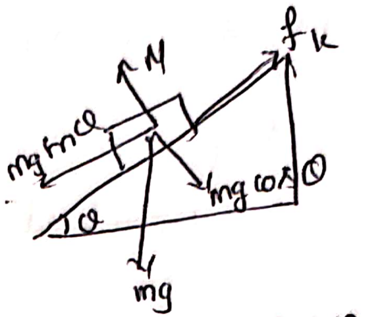
Thank

③

①

$\mu = \frac{1}{3}$



Given $N = 3F_{down}$ → ①

$F_{down} = mg(\sin\theta - \mu_k \cos\theta)$

$N = mg\cos\theta$

∴ From ①

$\cancel{mg}\cos\theta = 3\cancel{mg}[\sin\theta - \frac{1}{3}\cos\theta]$

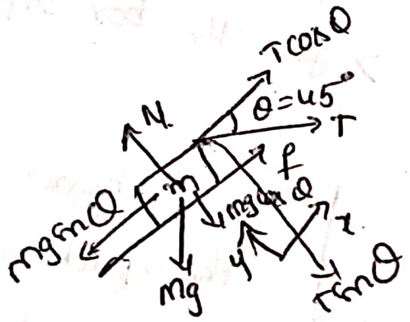
$\Rightarrow \cos\theta = 3\sin\theta - \frac{3\cdot 1}{3}\cos\theta$

$\Rightarrow \cos\theta + \frac{1}{3}\cos\theta = 3\sin\theta$

$\Rightarrow \frac{9}{3}\cos\theta = 3\sin\theta \Rightarrow \frac{\sin\theta}{\cos\theta} = \frac{9}{3}$

$\Rightarrow \tan\theta = \frac{9}{3} \Rightarrow \theta = \tan^{-1}(\frac{9}{3})$

②



$mg = 150N$; $T = 50N$

In horizontal direction

$\Sigma F_x = 0$

$\therefore mg\sin\theta = f + T\cos\theta$ [f = frictional force]

$\Rightarrow f = \mu N =$

$\Rightarrow mg\sin\theta - T\cos\theta = \mu N$ → ①

$\Sigma F_y = 0$

$\Rightarrow mg\cos\theta + T\sin\theta = N$ → ②

From ①

$\frac{①}{②} = \mu = \frac{mg\sin\theta - T\cos\theta}{N} = \frac{mg\sin\theta - T\cos\theta}{mg\cos\theta + T\sin\theta}$

$= \frac{150\sin 45 - 50\cos 45}{150\cos 45 + 50\sin 45} = \frac{\frac{150}{\sqrt{2}} - \frac{50}{\sqrt{2}}}{\frac{150}{\sqrt{2}} + \frac{50}{\sqrt{2}}} = \frac{100}{200} = 0.5$

(3)

For the sand without slipping on the surface

$$\tan\theta \geq \mu$$

$\tan\theta = \mu$

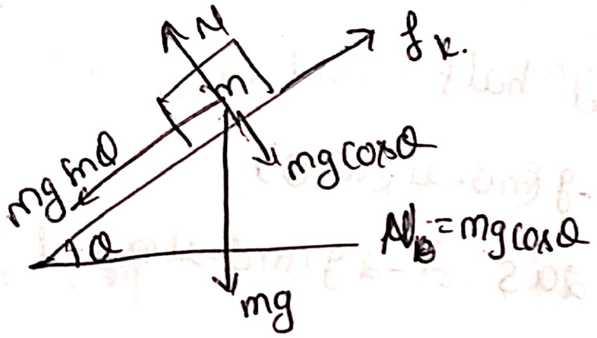
$\Rightarrow \tan\theta = \frac{h}{R}$

$\therefore \frac{h}{R} = \mu \Rightarrow h = \mu R$

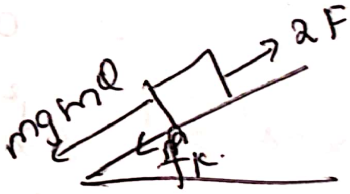
Volume $= \frac{1}{3}\pi R^2 h$

$\Rightarrow \frac{1}{3}\pi R^2(\mu R) = \frac{\mu}{3}\pi R^3$

(4)



