Physics 105 Class 13
TORQUE AND EQUILIBRIUM

Torque is something that, acting alone, would make an object at rest _____

If an object's center of mass does not accelerate,

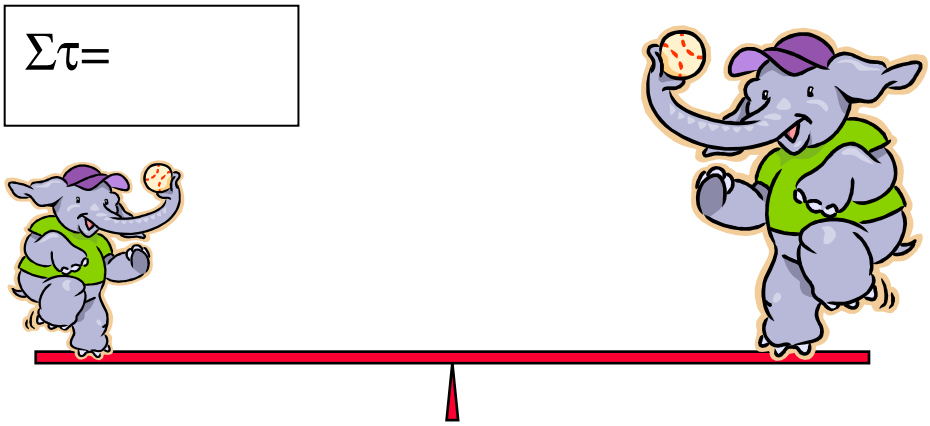
a_{cm}=_____, v_{cm} = _____

ΣF=

Is this enough for no motion? Demo: meter stick

α=_____, ω = _____

$\Sigma\tau$=



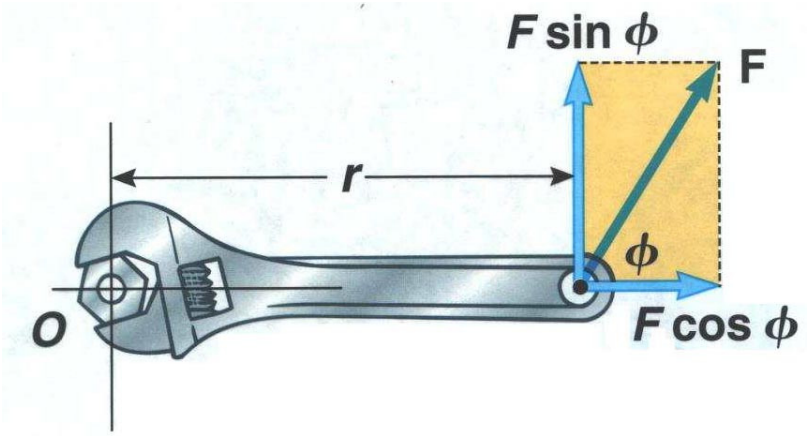
How do we get these elephants to balance?

Levers
Demo: metal rod with weights

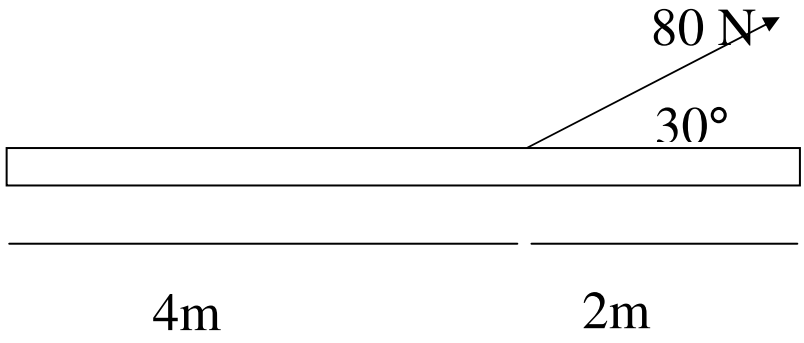
Forces that cause Torques

Let $\vec{r}$ be the vector from the pivot point to the force application point

- A force must be applied some distance (r) from pivot point—
- A force must have a *component* which is *perpendicular* to $\vec{r}$.

