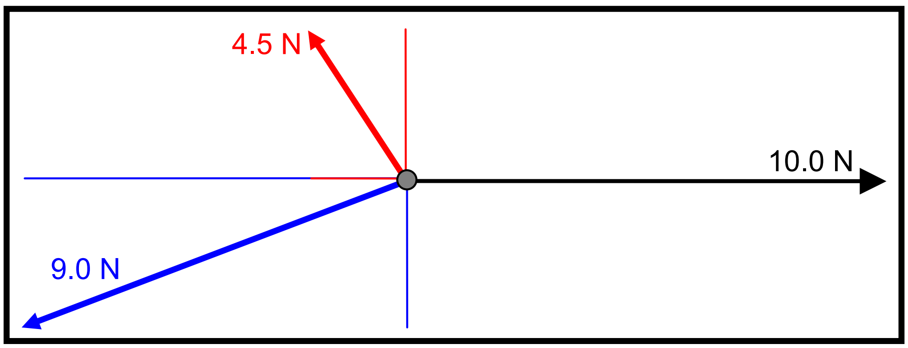
**Lab #5 Discussion**

In Lab #5 we are beginning an extensive study of force vectors and states of equilibrium. When you complete a FBD of an object which is in translational equilibrium, the sum of the forces acting on that object must add to zero. That is, any forces acting to the left must be balanced by an equal amount of force acting to the right; and any forces acting up must be balanced by the same amount of force acting down. This statement can be written mathematically as

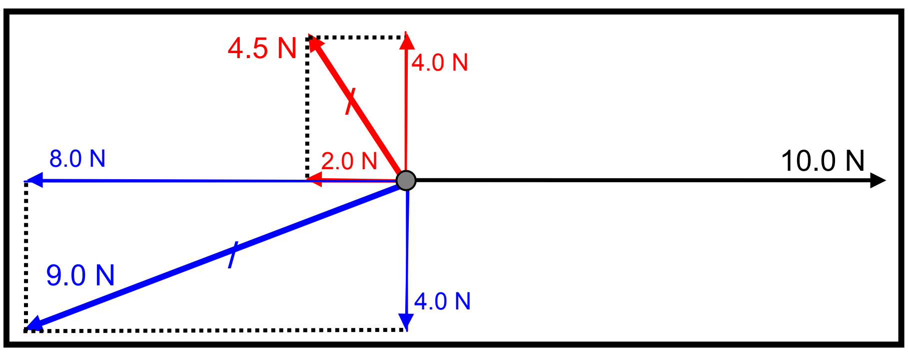
$$\sum F_x = 0$$
$$\sum F_y = 0$$

These forces are called **1st Law Forces** since the object's velocity is not being changed; that is, the object does not accelerate. Newton's First Law states that an object will continue in its current state of motion unless acted upon by an unbalanced, outside force. This law is called the **Law of Inertia**.

For example, in our lab, you collected data similar to the following diagram.




Obviously, the magnitudes of these forces do not initially "look" balanced since 9 + 4.5 ≠ 10. However, they are in equilibrium once you examine their x- and y-components.




Now if we examine only the x-components, we see that there is a single 10 N force pointing towards the right (+x) and two forces having x-components of 8 N and 2 N pointing to the left (-x). Since the 8 N component and the 2 N component add to 10 N we know that our horizontal forces are equal and opposite thus placing our object in equilibrium along the x-axis.

If we examine only the y-components, we see that there is a 4 N force acting towards the top (+y) and a second 4 N force acting towards the bottom (-y). Since these forces are equal and opposite, our object is also in equilibrium along the y-axis.

At this junction, we are now absolutely certain that the object on which these forces are acting is in a state of total translational equilibrium.

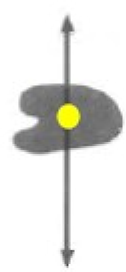
In the lab, you were asked to construct the x- and y-components by dropping dotted perpendiculars to the bordering x- and y-axes. Since your diagram was drawn to scale, you simply measured the lengths of your vectors to determine their magnitude.

