Physicsaholics

DPP – 1

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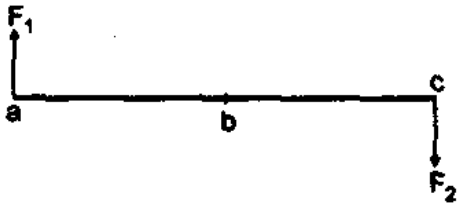
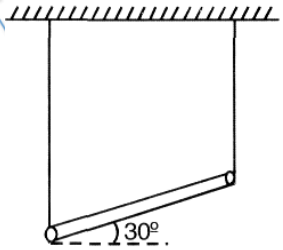
Q 1. Two forces F_1 and F_2 are acting on a rod abc as shown in figure



(a) If $F_1 = F_2$ then $\tau_a = \tau_b = \tau_c$ (of both forces)
(b) If $F_1 = F_2$ then $\tau_a = \tau_c \neq \tau_b$
(c) If $F_1 \neq F_2$ then $\tau_a \neq \tau_b \neq \tau_c$
(d) If $F_1 \neq F_2$ then $\tau_a = \tau_c \neq \tau_b$

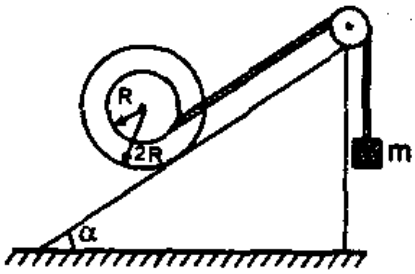
Q 2. A body is in equilibrium under the influence of a number of forces. Each force has a different line of action. The minimum number of forces required is
(a) 2, if their lines of action pass through the centre of mass of the body.
(b) 3, if their lines of action are not parallel.
(c) 3, if their lines of action are parallel.
(d) 4, if their lines of action are parallel and all the forces have the same magnitude.

Q 3. Thin uniform bar of m - 2 kg length l = 2 m is supported by ceiling by ideal strings. Then find tension in left string as given in situation of figure



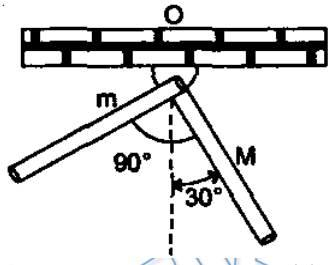
(a) 10 N (b) 20 N
(c) 15 N (d) 12 N

Q 4. A spool of mass M and radius 2R lies on an highly rough inclined plane as shown in figure. A light thread is wound around the connecting rube of the spool and its free end carries a weight of mass m. The value of m so that system will remain in equilibrium is



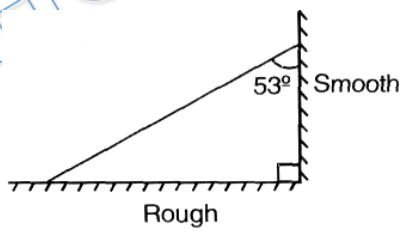
(a) 2 M sin α (b) M sin α
(c) 2M tan α (d) M cos α

Q 5. Two uniform rods of equal length but different masses are rigidly joined to form an L-shaped body, which is then pivoted as shown. If in equilibrium the body is in the shown configuration, ratio M/m will be :



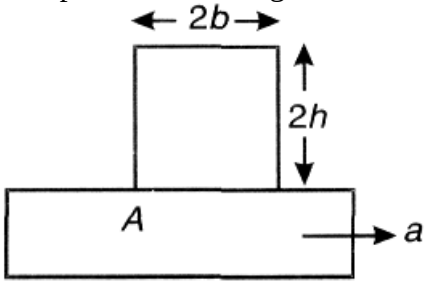
(a) 2 (b) 3 (c) √2 (d) √3

Q 6. A uniform ladder of mass 10 kg leans against smooth vertical wall making an angle 53° with it. The other end rests on rough horizontal floor. Then friction coefficient just necessary for ladder to be at rest is approximately



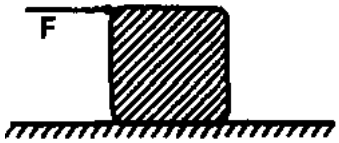
(a) 0.45 (b) 0.55 (c) 0.75 (d) 0.65

Q 7. A block of mass m height 2h and width 2b rests on flat car which moves horizontally with constant acceleration a as shown in figure then value of acceleration at which block topples about point A assuming there is sufficient friction to prevent slipping



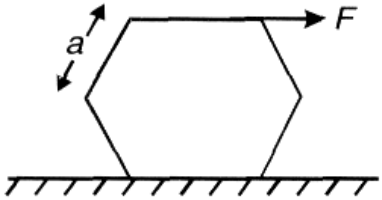
(a) hg/b (b) bg/h
(c) bh/g (d) bgh

Q 8. A force p is applied on the top of a cube as shown in figure. The coefficient of friction between the cube and the ground is p. If F is gradually increased, the cube will topple before sliding if :



(a) $\mu > 1$ (b) $\mu < \frac{1}{2}$ (c) $\mu > \frac{1}{2}$ (d) $\mu < 1$

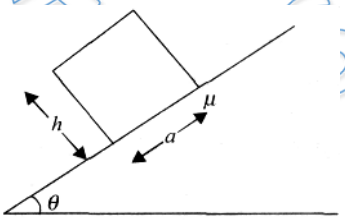
Q 9. When force F acts on side of hexagonal body for what range of coefficient of friction body will topple before sliding?



