Torque

Torque (τ) – measure of how effectively an applied force causes rotation

τ is called “tau”, and measured in N·m

$$\tau = F\, d\, \sin\theta$$

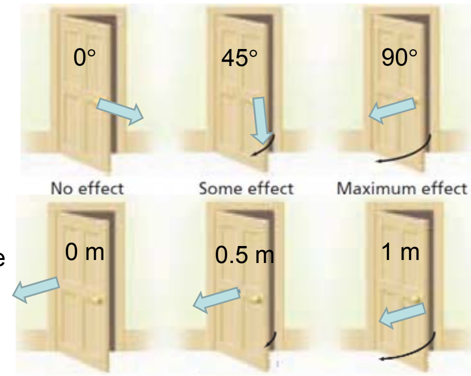
If the force is perpendicular (90°), then equation is:

$$\tau = F\, d$$

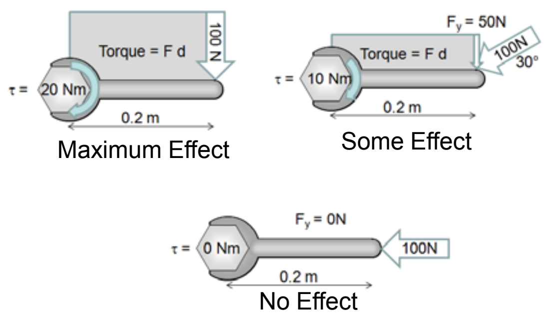
Torque Effects

Angle Effects

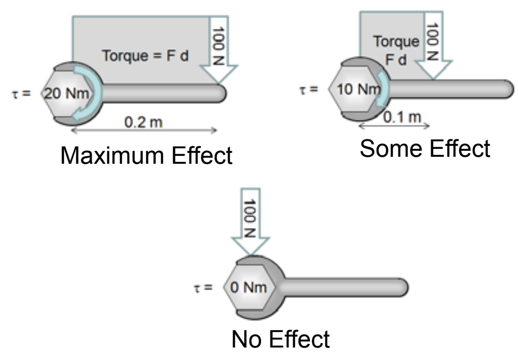
Distance Effects



Torque by Applied Angle



Torque by Location from Pivot



Torque at Equilibrium

Start with the rule:

$$\Sigma \tau = 0$$

$$\Sigma\tau = \Sigma\tau_{\text{Counter-clockwise}} - \Sigma\tau_{\text{clockwise}}$$

$$\Sigma\tau_{\text{Counter-clockwise}} = \Sigma\tau_{\text{clockwise}}$$

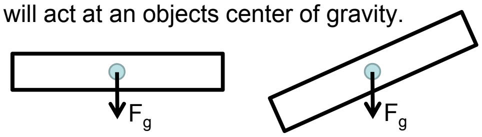
Torque Equilibrium

ALWAYS FOLLOW THESE STEPS:

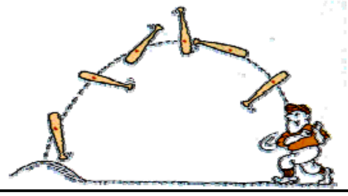
1. Draw a labeled free body diagram
2. Select a pivot point (pick something to “cancel”)
3. Determine torque directions (↺ or ↻)
4. Write net equation ($\Sigma\tau_{↺} = \Sigma\tau_{↻}$)
5. Calculate forces ($\tau = Fd \sin\theta$)
6. Solve for unknowns one at a time

Center of Gravity

F_g will act at an objects center of gravity.



An object rotates at its center of gravity.



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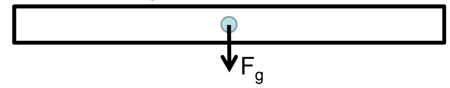
Finding Center of Gravity

For a uniform object, it will be at its center.



For an odd shaped object:

Hold an object at two places.

The CG is where the vertical lines intersect.

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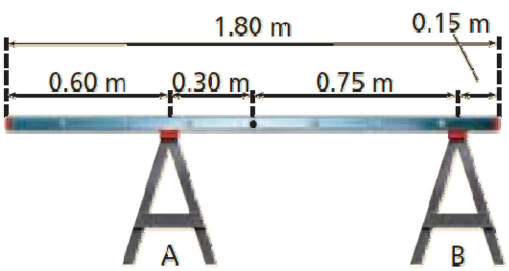
What is the force on each horse?

A 5.8-kg ladder rests on two sawhorses
The following measurements were taken:



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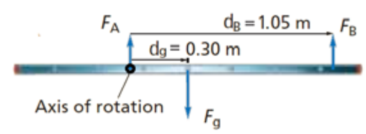
What is the force on each horse?

Draw the labeled free body diagram



Choose a pivot, this will "cancel" this out this force.

→ Distance = 0 at the pivot.

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What is the force on each horse?

Write net equation ($\Sigma\tau_{\circlearrowleft} = \Sigma\tau_{\circlearrowright}$)

$$\tau_B = \tau_g \rightarrow F_B d_B = F_g d_g$$

Solve for F_B

$$F_B = \frac{F_g d_g}{d_B} = \frac{(5.8\text{kg})(9.8\text{m/s}^2)(0.3\text{m})}{1.05\text{m}} = \boxed{16.24 \text{ N}}$$

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What is the force on each horse?

To find F_A, we know $\Sigma F_y = 0$

$$F_A + F_B - F_G = 0 \rightarrow F_A = F_g - F_B$$

$$F_A = (5.8\text{kg})(9.8\text{m/s}^2) - 16.24 \text{ N} = \boxed{40.6 \text{ N}}$$

This could also have been solved by choosing a new pivot point.

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