CHAPTER 9 PROJECT

Trigonometric Identities

Lasers are used in such varied applications as video players, checkout counter scanners, surgical operations, and weaponry. A beam of light from a flashlight shines for a couple hundred yards, but a laser's narrow band of light can be reflected off the moon and detected on Earth. A laser has this ability because its light is *coherent*. Coherent light means that each light wave has exactly the same amplitude, direction, and phase. Coherence reflects the superposition principle which states that when combining two waves, the resulting wave is the sum of the two individual waves.

Let's examine how the superposition principle works.

1. Consider two waves with a difference in displacement of $\frac{\pi}{2}$.

$$y_1 = 2\sin(kx - \omega t)$$
$$y_2 = 2\sin\left(kx - \omega t + \frac{\pi}{2}\right)$$

Using a trigonometric identity, add these two waves to find the equation of their superposition. What is the amplitude of the resulting wave?

2. The following equations are given.

$$y_1 = A\sin(kx - \omega t)$$
$$y_2 = A\sin(kx - \omega t + \delta)$$

a. For what values of δ would the amplitude be the largest? (This happens when two waves are coherent and it is called constructive interference.)

b. What is the smallest amplitude possible for $y_1 + y_2$?

c. For what values of δ would the smallest amplitude occur? (This is called destructive interference.)

3. Graph the following equations.

$$y_1 = 3\sin t$$
$$y_2 = 3\sin\left(t + \frac{\pi}{3}\right)$$

Now graph $y_1 + y_2$. Discuss the relationship between the three graphs.