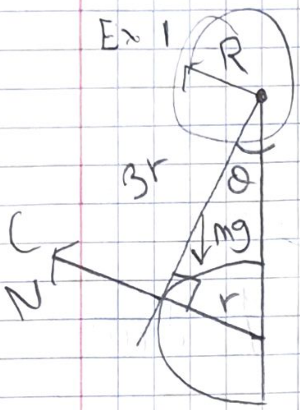
||

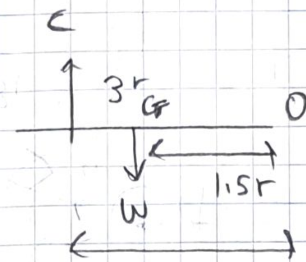
$\frac{31}{35}$

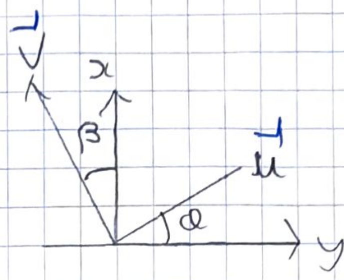
Ariven Seeneevassen

Mechanics Exam

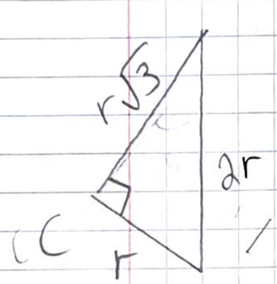
Ex 1

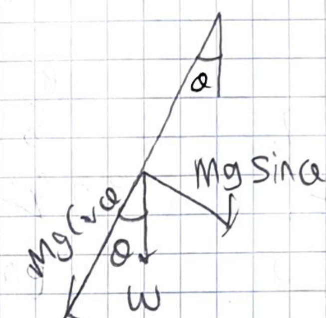


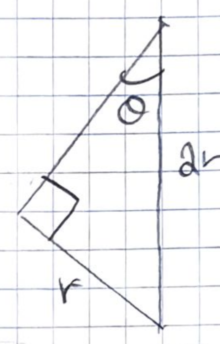




$90 - \alpha = \beta$







$\sin\theta = \frac{r}{2r} = \frac{1}{2}$

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a Take moment at O → G being centre of mass

$N \times OC = W\vec{v} \times OG$

Sum of ~~cl~~ clockwise moment = sum of anticlockwise moment

The contact force = N

$N \times \sqrt{3}\, r = Mg \sin\alpha \times \frac{3r}{2}$

$N \times \sqrt{3}\, r = Mg \times \frac{1}{2} \times \frac{3r}{2}$

$N \times \sqrt{3}\, r = \frac{3Mg\, r}{4}$

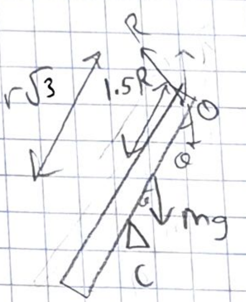
||||

$N = \frac{3Mg}{4\sqrt{3}}$

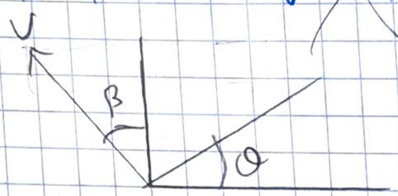
$= \frac{\sqrt{3}\, Mg}{4}$

3. Now, to get R, we take pivot at C. Being in static equilibrium, the slender rod ~~doe~~, the torqu is zero, so we can write again

Sum of clockwise moment = sum of anticlockwise moment.



~~R is in the $\vec{V}$ direction~~



NO

(1)

Distance of weight from pivot $= r\sqrt{3} - 1.5r$

thus, $mg\sin\theta\,(r\sqrt{3} - 1.5r) = R \times r\sqrt{3}$

$$R = \cancel{\frac{mg}{2}r} \quad \frac{mg}{2}\,\frac{(r\sqrt{3} - 1.5r)}{r\sqrt{3}}$$

$$\cancel{R = \frac{mg}{2}\left(1 - \frac{3}{2}r\right)}$$

$$R = \frac{mg}{2}\left(1 - \frac{\sqrt{3}}{2}\right)$$

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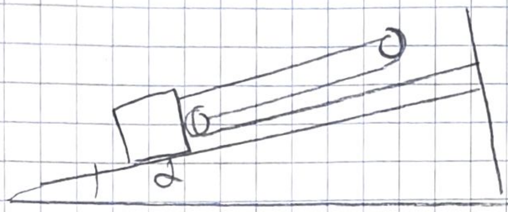
Mechanics

Ex 2

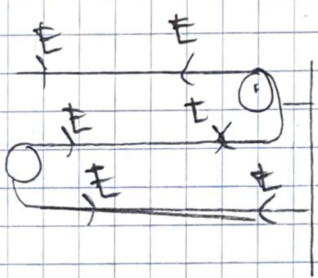


Consider this simple model.

} if in equilibrium, the tension in the cords are equal

Now, if we have a system of 3 pulleys, & in static condition, the tension in the 3 ropes will be the same. So

very good!



