can be considered as two forces acting at right angles to each other. Thus, the relation between resistance, reactance, and impedance may be illustrated by a right triangle. *[Figure 9-24]* Since these quantities may be related to the sides of a right triangle, the formula for finding the impedance can be found using the Pythagorean Theorem. It states that the square of the hypotenuse is equal to the sum of the squares of the other two sides. Thus, the value of any side of a right triangle can be found if the other two sides are known.

In practical terms, if a series AC circuit contains resistance and inductance, as shown in *Figure 9-25*, the relation between the sides can be stated as:

$$Z^2 = R^2 + (X_L - X_C)^2$$

The square root of both sides of the equation gives:

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

This formula can be used to determine the impedance when the values of inductive reactance and resistance are known. It can be modified to solve for impedance in circuits containing capacitive reactance and resistance by substituting X_C in the formula in place of X_L. In circuits containing resistance with both inductive and capacitive reactance, the reactances can be combined; but because their effects in the circuit are exactly opposite, they are combined by subtraction (the smaller number is always subtracted from the larger):

$$Z = X_L - X_C$$

or

$$X = X_C - X_L$$

Figure 9-25 shows example 1. Here, a series circuit containing a resistor and an inductor are connected to a source of 110 volts at 60 cycles per second. The resistive element is a simple measuring 6 ohms, and the inductive element is a

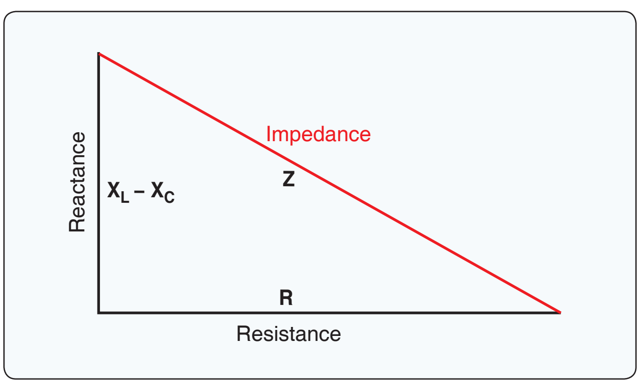

Figure 9-24. *Impedance triangle.*

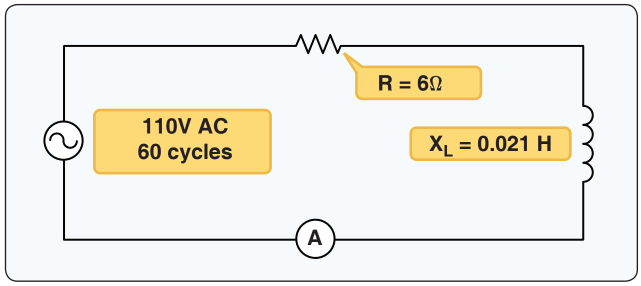

Figure 9-25. *A circuit containing resistance and inductance.*

coil with an inductance of 0.021 henry. What is the value of the impedance and the current through the circuit?

Solution:
First, the inductive reactance of the coil is computed:

$$X_L = 2\pi \times f \times L$$

$$X_L = 6.28 \times 60 \times 0.021$$

$$X_L = 8 \text{ ohms inductive reactance}$$

Next, the total impedance is computed:

$$Z = \sqrt{R^2 + X_L^2}$$

$$Z = \sqrt{6^2 + 8^2}$$

$$Z = \sqrt{36 + 64}$$

$$Z = \sqrt{100}$$

$$Z = 10\Omega$$

Remember when making calculations for Z always use inductive reactance not inductance, and use capacitive reactance, not capacitance.

Once impedance is found, the total current can be calculated.

$$I = \frac{E}{Z}$$

$$I = \frac{110V}{10\Omega}$$

$$I = 11 \text{ amps}$$

Since this circuit is resistive and inductive, there is a phase shift where voltage leads current.