

Name: \_\_\_\_\_ Period: \_\_\_\_\_ Due Date: \_\_\_\_\_  
 Lab Partners: \_\_\_\_\_

# F ORCE V ECTORS on a V ECTOR TABLE - WebAssign

**Purpose:** To show that three arrows, representing three vectors, representing three forces, which are acting on an object, must add up to zero if the body they act upon is at equilibrium. (*Ask yourself what you know about the vector sum of the forces when they cannot accelerate or move the object?*)

**Procedure:** Assemble the vector table and place the three springs so that the ring is in the center of the table. Always latch Spring #1 at 0°. Latch Spring #2 and Spring #3 in positions with force settings that center the ring on the table. Record the readings in grams and the angles in degrees for all 3 springs. Convert the readings in grams to newtons using the conversion factors for g-to-kg and kg-to-N. Solve for  $T_2$  and  $T_3$  as if both are unknown. Compare the theoretical (= *theoretically predicted or reference*) values to your measured or experimental values (= *measured*) values of  $T_2$  and  $T_3$ .  
 (%Error = 100% • |measured – reference| / reference)

**Solving the Vector Triangle:** Here we work an example solving the vector triangle using the law of sines. It is essential that you draw the appropriate diagrams reasonably well. Great accuracy is not required, but should be close to the correct relative lengths and directions. Closely follow the same steps while solving your own force triangles. Start by converting the readings in grams to force in newtons.

$$T_1 \text{ (true)} = \text{_____ g} \cdot \text{_____ kg/g} \cdot \text{_____ N/kg} = \text{_____ N} \angle 0.000^\circ = \text{Angle of Spring \#1}$$

$$T_2 \text{ (true)} = \text{_____ g} \cdot \text{_____ kg/g} \cdot \text{_____ N/kg} = \text{_____ N} \angle \text{_____}^\circ = \text{Angle of Spring \#2}$$

$$T_3 \text{ (true)} = \text{_____ g} \cdot \text{_____ kg/g} \cdot \text{_____ N/kg} = \text{_____ N} \angle \text{_____}^\circ = \text{Angle of Spring \#3}$$

### Analysis: Practice Problem

Draw a force diagram of the three forces (provided by the springs) pulling on the ring while it is stationary and centered in the middle of the apparatus.

Draw the vector triangle and solve for the magnitudes  $T_2$  and  $T_3$ . (*Assume the measured angles are exact. The ring is at equilibrium.*)

$$T_2 \text{ (meas)} = \text{_____ N}; T_2 \text{ (ref)} = \text{_____ N};$$

$$T_3 \text{ (meas)} = \text{_____ N}; T_3 \text{ (ref)} = \text{_____ N}$$

Calculate the %Error in the two measurements. Assume angles are exact & the predicted forces are references.

$$\%Error \text{ in } T_2 \text{ (meas)} = \text{_____} \% ; \%Error \text{ in } T_3 \text{ (meas)} = \text{_____} \%$$

**Trial I**

$$T_1 \text{ (true)} = \text{_____ g} \cdot \text{_____ kg/g} \cdot \text{_____ N/kg} = \text{_____ N} \angle 0.000^\circ = \text{Angle of Spring \#1}$$

$$T_2 \text{ (true)} = \text{_____ g} \cdot \text{_____ kg/g} \cdot \text{_____ N/kg} = \text{_____ N} \angle \text{_____}^\circ = \text{Angle of Spring \#2}$$

$$T_3 \text{ (true)} = \text{_____ g} \cdot \text{_____ kg/g} \cdot \text{_____ N/kg} = \text{_____ N} \angle \text{_____}^\circ = \text{Angle of Spring \#3}$$

**Analysis:**

Draw a force diagram of the three forces (provided by the springs) pulling on the ring while it is stationary and centered in the middle of the apparatus.

Draw the vector triangle and solve for the magnitudes  $T_2$  and  $T_3$ . (*Assume the measured angles are exact. The ring is at equilibrium.*)

$$T_2 \text{ (meas)} = \text{_____ N}; T_2 \text{ (ref)} = \text{_____ N};$$

$$T_3 \text{ (meas)} = \text{_____ N}; T_3 \text{ (ref)} = \text{_____ N}$$

Calculate the %Error in the two measurements. Assume angles are exact & the predicted forces are references.

$$\% \text{Error in } T_2 \text{ (meas)} = \text{_____} \% ; \% \text{Error in } T_3 \text{ (meas)} = \text{_____} \%$$

## Trial II

Repeat the procedure changing the angles on  $T_2$  and  $T_3$ .

$$T_1 \text{ (true)} = \text{_____ g} \cdot \text{_____ kg/g} \cdot \text{_____ N/kg} = \text{_____ N} \angle 0.000^\circ = \text{Angle of Spring \#1}$$

$$T_2 \text{ (true)} = \text{_____ g} \cdot \text{_____ kg/g} \cdot \text{_____ N/kg} = \text{_____ N} \angle \text{_____}^\circ = \text{Angle of Spring \#2}$$

$$T_3 \text{ (true)} = \text{_____ g} \cdot \text{_____ kg/g} \cdot \text{_____ N/kg} = \text{_____ N} \angle \text{_____}^\circ = \text{Angle of Spring \#3}$$

### Analysis:

Draw a force diagram of the three forces (provided by the springs) pulling on the ring while it is stationary and centered in the middle of the apparatus.

Draw the vector triangle and solve for the magnitudes  $T_2$  and  $T_3$ . (*Assume the measured angles are exact. The ring is at equilibrium.*)

$$T_2 \text{ (meas)} = \text{_____ N}; T_2 \text{ (ref)} = \text{_____ N};$$

$$T_3 \text{ (meas)} = \text{_____ N}; T_3 \text{ (ref)} = \text{_____ N}$$

Calculate the %Error in the two measurements. Assume angles are exact & the predicted forces are references.

$$\% \text{Error in } T_2 \text{ (meas)} = \text{_____} \% ; \% \text{Error in } T_3 \text{ (meas)} = \text{_____} \%$$

### Trial III

Repeat the procedure changing the angles on  $T_2$  and  $T_3$ , again.

$$T_1 \text{ (true)} = \text{_____ g} \cdot \text{_____ kg/g} \cdot \text{_____ N/kg} = \text{_____ N} \angle 0.000^\circ = \text{Angle of Spring \#1}$$

$$T_2 \text{ (true)} = \text{_____ g} \cdot \text{_____ kg/g} \cdot \text{_____ N/kg} = \text{_____ N} \angle \text{_____}^\circ = \text{Angle of Spring \#2}$$

$$T_3 \text{ (true)} = \text{_____ g} \cdot \text{_____ kg/g} \cdot \text{_____ N/kg} = \text{_____ N} \angle \text{_____}^\circ = \text{Angle of Spring \#3}$$

#### Analysis:

Draw a force diagram of the three forces (provided by the springs) pulling on the ring while it is stationary and centered in the middle of the apparatus.

Draw the vector triangle and solve for the magnitudes  $T_2$  and  $T_3$ . (*Assume the measured angles are exact. The ring is at equilibrium.*)

$$T_2 \text{ (meas)} = \text{_____ N}; T_2 \text{ (ref)} = \text{_____ N};$$

$$T_3 \text{ (meas)} = \text{_____ N}; T_3 \text{ (ref)} = \text{_____ N}$$

Calculate the %Error in the two measurements. Assume angles are exact & the predicted forces are references.

$$\% \text{Error in } T_2 \text{ (meas)} = \text{_____} \% ; \% \text{Error in } T_3 \text{ (meas)} = \text{_____} \%$$