Lab 2: The Force Table

R. Napora

Today you will be experimenting with a *force table* to attain a better understanding of vectors. The force table is shown in Fig.[1]. It is a round table with a center pin and angle divisions marked around its outside edge. A ring is placed around the center pin that has strings attached to it. Those strings are run over pulleys at different locations around the table and various masses are hung from their ends.

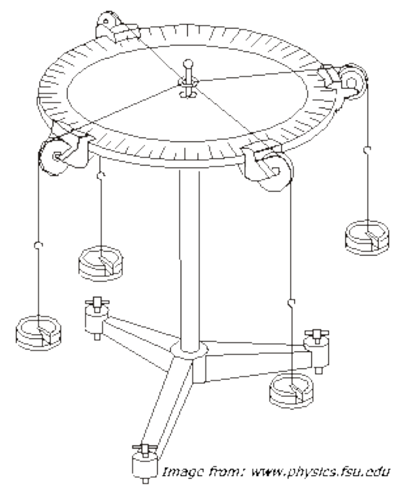
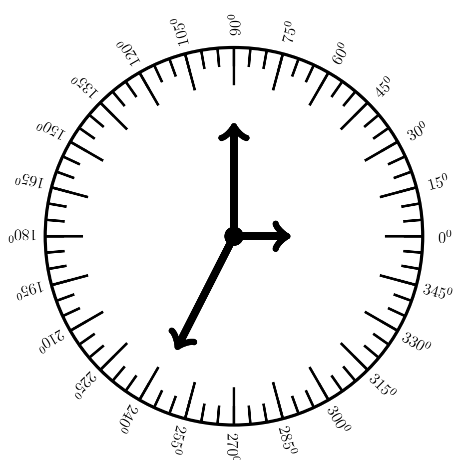


Fig.[1]: Schematic diagram of a force table.

Each string will exert a force on the ring that is proportional to the mass hung on it[1] and in a direction along the line of the string. Notice that force is a *vector* quantity. Since it has direction as well as magnitude, it is possible for two or more non-zero forces to balance out to a zero net force. This can be seen in the example below.

Example:
Say you have three forces, one of magnitude $0.20N$ pointing at 0^0, one of magnitude $0.40N$ pointing at 90^0, and one of magnitude $0.45N$ pointing at 243^0. These forces are represented by arrows in the diagram. We can show that these three vectors add up to a zero net force. We will do this by considering the x and y components separately.



[1]The force here is the mass times the acceleration due to gravity at the Earth's surface, i.e. $Force = Mass \times 9.81\ m/s^2$. The SI unit for force is called the Newton, N. $1\ N = 1\ kg \cdot m/s^2$.

First considering the x-components:

$$F_{net,x} = (0.20\ N)\cos(0^0) + (0.40\ N)\cos(90^0) + (0.45\ N)\cos(243^0)$$
$$F_{net,x} = 0.20N + 0N + (-0.20N)$$
$$F_{net,x} = 0$$

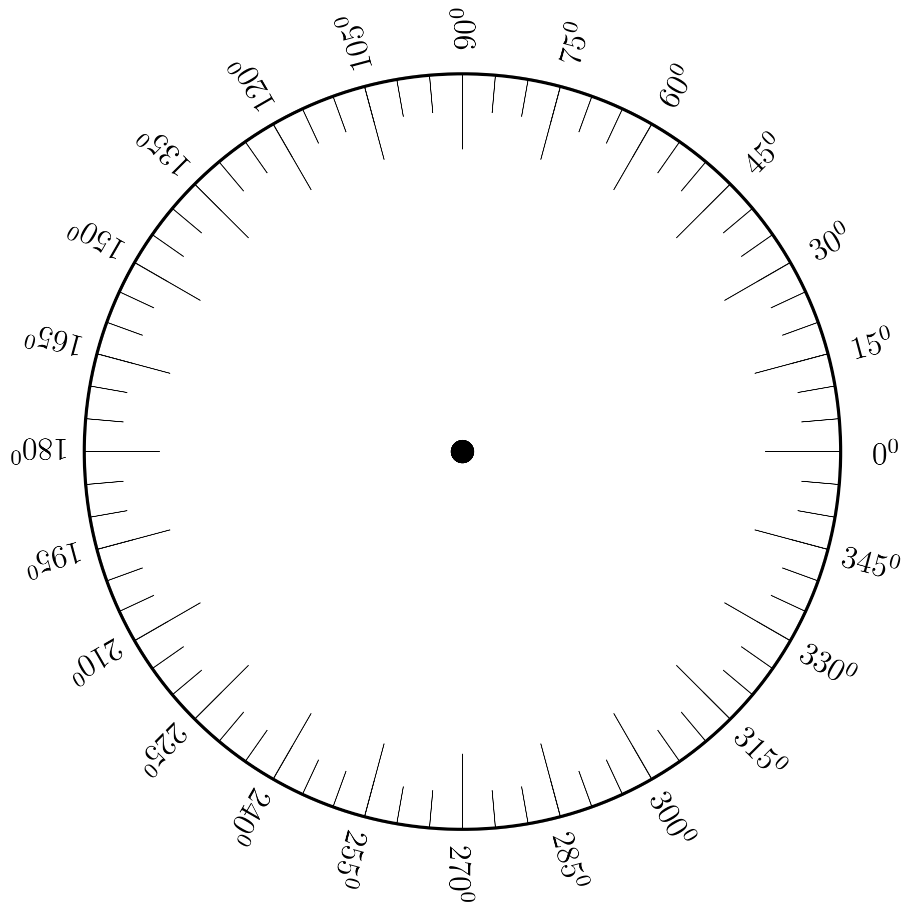
Now considering the y-components:

$$F_{net,y} = (0.20N)\sin(0^0) + (0.40N)\sin(90^0) + (0.45N)\sin(243^0)$$
$$F_{net,y} = 0N + 0.40N + (-0.40N)$$
$$F_{net,y} = 0$$

We see that these three vectors sum to *zero* in both the x and y directions. If you were to set these three forces up on the force table, the ring would remain centered around the pin without being moved in any direction. If the net force on the ring were ever *not* zero, there would be an imbalance and the ring would be pulled in some direction (if the center pin were not there to stop it).

For the remainder of this lab, you will be given sets of forces and be asked to *solve* for the force(s) needed to cancel them out. You will then test your predictions on the force table. I would also like you to sketch all of the force vectors on the diagrams provided. *Neatness counts!* When sketching vectors be sure to draw them such that their lengths are proportional to their magnitudes.

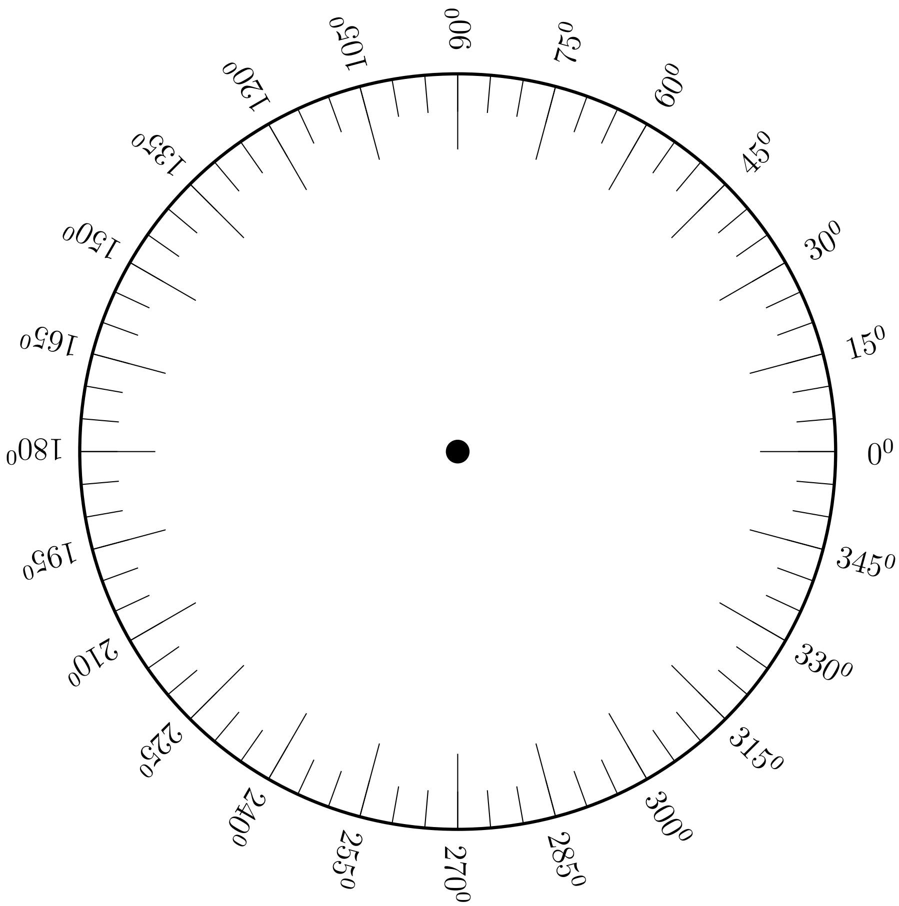
A few warnings:
(1) Be sure that your calculator is not in radians mode.
(2) When using inverse trigonometric functions, be sure that the angle you find is in the correct quadrant. A neat, clear picture helps tremendously with this.