(a) $\mu > 0.29$ (b) $\mu < 0.29$ (c) $\mu > 0.21$ (d) $\mu < 0.21$

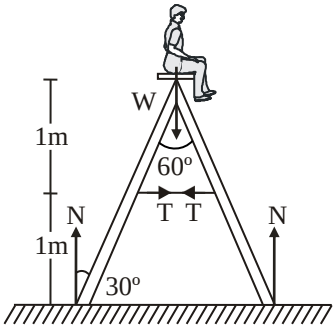
Q 10. The door of an almirah is 6ft high, 1.5 ft wide and weights 8 kg. The door is supported by two hinges situated at a distance of 1 ft from the ends. Assuming forces exerted on the hinges are equal in magnitude, the magnitude of the force is
(a) 15 N (b) 10 N (c) 28 N (d) 43 N

Q 11. A block with a square base measuring a × a, and height h, is placed on an inclined plane. The coefficient of friction is μ. The angle of inclination (θ) of the plane is gradually increased. The block will



(a) topple before sliding if $\mu > a/h$
(b) topple before sliding if $\mu < a/h$
(c) slide before toppling if $\mu > a/h$
(d) slide before toppling if $\mu < a/h$

Q 12. The ladder shown in figure has negligible mass and rests on a frictionless floor. The crossbar connects the two legs of the ladder at the middle. The angle between the two legs is 60°. The fat person sitting on the ladder has a mass of 80 kg. Find tension in the crossbar.

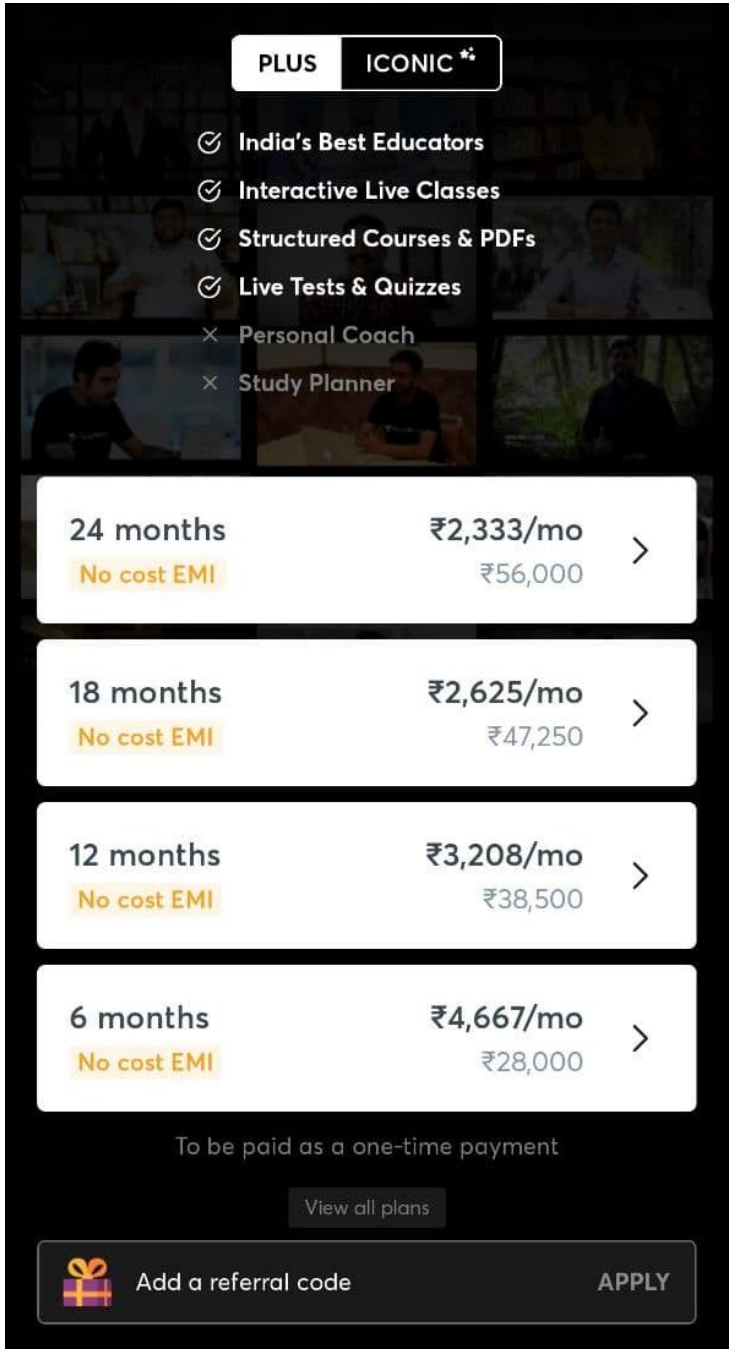


(a) 150 N
(b) 300 N
(c) 450 N
(d) 600 N

Q 13. To avoid overturning, A car should have
(a) Less height of centre of mass
(b) less width
(c) High width
(d) high length

Answer Key

Q.1 a, c	**Q.2 b, c, d**	**Q.3 a**	**Q.4 a**	**Q.5 d**
Q.6 d	**Q.7 b**	**Q.8 c**	**Q.9 a**	**Q.10 d**
Q.11 a, d	**Q.12 c**	**Q.13 a, c**		



