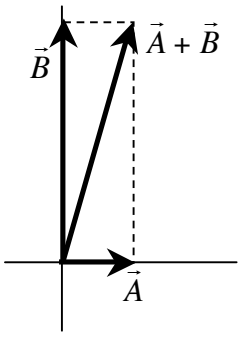
PHY2250 - HW 4 - "AC, & Cap Intro"

1. Signal A has an amplitude of 3V. Signal B has the same frequency as Signal A, but has an amplitude of 6V and a phase shift of 90 degrees relative to Signal A. Before he can apologiiiiiiiize, "Timbaland" plugs both signals into a "Y" adaptor…
   a. Considering the Signal A to be at 0 degrees (along the +x axis), draw the vectors, *i.e.* the "phasors," for both signals *and* their sum.
   b. What is the phase difference between the summed signal and Signal A?

   Answer:



The phase angle ϕ between $\vec{A}$ and $(\vec{A} + \vec{B})$ is given by

$$\phi = \tan^{-1}\left(\frac{6V}{3V}\right) = \tan^{-1}(2) = 63.4^{\circ}.$$

2. Walter Becker has a 25mF capacitor with a voltage of 9V applied across it (and left for a while). How much charge does it (eventually) store?

   Answer:

$$\mathbf{Q = VC = (9V)(0.025F) = 0.225C}$$

3. Tom Morello has a parallel plate capacitor with a plate area of 9 cm^2, a separation of 1 mm, and a dielectric constant of 1.5. What is its capacitance?

   Answer:

$$C = \kappa\varepsilon_0 \frac{A}{d} = (1.5)(8.85 \times 10^{-12}\text{F/m})\frac{(0.0009\text{m}^2)}{0.001\text{m}}$$
$$= 1.19 \times 10^{-11}\text{F}$$

4. For a lab in PHY2010, Dr. Hawley bought four 0.1μF ceramic capacitors.
   a. How many nF is 0.1μF?

   Answer: 100. 100 nF = 0.1μF

   b. If he wanted to make the total capacitance as large as possible, would he place the capacitors in series or parallel? What would this capacitance be?

   Answer: Parallel. C_T = 4*(0.1μF) = 0.4μF

FYI: The biography of the magnificent British physicist and devout "Sandemanian" Christian Michael Faraday (as in "Farads") is an entertaining tale. Check it out.