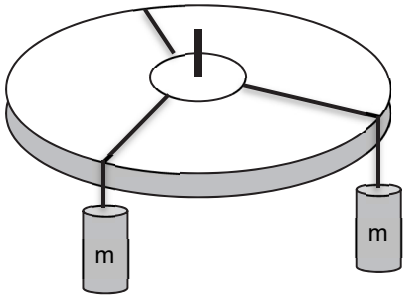
Experiment II - Vectors



The "Force Table" apparatus that you will use is illustrated at right. It is a large metal disk ruled in degrees like a protractor. Three masses that hang from strings that go over pulleys (not shown) exert forces on the ring in the center of the force table. If the forces from the three strings balance (add vectorially to zero) the ring will remain at rest. Be certain that all the strings point toward the center post of the table so the forces on the ring are radially outward. If they point near but not exactly at the center, it will lead to significant error in your measurements). You may have to adjust the attachment positions of the strings on the ring.

Put 75 g at 0° and 100 g at 90° (these include the mass of the hangers). Calculate the mass and angle that will balance them, however don't put a third mass there yet.

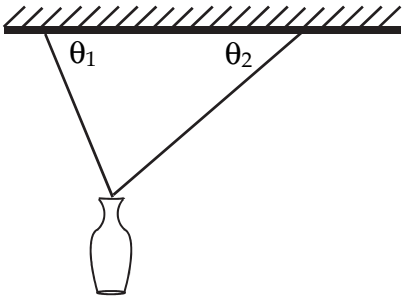
Test your calculated mass and angle to see that balances the first two masses. Remember that the mass hangers have mass, typically marked on the hanger.

Graded Activity: [5% for full credit; 15% for half credit] Determine the mass of the "mystery object" by using the force table. Use symmetry by putting the mystery mass at 0° and two identical masses at plus and minus the same angle. Adjust this angle until the masses balance.

Instructor Initials: _____	Date: _____

Vectors

(1) A lamp is hanging from two light cords. The cords make unequal angles with the ceiling, as shown in the diagram at right. The forces exerted by the strings are along the strings, the force of gravity is down, and because the lamp remains motionless, the sum of the forces must be zero. Don't get hung up on forces, as we will learn more about them later – this is a problem about vectors.



a) Draw three vectors on the diagram of the lamp showing the directions of the forces.

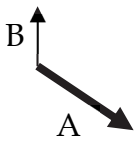
b) Is the horizontal component of the pull of the left cord on the lamp greater than, less than, or equal to the horizontal component of the pull of the right cord on the lamp? Explain your reasoning.

c) Is the magnitude of the pull of the left cord on the lamp greater than, less than, or equal to the magnitude of the pull of the right cord on the lamp? Explain your reasoning. Hint: consider your answer to part 2.

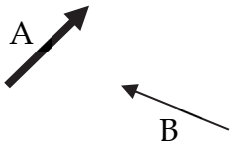
d) Is the vertical component of the pull of the left cord on the lamp greater than, less than, or equal to the vertical component of the pull of the right cord on the lamp? Explain your reasoning.

(2) For each situation shown, sketch the vectors $\vec{A}+\vec{B}$ and $\vec{A}-\vec{B}$. Also, decide which is longer, $\vec{A}+\vec{B}$ or $\vec{A}-\vec{B}$?

a)



b)



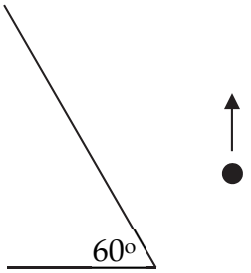
(3) Alan is jogging at a speed of 5 m/s at an angle of 120° with respect to the positive x-axis.

a) Write his velocity in component form.

b) $\vec{A} = 8.0\,\hat{i} - 4.0\,\hat{j}$, $\vec{B} = -3.0\,\hat{i} + 3.0\,\hat{j}$ and $\vec{C} = \vec{A} + 4\,\vec{B}$.
Write $\vec{C}$ in magnitude/angle form. Sketch the three vectors.

c) Patricia is walking at 3 m/s such that the x component of her velocity is 1 m/s. Write her velocity in component form. What is its angle? (There are two possible solutions. Find both.)

(4) A helicopter flies upwards at a speed of 6.0 m/s next to a pyramid. What is the component of the helicopter's velocity in the direction going along and up the pyramid's face? [Hints: add the appropriate coordinate system to the figure; can a component of a vector be greater than the vector's magnitude?]



(5) The position of a particle is given by: $\vec{r} = 4t^2\,\hat{i} + \sin(2t)\,\hat{j}$ with position and time in meters and seconds respectively. Find its velocity.

Since the problem does not specify any requirements, you are free to express the vector using any format you choose. Pick something convenient.