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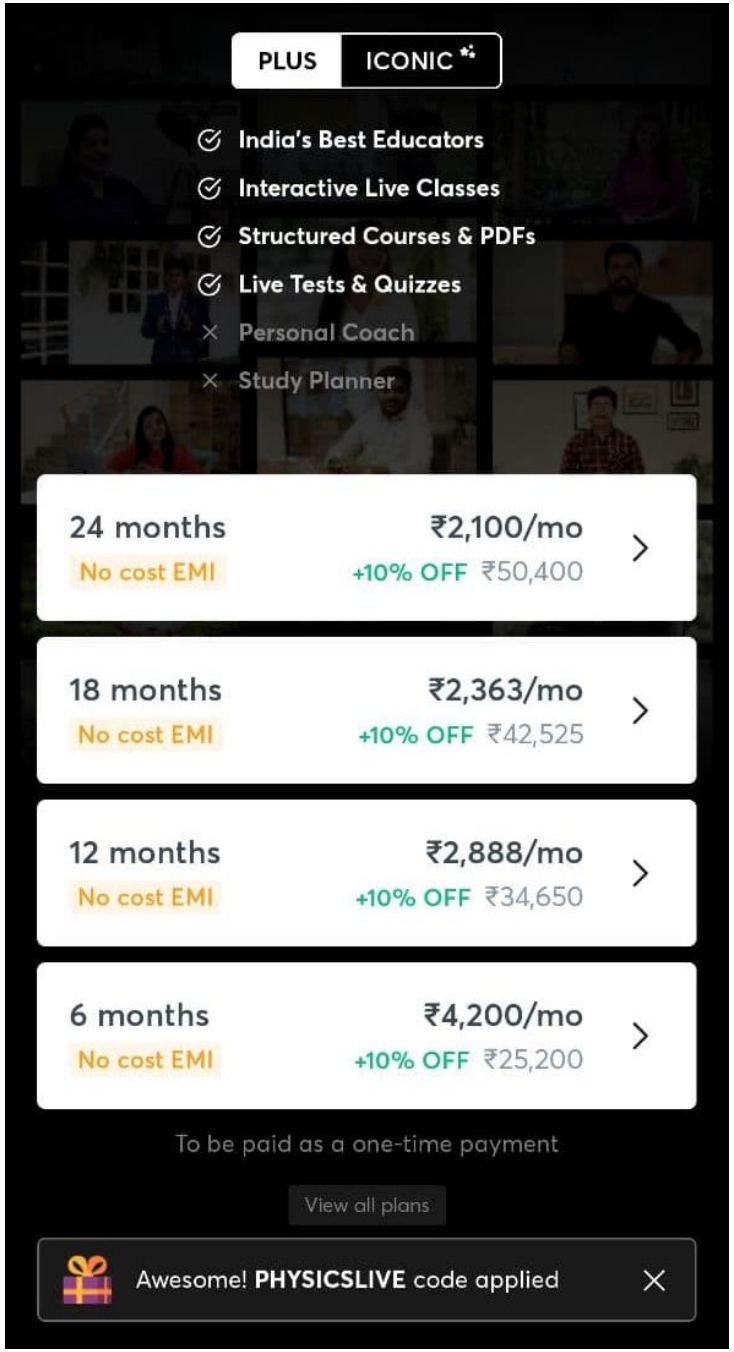


Written Solution

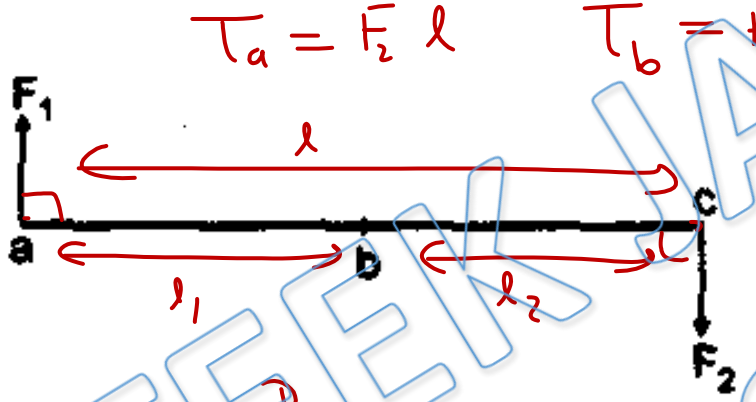
JEE Main & Advanced, NSEP, INPhO, IPhO

Physics DPP

DPP- 1 Rotation: Torque, Equilibrium & Toppling

By Physicsaholics Team

Q1) Two forces F_1 and F_2 are acting on a rod abc as shown in figure



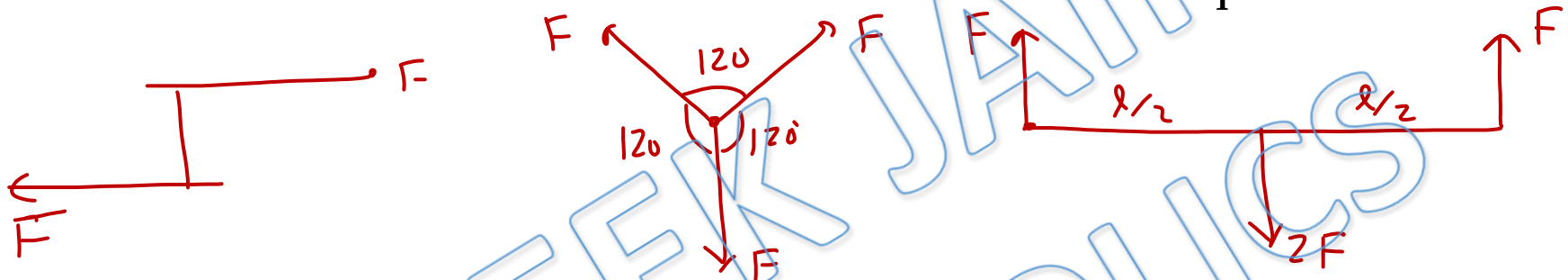
(a) If $F_1 = F_2$ then $\tau_a = \tau_b = \tau_c$ (of both forces)