For upward motion applied force 2F



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

$f_k = \mu_k N$

$= \mu_k mg\cos\theta$

$\therefore$

$2F = mg\sin\theta + f_k$

$\Rightarrow 2[mg\sin\theta - \mu mg\cos\theta] = mg\sin\theta + \mu_k mg\cos\theta$

$\Rightarrow 2\sin\theta - 2\mu\cos\theta = \sin\theta + \mu\cos\theta$

$\Rightarrow \sin\theta = 3\mu\cos\theta \Rightarrow \frac{\sin\theta}{\cos\theta} = 3\mu$

$\Rightarrow \frac{1}{3}\tan\theta = \mu$

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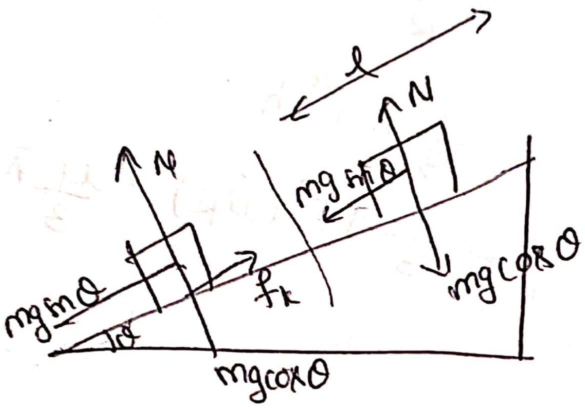
(5)

$$V_1 = \sqrt{2gl(\sin\theta + \mu\cos\theta)} \quad ; \quad V_2 = \sqrt{2gl(\sin\theta - \mu\cos\theta)}$$

$$\frac{V_1}{V_2} = \frac{\sqrt{2gl(\sin\theta + \mu\cos\theta)}}{\sqrt{2gl(\sin\theta - \mu\cos\theta)}} = \sqrt{\frac{\sin\theta + \mu\cos\theta}{\sin\theta - \mu\cos\theta}}$$

(6)



For first half

$a = g\sin\theta$

$V^2 = 2as$

$= 2g\sin\theta\, l \rightarrow (1)$

For second half

$a = -g(\sin\theta - \mu_k\cos\theta)$

$V^2 = 2as \Rightarrow -2g(\sin\theta - \mu\cos\theta)\, l \rightarrow (2)$

From (1) & (2)

$2gl\sin\theta = -2gl(\sin\theta - \mu\cos\theta)$

$\Rightarrow \sin\theta = -\sin\theta + \mu\cos\theta$

$\Rightarrow \sin\theta + \sin\theta = \mu\cos\theta$

$\Rightarrow 2\sin\theta = \mu\cos\theta$

$\Rightarrow \mu = 2\dfrac{\sin\theta}{\cos\theta}$

$\Rightarrow \mu = 2\tan\theta$

(7)

$$F_{up} = 2 F_{down} \qquad \theta = 60^\circ$$

$$\Rightarrow mg(\sin\theta + \mu\cos\theta) = 2mg(\sin\theta - \mu\cos\theta)$$

$$\Rightarrow \sin\theta + \mu\cos\theta = 2\sin\theta - 2\mu\cos\theta$$

$$\Rightarrow 3\mu\cos\theta = \sin\theta$$

$$\Rightarrow \mu = \frac{1}{3}\tan\theta = \frac{1}{3}\tan 60^\circ = \frac{\sqrt{3}}{3} = \frac{1}{\sqrt{3}}$$

(8)

when the body is just ready to slide

Angle of inclination = Angle of repose $= 45^\circ$

$$\therefore \mu = \tan\theta = \tan 45^\circ = 1$$

(9)

