Video Highlights

This table outlines a collection of activities and important ideas from the video.

Time	Feature	Comments
1:31	Guidelines for drawing FBD	
2:21	Falling block	A very simple example with a single force
2:43	Block on table	This section builds to more complex example including a push force, normal force, and tilted surface.
3:49	Bungee jump video	The drawing of the diagram starts at 4:29. This is a good opportunity for a discussion of why the forces are what they are at the bottom of the jump.
5:12	Dog sled example	
6:06	Golf ball example	Note that the diagram is drawn *immediately after* the ball loses contact with the ground.
7:04	Beginning of diagrams with errors section	Playing this section from here will include the introduction, which may help keep students from thinking that every diagram they see is correct.
7:46	Softball pitch example	Newton's 1st Law is ignored in this example.
8:22	Block on surface example	Decomposed forces were not removed in this example.
9:08	Car example	This example has velocity drawn on a force diagram, and also has no normal force.
9:54	Parachuter	Too many forces are included.
11:11	Car on road	This animation shows how changing forces on a car alter its movement.
12:02	When to avoid using free body diagrams	Set of 3 examples

Video Summary

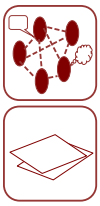
The video consists of four sections: a brief refresher on the method for drawing free body diagrams, examples of free body diagrams with an opportunity to practice, examples of situations in which diagrams have been drawn incorrectly (and corrections for them), a final segment that draws connections between free body diagrams and the physical situations they describe.

Phys 101 Materials

When appropriate, this guide is accompanied by additional materials to aid in the delivery of some of the following activities and discussions.

Pre-Video Materials

Two activity handouts are included in the appendix for this guide, as well as in a separate PowerPoint® file (Handout.pptx in the Pre-video and Post-video folders). The intent is to have one used before the video and one after. Have students gather in groups of 2-3. Only one person per group will need a copy of the handout. Once the groups have had enough time to draw the diagrams, have a few groups describe their diagrams. Call for opposing viewpoints and alternative diagrams.



1. Airplane handout (Appendix A1)

Typical issues that students have with this handout include:

- Some students may neglect the gravitational force and normal force. Rather than insisting on their inclusion, ask whether they are necessary and what benefit we might get from including them.
- Some students may have drawn a diagram of the plane by mistake.
- The horizontal forces are not balanced, which they should be.

There are two multiple-choice questions in the appendix. These questions work well with classroom response systems (clickers), but can also be used with a simple vote-by-hand-raise. When using these items, remember that they are discussion builders, not problems that the students need to answer correctly in order to get credit. Do not use these as test items.

2. Motorcycle problem (Appendix A2)

Choices 1 and 2 are probably the most defensible. The motorcycle may be tilted, but its normal force still points directly upward (perpendicular to the line of contact between the tire and road). If students have difficulty with this, ask them to imagine the tire in contact with the road.

3. Hot-air-balloon problem (Appendix A3)

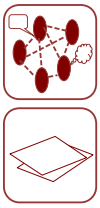
This is a "choose all that apply" problem. If your clicker system is not set up for that, you will need to make some alterations.

Some students may want to list both weight and buoyancy; others may consider the sum of the two to be a sort of "negative weight." Still others will list both weight and the influence of gravity. It will be helpful to state that you are not answering any questions until after the vote is taken.

Always ask what other force students would like to have if choice #6 shows up. Typical choices include wind, a force from the heat/flame in the balloon, and tension pulling downward from the basket. The latter two will need discussion to determine their validity as choices – what did students decide was part of the system?

Post-Video Materials

The first item below is connected to the first item in the pre-video materials. See the description there.

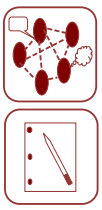


1. Sled handout (Appendix A4)

This picture has multiple problems. Once students start pointing them out, it may be good to keep track of them on the board and deal with them systematically.

- Some students may have drawn a diagram of the brother, rather than of the sled.
- Is the "Weight" the weight of the sled or of the brother?
- The non-tilted normal force is a classic mistake. It is probably worth taking a minute to underline the definition of "normal" as "perpendicular."

The two activities below are best suited for use in a discussion/recitation section. They can also be used by students outside of class who desire extra practice.



