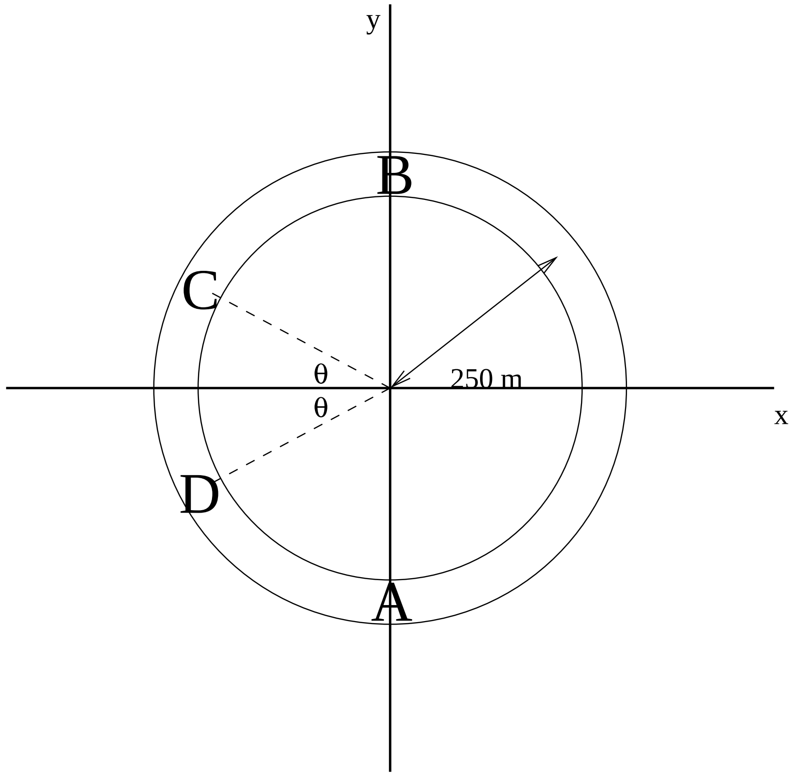
Physics 131
Vector Addition Exercises

You should treat the following as a lab exercise just like the ones you've been doing. Put it in the back of your lab notebook when you're done.

1. Suppose that two forces pull on the same object. The first force has a strength of 75.0 N and pulls in a direction 30.0° from the x axis. The second force has a strength of 65.0 N and pulls in a direction 160° from the x axis. (For this exercise, all you need to know about forces is that they obey the rules for vector addition. The N stands for "newton," which is the standard metric unit of force.)
(a) Draw a careful diagram of these two vectors, and use it to figure out what single force would be equivalent to the combination of these two. Use a ruler and protractor, and choose a scale for your diagram so that the diagram takes up a large portion of a single page.
(b) Now add the two vectors using trigonometry instead of graphical addition. Are the results consistent?

(c) What single force would cancel out the effects of the original two? That is, what third force, when added to those two, gives a total of zero? Give both magnitude and direction. (After you've answered the previous question, this one can be answered very quickly.)

2. Suppose a car is driving counterclockwise around a circular track as shown below. The radius of the track is 250 m, and the car is traveling at a steady speed of 45.0 m/s.[1]



(a) Give the magnitude and direction of the vector $\Delta\mathbf{v}_{AB}$ that represents the change in velocity between the moment when the car is at point A and the moment when the car is at point B. (Note: the velocity at any given moment is a vector whose magnitude is the car's speed at that moment and whose direction is the direction that the car is going at that instant. $\Delta\mathbf{v}$ still means final velocity minus initial velocity, but since the velocities are now vectors, you must use vector subtraction.)

(b) Determine the elapsed time between the moment the car is at point A and point B. Use this, together with the answer to part (a), to determine the car's average acceleration over this time interval. (Give both magnitude and direction.) **Note:** Acceleration is still defined the same way it was before: $\overline{\mathbf{a}} = \frac{\Delta\mathbf{v}}{\Delta t}$. The only difference is that $\Delta\mathbf{v}$ is now a vector.

[1]Professional driver on closed course. Do not attempt this yourself!

(c) Determine the change in velocity $\Delta \mathbf{v}_{CD}$ between the car's velocity at point C and at point D. Assume that the angle θ is $10°$. (Suggestion: First draw a picture of the two velocity vectors and use it to decide which way $\Delta \mathbf{v}$ is going to point. Then determine the relevant components (x or y) of the two velocity vectors.)

(d) Determine the elapsed time between the moment the car is at point C and the moment it is at point D, and use this to figure out the car's acceleration over the time interval from C to D. (Suggestion: In order to do this, decide what fraction of a complete circuit the car is making. How long does it take to make a complete circuit?)

(e) Repeat parts (c) and (d), but this time, assume the angle θ is 1°.

(f) Do you think the average accelerations you have determined make a good approximation to the instantaneous acceleration?

(g) What would the magnitude and direction of the instantaneous acceleration at point A be?