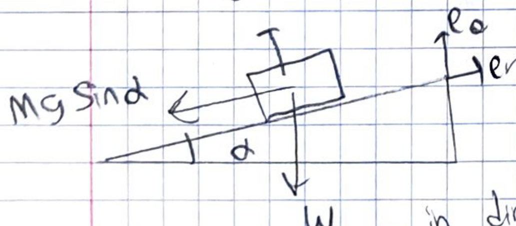
} total tension $\Uparrow$ T ⟹

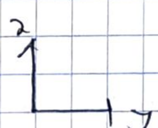
so, the force which man has to supply is divided by 3.

So, the force applied by man, $\cancel{P_s = 3T}$ $T = 3P_s$

$\cancel{T = \frac{P_s}{3}}$

cart + man $(M+m)$





$\vec{W}$ in direction of e_θ

$W + 3T = 0$

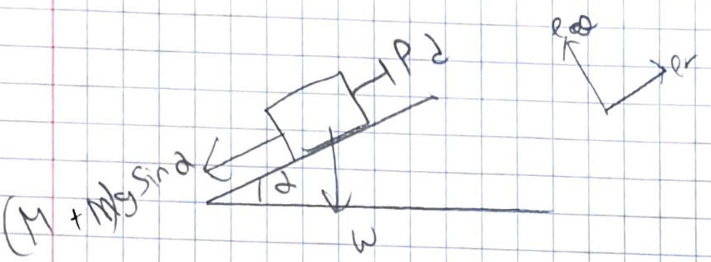
$\vec{e_r}$ $-(M+m)g\sin\alpha$ $\cancel{-Mg\sin\alpha}$ $+ 3T = 0$ $\sin\alpha$ $\cancel{3T = P_s}$ $T = \frac{P_s}{3}$

$-(M+m)g\sin\alpha$ $\cancel{-Mg\sin\alpha}$ $+3P_s = 0$

$P_s = \cancel{\frac{Mg\sin\alpha}{3}}$ $\frac{(M+m)g\sin\alpha}{3}$ ⟹

So, this result ~~pro~~ serves to prove that the force ~~& Re~~ that the man requires to supply is 3 times less.

2 Since it is no longer static,



The cart moving up the plane, there is a net resultant force up of the incline plane.

$$Pg - (M+m)g\sin\alpha = (M+m)a\,\vec{e_r}$$

The resultant force is in the $\vec{e_r}$ direction.

$$\frac{Pg-(M+m)g\sin\alpha}{M+m} = a$$

The acceleration being constant, we can use the equations of motion to find the time to climb up the incline plane.

We will use, $S = ut + \frac{1}{2}at^2$

where $S = D$, $u = 0$ since initially the system is static

a, the result from the previous question.

$$S = \overset{0}{\overset{\shortparallel}{ut}} + \frac{1}{2}at^2$$

$$\frac{2S}{a} = t^2$$

$$t^2 = \frac{2D(M+m)}{Pg-(M+m)g\sin\alpha} \qquad t = \sqrt{\frac{2D(M+m)}{Pg-(M+m)g\sin\alpha}}$$

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Mechanics

Ex 2

3.

Energy	Initial	Final
K.E	0	$\frac{1}{2}mv^2$
P.E	0	mgh

~~The height moved by the~~ man

Work done = Force x distance

$$= Ma_2 \times D$$

$$= (M+m)\left(\frac{Pg-(M+m)g\sin\alpha}{M+m}\right)D$$

$$= \left(Pg-(M+m)g\sin\alpha\right)D$$

|||

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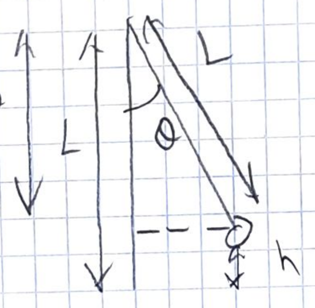
Mechanics Ex 3

(1) The crawler moving with constant speed, the ball possesses the same speed. Then the resultant force on the ball is zero. Then $a = 0$

(2) The angle between $a = 0$ & θ being 0, there is no work done by the ball since it is considered to be static.

(3) The ball moving also with speed u, the K.E of ball $= \frac{1}{2} m u^2$

(4) $L\cos\theta$



$h = L - L\cos\theta$

Energy	Initial ($\theta = 0$)	θ (Max)
K.E	$\frac{1}{2} m u^2$	0
P.E	0	$mg(L - L\cos\theta)$

Using Conservation of energy

$$P.E = K.E$$

$$mg(L - L\cos\theta) = \frac{1}{2}mv^2$$

$$L - L\cos\theta = \frac{v^2}{2g}$$

$$L\cos\theta = L - \frac{v^2}{2g}$$

$$\cos\theta = 1 - \frac{v^2}{2gL}$$

$$\cancel{\theta =}$$

$$\theta_{Max} = \arccos\left[1 - \frac{v^2}{2gL}\right]$$