2. Team Practice

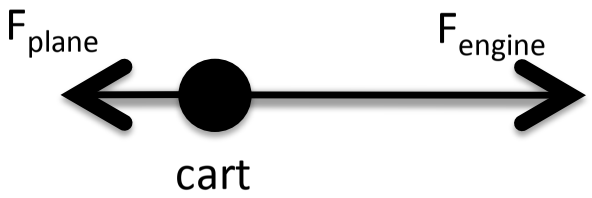
You will need at least one partner for this, and each of you will need paper and a pen or pencil. First, each of you will draw or describe (in writing) any sort of physical situation. Take no more than two minutes. When you are done, trade your description or drawing with a partner's. Now create a free body diagram for your partner's situation. When you are done, switch back and see if your partner drew what you would have expected.

If you are doing this at home, you can try to diagram situations that you find in videos online. Many sports or gymnastics videos are excellent for this purpose.

Airplane

Free-Body Diagram Handout #1

The cart pushing this plane is moving forward at constant velocity. What is wrong with the free body diagram of the cart below? Re-draw the diagram correctly. Be ready to defend your answer.



Draw Corrected Version Here:

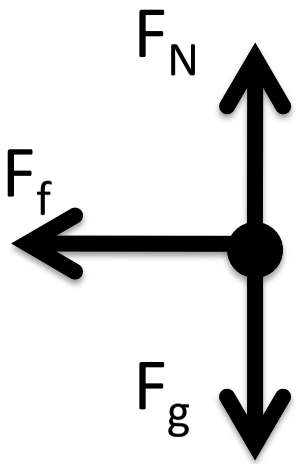
A1

Motorcycle

A2

Which Free Body Diagrams could properly represent this image?

1



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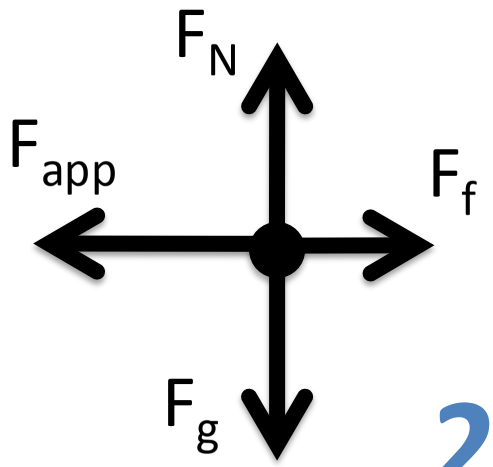

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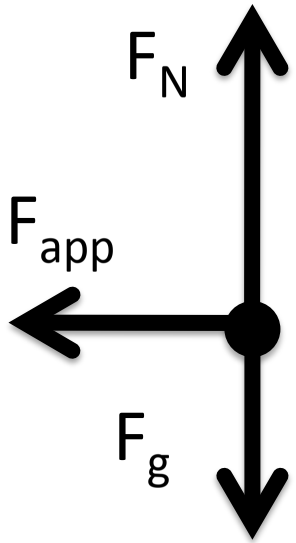

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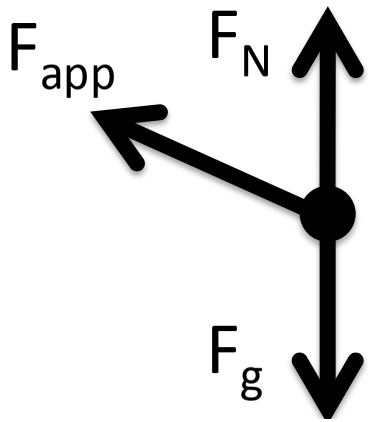

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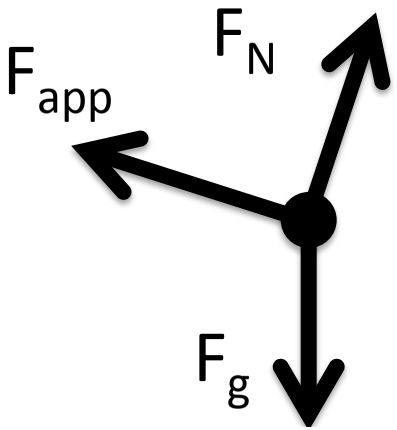

