Cheatography

Intro to Forces Cheat Sheet

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Newton's Three Laws

Newton's Three Laws of Motion set up the basic parameters for why objects behave the way they do. They are vital for understanding the units concerning force, work, and energy.

Newton's Three Laws are as follows:
1. INERTIA: An object at rest will remain at rest and an object in motion will remain in motion unless acted upon by an outside force.
2. DYNAMICS: The acceleration of an object is equal to the sum of all forces acting upon it divided by its mass.
3. ACTION AND REACTION: To every action there is an equal and opposite reaction.

Newton's Three Laws (Explained)

INERTIA	Inertia is *the tendency of an object to resist motion.* This means that an object will not move unless it is being forced to by something (gravity, a push, a force, etc.)
DYNAMICS	This law basically says that **F = m × a**, one of the most important equations in physics.
ACTION/REACTION	This law explains that for every force, there is a force of the same value that opposes it. For example, if you push on a wall with 100 N of force, the wall will push back with 100 N of force.

Questions and Answers!

In a situation where something is being pulled up or down, how do I know which force is acting and which force is reacting?

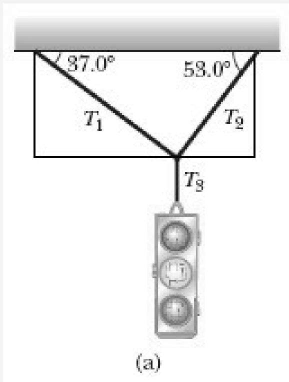
> The force that is doing the action is the active force (will come first in the equation) and the other force will be second (will come second in the equation). Generally if something is being *pulled*, then tension is doing the action.

Questions and Answers! (cont)

How do I know when to use ΣF = 0?

> If the mass is in *static equilibrium*, which means nothing is moving. Therefore, you can set the "up" force (tension) equal to the "down" force (gravity), and set the "left" force equal to the "right" force. **This does not apply for diagonal forces!**

Two-String Tension pt. 3



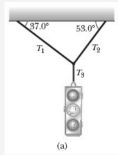
From this point forward, I've drawn in some extra triangles to make the problem easier to handle. By using geometry and some simple math, you can find the other angles in the two new triangles (I can't draw these into the image). The bottom right line is T^2x, the right side is T^2y, the left side is T^1y, and the bottom left line is T^1x.

Tension

Tension is entirely a type of force, but it's best to treat it as a separate idea from things like F^G or F^N. In a situation where an object is hanging from the ceiling, tension works as an opposition to the force of gravity.

Tension Explained

Two-String Tension



Find T^1 and T^2 if w = 435 kg.

This problem has a lot of steps, so it's easier to explain them as I go along.
First, we can find F^G, which is mass × gravity. Since the problem tells us that mass is 435 kg, we know that **F^G = 4263 N.**

Continue on to the second box.

Example Problem #1

How much force is needed to accelerate a 70 kg skier at 3 m/s²?
This question is pretty straightforward - all you need to do is use the equation **F = ma** and plug in 70 for the mass and 3 for the acceleration.

The answer to this question should be *210 N*.

Example Problem #2

If forces of 30 N and 35 N act in opposite directions on a 40 kg object, what is the acceleration of the object?
This question is pretty similar to the first, except that now we need to find the *net force* - the sum of all the forces acting on the object. **Be careful - usually sum means addition, but because the forces go in opposite directions, we need to *subtract* them.** Therefore, 35-30 = 5, then we plug in 5 N for the force and 40 for the mass.

The answer to this problem should be *0.125 m/s²*.

Example Problem #3

In this situation, to solve for tension, we would use the equation **F = m × a**, but since we are looking for *net force*, we would have to use F^G - T, because both forces are acting on the box.

Imagine a light hanging from the ceiling by a rope. The mass of the light is 50 kilograms. A) what are the two forces involved in this situation, B) what is the acceleration of the light, and C) find the tension in the string. Believe it or not, this is all we need to solve this problem. Again, we are going to use the equation **F = m × a**, but we need to change it to **F^G - T = m × a** because we need the *sum* of the forces acting upon the light. Since we know F^G, we know m, and we know a, we can plug them in and solve for T.

The answers to this problem should be: *A) tension and force due to gravity, B) acceleration = 0, and C) T = 490 N.*

Tension and SOHCAHTOA

Understanding SOHCAHTOA and how to use it is incredibly important in terms of tension and force (especially on inclines). SOHCAHTOA is a way to find angles and sides of a triangle using parts of it that you know. In any triangle, knowing how to find missing angles and sides is crucial to solving problems.

SOHCAHTOA stands for **sine = opposite/hypotenuse, cosine = adjacent/hypotenuse, tangent = opposite/adjacent**. Sine, cosine and tangent are often shortened to **sin, cos** and **tan**.

Two-String Tension pt. 2

Next, we can say that $\Sigma Fy = 0$ (because nothing on the y-axis is moving). Since there's three forces on the y-axis - T^1y, T^2y, and F^G - we can break this formula down into $(T^1y + T^2y) - F^G = 0$. By doing some simple algebra, we can rewrite this as **$T^1y + T^2y = 4263$ N**.
We'll set this formula aside and look at the x-axis. We know that $\Sigma Fx = 0$ because there's no movement on the x-axis either. Since there's only 2 forces on the x-axis, we can say that $T^2x - T^1x = 0$, and we can rewrite that as **$T^2x = T^1x$.**
Continue to the third box.

Two-String Tension pt. 4

This is where SOHCAHTOA comes in. First, we know that $\cos 53 = T^2x/T^2$. By multiplying both sides by T^2, we get $T^2 \cos 53 = T^2x$. By the same principle, $\cos 37 = T^1x/T^1$ and $T^1 \cos 37 = T^1x$. Then, since $T^2x = T^1x$, set $T^2 \cos 53 = T^1 \cos 37$. Divide both sides by cos 37 to get **$T^1 = 0.75T^2$.**
Now, we're going to go back to the *y* formulas. Using SOHCAHTOA, $T^1y = T^1 \sin 37$ and $T^2y = T^2 \sin 53$. Since we have substitute values for T^1y and T^2y, we can plug them into our original y equation: **$(T^1y + T^2y) = 4263$.** By using our new values, we get that $T^1 \sin 37 + T^2 \sin 53 = 4263$. Then, we substitute THOSE values for **$T^1 = 0.75T^2$** and we get the equation $(0.75T^2) \sin 37 + T^2 \sin 53 = 4263$, which simplifies to **$1.25T^2 = 4263$**. Our last step is to divide both sides by 1.25 and you have a value for T^2. Then, just put that value into the equation **$T^1 = 0.75T^2$.**.

The answers to this problem should be $T^1 = 2557.8$ *N* and $T^2 = 3410.4$ *N*.