ABSTRACT

The purpose of this experiment is to demonstrate that we can accurately balance the three masses will be in equilibrium in certain angles. To achieve this, we will place the same masses on two of the vectors and find the third angle. Once we've determined the third angle, we'll test our predictions by seeing if all three angles are equal so there can be equilibrium. This will allow us to compare the predicted range with the actual results. This process helps validate the equilibrium of the hanger no matter the angle.

PROCEDURE

In the first experiment we set up the first two vectors to two different angles which is 0° and 90° and we used a mass of 55g = 0.055kg we had to find the third angle which we found was 225°. Then we had to calculate the components of the force F3 so it can balance the other two components so there can be equilibrium. Then for the second experiment we repeated the same thing, and we used the same mass as the first experiment which is 55g = 0.055kg but we switched the angles, so we used 40° and 140° and for the third angle we did the calculations for it and found it was 270°. For the final experiment we had a choice to choose between 90°-180° and 180°-270° so we decided to chose 140° and 240° and we found the third angle to be 10° so there could be equilibrium.

DATA

Experiment 1, 2 & 3

TABLE 1

Trial	Theoretical		Measured		% Error	
	F3x(N)	F3y(N)	F3x(N)	F3y(N)	Error in x (%)	Error in y (%)
1	0.53933	0.53955	-0.49559	-0.49559	8.11	8.15
2	0	0.69401	0	0.69401	0	8.2
3	0.6831	0.1204	0.1179	0.1179	8.2	2.07

This table shows the three trials and the theoretical and measured data we calculated with the % Error that we also got which us unusually high but is less than 10% which is still accurate.

SAMPLE CALCULATION

First, we start with the first trial and do the calculations for each thing we are required to complete:

$$F_{1x} = 0.53933\ N$$
$$F_{2y} = 0.53955\ N$$
$$F_3 = \sqrt{F_{1x}^2 + F_{2y}^2}$$
$$F_3 = \sqrt{(0.53933)^2 + (0.53955)^2}$$
$$F_3 = \sqrt{0.29057 + 0.29057}$$
$$F_3 = \sqrt{0.58114}$$
$$F_3 \approx 0.76307\ N$$
$$\theta = \tan^{-1}\left(\frac{F_{2y}}{F_{1x}}\right)$$
$$\theta = \tan^{-1}\left(\frac{0.53955}{0.53933}\right)$$
$$\theta \approx 45^\circ$$
$$\theta_{\text{final}} = 270^\circ - \theta$$
$$\theta_{\text{final}} = 270^\circ - 45^\circ$$
$$\theta_{\text{final}} = 225^\circ$$
$$F_{3x} = F_3 \times \cos(\theta_{\text{final}})$$
$$F_{3x} = 0.76307 \times \cos(225^\circ)$$
$$F_{3x} \approx 0.76307 \times -0.7071$$
$$F_{3x} \approx -0.49559\ N$$
$$F_{3y} = F_3 \times \sin(\theta_{\text{final}})$$
$$F_{3y} = 0.76307 \times \sin(225^\circ)$$
$$F_{3y} \approx 0.76307 \times -0.7071$$
$$F_{3y} \approx -0.49559\ N$$

$$F_{3y} = 0.53955\ N$$
$$F_3 = \sqrt{F_{3x}^2 + F_{3y}^2}$$
$$F_3 = \sqrt{(0.53955)^2 + (0.53955)^2}$$
$$F_3 = \sqrt{0.29057 + 0.29057}$$
$$F_3 = \sqrt{0.58114}$$
$$F_3 \approx 0.76307\ N$$
$$\theta = \tan^{-1}\left(\frac{F_{3y}}{F_{3x}}\right)$$
$$\theta = \tan^{-1}\left(\frac{0.53955}{0.53955}\right)$$
$$\theta \approx 45^\circ$$
$$\theta_{\text{final}} = 270^\circ - \theta$$
$$\theta_{\text{final}} = 270^\circ - 45^\circ$$
$$\theta_{\text{final}} = 225^\circ$$
$$F_{3x} = F_3 \times \cos(\theta_{\text{final}})$$
$$F_{3x} = 0.76307 \times \cos(225^\circ)$$
$$F_{3x} \approx 0.76307 \times -0.7071$$
$$F_{3x} \approx -0.49559\ N$$
$$F_{3y} = F_3 \times \sin(\theta_{\text{final}})$$
$$F_{3y} = 0.76307 \times \sin(225^\circ)$$
$$F_{3y} \approx 0.76307 \times -0.7071$$
$$F_{3y} \approx -0.49559\ N$$
$$\%\text{Error in } F_{3x} = \frac{|F_{3x\ (\text{theoretical})} - F_{3x\ (\text{observed})}|}{F_{3x\ (\text{theoretical})}} \times 100$$
$$\%\text{Error in } F_{3x} = \frac{|0.53955 - (-0.49559)|}{0.53955} \times 100$$
$$\%\text{Error in } F_{3x} \approx 8.11\%$$
$$\%\text{Error in } F_{3y} = \frac{|F_{3y\ (\text{theoretical})} - F_{3y\ (\text{observed})}|}{F_{3y\ (\text{theoretical})}} \times 100$$
$$\%\text{Error in } F_{3y} = \frac{|0.53955 - (-0.49559)|}{0.53955} \times 100$$
$$\%\text{Error in } F_{3y} \approx 8.15\%$$