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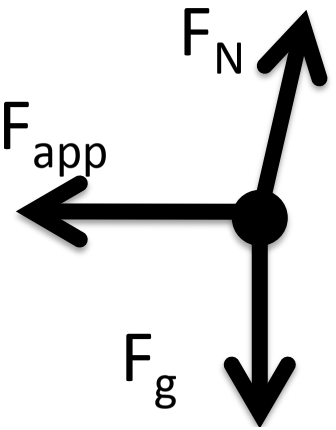


Balloon

A3

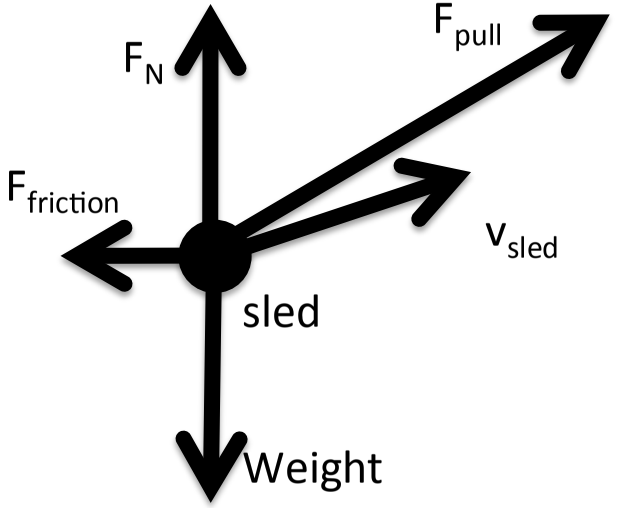
Which forces are present on the hot-air balloon in this image?

① Gravity
② A buoyant force
③ Weight
④ Air resistance
⑤ None of the above are necessarily present
⑥ Some other force

Sled

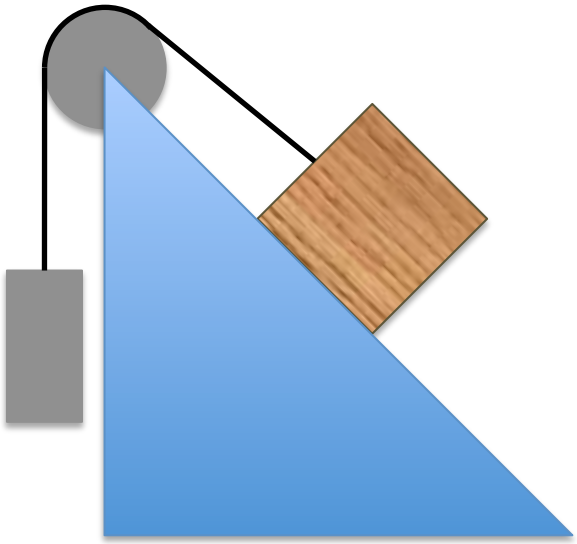
Free-Body Diagram Handout #2

The girl pulls her little brother uphill in a sled at constant velocity. What is wrong with the free body diagram of the sled below? Re-draw the diagram correctly. Be ready to defend your answer.

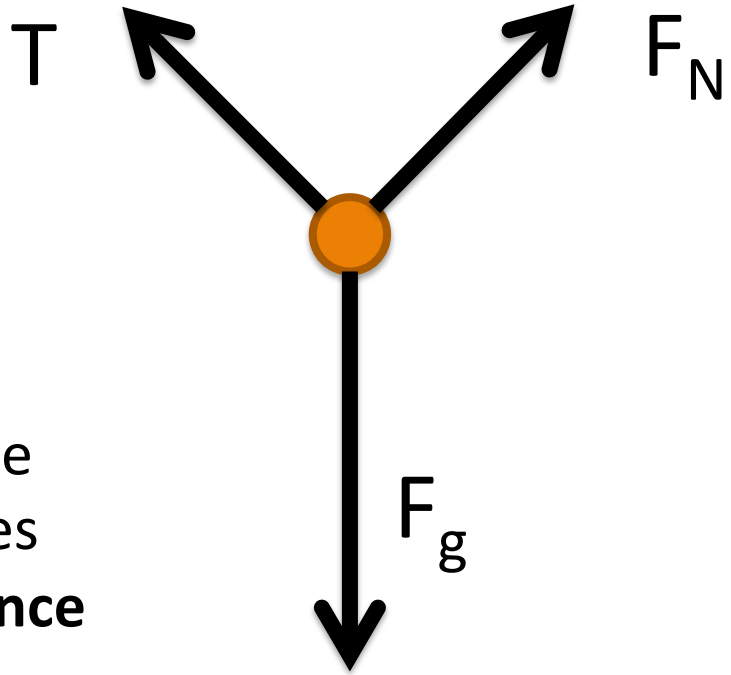


Draw Corrected Version Here:

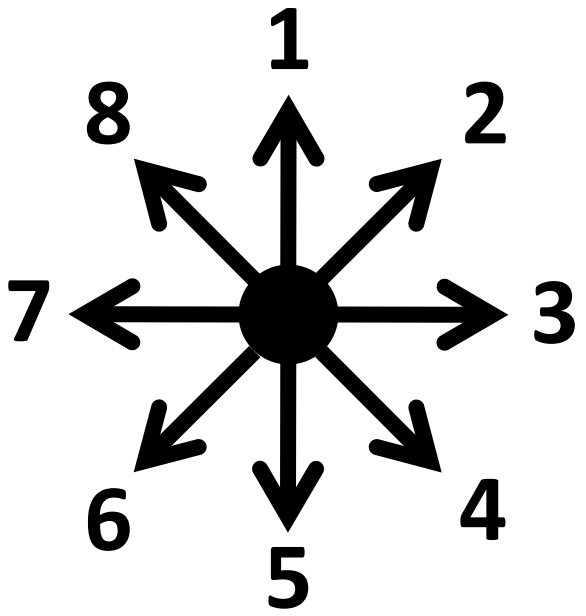
A4



Given the free body diagram below, in what direction is the wooden block moving?

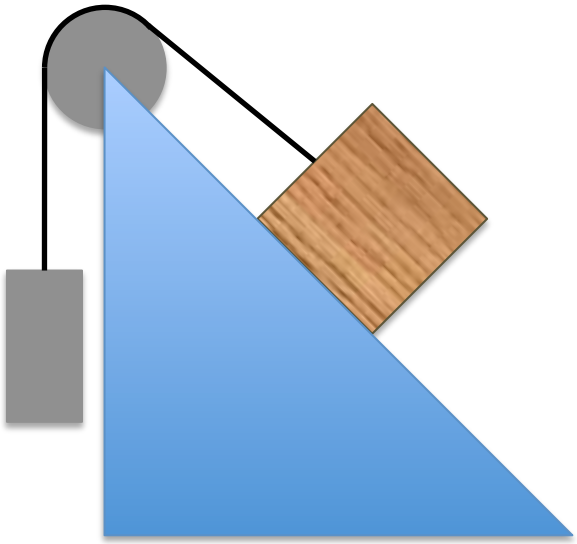


These forces **balance**



9 Not Moving

0 Can't Tell



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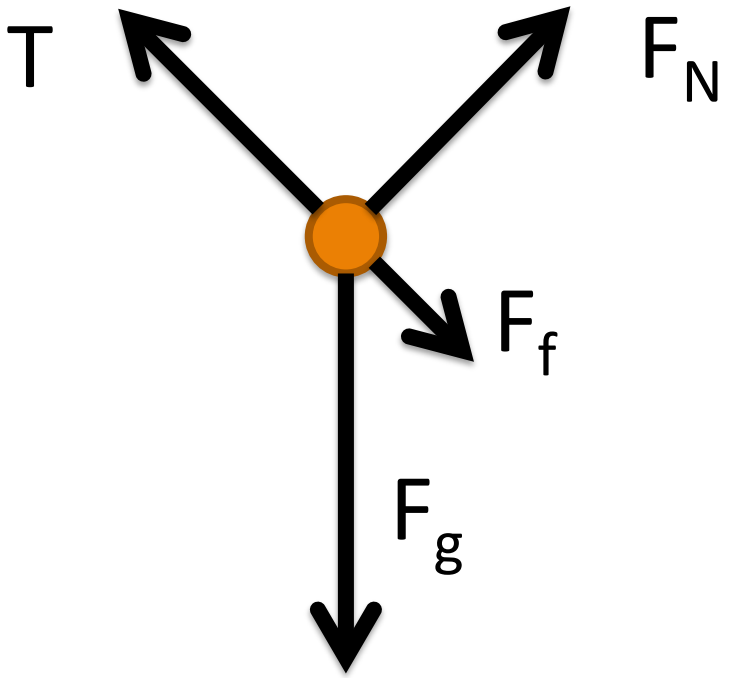