$m = 2$ kg

$u = 0$

$\mu_k = 0.6$, $\theta = 30$

frictional force

$$f_k = \mu_k mg\cos\theta$$

$$= 0.6 \times 2 \times 9.8 \times \cos 30$$

$$= 0.6 \times 19.6 \times \frac{\sqrt{3}}{2}$$

$$= 0.3 \times 19.6 \times 1.732$$

$$= 10.18 \text{ N}$$

(10)

$$t_{rough} = 1\frac{1}{3}\, t_{smooth}$$

$$\Rightarrow \sqrt{\frac{2l}{g(\sin\theta - \mu\cos\theta)}} = \frac{4}{3}\sqrt{\frac{2l}{g\sin\theta}}$$

$$\Rightarrow \frac{1}{\sqrt{\sin\theta - \mu\cos\theta}} = \frac{4}{3\sqrt{\sin\theta}}$$

S.o.b.s

$$\Rightarrow \frac{1}{\sin\theta - \mu\cos\theta} = \frac{16}{9\sin\theta}$$

$$\Rightarrow 9\sin\theta = 16\sin\theta - 16\mu\cos\theta$$

By Putting $\theta = 45^\circ$ and solve we get $\mu = \frac{7}{16}\tan\theta$

$$\Rightarrow \mu = \frac{7}{16}$$

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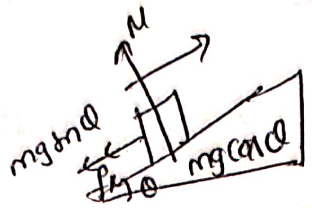
Because the force of friction always opposes the motion of a body



For upward motion $mg\sin\theta$ & f_k are in same direction

$$\therefore F_{net} = mg\sin\theta + f_k$$

For downward motion $mg\sin\theta$ & f_k are in opposite directions

$$F_{net} = mg\sin\theta - f_k$$

∴ so clearly we require more force in rough surface

14

$\mu_s = \frac{3}{4}$; $\mu_k = \frac{3}{5}$; $\theta = \sin^{-1}\left(\frac{3}{5}\right) \Rightarrow \sin\theta = \frac{3}{5}$

$mg = 10N$ $\quad \theta = 37^\circ$ $\quad \Rightarrow \cos\theta = \frac{4}{5}$

$f_s = \mu_s mg\cos\theta$

$= \frac{3}{4} \times 10 \times \frac{4}{5}$

$= 7.5\,N \times \frac{4}{5}$

$= 6N \rightarrow$ limiting friction

$f_k = \mu_k mg\cos\theta$

$= \frac{3}{5} \times 10 \times \frac{4}{5}$

$= \frac{24}{5} = 4.8\,N$

$\tan\alpha = \mu_s \Rightarrow \tan\alpha = \frac{3}{4} \Rightarrow \alpha = 37^\circ$

$\theta = \alpha$ so the body is ready to slide down

For motion

$$a = g[\sin\theta - \mu_k\cos\theta]$$

$$= 10\left[\frac{3}{5} - \frac{3}{5} \times \frac{4}{5}\right] = 10\left[\frac{15-12}{25}\right]$$

$$= \frac{10}{25} \times 3 = 0.12\,m/s^2$$

(15)

$\theta = 45^\circ$

$V_\uparrow = 10 \text{ m/s}$

$\Rightarrow \sqrt{2gl\sin\theta} = 10$

$\Rightarrow \sqrt{2l}\sqrt{g\sin\theta} = 10$

$\Rightarrow \sqrt{2l} = \frac{10}{\sqrt{g\sin\theta}}$

$t_\uparrow = \sqrt{\frac{2l}{g\sin\theta}}$

$\Rightarrow t_\uparrow = \frac{\frac{10}{\sqrt{g\sin\theta}}}{\sqrt{g\sin\theta}}$

$\Rightarrow t_\uparrow = \frac{1\cancel{0}}{g\sin\theta}$

$\Rightarrow t_\uparrow = \frac{1}{\sin 45} = \sqrt{2}\text{ sec}$

$a = g(\sin\theta)$

$= 10 \times \sin 45$

$= \frac{10}{\sqrt{2}} \text{ m/s}^2$

(16)