As you can see in the following calculations, we start by finding the magnitude and force of the first two vectors and then we do the calculation to find the third force and the calculation to find the third angle and to find the percent error of F3x and F3y.

$$F_1 = 0.053\,\text{kg} \times 9.81\,\text{m/s}^2$$

$$F_1 = 0.53955\,N$$

$$F_{1x} = F_1 \times \cos(140^\circ)$$

$$F_{1x} = 0.53955 \times \cos(140^\circ)$$

$$F_{1x} \approx 0.53955 \times -0.7660$$

$$F_{1x} \approx -0.4133\,N$$

$$F_{1y} = F_1 \times \sin(140^\circ)$$

$$F_{1y} = 0.53955 \times \sin(140^\circ)$$

$$F_{1y} \approx 0.53955 \times 0.6428$$

$$F_{1y} \approx 0.3469\,N$$

$$F_{2x} = 0.53955 \times \cos(40^\circ)$$

$$F_{2x} = 0.53955 \times 0.7660$$

$$F_{2x} \approx 0.4133\,N$$

$$F_{2y} = 0.53955 \times \sin(40^\circ)$$

$$F_{2y} = 0.53955 \times 0.6428$$

$$F_{2y} \approx 0.3469\,N$$

$$F_{3x} = F_{1x} + F_{2x}$$

$$F_{3x} = -0.4133 + 0.4133$$

$$F_{3x} = 0\,N$$

$$F_{3y} = F_{1y} + F_{2y}$$

$$F_{3y} = 0.3469 + 0.3469$$

$$F_{3y} \approx 0.6940\,N$$

$$F_3 = \sqrt{F_{3x}^2 + F_{3y}^2}$$

$$F_3 = \sqrt{(0)^2 + (0.6940)^2}$$

$$F_3 = \sqrt{0 + 0.4820}$$

$$F_3 \approx 0.6940\,N$$

$$\%\text{Error in } F_{3x} = 0\%$$

$$\%\text{Error in } F_{3y} = 8.2\%$$

We can see the same how we do the calculations for the first and second vectors first and then find the third angle and then find the forces and magnitude for the third angle and then find the percentage error for x and y and see the difference between measured and observed.

Experiment 3

$F_1 = mg = 0.655 \times 9.81 = 0.53955\,\mathrm{N}$
$F_2 = 0.53955\,\mathrm{N}$
$F_{1x} = 0.53955 \times \cos(140^\circ) = -0.4133$
$F_{1y} = 0.53955 \times \sin(140^\circ) = 0.34608$
$F_{2x} = 0.53955 \times \cos(240^\circ) = -0.2698$
$F_{2y} = 0.53955 \times \sin(240^\circ) = -0.4672$
$R_x = -0.6831\,\mathrm{N}$
$R_y = -0.12041\,\mathrm{N}$

Second part:

$F = mg$
$F_{3x} = 0.6831\,\mathrm{N}$
$F_{3y} = 0.12041\,\mathrm{N}$
$0.12041 = m \times 9.81$
$m = 0.122\,\mathrm{kg}$
$0.122\,\mathrm{kg} \times 9.81 = 0.1197$
$0.1197 \times \cos(10^\circ) = 0.1179$
$0.1197 \times \sin(10^\circ) = 0.1179$
$0.6831 - 0.1179$

Error percentages:

Error percentage for x:

$$\frac{0.12041 - 0.1179}{0.12041} \times 100 = 8.2\%$$

Error percentage for y:

$$\frac{0.12041 - 0.1179}{0.12041} \times 100 = 2.07\%$$

For the final trial we can see how we did the same as always and did the calculations for force and magnitude for the first two vectors and then find the third and do the same we did for the first two vectors with the third and find the percentage error.

DISCUSSION

In this lab, we tried to achieve equilibrium with each experiment as accurately as possible. In **Experiment 1** we determined the third angle by calculating the components of the third force and by placing the first two vectors to 0° and 90° and then calculating the force and components of each vector which for the first two vectors we used a mass of 55g = 0.055kg and for the third vector we used a mass of 65.5g = 0.0655kg. We did the same thing for **experiment 2** and **experiment 3**.

In **experiment 2** we did almost the same thing as what we did in **experiment 1** the difference is that we changed the angles to be 40° and 140° and then we did the calculations to find the third vector which we figured was 270° and we used the same mass as last experiment for the first two vectors which is of 55g = 0.055kg and for the third angle the mass was 70.7g = 0.0707kg.

In **Experiment 3** was similar as well but there are more changes made compared to the last two experiments so what we did is setup the first to vectors which as stated before we had the choice to choose between 90°-180° and 180°-270° and we chose 140° and 240° and after making the calculation and playing around with the equipment we found the third angle to be 10° and we still used the same masses for the first to vectors which is 55g = 0.055kg and after find the angle the mass for the third vector was 72.5g = 0.0725kg

There was minimal percent error for each experiment which was less than 10% which is what we need even if it is not as accurate it is still pretty decent percentage error and any discrepancies is most likely due to small variations in the masses or the setup for the experiment and the vectors were not exact which made for small discrepancies but in general the result were pretty valid and accurate.