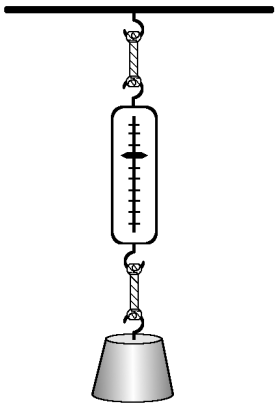
Physics 083 — *Pulleys*

Pulleys are one type of simple machine (along with levers and inclined planes) that you will use in Physics class. They make life easier by distributing the force needed to lift an object over several pieces of rope, so that the force you would need to use is much less than lifting the object directly. Since the tension in any one piece of rope is constant, **the tension on a piece of rope in a pulley system is the total force divided by the number of sections pulling upwards on the mass.** Assume that all ropes are vertical, unless specifically told otherwise. As well, assume that all pulleys and ropes have no mass.

A similar method will give the force pulling downwards on the ceiling. First, find the tension on each section of rope, then sum together all of the ropes with tensions that pull **down** on that pulley, and that will be the force on the ceiling. Often this force is larger than the weight of the object.

Another way to solve more challenging problems is shown in Example 3. Here, we treat the pulleys as a system at equilibrium (since nothing is moving, forces up must equal forces down). Create an equation for each pulley or piece of rope, and combine them to solve for the tensions involved. Remember that all sections of the same rope must have the same tension. (So in Example 3, all the pieces labeled "A" will have the same tension).

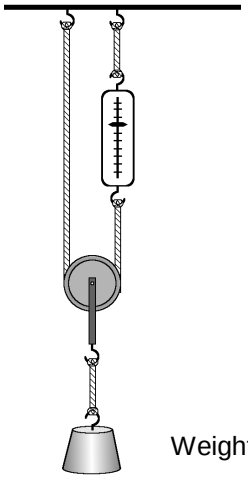
Example 1



Weight = 200 N

Scale Reading: 200 N

Example 2

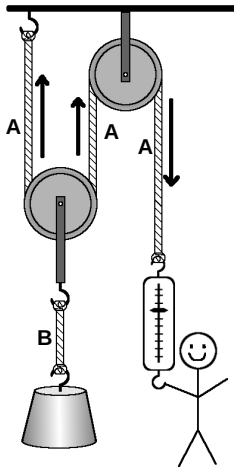


Weight = 200 N

200 N ÷ 2 ropes = 100 N

Scale Reading: 100 N

Example 3



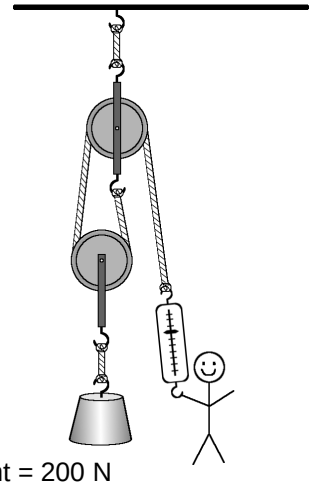
Weight = 200 N

Only 2 of the pulley ropes pull up on the mass!

Scale Reading: 100 N

Alternate Method:
B = 200 N.
2*A = B (since 2 of rope A are supporting that pulley)
2A = 200 N so A = 100 N.
The scale will read tension A, 100 N.

Problem 1

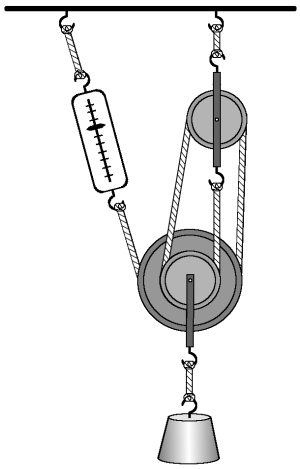


Weight = 200 N

Scale Reading:_____

Force between ceiling and pulley:_____

Problem 2

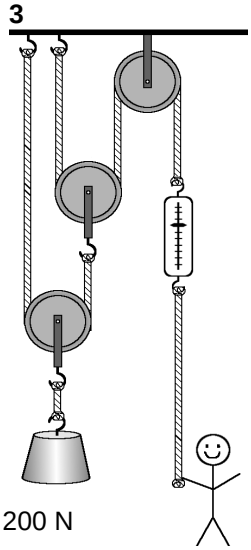


Weight = 200 N

Scale Reading:_____

Force between ceiling and pulley:_____

Problem 3

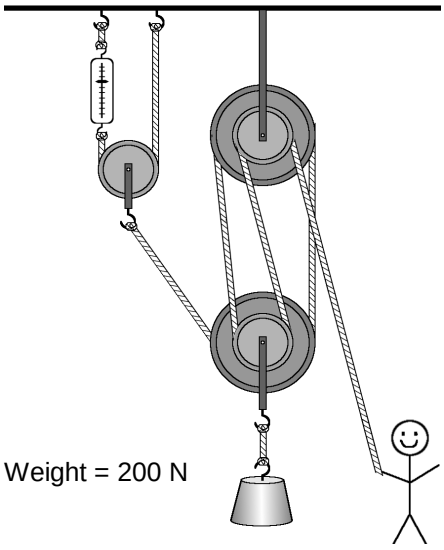


Weight = 200 N

Scale Reading:_____

Force between ceiling and pulley:_____

Problem 4

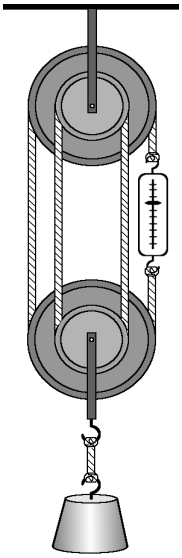


Weight = 200 N

Scale Reading:_____

Force between ceiling and pulley:_____

Problem 5

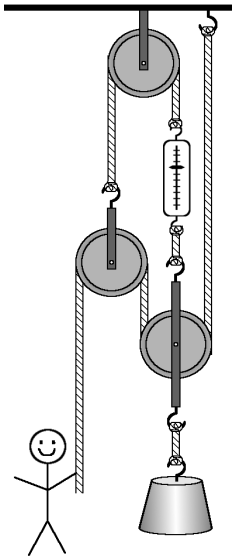


Weight = 200 N

Scale Reading:_____

Force between ceiling and pulley:_____

Problem 6



Weight = 200 N

Scale Reading:_____

Force exerted by person:_____

Answers

1. 100 N, 300 N
2. 50 N, 150 N
3. 50 N, 100 N
4. 25 N, 200 N
5. 50 N, 200 N
6. 100 N, 50 N