(b) If $F_1 = F_2$ then $\tau_a = \tau_c \neq \tau_b$

(c) If $F_1 \neq F_2$ then $\tau_a \neq \tau_b \neq \tau_c$

(d) If $F_1 \neq F_2$ then $\tau_a = \tau_c \neq \tau_b$

Q2) A body is in equilibrium under the influence of a number of forces. Each force has a different line of action. The minimum number of forces required is

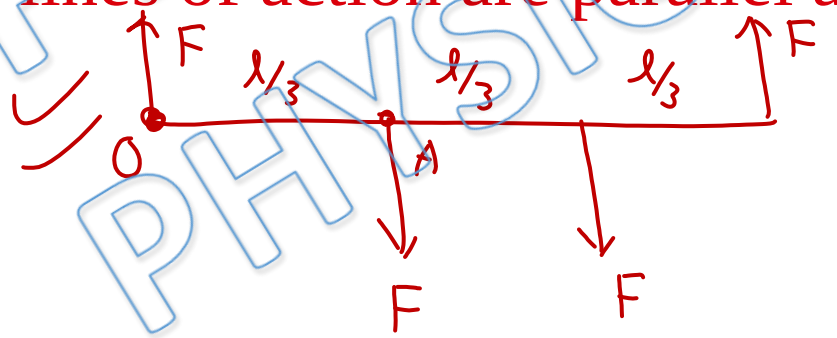


(a) 2, if their lines of action pass through the centre of mass of the body.

(b) 3, if their lines of action are not parallel.

(c) 3, if their lines of action are parallel.

(d) 4, if their lines of action are parallel and all the forces have the same magnitude.



Q3) Thin uniform bar of m - 2 kg length l = 2 m is supported by ceiling by ideal strings. Then find tension in left string as given in situation of figure

(a) 10 N

(b) 20 N

(c) 15 N

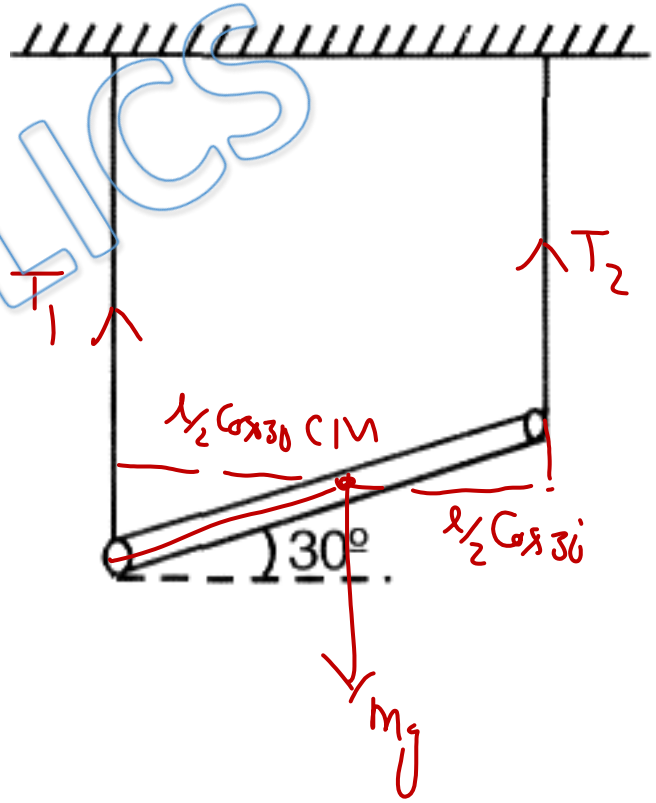
(d) 12 N

$\tau_{cm} = 0$

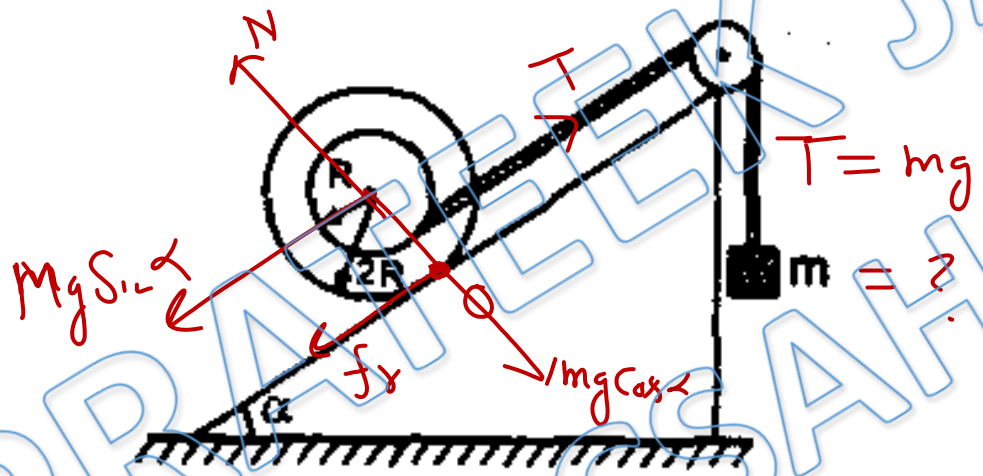
$\Rightarrow T_1 \frac{l}{2}\cos 30 = T_2 \frac{l}{2}\cos 30$

