

1. Find all possible two-dimensional vectors of length 8 that make an angle of  $30^\circ$  with the negative  $x$ -axis.
2. Find three two-dimensional unit vectors that make equal angles with each other.
3. Find all possible three-dimensional unit vectors that make angles of  $30^\circ$  with the positive  $x$ -axis and  $80^\circ$  with the positive  $y$ -axis. Find the angles that these vectors make with the positive  $z$ -axis.
4. Take the earth to be a sphere of radius one unit and establish a right-handed coordinate system with the origin at the center of the earth, the positive  $x$ -axis passing through the intersection of the equator and the prime meridian, and the positive  $z$ -axis passing through the north pole. Let  $P$  be the point on the earth with latitude  $\phi$  and longitude  $\theta$ . Take  $0 < \phi \leq \pi/2$  to correspond to the northern hemisphere and  $0 < \theta < \pi$  to correspond to the eastern hemisphere.
  - a. Find the components of a unit vector from the origin to  $P$ .
  - b. Find the components of a unit vector that is perpendicular to the earth at  $P$ .
  - c. Find the components of a unit vector pointing due east at the point  $P$ .
  - d. Find the components of a unit vector pointing due north at the point  $P$ .
  - e. Find the components of a unit vector pointing due northeast at the point  $P$ .
  - f. Find the components of a unit vector pointing  $\rho$  radians east of due north at the point  $P$ .
- 5a. Under what geometric condition on the vectors  $\mathbf{v}$  and  $\mathbf{w}$  does  $|\mathbf{v} + \mathbf{w}| = |\mathbf{v}| + |\mathbf{w}|$ ?
- b. Under what geometric condition on the vectors  $\mathbf{v}$  and  $\mathbf{w}$  does  $|\mathbf{v} + \mathbf{w}| = |\mathbf{v} - \mathbf{w}|$ ?