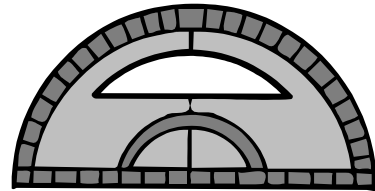


# Forces in Equilibrium

*According to Newton's First Law of Motion, an object remaining at rest even when forces are acting upon it does so because there is **no net force** acting on the object. This means that the **resultant** or **vector sum** of all the forces acting on the object is zero. An object in this state or condition is said to be "in **equilibrium**."*

In this lab exercise, you will apply forces to an object in such a way that the object remains stationary. You will then verify that the resultant force is indeed zero.

1. Place the ring (washer) over the origin of your polar grid paper with the force scales attached in the positions indicated in the data table.
2. Pull each scale in the indicated directions. Pull so that the ring remains centered over the origin. At least one of your forces should be over 15.0 N.
3. Record the reading on each scale. Record to the nearest tenth of a Newton when using these 0-20 N scales.
4. Calculate the horizontal (x) and vertical (y) components of each force.
5. Sum the components. Record these values in the data tables.
6. Use the Pythagorean Theorem and the inverse tangent function to calculate each resultant force's magnitude and direction. Your resultant magnitudes should be close to zero.



	<b>Force (Newtons)</b>	<b>Angle (Degrees)</b>	<b>Horizontal Component</b>	<b>Vertical Component</b>
A		0 (East)		
B		110 (70° NW)		
C		200 (20° SW)		
Sum of Components =				
<b>Resultant =</b>				

	<b>Force (Newtons)</b>	<b>Angle (Degrees)</b>	<b>Horizontal Component</b>	<b>Vertical Component</b>
A		45		
B		135 (45° NW)		
C		270 (South)		
Sum of Components =				
<b>Resultant =</b>				

	Force (Newtons)	Angle (Degrees)	Horizontal Component	Vertical Component
A		80		
B		210 (30° SW)		
C		280 (80° SE)		
Sum of Components =				
<b>Resultant =</b>				

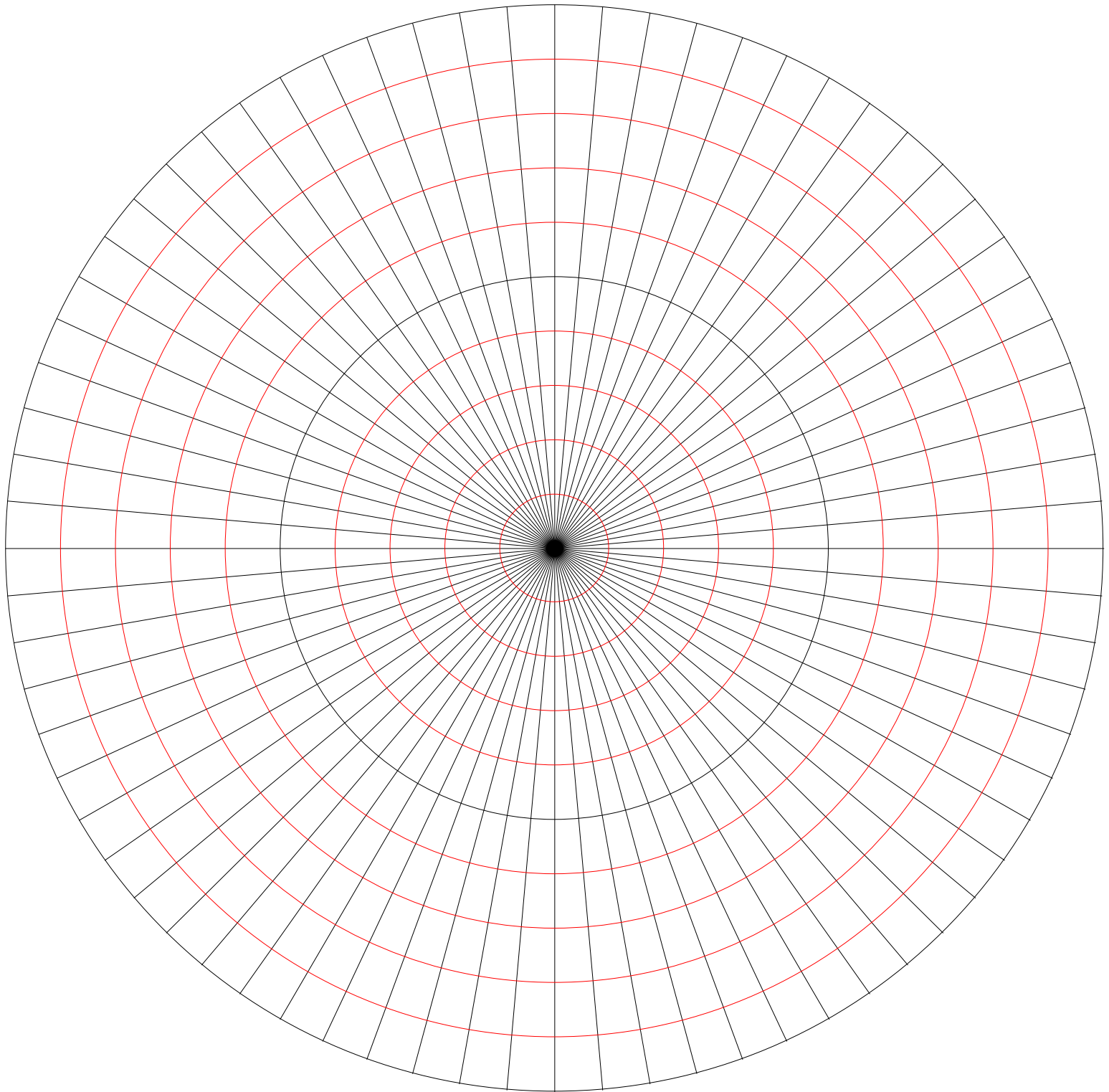
	Force (Newtons)	Angle (Degrees)	Horizontal Component	Vertical Component
A		60		
B		190 (10° SW)		
C		340 (20° SE)		
Sum of Components =				
<b>Resultant =</b>				

	Force (Newtons)	Angle (Degrees)	Horizontal Component	Vertical Component
A		25		
B		180 (West)		
C		335 (25° SE)		
Sum of Components =				
<b>Resultant =</b>				

*Join with another group for this final trial.*

	Force (Newtons)	Angle (Degrees)	Horizontal Component	Vertical Component
A		0 (East)		
B		20		
C		120 (60° NW)		
D		240 (60° SW)		
E		315 (45° SE)		
Sum of Components =				
<b>Resultant =</b>				

**Extension:** Draw vector diagrams ("head to tail") for each set of forces in order to verify that the resultant force is zero.



Graph constructed using a free graphing program found at [http://www.mathematicshelpcentral.com/graph\\_paper.htm](http://www.mathematicshelpcentral.com/graph_paper.htm)