Terwilliger's Physics

presents

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The Vertical Force Table

Lab - Vectors Name _____

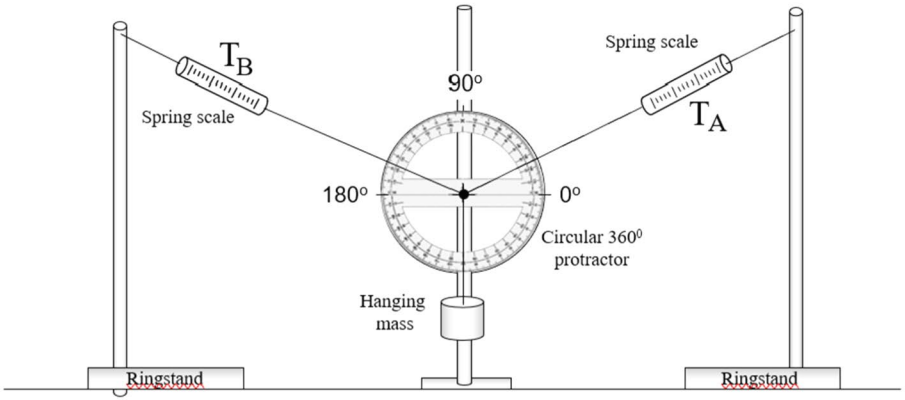
Purpose of this Lab: This lab consists of three vectors that are in equilibrium, two tensions measured by spring scales and the weight attached as shown below. You will first find the resultant of the two tensions. The equilibrant of the two tensions should be equal to the weight.

Materials: Three ring stands, two spring scales, a 360 degree protractor that is attached to a wooden dowel, known standard weight, and a a string that connects as shown below.

Procedure:

1. Calibration of the spring scales: Hold the springs vertically and see if the scale reads zero. Adjust the nut on the top of the scale if the scale does not read zero. Now hang a known weight from the scale (eg: 200grams, 500g, etc. according to the maximum limit of the scale) and see if the scale reads the weight within .1 Newtons. If it is off by more than .1 N see your friendly physics facilitator.

