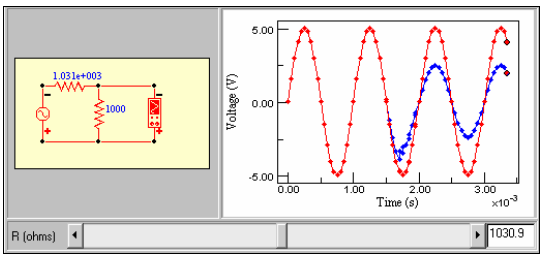
Worksheet for Exploration 31.1: Amplitude, Frequency and Phase Shift



We characterize the voltage (or current) in AC circuits in terms of the amplitude, frequency (period) and phase. The sinusoidal voltage of this function generator is given by the equation $V(t) = V_0 \sin(\omega t - \varphi) = V_0 \sin(2\pi f t - \varphi)$, where V_0 is the amplitude, f is the frequency ($\omega = 2\pi f$ is the angular frequency), and φ is the phase angle **(voltage is given in volts and time is given in seconds)**. Restart.

To begin with, keep the resistance of the variable resistor equal to zero. Pick values for the voltage amplitude (between 0 and 20 V), frequency (between 100 and 2000 Hz) and phase angle (between -2π and 2π).

a. What does the amplitude on the graph correspond to?

b. If you increase the amplitude, what do you expect to happen? Try it.

c. Measure the time between two peaks (or valleys) on the graph. This is the period (T). What does 1/T equal?

Inputs: Amplitude = _____

frequency = _____

phase shift = _____

Measured value: T = _____ 1/T = _____

d. What do you need to change to increase the time between two peaks? Try it.

e. Compare the plots when φ = 0 and when φ = 0.5*π. (You can right-click inside the plot to make a copy.)

f. What happens when φ = π?

g. Pick a value of φ other than 0. Measure the time, t (measured from t = 0), it takes for the graph to cross the horizontal axis with a positive slope (going up). φ should be equal to $2\pi f t$. So, the phase (or phase shift) tells you how much the graph is shifted from a straight $\sin 2\pi f t$ curve.

Inputs: Amplitude = _____

frequency = _____

phase shift = _____

Measured: t = _____ (for graph to cross the horizontal axis with a positive slope)

$2 \pi f t$ = _____

h. Note that when φ = 0.5*π, the plot is a cosine curve. Why?

Now, change the variable resistor. The plot shows both the voltage across the 1000 Ω resistor **(blue)** and the voltage supply **(red)**. Kirchhoff's laws hold for any instant of time in an AC circuit.

i. Use the techniques you learned for DC circuits to calculate the current in the circuit at several different points.

Inputs: Amplitude = _____

frequency = _____

R_{var} = _____

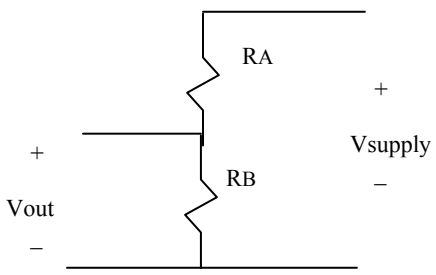
phase shift = _____

i. Use V = IR at any point in time.

t(sec)	V (volts)	I(amps)

j. Verify that this circuit is simply a voltage divider.

i. Voltage Divider. Expression for V_{out} as a function of V_{supply} and R_A and R_B:



k. What value does the variable resistor need to have for the maximum voltage across the 1000-Ω resistor to be 1/3 of the value of the source?

i. R_{var} = _____

ii. Calculations (to determine R_{var}):