Answer to Essential Question 1.7: Yes, you could have an equation with no real solutions. In that case when you applied the quadratic formula you would get a negative under the square root, while the graph would still be parabolic but would not cross (or touch) the *x*-axis.

Chapter Summary

Essential Idea

Physics is the study of how things work, and in analyzing physical situations we will try to apply a logical, systematic approach. Some of the basic tools we will use include:

Units

Our primary set of units is the système international (SI), based on meters, kilograms, and seconds, and four other base units. SI is widely accepted in science worldwide, and convenient because conversions are based on powers of ten. Converting between units is straightforward if you know the appropriate conversion factor(s).

Significant Figures

Three useful guidelines to follow when rounding off include:

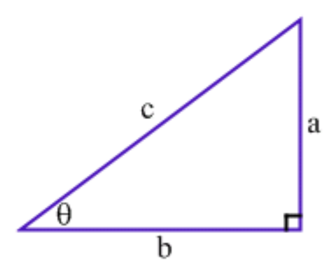
1. Round off only at the end of a calculation when you state the final answer.

2. When you multiply or divide, round your final answer to the smallest number of significant figures in the values going into the calculation.

3. When adding or subtracting, round your final answer to the smallest number of decimal places in the values going into the calculation.

Trigonometry

In a right-angled triangle we use the following relationships:



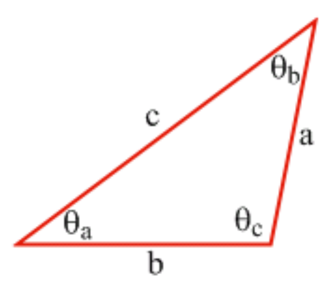
$$\sin\theta = \frac{opposite}{hypotenuse} = \frac{a}{c}; \qquad \cos\theta = \frac{adjacent}{hypotenuse} = \frac{b}{c}; \qquad \tan\theta = \frac{opposite}{adjacent} = \frac{a}{b}.$$

We relate the three sides using: $c^2 = a^2 + b^2$. (Eq. 1.1: **The Pythagorean Theorem**)

Many triangles do not have a 90˚ angle. For a general triangle, such as that in Figure 1.3, if we know the length of two sides and one angle, or the length of one side and two angles, we can use the Sine Law and the Cosine Law to find the other sides and angles.

$$\frac{\sin\theta_a}{a} = \frac{\sin\theta_b}{b} = \frac{\sin\theta_c}{c}.$$ (Equation 1.2: **Sine Law**)

$$c^2 = a^2 + b^2 - 2ab\cos\theta_c.$$ (Equation 1.3: **Cosine Law**)



Vectors

A vector is a quantity with both a magnitude and a direction. Vectors can be added geometrically (drawn tip-to-tail), or by using components.

A unit vector is a vector with a length of one unit. A unit vector is denoted by having a carat on top, which looks like a hat, like $\hat{x}$ (pronounced "x hat").

A vector can be stated in unit-vector notation or in magnitude-direction notation.

A Method for Adding Vectors Using Components

1. Draw a diagram of the situation, placing the vectors tip-to-tail to show how they add geometrically.
2. Show the coordinate system on the diagram, in particular showing the positive direction(s).
3. Make a table showing the x and y components of each vector you are adding together.
4. In the last line of this table, find the components of the resultant vector by adding up the components of the individual vectors.

Algebra and Dimensional Analysis

Dimensional analysis can help check the validity of an equation. Units must be the same for values that are added or subtracted, as well as the same on both sides of an equation.

A quadratic equation in the form $ax^2 + bx + c = 0$ can be solved by using the quadratic formula:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$

(Equation 1.4: **The quadratic formula**)