WIND STUDY

Wind Study is intended for grades 5-8 and 8-11
Questions posted on: Monday Answers posted on: Friday
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2024Q4

TENSION & SINGLE PULLEYS

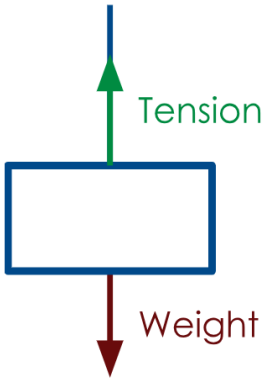
Hello students! Today, we'll be learning about tension and single pulleys. *Tension* is the pulling force in play when ropes are used to lift things in the air. At One Energy, we use single pulleys when rigging and lifting different turbine components. The value of tension cannot be negative. If the tension in a rope is 0, the rope is slack.

Single pulleys are used to redirect the pulling force of ropes in a way that is more convenient to the work that we are trying to do. There are also *multiple pulley* systems called "Block and Tackle" systems that can increase the amount of weight liftable with a given force. However, today's questions are only regarding single pulleys.

When rigging a load, we use tension in ropes to hold things steady, making sure all forces acting on the body are balanced. If not, the load will start to accelerate and will no longer be held at rest. If we are only trying to hold a load steady, we balance the upwards component of tension with weight (mass * acceleration due to gravity, or w = m*g)

Any unbalanced system of forces will result in acceleration as described in Newton's Laws of motion:

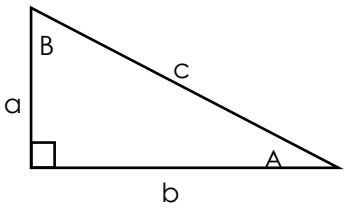
$$Net\ Force = Mass * Acceleration$$



Tension + Weight = 0
(Balanced)

Additionally, because pulleys redirect the direction of force, it is important to keep in mind that when a force acts at an angle to the object, we must use trigonometry to find out how much of the force is acting in the direction that we are interested in.

$\sin(A) = \frac{a}{c}$	$\tan(A) = \frac{a}{b}$	$\cos(A) = \frac{b}{c}$
$\sin\left(\frac{a}{c}\right)^{-1} = A$	$\cos\left(\frac{b}{c}\right)^{-1} = A$	$a^2 + b^2 = c^2$



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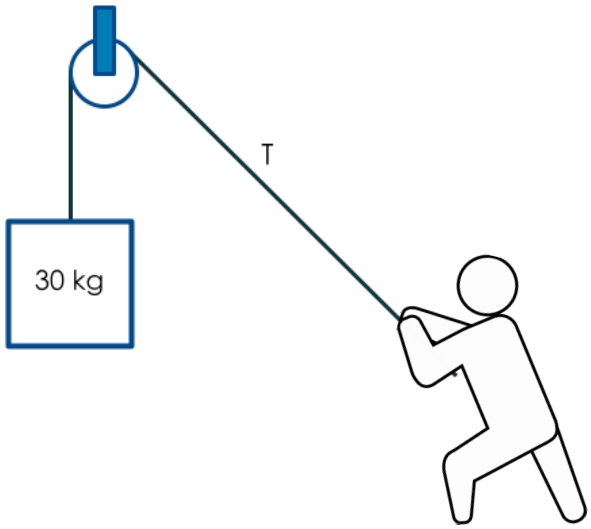
Level 1: The block in the diagram below has a mass of 30 kg and is being suspended without moving in the air (balanced forces) by the person pulling on the rope. How much tension is acting along the rope? Do you think the angle of the rope affects the lifting force? (Note: $g = 9.81\ m/s^2$.) Assume the pulley itself is massless and frictionless.



Level 2: In the diagram below, the block in the middle is held without moving (disregard possible rotation). If the mass of the block is 10 kg, and the tension in the second rope (T_2) is196.2 N, what angle θ must the rope be pulling the block at? What would the tension in the first rope (T_1) be? (Hint: If the weight of the block is acting downwards, what component of T_2 is balancing the weight? What force balances the other component?) Assume the pulley itself is massless and frictionless.