# Newton's Laws ♦ Homework

**Newton's Three Laws**

**1.** In the absence of an unbalanced force acting on an object, the object will remain stationary or move at constant speed in a straight line.

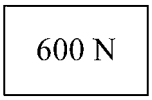
**2.** If there is a net force $\Sigma F$ on an object of mass $m$, the object will accelerate according to the equation $\Sigma F = ma$, where $a$ is the acceleration of the object. The acceleration is in the same direction as the net force.

**3.** If object $A$ exerts a force on object $B$, then $B$ exerts an equal and opposite force on $A$. *Example:* If the sun exerts a force of magnitude $F$ on the earth then the earth exerts a force of magnitude $F$ on the sun in the opposite direction.

**Symbols used:**

Ceiling: 

Weightless String: 

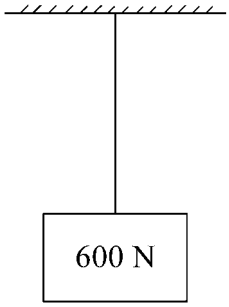
600-Newton Weight: 


**Note:** The *weight* of an object is the force of gravity on it. When we say that an object is *weightless*, we mean that its weight is negligible compared to that of other objects under consideration. The tension in a weightless string is the force that each end of the string exerts (or, by Newton's third law, the force that is exerted *on* each end).

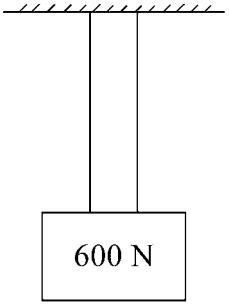
**Problems:**

1. For each of the diagrams (a), (b), and (c), below, showing a weight hanging by one or more strings, find the tension in each string. In (b), assume that both strings have the same tension. In (c), assume that all three strings have the same tension.

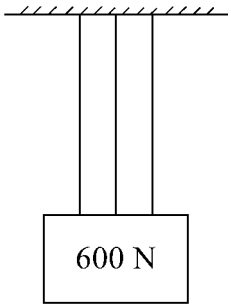
(a)



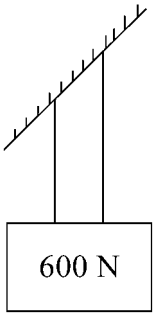

(b)




(c)

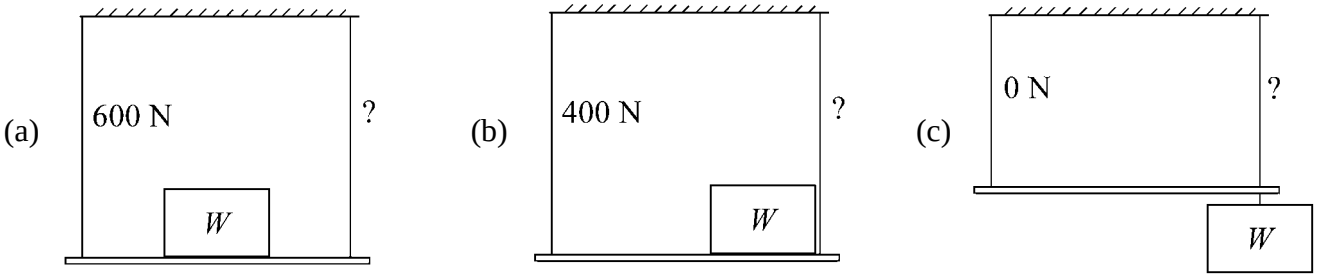



2. For the figure on the right, assume that the two strings are spaced equal distances from the ends of the weight. Say whether the two strings have the same tension or not. If not, which string has the higher tension? Explain your answer in either case.



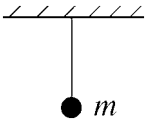

(Continued on other side)

3. For each of the diagrams below showing a bar hanging by two strings from a ceiling, find the tension in each string and the weight *W*. *W* is the same in each case, and the weight of the bar is negligible.




4. If, instead of being weightless, the bar in each of the diagrams of problem 3, above, weighs 200 N, what will be the new tension in each string? Assume that *W* is unchanged.

*The following information applies to questions 5–6:* A ball of weight *W* hangs by a string of negligible mass from a ceiling as shown to the right. Consider the following forces:




i) the force on the ceiling due to the string,
ii) the force on the string exerted by the ceiling,
iii) the force on the ball exerted by the string,
iv) the force on the string exerted by the ball,
v) the gravitational force on the ball exerted by the earth,
vi) the gravitational force on the earth exerted by the ball.

5. Which of the above forces are equal in magnitude?

6. Identify which of the above forces are action-reaction pairs?

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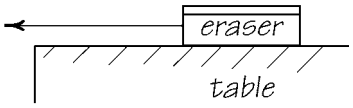
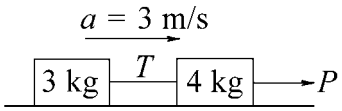
7. An eraser of mass 0.1 kg is being pulled to the left along a frictionless horizontal surface by a string. If the tension in the string is 20 N, what is the acceleration of the eraser?




8. Two masses are being accelerated to the right at 3 m/s$^2$ along a frictionless horizontal surface by a force *P*. Find *P* and the tension *T* in the string.




9. Two masses are being accelerated to the right along a frictionless horizontal surface by a force *P*= 20 N. Find the mutual acceleration of the two blocks and the tension *T* in the string joining them.