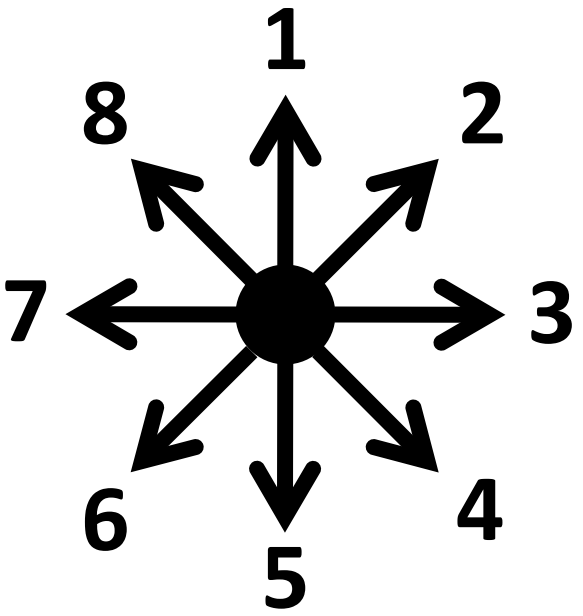

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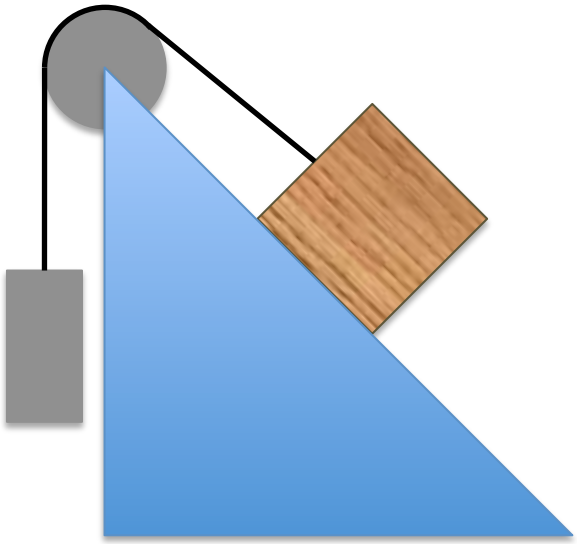

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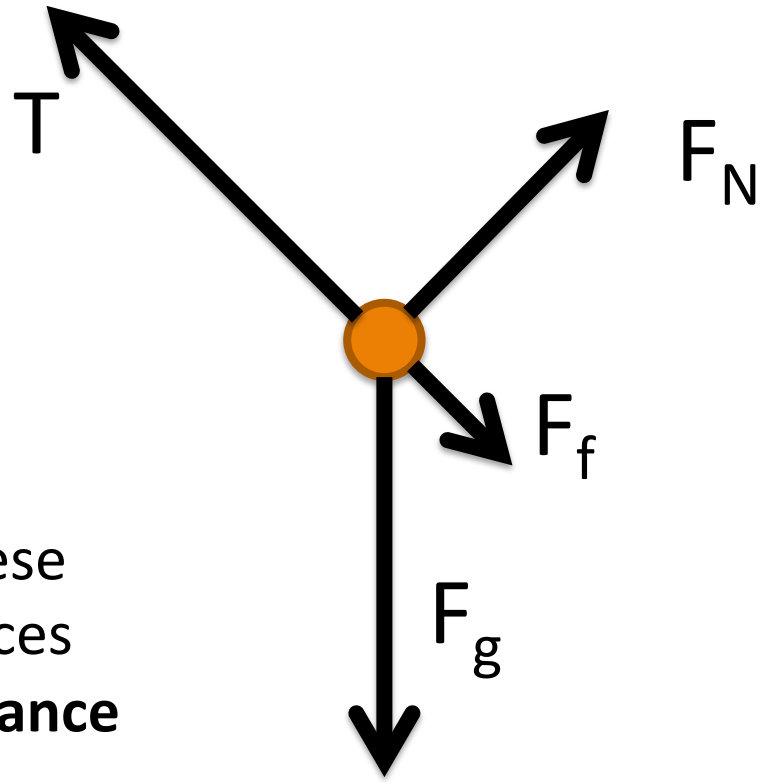

