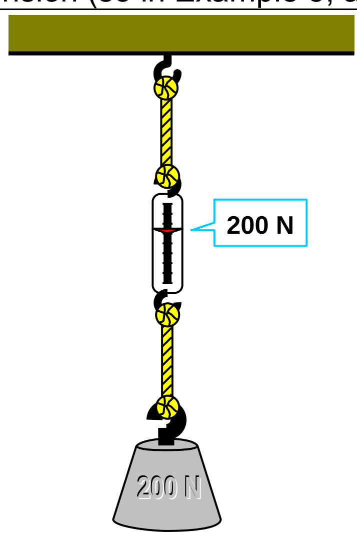
VANCOUVER COMMUNITY COLLEGE

Pulleys

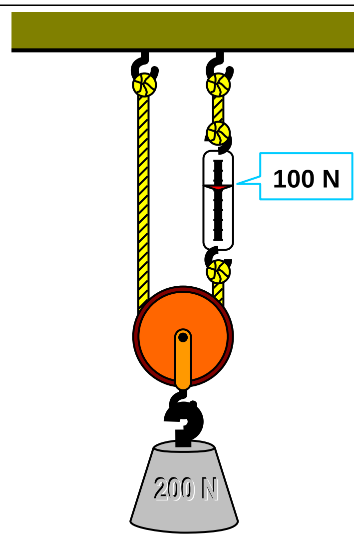
Pulleys are one type of simple machine (along with levers and inclined planes) that you will use in Physics class. Pulleys make life easier by distributing the force needed to lift an object over several lengths of rope, so that the force you need to use is less than if you were to lift the object directly. Since the tension in any one rope is constant, **the tension on a rope in a pulley system is the total force divided by the number of sections of rope pulling up the mass.** (See the examples below.) Assume that all ropes in this worksheet are vertical, and that all pulleys and ropes have zero mass.

You may also be asked to find the force pulling down on an anchor in the ceiling. First, find the tensions on the ropes, then add all of the tensions on ropes that pull down, and that will be the force on the ceiling. This force can be larger than the weight of the object.

A way to solve more challenging problems is shown in Example 3. We look at the mechanism as a system in equilibrium — nothing is moving, so the net vertical force must be zero. Create an equation that sets the forces going up equal to the forces going down, then solve for tension. Remember that all parts of the same rope have the same tension (so in Example 3, all three sections labelled A have the same tension).

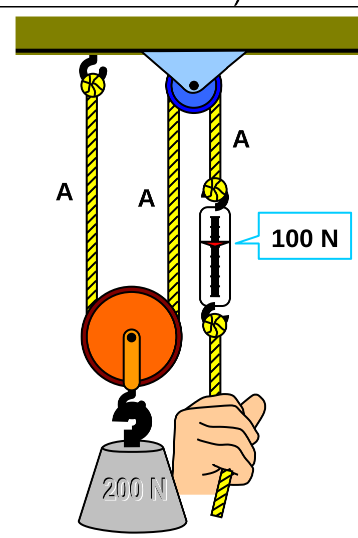


Example 1:
The scale reading is simply 200 N.



Example 2:

$F_T = F_g \div n$
$= 200\text{ N} \div 2$ ropes
$= 100\text{ N}$



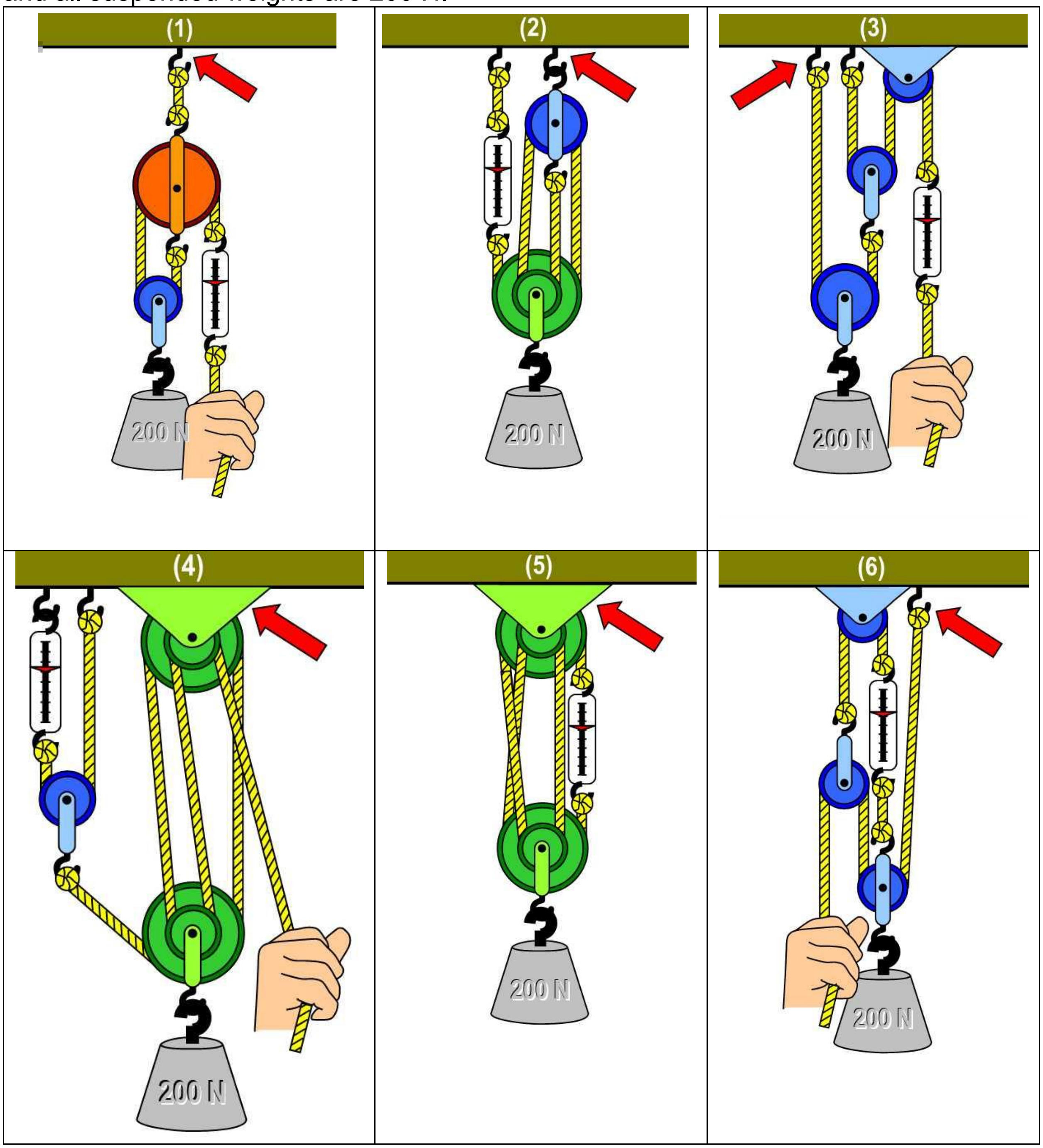
Example 3:

$F_T = F_g \div n$
Only 2 ropes support the weight!
$= 200\text{ N} \div 2$ ropes
$= 100\text{ N}$
or, consider the axle of the large pulley:
$\Sigma F_y = 0$
$A + A - F_g = 0$
$2A - 200\text{ N} = 0$
$2A = 200\text{ N}$
$\therefore A = 100\text{ N} = F_T$

Authored by Anonymous

EXERCISES

A. For each diagram, determine a) the reading on the spring scale, and b) the force pulling down on the indicated anchor in the ceiling. All these systems are in equilibrium, and all suspended weights are 200 N.



SOLUTIONS

A. (1) a) 100 N b) 300 N (2) a) 50 N b) 150 N (3) a) 50 N b) 100 N
(4) a) 25 N b) 200 N (5) a) 50 N b) 200 N (6) a) 100 N b) 50 N