1. Consider the vector $\overrightarrow{\mathbf{u}}=\langle 4,1,-2\rangle$.
(a) Give three different vectors that are parallel to $\overrightarrow{\mathbf{u}}$.
(b) Give two different vectors that are perpendicular to $\overrightarrow{\mathbf{u}}$ and not parallel to each other.
(c) Give the vector that is five times as long as $\overrightarrow{\mathbf{u}}$ and in the direction opposite $\overrightarrow{\mathbf{u}}$.
(d) Give the vector of magnitude five in the direction of $\overrightarrow{\mathbf{u}}$. Glve your answer in exact form!
2. For $\overrightarrow{\mathbf{u}}$ and $\overrightarrow{\mathbf{v}}$ shown to the right, draw two diagrams showing how to get the vector $\overrightarrow{\mathbf{w}}=\overrightarrow{\mathbf{u}}+\overrightarrow{\mathbf{v}}$ by the parallelogram method and the tip-to-tail method. Label $\overrightarrow{\mathbf{w}}$ clearly, and label each diagram as either parallelogram or tip-to-tail.
3. (a) For $\overrightarrow{\mathbf{u}}$ and $\overrightarrow{\mathbf{v}}$ shown to the right, indicate clearly the two vectors $\operatorname{proj}_{\overrightarrow{\mathbf{u}}} \overrightarrow{\mathbf{v}}$ and $\operatorname{perp}_{\overrightarrow{\mathbf{u}}} \overrightarrow{\mathbf{v}}$.
(b) How do $\operatorname{proj}_{\overrightarrow{\mathbf{u}}} \overrightarrow{\mathbf{v}}$ and $\operatorname{perp}_{\overrightarrow{\mathbf{u}}} \overrightarrow{\mathbf{v}}$ relate to each other, geometrically? Answer with a brief written statement.
(c) How do $\operatorname{proj}_{\overrightarrow{\mathbf{u}}} \overrightarrow{\mathbf{v}}$ and $\operatorname{perp}_{\overrightarrow{\mathbf{u}}} \overrightarrow{\mathbf{v}}$ relate to $\overrightarrow{\mathbf{v}}$, algebraically?

## Answer with a brief mathematical statement.


4. Let $\overrightarrow{\mathbf{u}}=\langle 1,-3,2\rangle$ and $\overrightarrow{\mathbf{v}}=\langle 2,2,-1\rangle$. Write $\overrightarrow{\mathbf{u}}$ as the sum of two vectors, one of which is parallel to $\overrightarrow{\mathbf{v}}$ and the other of which is perpendicular to $\overrightarrow{\mathbf{v}}$.
5. Give the terminal point $Q$ of the vector $\overrightarrow{P Q}=\langle-2,1,3\rangle$ with initial point $P(-5,4,1)$.
6. Consider the line with vector equation $\overrightarrow{\mathbf{x}}=\langle 3,4,-2\rangle+t\langle 4,-2,-6\rangle$.
(a) Is the point $(-11,11,19)$ on the line? How do you know?
(b) Is the point $(5,3,-4)$ on the line? How do you know?
(c) Which of the following ARE NOT vector equations for the given line?

- $\overrightarrow{\mathbf{x}}=\langle 3,4,-2\rangle+t\langle 2,1,3\rangle$
- $\overrightarrow{\mathbf{x}}=\langle 7,2,-8\rangle+t\langle 4,-2,-6\rangle$
- $\stackrel{\rightharpoonup}{\mathbf{x}}=\langle 3,4,-2\rangle+t\langle-2,1,3\rangle$
- $\overrightarrow{\mathbf{x}}=\langle 4,-2,-6\rangle+t\langle 2,-1,-3\rangle$
(d) Give a vector equation of the line that contains $(-4,2,3)$ and is parallel to the given line.
(e) Give a vector equation of the line that contains $(1,7,2)$ and is perpendicular to the given line.

7. A plane has equation $2 x+y-z=4$.
(a) Give three points on the plane.
(b) Give the equation of the line containing $(1,2,3)$ and perpendicular to the given plane.
(c) Give the equation of the plane containing $(4,-1,-3)$ and perpendicular to the given plane.
(d) Determine the point where the line with parametric equations $x=-1+2 t, \quad y=4+t, \quad z=$ $1-t$ intersects the given plane.
8. Determine the equation(s) of the line in $\mathbb{R}^{3}$ containing the points $P(1,5,-2)$ and $Q(3,3,2)$.
9. Determine the equation(s) of the plane in $\mathbb{R}^{3}$ containing the points $P(1,0,-2), Q(5,4,1)$ and $R(2,2,3)$.
10. A particle traveling in $\mathbb{R}^{2}$, with its position at any time $t$ minutes given by

$$
x=t^{2}-3, \quad y=t+1, \quad \text { where } x \text { and } y \text { are in feet. }
$$

Give each of the following, labeling with correct notation and units.
(a) The velocity at time $t=3$.
(b) The acceleration at time $t=3$.
(c) The speed at time $t=3$.
(d) The displacement from time $t=1$ to $t=3$.
(e) The average velocity from time $t=1$ to $t=3$.
11. Determine the rectangular equation of motion for each set of parametric equations, showing clearly how you do it.
(a) $x=t^{2}-3, y=t+1$
(b) $x=2 \sin \pi t, y=5 \cos \pi t$

Use the sets of two parametric equations given in Exercises 1 through 6 of Assignment 2 to answer the following.
12. (a) Give two of the exercises for which the path is the same, as indicated by the rectangular equation. (There are two answers to this question - choose the ones with the smaller exercise numbers.)
(b) How are the velocities the same, and how are they different, for the two cases?
(c) Is the velocity constant for either, or both, of the cases? How about the speed?
(d) Is the acceleration constant for either, or both, of the cases?
13. (a) Give the other two exercises for which the path is the same, as indicated by the rectangular equation.
(b) Compare how the particle travels in the two cases, in terms of speed and direction on the path.
(c) Is the velocity constant for either, or both, of the cases? How about the speed?
(d) Is the acceleration constant for either, or both, of the cases?
(e) For each of the two cases, compare the position vector and the acceleration vector. How are they related?
14. Consider the first of the two cases that you have not yet worked with. Are any of the velocity, speed and/or acceleration constant?
15. Consider the first of the two cases that you have not yet worked with.
(a) Are any of the velocity, speed and/or acceleration constant?
(b) Compare the position vector and the acceleration vector. How are they related?