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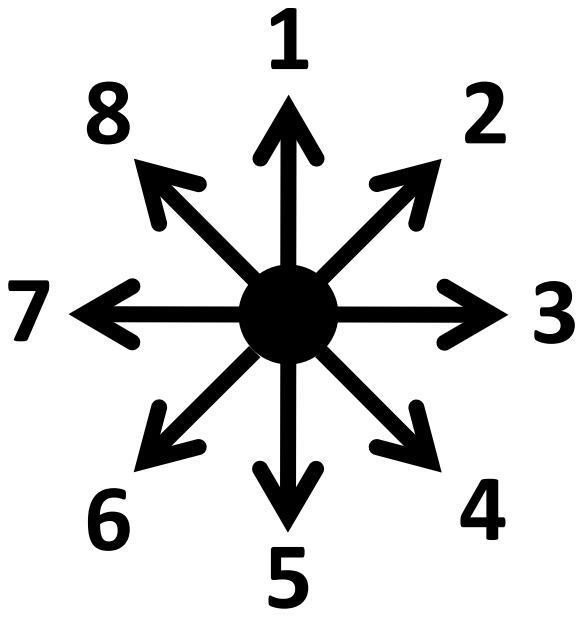

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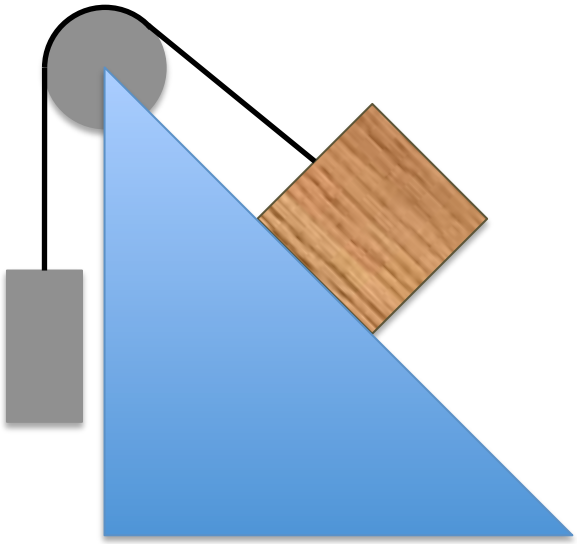

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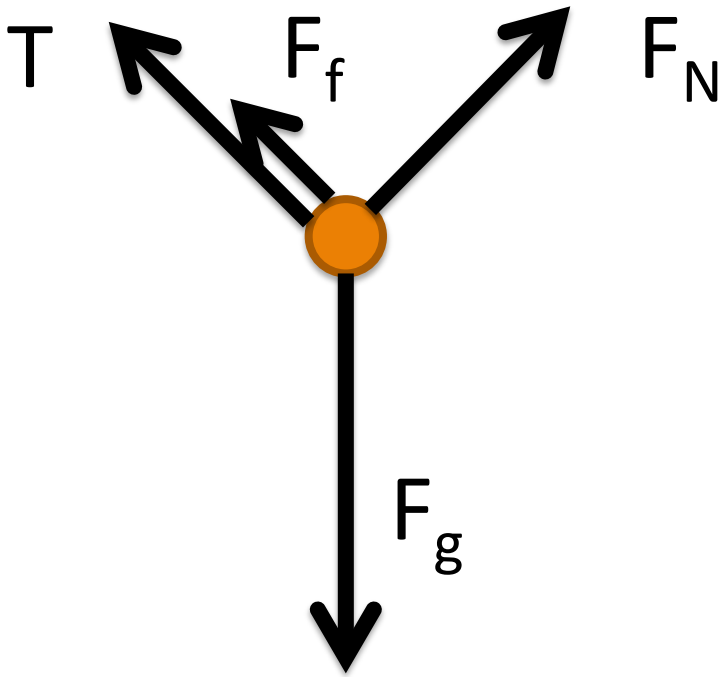

