Trigonometry and the Pythagorean Theorem

$$\sin \theta = \frac{a}{c}$$

$$\cos \theta = \frac{b}{c}$$

$$\tan \theta = \frac{a}{b}$$
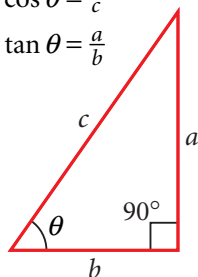

Figure 4

The portion of mathematics that is based on the relationships between the sides and angles of triangles is called *trigonometry.* Many of the concepts of this branch of mathematics are of great importance in the study of physics. To review some of the basic concepts of trigonometry, consider the right triangle shown in **Figure 4,** where side *a* is opposite the angle θ, side *b* is adjacent to the angle θ, and side *c* is the hypotenuse of the triangle (the side opposite the right angle). The most common trigonometry functions are summarized in **Table 8,** using this figure as an example.

Table 8 Trigonometry Functions

sine (sin)	$\sin \theta = \dfrac{\text{side opposite } \theta}{\text{hypotenuse}} = \dfrac{a}{c}$
cosine (cos)	$\cos \theta = \dfrac{\text{side adjacent to } \theta}{\text{hypotenuse}} = \dfrac{b}{c}$
tangent (tan)	$\tan \theta = \dfrac{\text{side opposite } \theta}{\text{side adjacent to } \theta} = \dfrac{a}{b}$
inverse sine ($\sin^{-1}$)	$\theta = \sin^{-1}\left(\dfrac{\text{side opposite } \theta}{\text{hypotenuse}}\right) = \sin^{-1}\left(\dfrac{a}{c}\right)$
inverse cosine ($\cos^{-1}$)	$\theta = \cos^{-1}\left(\dfrac{\text{side adjacent to } \theta}{\text{hypotenuse}}\right) = \cos^{-1}\left(\dfrac{b}{c}\right)$
inverse tangent ($\tan^{-1}$)	$\theta = \tan^{-1}\left(\dfrac{\text{side opposite } \theta}{\text{side adjacent to } \theta}\right) = \tan^{-1}\left(\dfrac{a}{b}\right)$

When $\theta = 30°$, for example, the ratio of *a* to *c* is always 0.50. In other words, $\sin 30° = 0.50$. Sine, cosine, and tangent are quantities without units because each represents the ratio of two lengths. Furthermore, note the following trigonometry identity:

$$\frac{\sin \theta}{\cos \theta} = \frac{\dfrac{\text{side opposite } \theta}{\text{hypotenuse}}}{\dfrac{\text{side adjacent to } \theta}{\text{hypotenuse}}} = \frac{\text{side opposite } \theta}{\text{side adjacent to } \theta} = \tan \theta$$

Some additional trigonometry identities are as follows:

$$\sin^2\theta + \cos^2\theta = 1$$
$$\sin \theta = \cos(90° - \theta)$$
$$\cos \theta = \sin(90° - \theta)$$