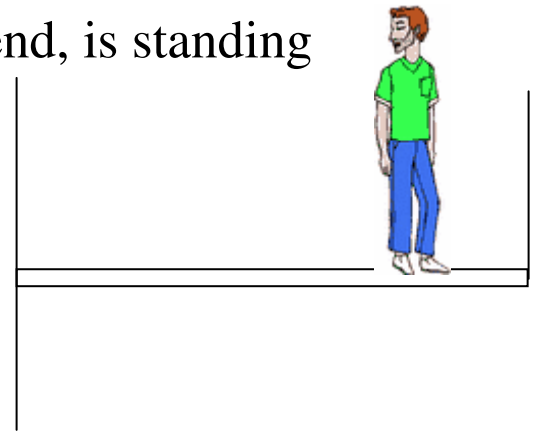


$\tau = F_{\perp} r = (F \sin\theta) r$



Physics 105 Class 13

A 1500 N man, 1 meter from the right end, is standing on a board supported by a wall and a rope. The board weighs 800 N and is 4 meters long.



What is the torque of the man about the left end? (include sign!)

What is the torque of the board about the left end? (include sign!)

Then what must the torque of the rope be about the left end? (include sign!)

What is the tension in the rope?

What is the force of the wall on the board?

Physics 105 Class 13

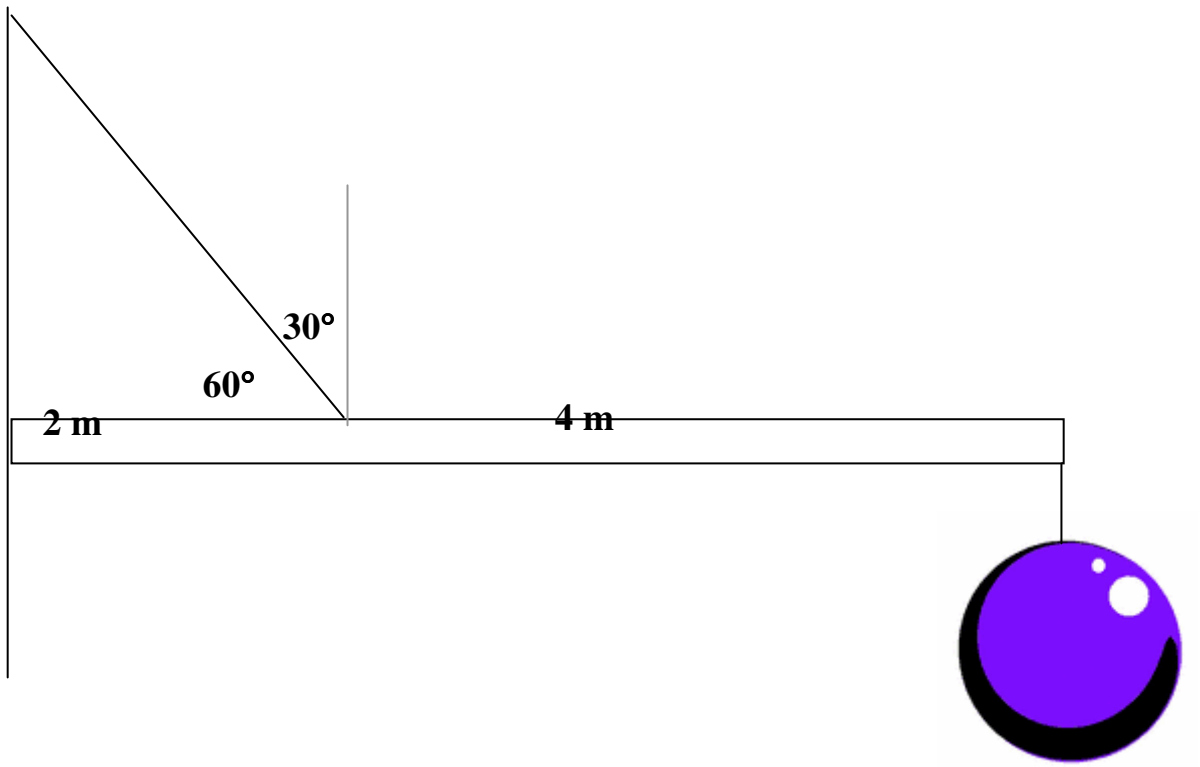
Equilibrium and torque methods

1. Draw a free-body-diagram of the object alone.
2. Include all forces in the diagram
3. The weight of objects is at their *center of gravity.*
4. Decide on a "pivot" point (origin) to calculate torques. (Best to choose pivot where don't need to know forces)
5. Decide on + and – senses of rotation.
6. Find moment arms or perpendicular components of forces.
7. Use $\Sigma\tau = 0$ and $\Sigma\mathbf{F}=0$ until you find all the information you need.

Center of gravity (or mass): The point at which gravity effectively acts, where all the weight can be considered to be concentrated.

Physics 105 Class 13

A pivoting 6m beam weighs 800 N, and supports a glass sphere. The tension in the cable attached to the wall and the beam is 5000 N. Find the weight of the sphere.