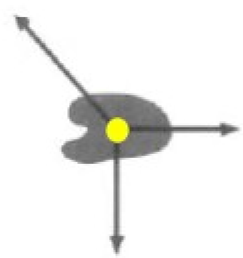
We also noticed that the use of three colors aided your analysis - one color for each of the original force vectors and its associated x- and y-components.

At this point in your lab work, you should be able to construct scale diagrams and construct x- and y-components. Based on your homework packet of *CP Workbook* pages, you should also be able to construct the resultant force based on given concurrent vectors. Therefore, you should be able to determine if an object is in a state of static translational equilibrium.

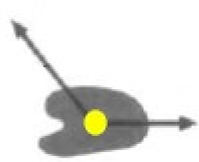
The adjective “translational” has become necessary because we will soon be examining rigid beams which can rotate as well as translate. Then our task will be to determine if the beam is in a state of rotational equilibrium as well as translational equilibrium.

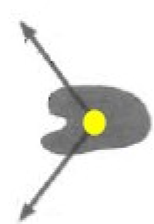
Exercise #1. Which of the objects shown below is in a state of translational equilibrium? Prove your choice(s). Each vector starts on the “yellow dot” at the center of the object.



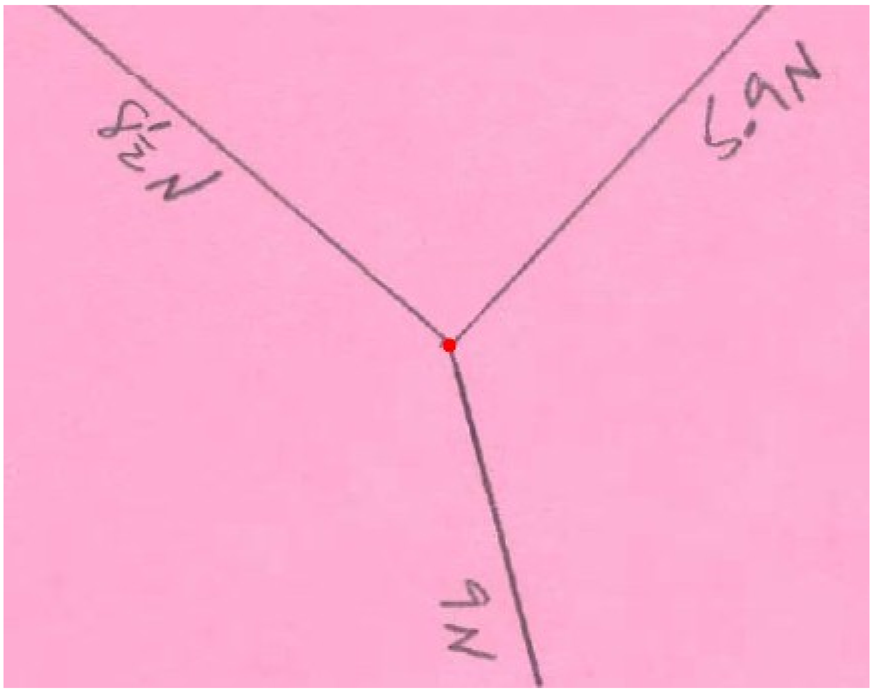


Exercise #2. Two forces are shown acting on each object below. Construct the required third force to place the object in translational equilibrium. Each vector starts on the “yellow dot” at the center of the object.





Exercise #3. Carefully complete a scale diagram of the following three forces. Construct and measure the x- and y-components of any appropriate forces and determine if the central object is in a state of translational equilibrium.




| vector description | magnitude (N) | length (cm) | y-component (cm) | x-component (cm) |
|---|---|---|---|---|
| longest | 9.0 | | | |
| midsized | 8.5 | | | |
| shortest | 5.9 | | | |