$\theta = 45^\circ$

$t_d = 2$

For smooth

$t_d = \sqrt{\frac{2l}{g\sin\theta}}$

$\Rightarrow 2 = \sqrt{\frac{2l}{g}} \times \frac{1}{\sqrt{\sin\theta}}$

$\Rightarrow 2\sqrt{\sin\theta} = \sqrt{\frac{2l}{g}}$

For rough

$t_d = \sqrt{\frac{2l}{g(\sin\theta - \mu\cos\theta)}}$ $\mu = 0.5$

$\Rightarrow t_d = \sqrt{\frac{2l}{g}} \times \frac{1}{\sqrt{\sin\theta - \mu\cos\theta}}$

$\Rightarrow t_d = 2\sqrt{\sin\theta} \times \frac{1}{\sqrt{\sin\theta - \mu\cos\theta}}$

$= 2\sqrt{\sin 45} \times \frac{1}{\sqrt{\sin 45 - 0.5\cos 45}}$

$= 2\sqrt{\frac{1}{\sqrt{2}}} \times \frac{1}{\sqrt{\frac{1}{\sqrt{2}} - \frac{0.5}{\sqrt{2}}}}$

$= 2\frac{1}{\sqrt{\cancel{\sqrt{2}}}} \times \frac{1}{\sqrt{\frac{1-0.5}{\cancel{\sqrt{2}}}}} \Rightarrow 2 \times \frac{1}{\sqrt{0.5}}$

$= 2\sqrt{2}\text{ sec}$ $= 2 \times 1.414$

$= 2.828\text{ sec.}$

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(17)

$m = 0.5\ kg$ For the body to move with uniform

$\theta = 30^\circ$; $\mu = 0.2$ velocity : acceleration $= 0$

$\therefore \quad mg\sin\theta - \mu N + F = ma$

$\Rightarrow 0.5 \times 10 \times \sin 30 - \mu\, mg \cos 30 + F = 0$

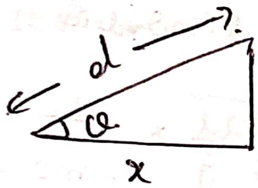
$\Rightarrow 5 \times \frac{1}{2} - 0.2 \times 0.5 \times 10 \times \frac{\sqrt{3}}{2} + F = 0$

$\Rightarrow 2.5 - 0.1 \times 5 \times 1.732 + F = 0$

$\Rightarrow F = -1.633\ N$

Force is 1.6 N (upward) Parallel to inclined plane

(18)



$\cos\theta = \frac{x}{d} \Rightarrow d = \frac{x}{\cos\theta}$

d is distance travelled by the body in t sec

$\therefore$ From $S = ut + \frac{1}{2}at^2$ $a = g\sin\theta$; $u = 0$

$\Rightarrow d = 0 \times t + \frac{1}{2} g\sin\theta\, t^2$

For min time $\Rightarrow d = \frac{g\sin\theta}{2} t^2 \Rightarrow t = \sqrt{\frac{2d}{g\sin\theta}}$

$\therefore \frac{dt}{d\theta} = 0 \quad \Rightarrow \frac{d}{d\theta}\left[\sqrt{\frac{2d}{g\sin\theta}}\right] = 0$

$\Rightarrow \sqrt{\frac{2d}{g}} \frac{d}{d\theta} \frac{1}{\sqrt{\sin\theta}} = 0$

$\Rightarrow \sqrt{\frac{2d}{g}} \left[-\frac{1}{2}(\sin\theta)^{-\frac{3}{2}} \cos\theta\right] = 0 \Rightarrow \theta = 45^\circ$

$\therefore a = g\sin\theta$ $\Rightarrow \cos\theta\,(\sin\theta)^{-\frac{3}{2}} = 0$