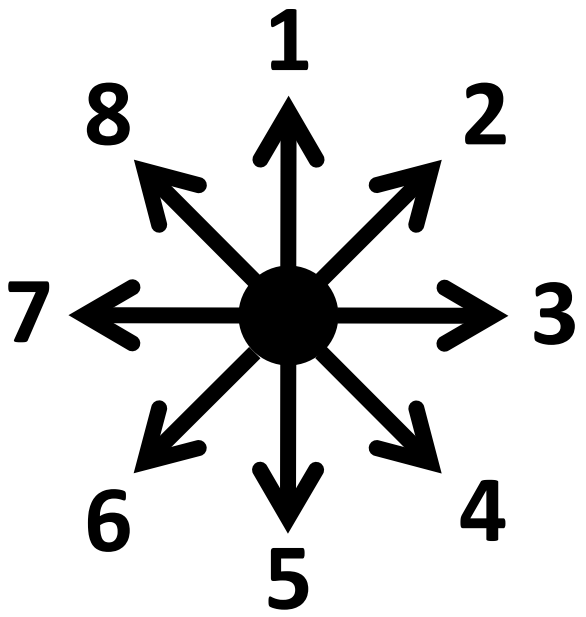

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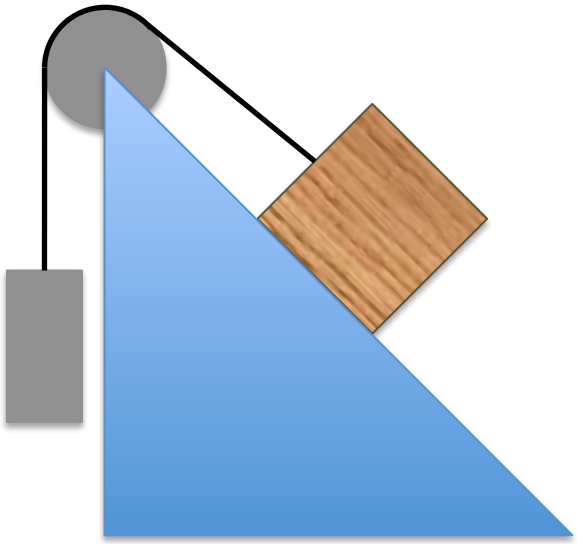

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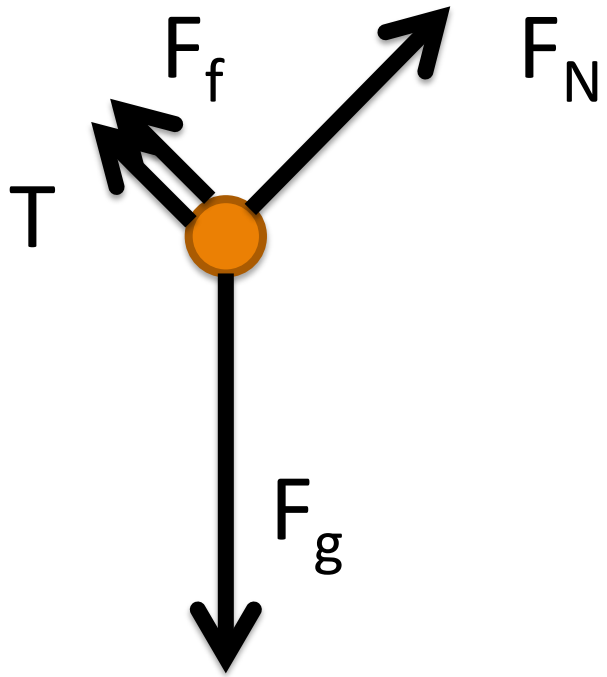

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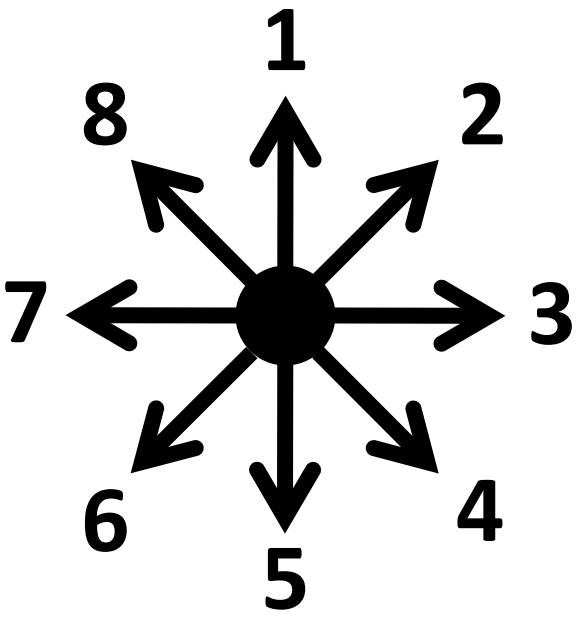

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