**Conceptual Questions:**

1. Are two vectors with the same magnitude necessarily equal?
2. Can two zero perpendicular vectors be added together so their sum is zero?
3. Can three or more vectors with unequal magnitudes be added together so their sum is zero? If so, show by means of a tail-to-head arrangement of the vectors how could this occur?
4. The magnitude of a vector has doubled, its direction remaining the same. Can you conclude that the magnitude of each component of the vector has doubled?

**Problems**

***(Trigonometry)***

1. You are driving into St. Louis, Missouri, and in the distance you see the famous Gateway-to-the-West arch. This monument rises to a height of 192 meters. You estimate your line of sight with the top of the arch to be 2.0o above the horizontal. Approximately how far (in kilometers) are you from the base of the arch?
2. A highway is to be built between towns, one which lies 35.0 km south and 72.0 km west of the other. What is the shortest length of highway that can be built between the two towns, and at what angle would this highway be directed with respect to due west?
3. A person is standing at the edge of the water and looking out at the ocean. The height of the person’s eyes above the water is *h* = 1.6 m, and the radius of the earth is *R* = 6.38 x 106 m. In other words, what is the distance *d* from the person’s eyes to the horizon? (*Note: At the horizon the angle between the line of sight and the radius of the earth is 90o*).

***(Vector Addition and Subtraction)***

1. A circus performer begins his act by walking out along a nearly horizontal high wire. He slips and falls to the safety net, 25.0 ft below. The magnitude of this displacement from the beginning of the walk to the net is 26.7 ft. (a) How far out along the high wire did he walk? (b) Find the angle that his displacement vector makes below the horizontal.
2. Your friend has slipped and fallen. To help her up, you pull with a force **F→**. The vertical component of this force is 130 newtons, and the horizontal component is 150 newtons. Find (a) the magnitude of **F→** and (b) the angle$θ$.

(***Addition of vectors by Means of Components***)

1. A golfer, putting on a green, requires three strokes to “hole the ball.” During the first putt, the ball rolls 5.0 due east. For the second putt, the ball travels 2.1 m at the angle of 2.0o north of east. The third putt is 0.50 m due north. What displacement (magnitude and direction relative to due east) would have been needed to “hole the ball” on the very first putt?
2. Three forces are applied to an object, as indicated in the drawing. Force **F1→** has a magnitude of 21.0 newtons (N) and is directed by 30.0o to the left of **+***y* axis. Force **F2→** has a magnitude of 15.0 N and points along **+***x* axis. What must be the magnitude and direction of the third force **F3→** such that the vector sum of three forces is 0 N?