$= g\sin 45^\circ$

$= \frac{g}{\sqrt{2}}$ $\Rightarrow \frac{\cos\theta}{\sin\theta} \times \sin\theta^{-\frac{1}{2}} = 0$

$= \cot\theta \times \frac{1}{\sqrt{\sin\theta}} = 0$ $\cancel{\Rightarrow \cot\theta = 0}$

(20)

For a body sliding down $a = g\sin\theta$

(a) $\theta = 30°$; $a = g\sin 30 = \frac{g}{2}$

(b) $\theta = 45°$ $a = g\sin 45 = \frac{g}{\sqrt{2}} = \frac{g}{1.414}$

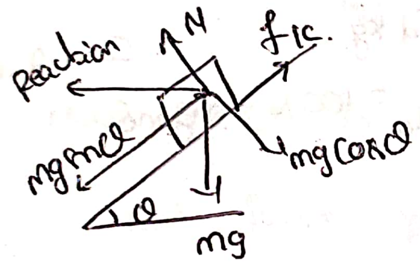
(c) $\theta = 60°$ $a = g\sin 60° = g \times \frac{\sqrt{3}}{2} = \frac{1.732}{2}g$

(d) $\theta = 90°$ $a = g\sin 90° = g.$

L Task

CUQ:

(1)



As block is stationary on inclined plane force $= mg\sin\theta$ and Normal reaction on block $N = mg\cos\theta$

$\therefore$ Net Reaction on the block by plane

$= \sqrt{(mg\sin\theta)^2 + (mg\cos\theta)^2} = \sqrt{(mg)^2\sin^2\theta + (mg)^2\cos^2\theta}$

$= mg\sqrt{\sin^2\theta + \cos^2\theta} = mg \uparrow.$

(2)

The velocity attained will be same since heights are same $v = \sqrt{2gh}$.

But acceleration for vertical fall is g, and for the sliding wooden block it will be $g\sin 30° = 0.5g$

$\therefore \underline{v_1 = v_2}$ $t = \sqrt{\frac{2l}{g\sin\theta}}$ $t \propto \frac{1}{\sqrt{g\sin\theta}}$ $\therefore \frac{t_1}{t_2} = \frac{g}{0.5g}$

$\Rightarrow \underline{t_1 = 2t_2}$

(4) From $v^2-u^2=2as$; $a=g(\sin\theta+\mu\cos\theta)$

$\Rightarrow 0-u^2=-2g(\sin\theta+\mu\cos\theta)\,l.$ $\quad\therefore \mu=\tan\theta$

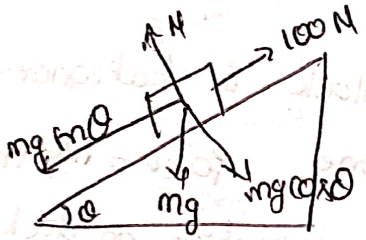
$\Rightarrow u^2=2gl[\sin\theta+\tan\theta\cos\theta)$

$\Rightarrow u^2=2gl[\sin\theta+\frac{\sin\theta}{\cos\theta}\cos\theta]$

$\Rightarrow u^2=4gl\sin\theta$. From this equation it is clear that the body stays at rest and not will slide down

SAQ's

(1)



$m=2$ kg

$F_{Parallel}=100N=mg\sin\theta$ $\quad a=2\ m/s^2$

Given, velocity is moving with uniform velocity so block is in equilibrium $\Rightarrow mg\sin\theta=100N$

let Force F is applied to the block inclined Plane to move the block with $a=m/s^2$

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

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

$=100+2\times2$

$=104$ N.

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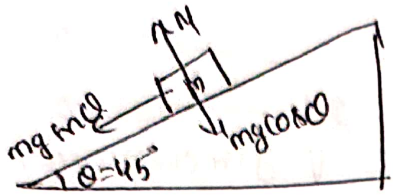

we consider the case with no friction.