The torque of the beam weight about the left end is_____ Nm. (include sign!)

P3. The torque of the cable about the left end is_____ Nm. (include sign!)

P4. By balancing the torques, the torque due to the ball about the left end must be _____ Nm (include sign!)
The weight of the ball is

P5. The *horizontal* (x) force component of the pivot on the beam is (hint: sum forces)

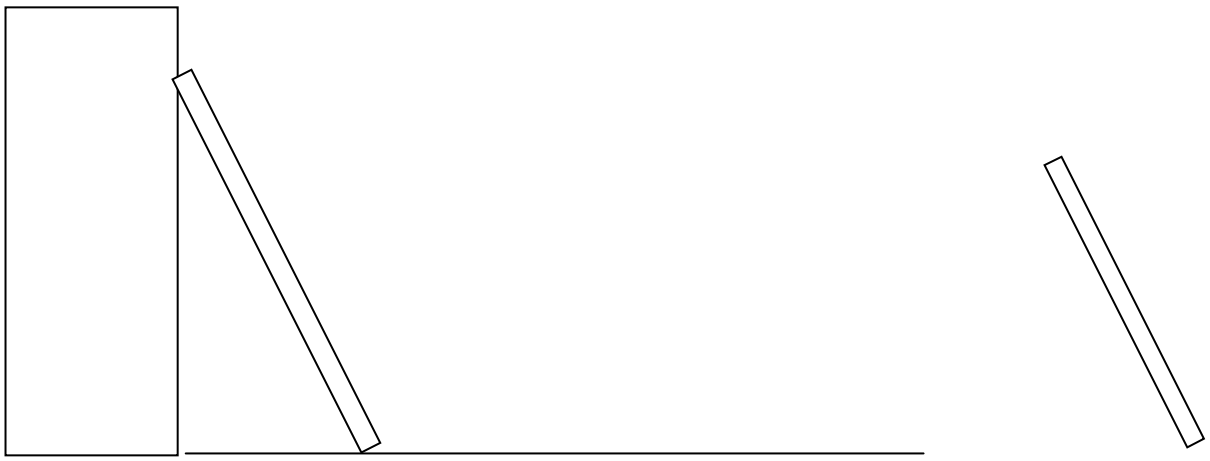
1. to the right
2. to the left
3. zero

P6. The *vertical* (y) force component of the pivot on the beam is (hint: sum forces, or think torques using a *different* pivot point!)

1. up
2. down
3. zero

The x component of the pivot force on the beam is:

The y component of the pivot force on the beam is:



A ladder leans against a frictionless wall. The ground has friction. The ladder doesn't slip

P7. Draw a FBD of the ladder. You should have four forces.

P8. The torque of the wall's normal force about the ground contact point is _____ compared to the torque of the weight about the ground contact point. (Compare magnitudes)

1. more than
2. less than
3. the same

P9. The ground's frictional force is _____ compared to the wall's normal force. (Same choices)

P10. The ground's normal force is _____ compared to the weight. (Same choices)

HOMEWORK HINTS: