DETERMINING RESULTANT MAGNITUDE AND DIRECTION

In Section 1, the magnitude and direction of a resultant were found graphically. However, this approach is time consuming, and the accuracy of the answer depends on how carefully the diagram is drawn and measured. A simpler method uses the Pythagorean theorem and the tangent function.

Use the Pythagorean theorem to find the magnitude of the resultant

Imagine a tourist climbing a pyramid in Egypt. The tourist knows the height and width of the pyramid and would like to know the distance covered in a climb from the bottom to the top of the pyramid. Assume that the tourist climbs directly up the middle of one face.

As can be seen in **Figure 7,** the magnitude of the tourist's vertical displacement, Δy, is the height of the pyramid. The magnitude of the horizontal displacement, Δx, equals the distance from one edge of the pyramid to the middle, or half the pyramid's width. Notice that these two vectors are perpendicular and form a right triangle with the displacement, **d.**
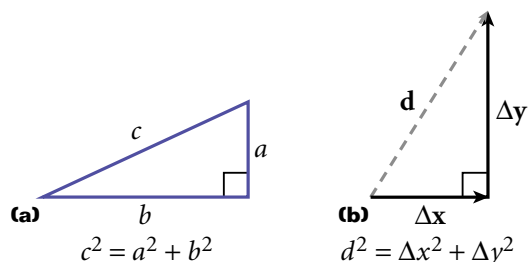
As shown in **Figure 8(a),** the Pythagorean theorem states that for any right triangle, the square of the hypotenuse—the side opposite the right angle—equals the sum of the squares of the other two sides, or legs.

Figure 7
Because the base and height of a pyramid are perpendicular, we can find a tourist's total displacement, **d,** if we know the height, Δy, and width, $2\Delta x$, of the pyramid.

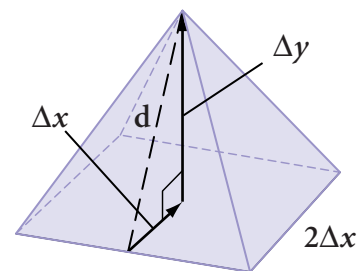
PYTHAGOREAN THEOREM FOR RIGHT TRIANGLES

$$c^2 = a^2 + b^2$$

(length of hypotenuse)^2 = (length of one leg)^2 + (length of other leg)^2

In **Figure 8(b),** the Pythagorean theorem is applied to find the tourist's displacement. The square of the displacement is equal to the sum of the square of the horizontal displacement and the square of the vertical displacement. In this way, you can find out the magnitude of the displacement, *d.*

Figure 8
(a) The Pythagorean theorem can be applied to any right triangle. **(b)** It can also be applied to find the magnitude of a resultant displacement.

(a) $c^2 = a^2 + b^2$

(b) $d^2 = \Delta x^2 + \Delta y^2$