In this case

$$a_s = g\sin\theta = g\sin 45^\circ = \frac{g}{\sqrt{2}}$$

From = $v = \sqrt{2a_s l}$; Here l is length of inclination

$v = \sqrt{2\frac{g}{\sqrt{2}} l}$; we are given that $v_{rough} = \frac{1}{2} v_{smooth}$

$$v_{Rough} = \frac{1}{2}\sqrt{2 \times a_{smooth}\, l}.$$

$$\Rightarrow \sqrt{2a_{rough} l} = \frac{1}{2}\sqrt{2l \times a_{smooth}} \quad \text{S.O.B.S}$$

$$\Rightarrow 2l\, a_{rough} = \left(\frac{1}{4}\right) (\cancel{2l}\, a_{smooth})$$

$$\Rightarrow a_{rough} = \frac{1}{4} a_{smooth}$$; $f = \mu N = \mu mg\cos\theta$

$f = \mu mg\cos 45^\circ = \frac{\mu mg}{\sqrt{2}}$

Now consider the case of the rough inclined plane.

Net force is given by $mg\sin\theta - f = m a_{rough}$

$$\Rightarrow mg\sin 45^\circ - f = m\, a_{rough}$$

$$\Rightarrow \frac{mg}{\sqrt{2}} - f = m \times \frac{a_{smooth}}{4}$$

$$\Rightarrow \frac{mg}{\sqrt{2}} - \frac{\mu mg}{\sqrt{2}} = \frac{m}{4}\frac{g}{\sqrt{2}}$$

$$\Rightarrow \frac{1}{\sqrt{2}} - \frac{\mu}{\sqrt{2}} = \frac{1}{4\sqrt{2}}$$

$$\Rightarrow 1 - \mu = \frac{1}{4}$$

$$\Rightarrow \mu = 1 - \frac{1}{4}$$

$$\Rightarrow \mu = \frac{3}{4}$$

③

$\theta = 45^\circ$

$$t_d = 2t_a$$

$$\Rightarrow \sqrt{\frac{2l}{g(\sin\theta-\mu\cos\theta)}} = 2\sqrt{\frac{2l}{g(\sin\theta+\mu\cos\theta)}}$$

squaring on both sides we get

$$\Rightarrow \left[\sqrt{\frac{2l}{g(\sin\theta-\mu\cos\theta)}}\right]^{\cancel{2}} = 2^2\left[\sqrt{\frac{2l}{g(\sin\theta+\mu\cos\theta)}}\right]^{\cancel{2}}$$

$$\Rightarrow \frac{2\cancel{l}}{g(\sin\theta-\mu\cos\theta)} = 4\frac{\cancel{2l}}{g(\sin\theta+\mu\cos\theta)}$$

$$\Rightarrow \sin\theta+\mu\cos\theta = 4(\sin\theta-\mu\cos\theta)$$

$$\Rightarrow \sin\theta+\mu\cos\theta = 4\sin\theta-4\mu\cos\theta$$

$$\Rightarrow 5\mu\cos\theta = 3\sin\theta$$

$$\Rightarrow \mu = \frac{3}{5}\frac{\sin\theta}{\cos\theta} = 0.6\tan\theta = 0.6\times\tan 45^\circ$$

$$\Rightarrow \mu = 0.6$$

④

$l = 5m$; $\theta = 30^\circ$

$$t = \sqrt{\frac{2l}{g\sin\theta}}$$

$$= \sqrt{\frac{2\times5}{10\sin30}}$$

$$= \sqrt{\frac{1\cancel{0}}{\cancel{10}\times\frac{1}{2}}}$$

$$= \sqrt{2}\ \text{sec}$$

⑤

$\theta = 30^\circ$ $u = 10\ m/s$ $v = 0$

From $v^2-u^2 = 2as$

$$\Rightarrow 0^2-10^2 = 2(-g\sin\theta)s$$

$$\Rightarrow \cancel{-}100 = \cancel{-}2\times10\times\sin30^\circ s$$

$$\Rightarrow 10\cancel{0} = \cancel{2}\times\cancel{10}\times\frac{1}{\cancel{2}}\times s$$

$$\Rightarrow s = 10m$$

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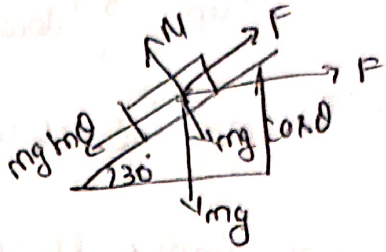
⑥

