Please answer the following questions. **Answers without justifying work will receive no credit.** Partial credit will be given as appropriate, do not leave any problem blank.

1. (6 points each) Consider the vector-valued function, 
\[ \mathbf{r}(t) = e^{t^2}, \sqrt{t+2}, \frac{-\sin t}{t} \].

(a) Find \( \mathbf{r}'(t) \).

(b) Find \( \lim_{t \to 0} \mathbf{r}(t) \).

(c) Is \( \mathbf{r}(t) \) continuous at \( t = 0 \)? You must explain your answer.
2. (5 points each) Consider the point with coordinates \((-4, 1, 2)\) and the vector \(\langle 2, 3, 4 \rangle\).

(a) Find the equation of the plane passing through the point and perpendicular to the vector.

(b) Find the equation of the line passing through the point in the direction of the vector.

3. (7 points) Consider the vector \(\mathbf{a} = 3\mathbf{i} + 4\mathbf{j} - \mathbf{k}\).

Find two vectors parallel to \(\mathbf{a}\) that have length 3.
4. (12 points) Find the arc length of the curve $\mathbf{r}(t) = \langle 2t^{3/2}, \cos 2t, \sin 2t \rangle$ for $0 \leq t \leq 1$. 
5. (3 points each) In the following problems use the vectors $\mathbf{a} = \langle 1, 2, 0 \rangle$, $\mathbf{b} = \langle 1, 3, 1 \rangle$, $\mathbf{c} = \langle 0, 1, 0 \rangle$, and $\mathbf{d} = \langle 3, -2, 2 \rangle$. Find the following results or explain why the requested operation is impossible.

(a) $\mathbf{a} \times (\mathbf{b} + \mathbf{c})$

(b) $(\mathbf{a} \cdot \mathbf{d}) \times \mathbf{b}$

(c) $(\mathbf{c} \times \mathbf{d}) \cdot \mathbf{d}$

(d) $\frac{\mathbf{a} \times \mathbf{c}}{\mathbf{b} \cdot \mathbf{d}}$
6. (10 points) Find the angle (expressed to the nearest degree) between the following vectors.

\[ a = 2i - 3j + k \text{ and } b = 4i + 5j - 3k \]
7. (2 points each) Determine whether each of the following statements is always true or sometimes false.

(a) For any vectors \( \mathbf{u} \) and \( \mathbf{v} \), \( \mathbf{u} \cdot \mathbf{v} = \mathbf{v} \cdot \mathbf{u} \).

(b) For any vectors \( \mathbf{u} \) and \( \mathbf{v} \), \( \mathbf{u} \times \mathbf{v} = \mathbf{v} \times \mathbf{u} \).

(c) For any vectors \( \mathbf{u} \) and \( \mathbf{v} \), \( (\mathbf{u} \times \mathbf{v}) \cdot \mathbf{u} = 0 \).

(d) For any vectors \( \mathbf{u} \) and \( \mathbf{v} \), and any scalar \( c \), \( c(\mathbf{u} \cdot \mathbf{v}) = (c\mathbf{u}) \cdot \mathbf{v} \).

(e) A linear equation \( Ax + By + Cz + D = 0 \) represents a line in space.

(f) The derivative of a vector function is obtained by differentiating each component function.

8. (2 points each) Identify by name the type of surface represented by the equations below.

(a) \( x^2 + y + z^2 = 1 \)

(b) \( x^2 - 4y^2 + z^2 = 4 \)

(c) \( x^2 - y^2 - z = 0 \)
9. (5 points) Three children are pulling on ropes tied together at a common point as in the figure below. The first child pulls in the direction of the positive \(x\)-axis with a force of 20 lbs. The second child pulls in the direction of the positive \(y\)-axis with a force of 15 lbs. If the point where the ropes are tied together does not move, in what direction and with what force must the third child be pulling?
10. (5 points) Show that the points with coordinates (2, 2, 2), (2, 0, 1), and (4, 1, −1) are the vertices of a right triangle.