$T_1 + T_2 = mg$

$T_1 = \frac{mg}{2}$



Q4) A spool of mass M and radius 2R lies on an highly rough inclined plane as shown in figure. A light thread is wound around the connecting rube of the spool and its free end carries a weight of mass m. The value of m so that system will remain in equilibrium is



(a) 2 M sin α
(b) M sin α
(c) 2M tan α
(d) M cos α

$\tau_0 = 0$

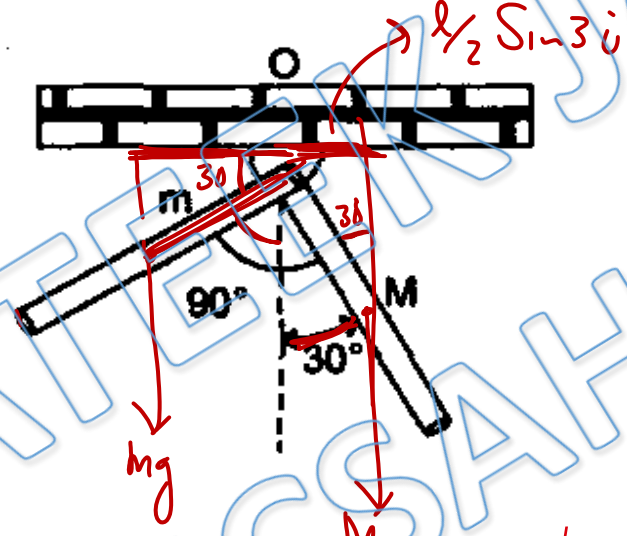
$Mg\sin\alpha \times 2R = mg \times R$

$m = 2M\sin\alpha$

Q5) Two uniform rods of equal length but different masses are rigidly joined to form an L-shaped body, which is then pivoted as shown. If in equilibrium the body is in the shown configuration, ratio M/m will be :

$mg \times \frac{\ell}{2} \cos 30 = Mg \frac{\ell}{2} \sin 30$

$\frac{M}{m} = \cot 30 = \sqrt{3}$



(a) 2 (b) 3 (c) $\sqrt{2}$ (d) $\sqrt{3}$

Q6) A uniform ladder of mass 10 kg leans against smooth vertical wall making an angle 53° with it. The other end rests on rough horizontal floor. Then friction coefficient just necessary for ladder to be at rest is approximately

(a) 0.45

(b) 0.55

(c) 0.75

(d) 0.65

$N_1 = mg$, $N_2 = f$

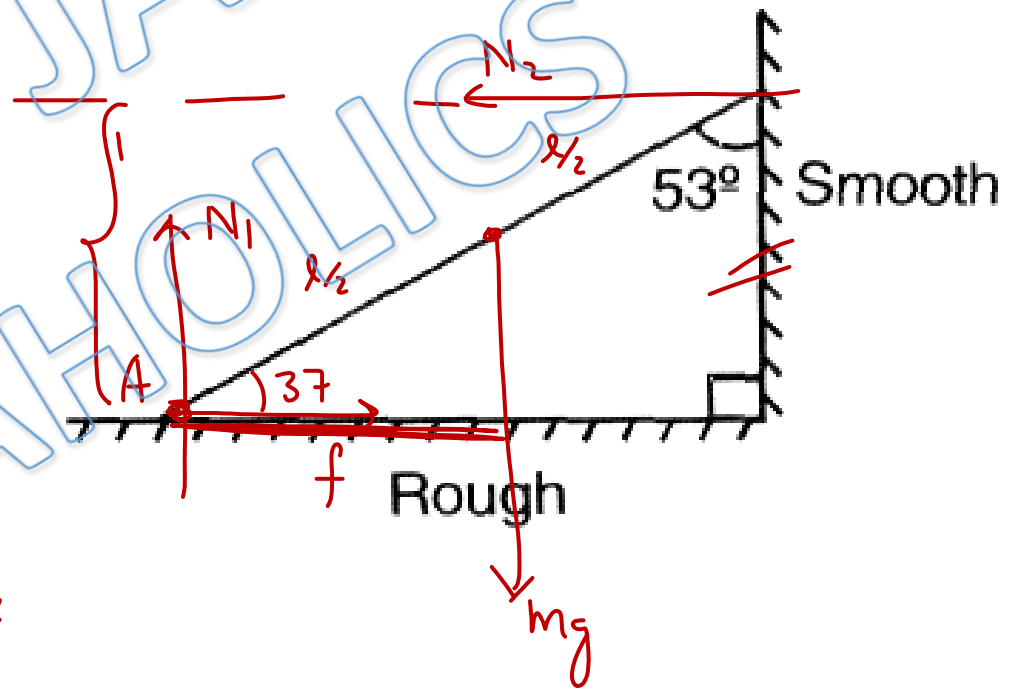
$mg \frac{\ell}{2} \cos 37 = N_2 \ell \sin 37$