$m = 30\,kg$ $\quad v = 5\,m/s$

$\theta = 60^\circ$ $\quad f_k = 100\,N.$



Given a 30 kg box has to move up an inclined slope of 30° to the horizontal at a uniform velocity of 5 m/s. If the frictional force retarding the motion is 150N.

To find the horizontal force required to move up

∴ From fig $\quad$ Force of friction = 150 N.

Net horizontal force $F' - f = mg\sin\theta$

$\Rightarrow F' = mg\sin\theta + f$

$\Rightarrow F' = 30 \times 10 \times \sin 60 + 150$

$= 30 \times 10 \times \frac{\sqrt{3}}{2} + 150 = \cancel{300N}\ 410N$

∴ To Pull the body up the plane

Horizontal force is $\cancel{F\cos\theta = 300}$

$\cancel{\Rightarrow F \cos 60 = 300}$

$\cancel{\Rightarrow F \frac{1}{2} = 300 \Rightarrow \dots N}$

$F\cos\theta = 410$

$\Rightarrow F\cos 60 = 410$

$\Rightarrow F\,\frac{1}{2} = 410 \quad \Rightarrow F = 820\,N$

⑦

$m = 1$ metric ton $= 10^3\,kg$

$\sin\theta = \frac{1}{2}$; $v = 36\,kmph = 10\,m/s$

$\mu = \frac{1}{\sqrt{3}}$; $\cos\theta = \sqrt{1-\sin^2\theta} = \sqrt{1-\frac{1}{4}} = \frac{\sqrt{3}}{2}$

As is known force required

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

$= mg\,[\sin\theta + \mu\cos\theta]$

$\Rightarrow F = 10^3 \times 9.8 \left[\frac{1}{2} + \frac{1}{\sqrt{3}}\,\frac{\sqrt{3}}{2}\right]$

$\Rightarrow F = 98 \times 10^2\,N$

Power $= F \times v$

$= 98 \times 10^2 \times 10$

$= 98 \times 10^3\,W$

$= 98\,kW$

(8)

$F_{up} = 3 F_{down}$; $\mu = \frac{1}{2\sqrt{3}}$

$\Rightarrow \cancel{mg}[\sin\theta + \mu_k \cos\theta] = 3\ \cancel{mg}[\sin\theta - \mu_k \cos\theta]$

$\Rightarrow \sin\theta + \mu_k \cos\theta = 3\sin\theta - 3\mu_k \cos\theta$

$\Rightarrow 4\mu_k \cos\theta = 2\sin\theta$

$\Rightarrow \cancel{4}^{2} \times \frac{1}{\cancel{2}\sqrt{3}} = \cancel{2}\frac{\sin\theta}{\cos\theta}$ $\Rightarrow \tan\theta = \frac{1}{\sqrt{3}}$

$\Rightarrow \theta = 30°$

(9)

$m = 10\,kg$; $\theta = 30°$; $\mu = 0.5$

Force required to pull the body up

$F = mg[\sin\theta + \mu\cos\theta]$

$= 10 \times 9.8[\sin 30 + 0.5 \cdot \cos 30]$

$\Rightarrow 98\left[\frac{1}{2} + \frac{0.5 \times \sqrt{3}}{2}\right]$

$\Rightarrow 49\,(1 + 0.5 \times 1.732)$

$\Rightarrow 49 \times 1.866 = 91.4N$

(10)

$m = 0.5\,kg$; $\theta = 30°$; $\mu = 0.2$.