2. Once the scales are calibrated, set up the apparatus as shown in the diagram below: (See steps below)

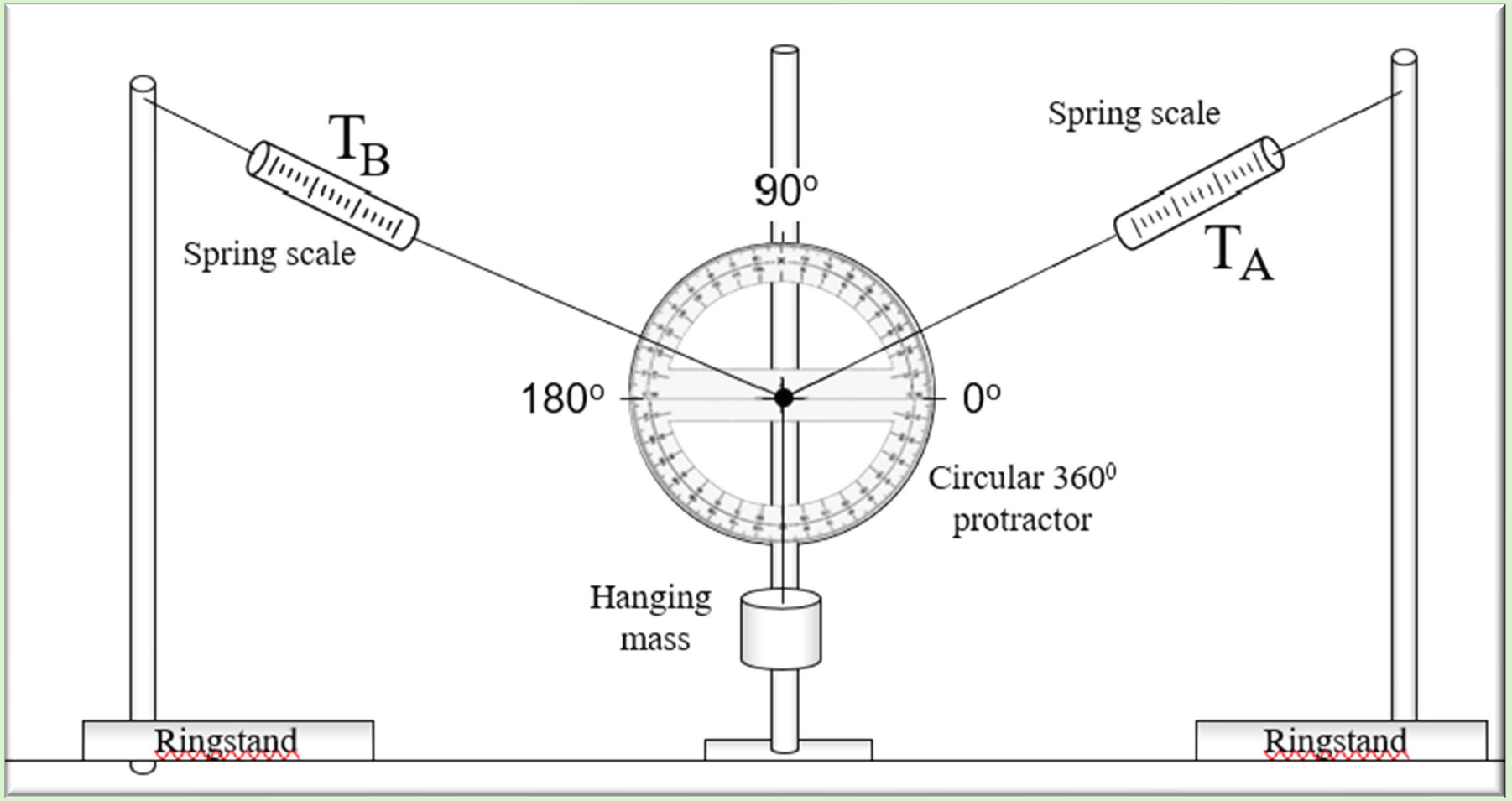


Setup:

1. Hang the scales on the ring-stand supports. Attach the weight to the bottom strings as shown above.

2. Center the knot with the center of the circular protractor by moving the protractor up or down on the support rod. Align the 270° mark on the protractor (straight down) with the string that supports the weight.

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T_B
Spring scale
90°
Spring scale
T_A
180°
0°
Circular 360⁰ protractor
Hanging mass
Ringstand
Ringstand

Data:

Record the weight used, Tension in each string (T_A, T_B), and the angles (θ_A, θ_B) in the data table below. (This is Trial #1)

Repeat the above procedure using a different weight and/or different angles. (The knot where the strings all join will slide up and down.) (This is Trial #2)

w = mg

w = .5 kg (9.8 m/s^2)

w = 4.9 N

Data Table

	Trial # 1	Trial # 2
Hanging Weight	4.9 N	
T_A	3.6 N	
θ_A	37°	
T_B	4.0 N	
θ_B	135°	

Calculations:

1. First, find the resultant of the two tensions, T_A and T_B (trial #1 and Trial #2) using the POLYGON (head to tail) method. Use the protractor pages below to plot the vectors and then find the resultant graphically.

2. Determine the Equilibrant of T_A and T_B and record in the section given below the protractors.

3. Now compare the equilibrant to the actual weight. Determine the precent error in magnitude and the percent error in direction. (Show all work on the protractor pages)

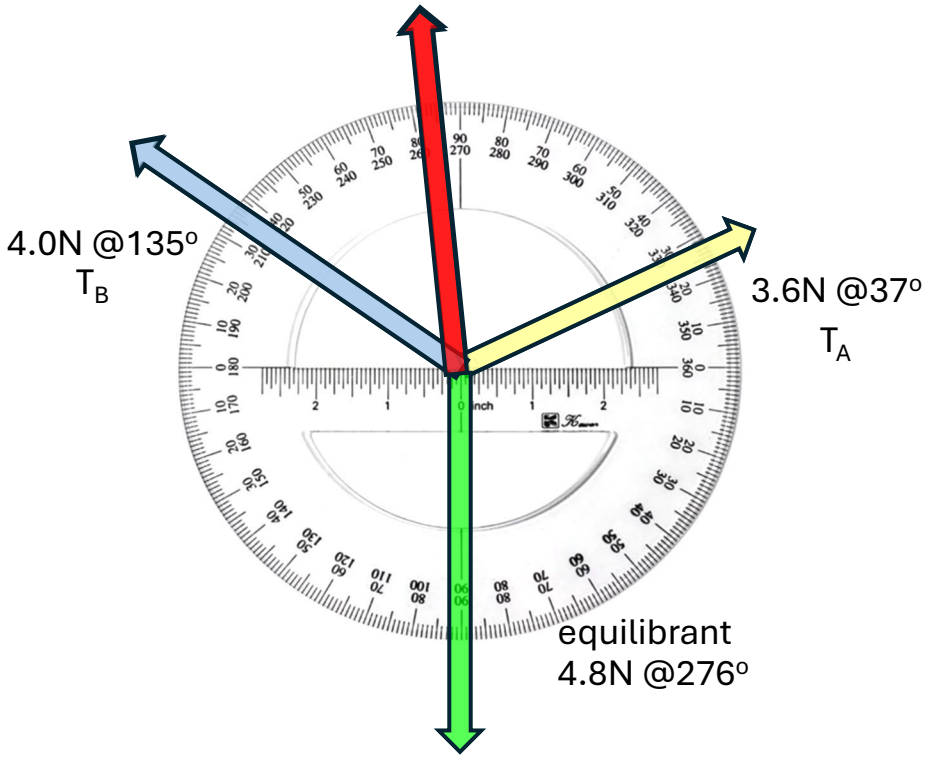
NOTE: The weight is the actual value and the Equilibrant is the experimental value.