$\frac{mg}{2} \times \frac{4}{5} = f \times \frac{3}{5}$

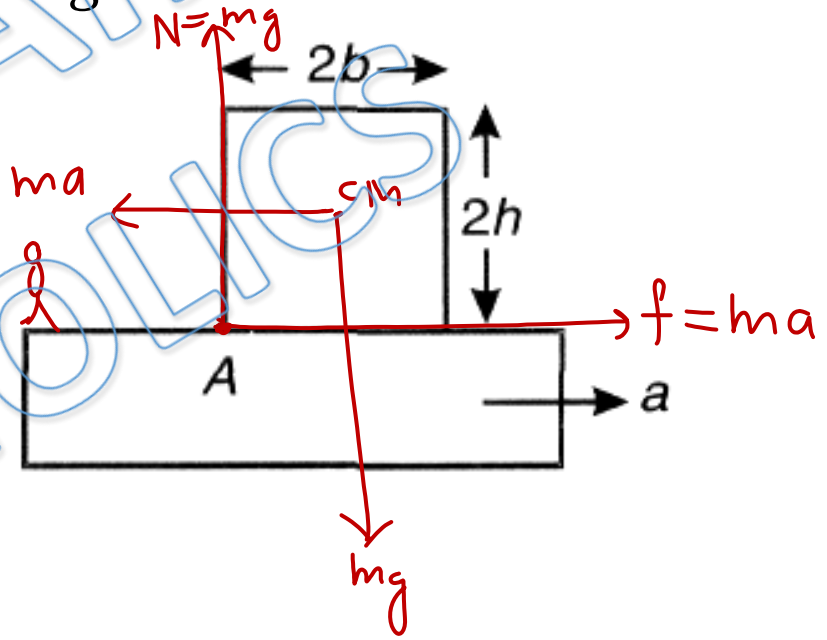
$f = \frac{2mg}{3} \leq f_{max}$

$\frac{2mg}{3} \leq \mu mg$

$\mu \geq \frac{2}{3}$



Q7) A block of mass m height 2h and width 2b rests on flat car which moves horizontally with constant acceleration a as shown in figure then value of acceleration at which block topples about point A assuming there is sufficient friction to prevent slipping



$\tau_A = 0$

$\Rightarrow$ $ma \times h = mg b$

$a = \frac{gb}{h}$

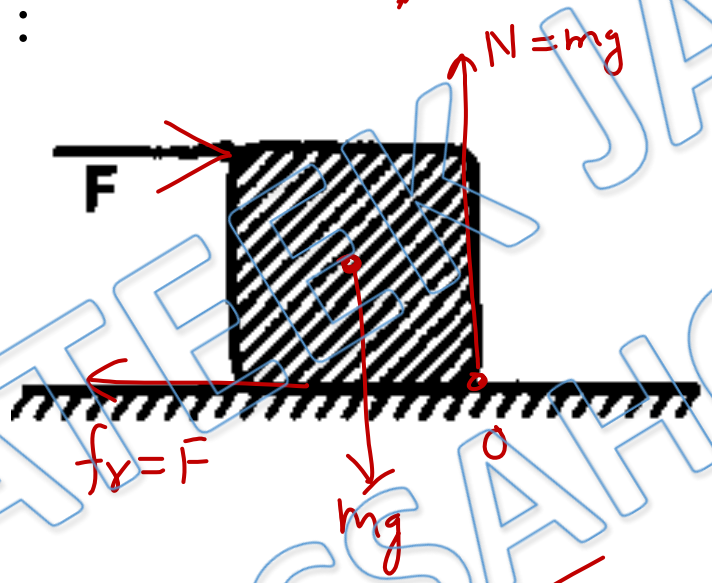
(a) hg/b

(b) bg/h

(c) bh/g

(d) bgh

Q8) A force p is applied on the top of a cube as shown in figure. The coefficient of friction between the cube and the ground is μ. If F is gradually increased, the cube will topple before sliding if :