Force required to slide down $F = mg(\sin\theta - \mu\cos\theta)$

$F = 0.5 \times 9.8[\sin 30 - 0.2 \times \cos 30)$

$= 4.9\left[\frac{1}{2} - 0.2 \times \frac{\sqrt{3}}{2}\right]$

$= 4.9[0.5 - 0.1732]$

$= 4.9 \times 0.3268$

$= 1.6N$

14

$$t_{ascen} = \sqrt{\frac{2l}{g(\sin\theta + \mu\cos\theta)}} \; ; \; t_{descen} = \sqrt{\frac{2l}{g(\sin\theta - \mu\cos\theta)}}$$

15

$\mu = 0.5$

$N = 2F_{down}$

$\Rightarrow Mg\cos\theta = 2mg[\sin\theta - \mu\cos\theta]$

$\Rightarrow \cos\theta = 2\sin\theta - 2\mu\cos\theta$

$\Rightarrow \cos\theta = 2\sin\theta - 2(0.5)\cos\theta$

$\Rightarrow \cos\theta = 2\sin\theta - \cos\theta$

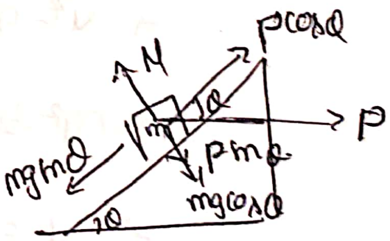
$\Rightarrow 2\cos\theta = 2\sin\theta$

$\Rightarrow \cos\theta = \sin\theta$

$\Rightarrow \theta = 45°$

16

The force required to a body up an inclined plane is



$F = mg\sin\theta + \text{frictional force}$

$= 30 \times 10 \times \sin 30 + 150$

$= 30 \times 10 \times \frac{1}{2} + 150$

$= 300N.$

friction $= 150N$

$m = 30$ kg

$\theta = 30°$

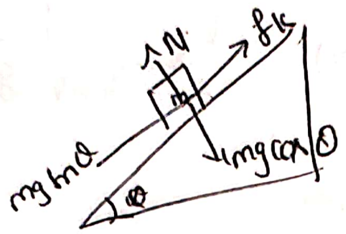
If $P \Rightarrow$ horizonal force

$F = P\cos\theta$

$\Rightarrow 300 = P\cos 30°$

$\Rightarrow 300 = P\frac{\sqrt{3}}{2} \Rightarrow P = \frac{2}{\sqrt{3}} \times 300 = 346N$

(13)



when body is moving down frictional force acts in upward direction $f_k = \mu_k N$

$\therefore$ Net force $= mg\sin\theta - f_k$ $\quad [N = mg\cos\theta]$

$\Rightarrow f_k = \mu_k mg\cos\theta$

$\Rightarrow ma = mg\sin\theta - \mu_k mg\cos\theta$

$\Rightarrow \cancel{m}a = \cancel{m}g[\sin\theta - \mu_k\cos\theta]$

$\Rightarrow a = g[\sin\theta - \mu_k\cos\theta]$

work done by friction $w = f_r \times s$

$= \mu_k mg\cos\theta \; l$

From $v^2 - u^2 = 2as$ $\quad s = l$

$\Rightarrow v^2 - 0^2 = 2g(\sin\theta - \mu_k\cos\theta) l$

$\Rightarrow v^2 = 2gl(\sin\theta - \mu_k\cos\theta)$

$\Rightarrow v = \sqrt{2gl(\sin\theta - \mu_k\cos\theta)}$

(14)

If Angle of inclination = Angle of repose

$\mu = \tan\theta$

$a = -g[\sin\theta + \mu\cos\theta]$

$a = -g[\sin\theta + \tan\theta\cos\theta]$

$a = -g[\sin\theta + \frac{\sin\theta}{\cos\theta}\cos\theta]$

$\Rightarrow a = 2g\sin\theta$ [-ve shows Retardation]

Time of ascent $= \sqrt{\frac{2l}{a}} = \sqrt{\frac{2l}{2g\sin\theta}}$

$= \sqrt{\frac{l}{g\sin\theta}}$

c, a are correct