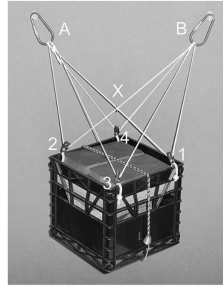


Static Equilibrium



Questions?

Static Equilibrium

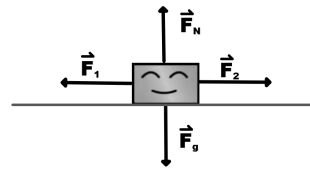
Static = not moving
Equilibrium = balance

When the net force (the sum of all forces acting on an object) in both the x and y directions is zero, we can say that the object is at equilibrium. The forces are balanced.

By Newton's ____ Law, an object with no net force acting on it will not accelerate. Thus, objects in equilibrium do not accelerate.

Often, these objects are at rest, hence the term static.

ex) Static Equilibrium



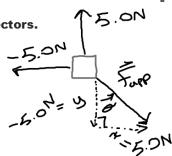
- Force 1 = Force 2 (in magnitude)
- Normal force = Gravitational force (in magnitude)
- The box is at rest.

$$\vec{F}_{netx} = 0$$

$$\vec{F}_{nety} = 0$$

ex) Ashley and Megan are "steering" a 4H steer into a pen with ropes. Ashley pulls with 5.0 N due North while Megan pulls with 5.0 N due West. With what force must the steer pull at to maintain static equilibrium?

Step 1: Draw the vectors.



$$F_{opp} = \sqrt{(5N)^2 + (5N)^2}$$

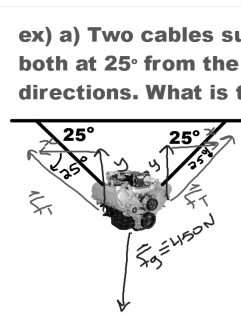
$$= 7.1N$$

$$\theta = 45^\circ \text{ E of S}$$

Step 2: Write out net force statements.

Step 3: Solve for the missing force.

ex) a) Two cables suspend a 450 N engine. The ropes are both at 25° from the horizontal, acting in opposite directions. What is the force of tension in each rope?



Step 1: Draw the vectors.

Step 2: Write out net force statements.

$$\sin(25^\circ) = \frac{opp}{hyp}$$

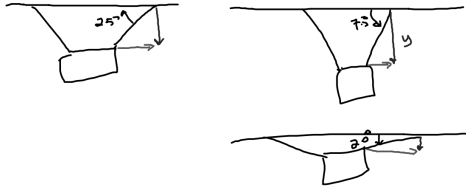
$$hyp = \frac{225N}{\sin(25^\circ)}$$

$$= 532N$$

$$= 5.3 \times 10^2 N$$

Step 3: Solve for the missing force.

b) What will happen to the tension in the cables if the angle of the cables increase? Decrease?



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ex) A 50 kg sign is suspended by two ropes tied to buildings. Rope A makes an angle of 30° to the horizontal while rope B is perfectly horizontal. What is the tension in each rope?

Step 1: Draw the vectors.
Step 2: Write out total force statements.

Step 3: Solve for the missing force.

$$y = 490.5 \text{ N}$$

$$\sin(30^\circ) = \frac{490.5 \text{ N}}{F_{T1}}$$

$$F_{T1} = \frac{490.5 \text{ N}}{\sin(30^\circ)}$$

$$= 981 \text{ N}$$

$$= 0.5 \times 1962 \text{ N}$$

$$F_{T2} = 490.5 \text{ N}$$

$$F_{T2} = 85 \times 15 \text{ N}$$

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ex) A 3.0 kg photo of LD (width = 80 cm) is hung by a 120 cm wire attached to the corners of the frame. The frame is then hung on a nail so it is level. What is the magnitude of the tension in each part of the wire?

*Warning: Diagram not drawn to scale.

$$+29.43 \text{ N} = 2y$$

$$14.715 \text{ N} = y$$

$$\theta = \cos^{-1}\left(\frac{40 \text{ cm}}{60 \text{ cm}}\right)$$

$$\theta = 48^\circ$$

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Bonus LD Caliber Example

LD is suspended by two ropes between two buildings. The first rope makes an angle of 20° to the horizontal, the second rope makes an angle of 35° to the horizontal. What is the tension needed in each rope to suspend LD's beefy 847 N weight?

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Practice: Page 136 #5, 7, 8

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