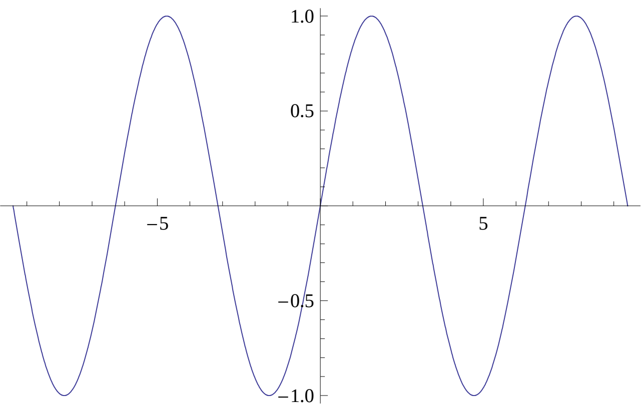
# Properties of Trig Functions

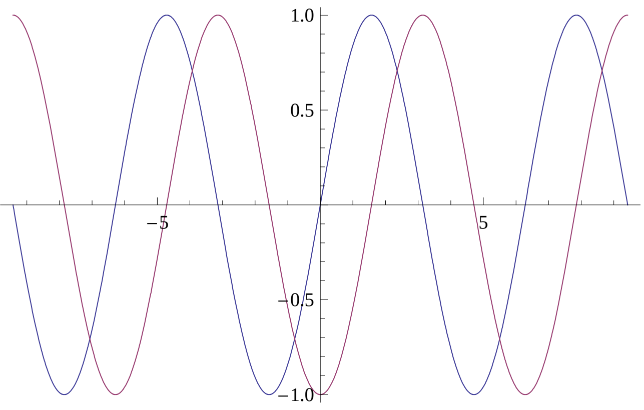
Let's look at a graph of the sine function




There are several important properties to notice.  First, notice that the value of the sine is always in the range of -1 to +1.  Notice also how the sine function shows  maxima and minima and also that the sine function is equal to zero.

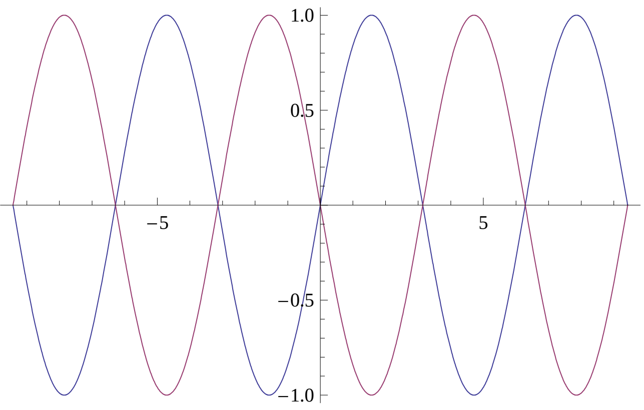
Let's look a little more deeply at the sine function.  We can recall that the sine function reaches its maximum value of +1 when the angle is 90 degrees, or when the angle (measured in radians) is $\pi/2$.  The sine function achieves its minimum value of -1 when the angle is 180 degrees or when the angle (measured in radians) is $\pi$.

Now, let's look at two sine waves placed on the same graph.  These are both sine waves, but will be out of phase with each other by 90 degrees (or by $\pi/2$ radians).  This is the same as thinking about two identical sine waves, except that one is always trailing the other by $\pi/2$ radians.



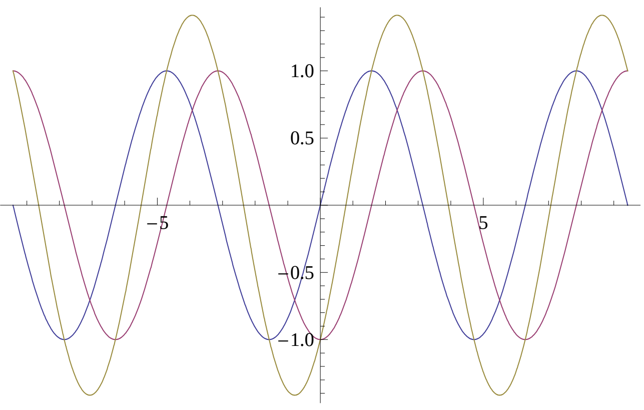

The curve in blue is the same as the sine wave plotted above, the curve in purple is 90 degrees out of phase of the blue curve.  This means that when the blue curve reaches its maximum value, the red curve is at zero.

Now, let's look at curves that are out of phase by 180 degrees, or by $\pi$ radians.



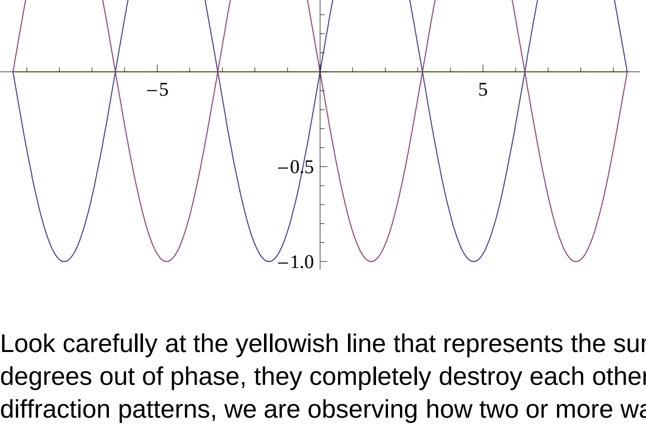

Imagine now that these sine waves represent the intensity of light or sound transmitted by two different sources.  The total intensity you receive from the two sources depends on how the two waves add at your location.  The plots below will show how these two waves add (the yellowish curve will represent the sum of the two waves.)

Summing the two waves out of phase by 90 degrees:




Let's look at the above curve a little more closely.  We can see that there are locations where the waves add to produce greater intensity (a brighter light or greater sound), and there are places where the waves cancel out to produce no intensity at all.  The former situation is called constructive interference, and the latter is known as destructive interference.

Now, let's look at what happens when two waves 180 out of phase are added together.




Look carefully at the yellowish line that represents the sum of the waves.  Notice that when the two waves are 180 degrees out of phase, they completely destroy each other, producing no light or sound at all.  When we study diffraction patterns, we are observing how two or more waves can combine to produce more intense waves, or can combine to completely null themselves out.