MEASURING FORCE: UNDERSTANDING MASS & WEIGHT

1. Using your spring scale find something in the classroom that you can suspend from your spring scale that measures a force of approximately one Newton. Find the mass of the object and record it below along with the measured force.

   OBJECT: Mouse

   Force Measured: 1.0 N Mass Measured: 100 g = 0.1 kg

2. Using the process of the previous question find an object that measures approximately a force of 10 N on the spring scale.

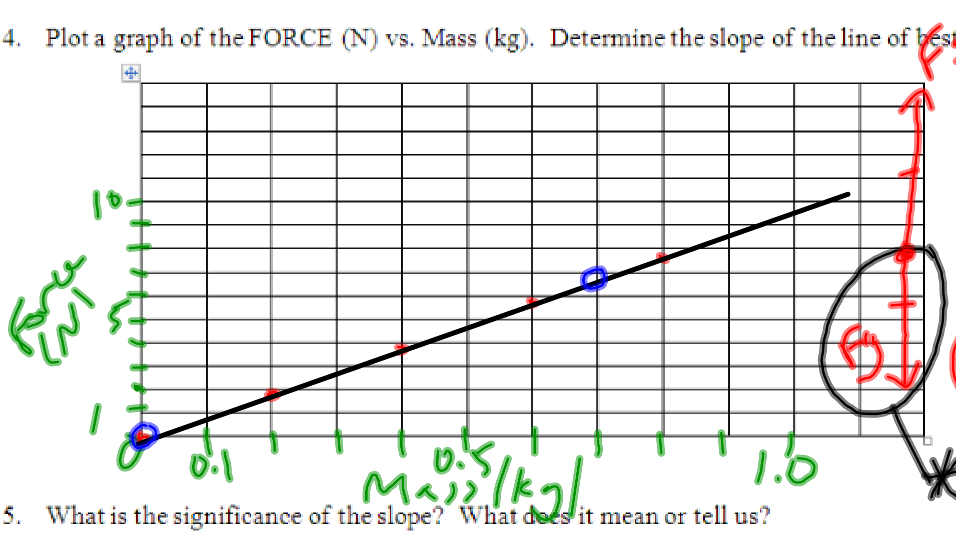
   OBJECT: Keyboard

   Force Measured: 9 N Mass Measured: 900 g = 0.9 kg

3. Make measurements of the force reading on a spring scale and the following masses. Record your results in the table below.

Mass (kg)	Force (N)
0	0
0.200	2
0.400	3.9
0.600	5.9
0.800	7.8

4. Plot a graph of the FORCE (N) vs. Mass (kg). Determine the slope of the line of best fit on the graph.



$slope = \frac{rise}{run}$

$= \frac{7N}{0.7kg}$

$= \boxed{10 \frac{N}{kg}}$

$\boxed{g = 9.8 \, N/kg}$

* The force of gravity on an object is the "weight"

5. What is the significance of the slope? What does it mean or tell us?

6. Use your skills of interpolation and extrapolation to predict the force required to hold a mass of:

   Calculate the weight of each mass.

   $\boxed{F_g = m \cdot g}$

   a) 350g F= 3.43N b) 1.200kg F= 11.76N c) 2.0 kg F= 19.6 N

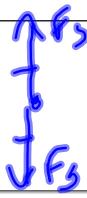
$F_g = m \cdot g$

$= (0.350 \cancel{kg})(9.8 \frac{N}{\cancel{kg}})$

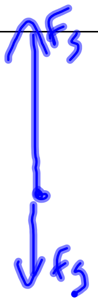
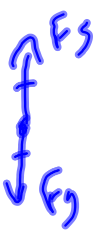
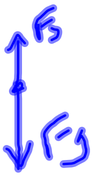
$= 3.43N$

Weight and Newton's Second Law

To correctly interpret the various measurements of force (i.e. "weight") that appear on the spring scale in the various situations investigated, it is important to realize that the reading on any weighing scale is a measurement of the upward force the scale is imparting on the object being weighed. In the situation where the object and scale are both at rest, the scale indicates how much force it needs to produce to counterbalance *the downward force of gravity on the object* – **this is the proper scientific definition of an object's *weight*.** For the case of an everyday bathroom scale, this reading tells us how much 'normal force' the scale is pushing up on our body with. For the case of an object suspended by a spring scale and string we would say the reading is a measurement of either the 'tension' in the string or the 'spring force' in the spring that is pulling up on the object. Both kinds of scales, however, would produce the exact same amount of force to counterbalance the force of gravity on any one particular object, and therefore give a correct reading of that object's weight.

Situation	FBD of Object	Measured Weight of Object
Object is suspended (at rest) by a spring scale which hangs from a string that is attached to the ceiling		10N (9.8N)

(m=1kg)

Situation	FBD of Object	Prediction of Measured Weight of Object	Measured Weight of Object	Explanation
The string is hung over a pulley and pulled by the teacher such that the object moves upward at a constant speed		Fnet ↑ Just as pulling begins: a = ↑ Less than initial weight Equal to initial weight [✓ Greater than initial weight]		
The string is hung over a pulley and pulled by the teacher such that the object moves upward at a constant speed		Fnet = 0 Half way through the 'journey': a = 0 Less than initial weight [✓ Equal to initial weight] Greater than initial weight		
The string is hung over a pulley and pulled by the teacher such that the object moves upward at a constant speed		Fnet = ↓ Just as pulling stops: a = ↓ [✓ Less than initial weight] Equal to initial weight Greater than initial weight		