

1. 10 pts. If $p = (-4, 1)$ and $q = (3, -5)$, find two vectors parallel to $\vec{pq}$ with length 10.
2. 10 pts. Three forces with magnitudes of 400 newtons, 280 newtons, and 350 newtons act on an object at angles of -30° , 45° , and -135° with the positive x -axis, respectively. Find the magnitude and direction of the resultant force $\mathbf{F}$.
3. 10 pts. A remote sensing probe falls vertically with a terminal velocity of 60 m/s when it encounters a horizontal crosswind blowing north at 6 m/s and an updraft blowing vertically at 10 m/s. Find the magnitude and direction of the resulting velocity $\mathbf{v}$ relative to the ground.
4. 10 pts. Find the equation of the sphere passing through points $p = (1, 0, 5)$ and $q = (2, 3, 9)$, with center at the midpoint of the segment $\overline{pq}$.
5. 10 pts. each Let $\mathbf{u} = \langle 2, -1, 9 \rangle$ and $\mathbf{v} = \langle -2, 4, 3 \rangle$.
 - (a) Find the angle between $\mathbf{u}$ and $\mathbf{v}$ to the nearest tenth of a degree.
 - (b) Find $\text{proj}_{\mathbf{v}} \mathbf{u}$, the orthogonal projection of $\mathbf{u}$ onto $\mathbf{v}$.
6. 10 pts. Find the components of the vertical force $\mathbf{F} = \langle 0, -12 \rangle$ in the directions parallel to and normal to the plane that makes an angle of $\pi/6$ with the positive x -axis.
7. 10 pts. Find the area of the parallelogram that has two adjacent sides given by $\mathbf{u} = \langle -3, 0, 2 \rangle$ and $\mathbf{v} = \langle 1, 1, 1 \rangle$.
8. 10 pts. Find a parametrization for the line through the point $(-3, 4, 2)$ that is perpendicular to both $\mathbf{u} = \langle 1, 1, -5 \rangle$ and $\mathbf{v} = \langle 0, 4, 0 \rangle$.
9. 10 pts. Find a parametrization for the tangent line to the curve
$$\mathbf{r}(t) = \langle 3t - 1, 7t + 2, t^2 \rangle$$
at the point corresponding to $t = 1$, making sure the orientation of the line is the same as the direction of the tangent vector at that point.
10. 10 pts. Find the length of the curve
$$\mathbf{r}(t) = \langle \cos t + \sin t, \cos t - \sin t \rangle, \quad t \in [0, 2\pi].$$
11. 10 pts. Find the curvature of the curve
$$\mathbf{r}(t) = \langle \sqrt{3} \sin t, \sin t, 2 \cos t \rangle.$$