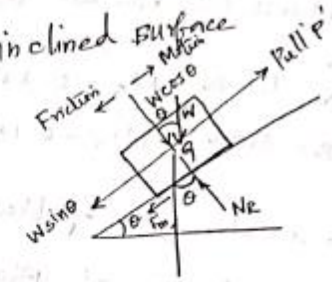
μ = Coefficient of friction

$F_m = \mu N_R$

$F_\mu = \mu W$

$N_R = \mu \cdot$

Case ② : Body pulled up on an inclined surface



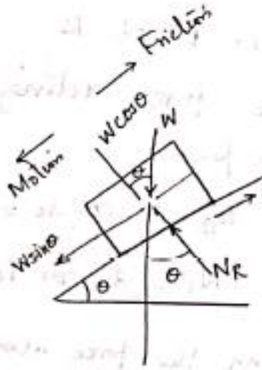
To find Fm

$N_R - W\cos\theta = 0$

$N_R = W\cos\theta$

$F_m = \mu W\cos\theta$

Case ③ : Body sliding downwards.



$N_R - W\cos\theta = 0$

$N_R = W\cos\theta$

$F_m = \mu W\cos\theta$

D'Alembert's Principle:

$P = ma$

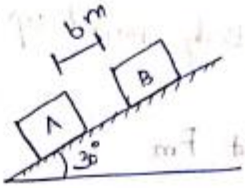
P – External force
m – mass of moving body
a = acceleration of body

It states that the system of forces acting on a body in motion is in dynamic equilibrium with inertia force of the body.

(1) Two blocks A and B of weight 100N and 200N resp. are initially at rest on a 30° inclined plane as shown in diagram. The distance between the blocks is 6m. The coef of friction between the block A and the plane is 0.25 and that between the block B and the plane is 0.15. If they are released at same time, in what time the upper block (B) reaches the lower block (A).

$W_A = 100N \quad \mu_A = 0.25$

$W_B = 200N \quad \mu_B = 0.15$

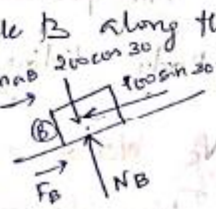


$a_A \Rightarrow$ acceleration of block A

a_B = acceleration of Block B.

Consider Block B

The force acting on the block B along the inertia force



$N_B - 200\cos 30 = 0$

$N_B = 200\cos 30 = 173.2N$

Resolving the force along the plane

$$F_B - 200\sin 30 + ma_B = 0$$

$$\mu_B N_B - 200\sin 30 + \left(\frac{200}{9.81} a_B\right) = 0$$

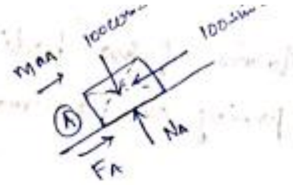
$$(0.15 \times 173.2) - 100 + 20.38 a_B = 0$$

$$a_B = 3.63 \ m/s^2$$

Consider Block A

Forces acting on the block A, along with the inertia force.

Resolving the forces along the plane



$$F_A + m_A a_A - 100 \sin 30 = 0$$

$$\mu_A N_A + m a_A - 100 \sin 30 = 0$$

$$(0.25 \times 86.6) + \left(\frac{100}{9.81} a_A\right) - 100 \sin 30 = 0$$

$$a_A = 2.78 \, m/s^2$$

let t = time at which the blocks A and B touches each other, after released at same time from rest.

S_A = Distance travelled by Block A in time t

S_B = " " " " B in " "

<u>To find S_A</u>

$$s = ut + \frac{1}{2} a t^2 \qquad u_A = 0$$

$$S_A = u_A t + \frac{1}{2} a_A t^2 \qquad a_A = 2.78 m/s^2$$

$$S_A = 0 + (\frac{1}{2} \times 2.78 \times t^2)$$

$$S_A = 1.39 t^2$$

$$S_B = u_B + \frac{1}{2} a_B t^2 \qquad u_B = 0$$

$$a_B = 3.63 \, m/s^2$$

$$S_B = 0 + \frac{1}{2} \times 3.63 \times t^2$$

$$S_B = 1.815 t^2$$

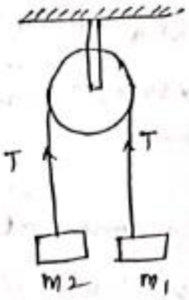
When two blocks touches each other then

$$S_B = S_A + 6$$

$$1.815 t^2 = 1.39 t^2 + 6$$

$$\boxed{t = 3.75 \, sec}$$

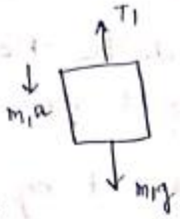
Motion of two bodies connected by a string and passing over a smooth pulley



a = acceleration of bodies in m/s^2

T = Tension in the string in N

Consider the mass m_1



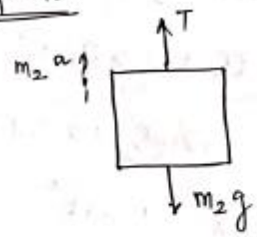
The FBD of m_1 along with Inertia force $(m_1 a)$

applying $\Sigma V = 0$

$$T_1 - m_1 g - m_1 a = 0 \quad \text{(or)} \quad T - m_1 g = m_1 a \rightarrow (1)$$

$m_1 < m_2$

Consider the mass m_2



$\Sigma V = 0$

$$T + m_2 a - m_2 g = 0$$

$$m_2 a = m_2 g - T \Rightarrow (2)$$

On solving (1) & (2) we can find a, and T.