1. Find the center and radius of the sphere with the given equation.
   (a) \( x^2 + y^2 + z^2 + 4x - 6y = 0 \)
   (b) \( 3x^2 + 3y^2 + 3z^2 - 18z - 48 = 0 \)

2. Determine whether vectors \( \vec{a} \) and \( \vec{b} \) are parallel, perpendicular, or neither.
   (a) \( \vec{a} = \langle 4, -2, 6 \rangle \), \( \vec{b} = \langle 8, -3, 9 \rangle \)
   (b) \( \vec{a} = 12\vec{i} - 20\vec{j} + 16\vec{k} \), \( \vec{b} = -9\vec{i} + 15\vec{j} - 12\vec{k} \)
   (c) \( \vec{a} = \langle 4, -2, 6 \rangle \), \( \vec{b} = \langle 4, 2, 2 \rangle \)

3. Do the points \((0, -2, 4)\), \((1, -3, 5)\), \((4, -6, 8)\) lie on a single straight line?

4. Find the work \( W \) done by the force \( \vec{F} = -\vec{C} + \vec{E} \) in moving a particle in a straight line from \((0, 0, 1)\) to \((3, 1, 0)\).

5. Find two different unit vectors perpendicular (orthogonal) to both \( \vec{a} = \langle 3, 12, 0 \rangle \) and \( \vec{b} = \langle 0, 4, 3 \rangle \).

6. Is it always the case that \( (\vec{a} \times \vec{b}) \times \vec{z} = \vec{a} \times (\vec{b} \times \vec{z}) \)?
   Prove or give a counterexample.
7. Find the volume of the parallelepiped with adjacent edges \( \langle 1, 3, -2 \rangle, \langle 2, 4, 5 \rangle, \langle -3, -2, 2 \rangle. \)

8. Compute the area of the parallelogram with vertices \( (1, 2, 3), (4, -2, 1), (-3, 1, 0), (0, -3, 2) \).

9. If \( (\vec{a} \times \vec{b}) \cdot \vec{c} = 0 \), what can you say about the geometric relation between \( \vec{a} \), \( \vec{b} \), and \( \vec{c} \) ?

10. Find a parametric equation for (i.e., vector-valued function with output) the line containing \( \langle 1, 2, -1 \rangle \) and \( \langle 3, 2, 1 \rangle \).

11. Find implicit (for example, symmetric) equations for the line in Problem 10.

12. Find an equation for the plane containing the lines given by the vector-valued functions

\[ \vec{r}_1(t) = \langle 1 + 2t, t, 1 + 3t \rangle, \]
\[ \vec{r}_2(t) = \langle 1 - t, t, 1 + 4t \rangle. \]

13. What is a normal vector to the plane given by

\[ 2x - 3z = 1 \]?

14. Are the lines
given by \[ \vec{\mathbf{r}}_1(t) = \langle 2 + 2t, t, 2 + 3t \rangle, \]
\[ \vec{\mathbf{r}}_2(t) = \langle -t, 1 + t, 5 + 4t \rangle \]
parallel, skew, or neither? Justify your answer.

15. Compute the angle between the planes

\[ 3y - 5 = 0 \]
and
\[ -2x - 2y + 1 = 0. \]

16. Find a parametric equation for the line that is the intersection of the planes

\[ 2x + 3y - 5 = 0, \]
\[ x - 2 + 1 = 0. \]

17. A parametric curve is given by

\[ \vec{\mathbf{r}}(t) = \langle 3 \cos 2t, 3 \sin 2t, 8t \rangle. \]
Find its velocity, speed, and acceleration at time \( t = \frac{7\pi}{8} \).

18. Suppose a particle is moving with acceleration

\[ \vec{a}(t) = \langle t, t^2, t^3 \rangle, \]
initial position \( \vec{\mathbf{r}}(0) = \langle 10, 0, 0 \rangle \) and initial velocity \( \vec{\mathbf{v}}(0) = \langle 0, 10, 0 \rangle \). Find \( \vec{\mathbf{r}}(t) \).
19. Compute the arc length function of
\[ \vec{r}(t) = \langle 6e^t \cos t, 6e^t \sin t, 17e^t \rangle \]
for \( t \in [0, 1] \).

20. Compute the unit tangent vector of
\[ \vec{r}(t) = \langle t \cos(t), t^2, e^t \rangle \] at \( t = 0 \).
1. (a) Center \((-2, 3, 0)\), radius \(\sqrt{13}\)
   (b) Center \((10, 0, 3)\), radius 5

2. (a) Parallel
   (b) Parallel
   (c) Neither

3. Yes.

4. 4 units

5. \(\frac{1}{13} \langle 12, -3, 4 \rangle\) and \(-\frac{1}{13} \langle 12, -3, 4 \rangle\).

6. \(\vec{a} = \langle 1, 0, 0 \rangle\), \(\vec{b} = \langle 1, 1, 0 \rangle\), \(\vec{c} = \langle 1, 1, 1 \rangle\).

7. \(55\)

8. \(5 \sqrt{30}\)

9. Either \(\vec{a}\) is parallel to \(\vec{b}\) or \(\vec{c}\) is parallel to the plane containing \(\vec{a}\) and \(\vec{b}\).

10. \(\vec{v}(t) = \langle 3 + 2t, 2, 1 + 2t \rangle\)

11. \(y = 2, \ x - 2 = 2\).

12. \(x - 11y + 3z = 4\)

13. \(\vec{n} = \langle 2, 0, -3 \rangle\).
14. skew

15. \( \frac{\pi}{4} \)

16. \( \mathbf{r}(t) = \langle 1 - 3t, 1 + 2t, 2 - 3t \rangle \).

17. \( \sqrt[5]{\left( \frac{7\pi}{8} \right)} = \langle 8\sqrt[5]{2}, 3\sqrt[5]{2}, 8 \rangle \),
   \( \sqrt[6]{\left( \frac{7\pi}{8} \right)} = 10 \),
   \(-\sqrt[2]{\left( \frac{7\pi}{8} \right)} = \langle -6\sqrt{2}, 6\sqrt{2}, 0 \rangle \).

18. \( \mathbf{r}'(t) = \langle \frac{1}{5}t^5 + 10, \frac{1}{12}t^9 + 10t, \frac{1}{20}t^5 \rangle \).

19. \( s(t) = \frac{361}{2} \left( e^{2t} - 1 \right) \).

20. \( \langle \frac{1}{\sqrt{2}}, 0, \frac{1}{\sqrt{2}} \rangle \).