Case I. $\vec{A} + \vec{B} + \vec{C} = \vec{0}$

vector	mass, kg	magnitude, N	direction	x-component	y-component
$\vec{A}$	0.200		30^0		
$\vec{B}$	0.200		120^0		
$\vec{C}$					

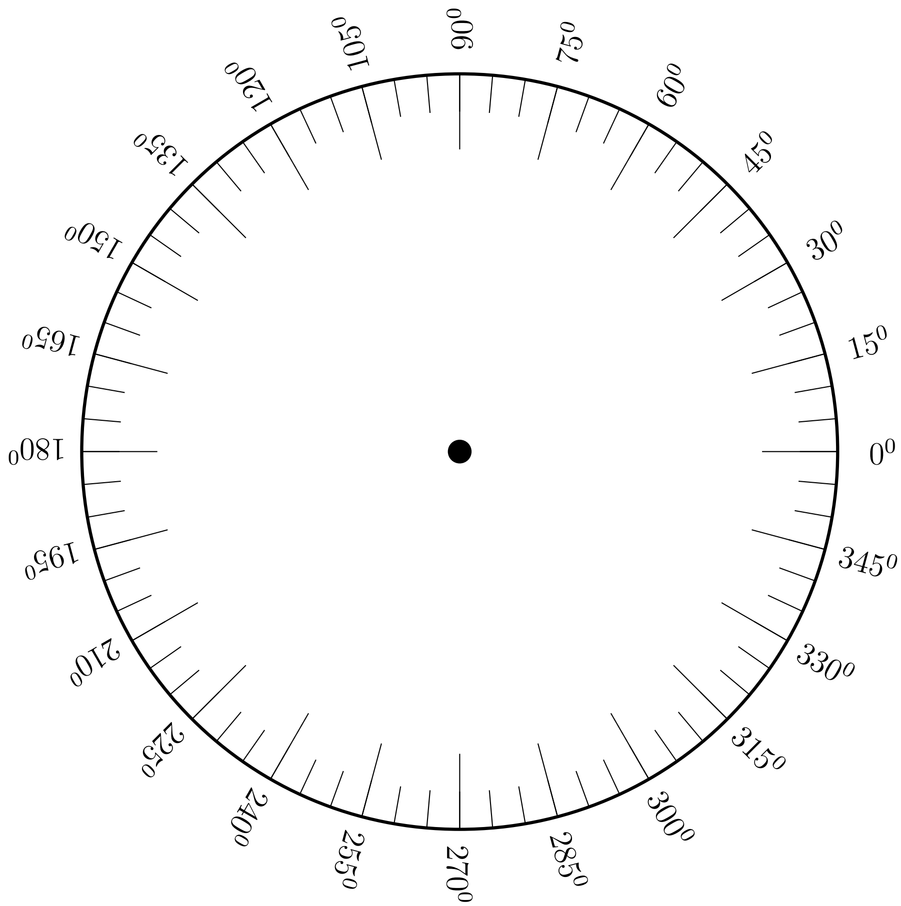
verified: ________________________



Case II. $\vec{A} + \vec{B} + \vec{C} = \vec{0}$

vector	mass, kg	magnitude, N	direction	x-component	y-component
$\vec{A}$	0.200		20^0		
$\vec{B}$	0.150		80^0		
$\vec{C}$					