The % error in direction is determined using the following equation:

$$\%\text{error} = \frac{(270^\circ - \text{experimental direction})}{180^\circ} \times 100$$

Head-to-Tail Method
(Trial #1)

YOUR SCALE
1 cm = _____ N



Equilibrant = _____ N @ _____ degrees

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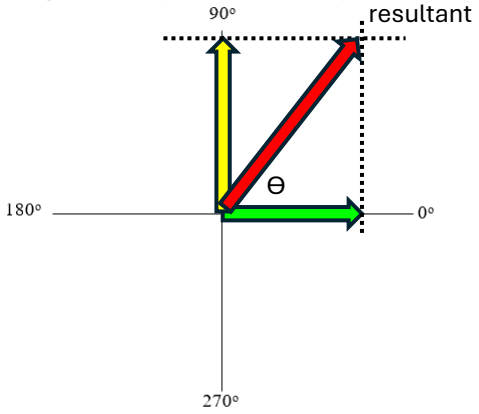
Calculations using the Component Method:

Now use the two Component Method Tables (below) to solve for the resultant of the two tensions T_A and T_B (trial #1 and Trial #2).

COMPOSITION of VECTORS or The COMPONENT METHOD (Trial #1)

Vector Magnitude and Direction	Substitute X-component ($V_x=V\cos\theta$)	Solve	Substitute Y-component ($V_Y=V\sin\theta$)	Solve
3.6N @ 37°	3.6N cos 37°	2.875N	3.6N sin 37°	2.166N
4.0N @ 135°	4.0N cos 135°	-2.828N	4.0N sin 135°	2.828N
	Sum of X-components (ΣV_x)	.047N	Sum of Y-components (ΣV_Y)	4.99N

Sketch the sum of the X and Y components below. Draw in the RESULTANT vector and label the resultant's angle. Draw and label the EQUILIBRANT. (Also label the direction)



Using problem format, solve for the resultant's **MAGNITUDE** and **DIRECTION** in the space below.

$$c^2 = a^2 + b^2$$

$$c = \sqrt{(.047N)^2 + (4.99N)^2}$$

$$c = 4.99N$$

$$\tan \Theta = \frac{4.99N}{.047N}$$

$$\Theta = \tan^{-1}\left(\frac{4.99N}{.047N}\right)$$

$$\Theta = 89.46°$$

Equilibrant = 4.99N N @ 269.46° degrees

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Calculation for Percent Error: In the space below calculate the percent error for the component method in both magnitude and direction for Trial 1 and Trial 2 and then record all lab results in the tables below.

Trial 1

Magnitude:

$$\%\ \text{error} = \left(\frac{\text{accepted - experimental}}{\text{accepted}}\right) x100$$

$$\%\ \text{error} = \left(\frac{4.9N - 4.99N}{4.9N}\right) x100$$

$$\%\ \text{error} = -1.84\ \%$$

Direction:

$$\%\text{error} = \frac{(270^o - \text{experimental direction})}{180^o} \text{ X } 100$$

$$\%\ \text{error} = \left(\frac{270^o - 269.46^o}{180^o}\right) x100$$

$$\%\ \text{error} = 0.3\%$$

Trial 2

Magnitude:

Direction:

Polygon Method also referred to as the Graphical Method				
	Trial 1		Trial 2	
	Magnitude	Direction	Magnitude	Direction
Hanging Weight				
Resultant				
Equilibrant				
Percent Error				

Component Method				
	Trial 1		Trial 2	
	Magnitude	Direction	Magnitude	Direction
Hanging Weight				
Resultant				
Equilibrant				
Percent Error				

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Questions

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AZURITE

$Cu_3(CO_3)_2(OH)_2$