for sliding

$F_{min} = \mu mg$

for toppling

$F\ell = mg\ell/2$

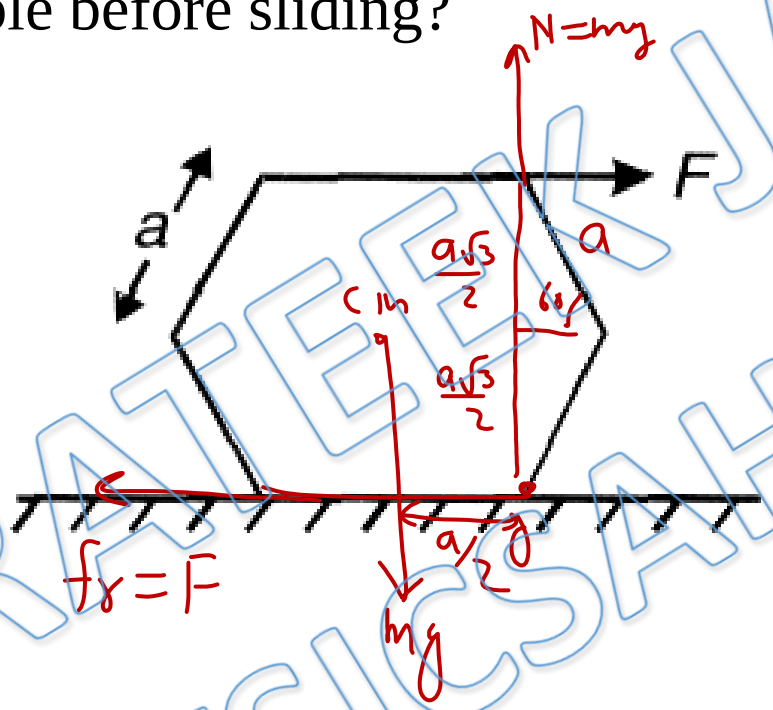
$F = mg/2$

(a) $\mu > 1$ (b) $\mu < \frac{1}{2}$ (c) $\mu > \frac{1}{2}$ (d) $\mu < 1$

$\frac{mg}{2} < \mu mg$

$\mu > 1/2$

Q9) When force F acts on side of hexagonal body for what range of coefficient of friction body will topple before sliding?



for Sliding

$F_{min} = \mu mg$

for toppling

$F \cdot a\sqrt{3} = mg \cdot \frac{a}{2}$

$F = \frac{mg}{2\sqrt{3}}$

(a) $\mu > 0.29$ (b) $\mu < 0.29$ (c) $\mu > 0.21$ (d) $\mu < 0.21$

$\frac{mg}{2\sqrt{3}} < \mu mg$

$\mu > \frac{1}{2\sqrt{3}} = \frac{\sqrt{3}}{6} = \frac{1.73}{6}$

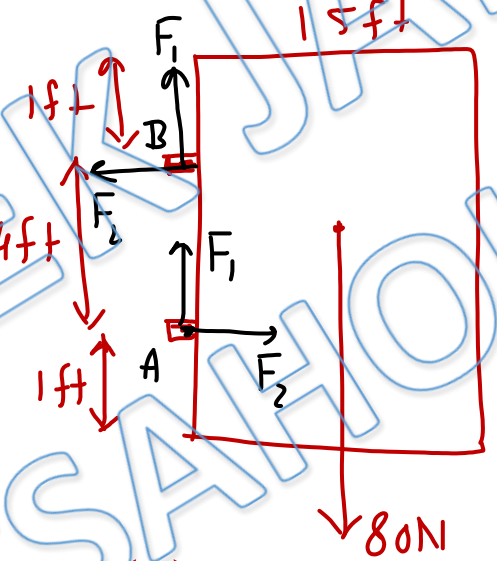
Q10) The door of an almirah is 6ft high, 1.5 ft wide and weights 8 kg. The door is supported by two hinges situated at a distance of 1 ft from the ends. Assuming forces exerted on the hinges are equal in magnitude, the magnitude of the force is

$2F_1 = 80$

$F_1 = 40\,N$

$\tau_A = 0 \Rightarrow \frac{80 \times 15}{2} = F_2 \times 4$

$F_2 = 15\,N$



(a) 15 N (b) 10 N (c) 28 N (d) 43 N

$F = \sqrt{(40)^2 + (15)^2} = \sqrt{1600 + 225}$

$= \sqrt{1825}$

Q11) A block with a square base measuring a × a, and height h, is placed on an inclined plane. The coefficient of friction is μ. The angle of inclination (θ) of the plane is gradually increased. The block will

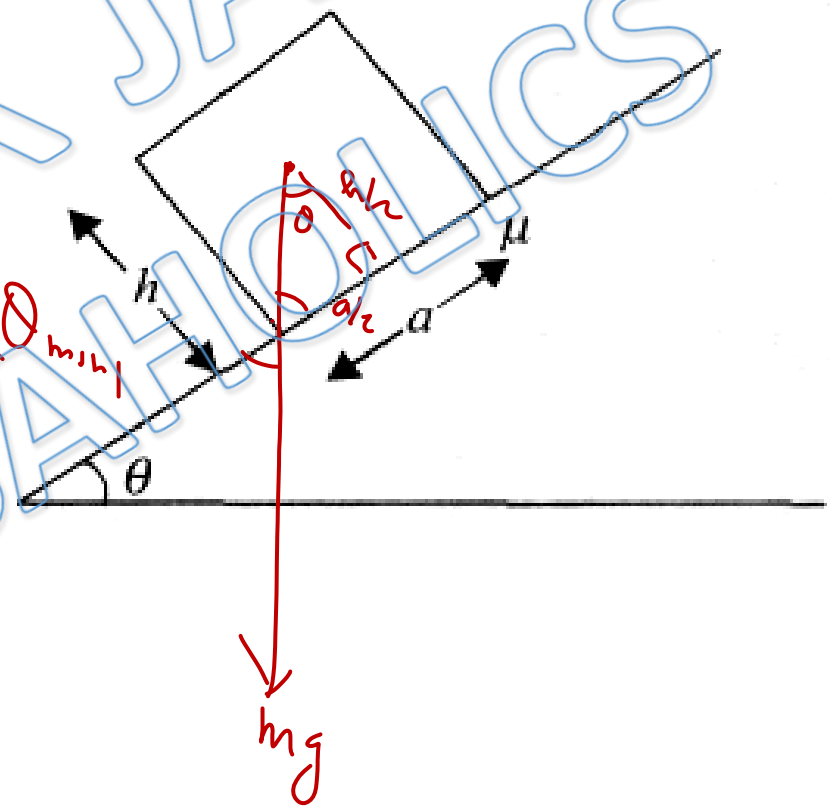
for sliding $\theta_{min_1} = \tan^{-1}(\mu)$

for toppling $\theta_{min_2} = \tan^{-1}(a/h)$

for toppling before sliding $\theta_{min_2} < \theta_{min_1}$

(a) topple before sliding if μ > a/h
(b) topple before sliding if μ < a/h
(c) slide before toppling if μ > a/h
(d) slide before toppling if μ < a/h

$\frac{a}{h} < \mu$



Q12) The ladder shown in figure has negligible mass and rests on a frictionless floor. The crossbar connects the two legs of the ladder at the middle. The angle between the two legs is 60°. The fat person sitting on the ladder has a mass of 80 kg. Find tension in the crossbar.

