proprep™

Physics 1

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Torque

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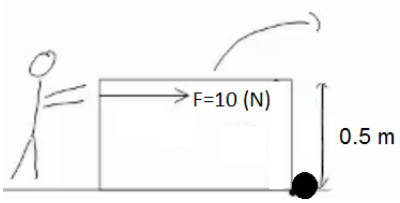
1) R Effective

A man pushes a box of high 0.5m and exerts a force of F (see diagram).
There is no friction between the box and the ground.
The man pushes the box until it reaches a rock and the box flips over
(the position of the rock becomes the axis of rotation).
What is the moment of force?

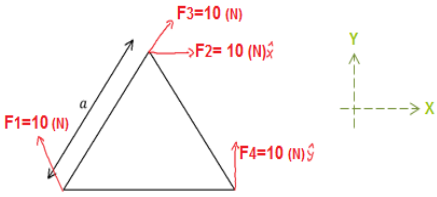


Torque Equation

2) Moments on a Triangle

An equilateral triangle is given with sides of length a.

a. Calculate the torque of the forces in the diagram about the axis perpendicular to the page, which goes through the bottom left corner of the triangle.



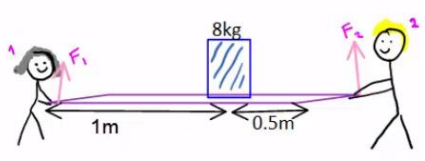
b. The mass of the triangle is M and the center of mass is located at $\left(\frac{1}{2}a, \frac{1}{2\sqrt{3}}a\right)$.
Work out of the gravity's moment of force.

c. Work out the moments about the center of mass of the triangle, again, and assume that the angle between F_1 and the side of the triangle is $60°$.

3) Why does the gravitational force act on the center of masss?

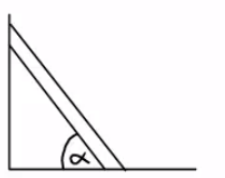
Exercises

4) Two People Holding a Plank



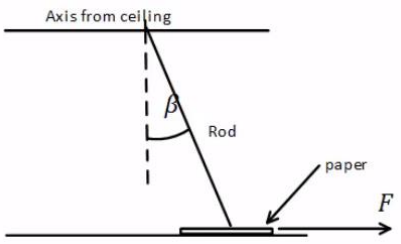
Two people hold a wooden plank of mass $12\ \text{kg}$ and of length 1.5m. On the plank, 0.5m from the person on the right, a box of mass $8\ \text{kg}$ is placed. The people are stationary.
What force does each person apply to the system?

5) Ladder on a Wall



A ladder of mass m and length L is leaning on a smooth wall and rough floor.
What forces are acting on the ladder?

6) Rod Resting on a Paper



A rod of length L and mass M is attached to the ceiling via an axis. The other end of the rod is resting on a sheet of paper that is resting on the floor. The angle between the rod and the axis is β, and the coefficient of static friction between the rod and the paper, and the paper and the floor are μ_s.

a. The paper is pulled rightwards with a force F. What is the minimal force required in order to pull the paper from underneath the rod? Assume that the rod remains stationary.
b. Redo part a, but this time when the force is acting leftwards.

Answer Key:

1) $5Nm$

2) a. $\vec{\tau} = \vec{r} \times \vec{F}, \quad |\vec{\tau}| = |\vec{r}||\vec{F}|\sin\alpha$ b. $\vec{\tau}_g = Mg\frac{a}{2}$

c. $\vec{\tau}_1 = \frac{-109}{\sqrt{3}}, \quad \vec{\tau}_2 = \frac{-10a}{\sqrt{3}}, \quad \vec{\tau}_3 = \frac{-5a}{\sqrt{3}}, \quad \vec{\tau}_4 = 5a, \quad \vec{\tau}_g = 0$

3) Refer to the video.

4) $F_1 = 86 \cdot 6N, \quad F_2 = 113 \cdot 3N$

5) $f = \mu N$

6) a. $F_{\min} = \frac{\mu_s M_g \sin\beta}{\sin\beta + \mu_s \cos\beta}$ b. $F_{\min} = \frac{\mu_s M_g \sin\beta}{\sin\beta - \mu_s \cos\beta}$