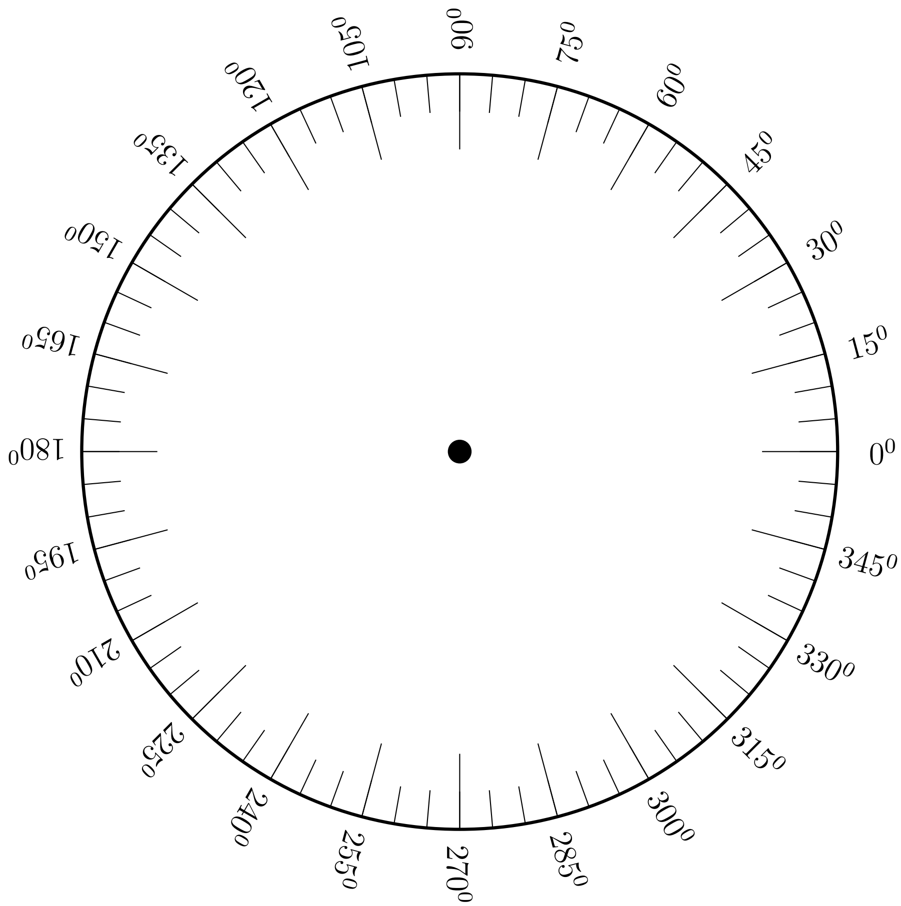
verified: ________________________



Case III. $\vec{A} + \vec{B} + \vec{C} = \vec{0}$

vector	mass, kg	magnitude, N	direction	x-component	y-component
$\vec{A}$	0.200		0^0		
$\vec{B}$	0.150		90^0		
$\vec{C}$					

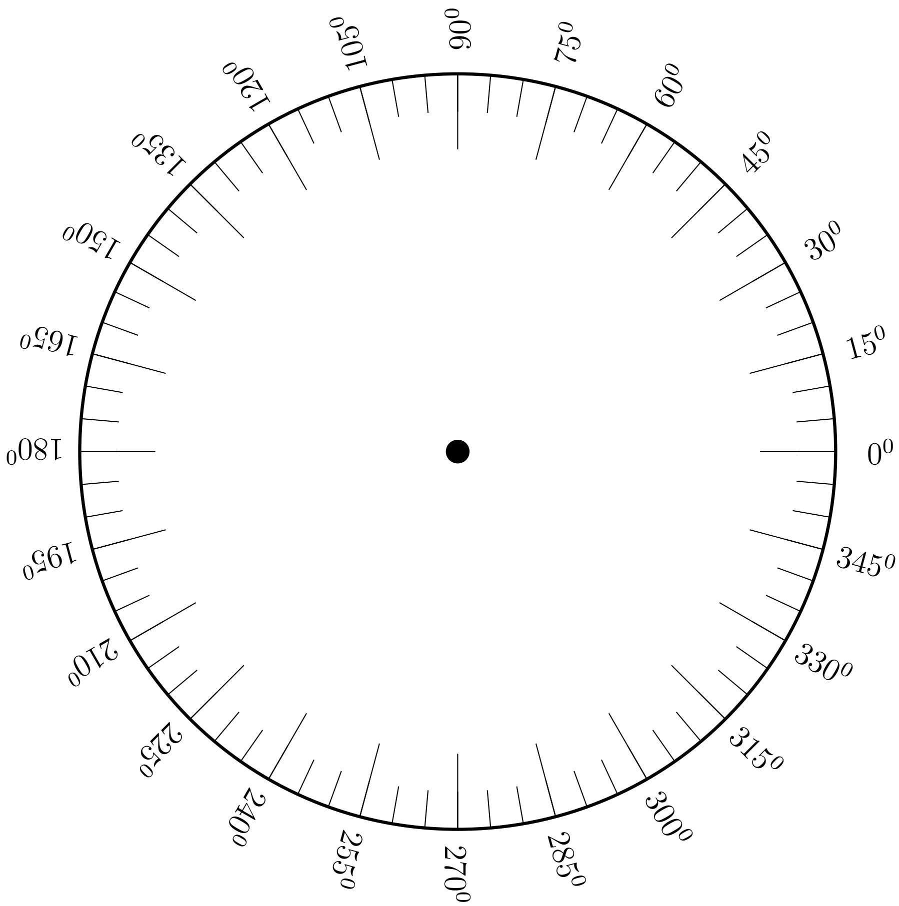
verified: __________________________



Case IV. $\vec{A} + \vec{B} + \vec{C} = \vec{0}$

vector	mass, kg	magnitude, N	direction	x-component	y-component
$\vec{A}$			0^0		
$\vec{B}$			90^0		
$\vec{C}$	0.300		240^0		

verified: ________________________



Case V. $\vec{A} + \vec{B} + \vec{C} + \vec{D} = \vec{0}$

vector	mass, kg	magnitude, N	direction	x-component	y-component
$\vec{A}$	0.100		30^0		
$\vec{B}$	0.200		90^0		
$\vec{C}$	0.300		225^0		
$\vec{D}$					

verified: __________________________