(a) 150 N

(b) 300 N

(c) 450 N

(d) 600 N

$2N = 800$

$N = 400$

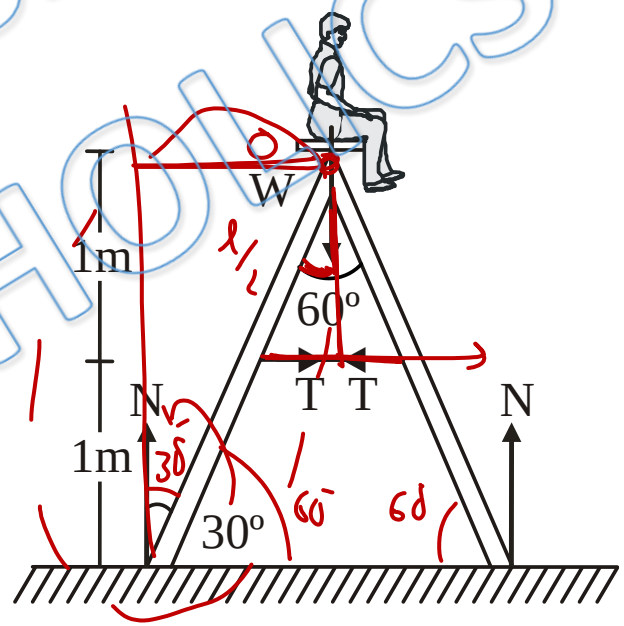
$T_0 = 0$ on left leg

$T \times \frac{1}{2} \cos 30 = N \sin 30$

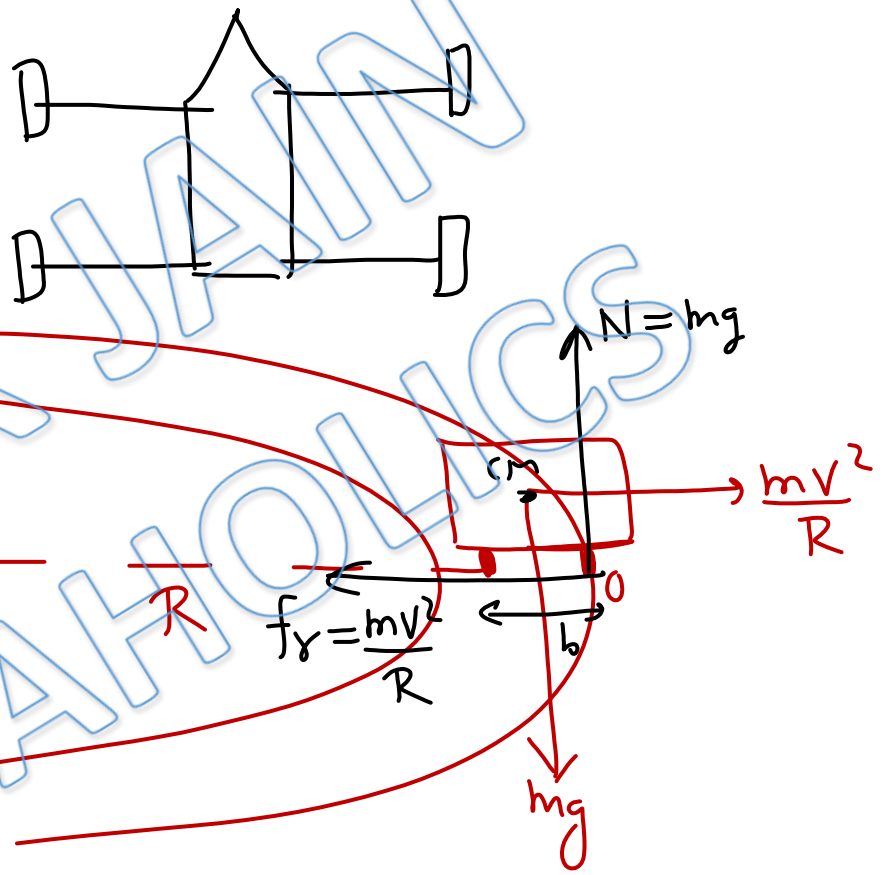
$T \times \frac{1}{2} \times \frac{\sqrt{3}}{2} = 400 \times \frac{1}{2}$

$T = \frac{800}{\sqrt{3}} \quad N = \frac{800\sqrt{3}}{3}$

$= 450\ N$



Q13) To avoid overturning, A car should have



(a) Less height of centre of mass

(b) less width

(c) High width

(d) high length

$\tau_0 = 0$

$\frac{mv^2}{R} \times h_{cm} = mg\frac{b}{2}$

$v = \sqrt{\frac{Rgb}{2h_{cm}}}$

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