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1. Parts (a) and (b) are separate problems with no relation.

   (a) (6 points) Determine if the following vectors are coplanar.

   $$\mathbf{a} = 2\mathbf{j} - 3\mathbf{k}$$
   $$\mathbf{b} = -3\mathbf{i} - 2\mathbf{j} + \mathbf{k}$$
   $$\mathbf{c} = \mathbf{i} - \mathbf{k}$$

   (b) (8 points) A force of $\mathbf{F} = \langle 2, -2, 1\rangle$ is used to move a mass from $(1, -1, 2)$ to $(2, -1, 3)$. Assume the components of $\mathbf{F}$ are measured in Newtons, and that the units of the components of the points is meters. Find the work done in moving this mass. (Include the correct units in your final answer.)

2. Consider the following two planes and line:

   - First Plane: $6x - 5y + z = 3$
   - Second Plane: $2x + y - 2z = 1$
   - Line: $\mathbf{r}(t) = \langle 1, 2, 0\rangle + t\langle 6, -5, 1\rangle$.

   (a) (8 points) Find the equation of the plane that contains the given **line** and the point $(0, 0, 1)$. Your final answer should be in the form $ax + by + cz = d$.

   (b) (8 points) Determine the angle between the **plane you found in (a)** and the **First Plane**.

   (c) (8 points) Find the parametric equations of the line of intersection of the **First Plane** and the **Second Plane**.

3. In this problem, we consider two quadric surfaces. The two quadric surfaces are not related.

   (a) (10 points) Consider the quadric surface with points $P(x, y, z)$, for which the distance from P to the closest point on the z-axis is twice the distance from P to the closest point on the xy-plane

      i. Determine the standard equation of the surface.
      ii. Identity the type of surface.

   (b) (16 points) Consider the quadric surface given by

   $$x^2 - 2y^2 - 4z^2 - 4x + 24z - 36 = 0.$$

      i. Determine the standard equation of the surface.
      ii. Identity the type of surface.
      iii. Determine the point(s) on the surface that intersects the line

   $$\mathbf{r}(t) = \langle 10t + 2, 4\sqrt{2}t, 3t\rangle.$$

4. There are two particles moving through space whose positions after t seconds are given by the following, where each component is measured in meters:

   - First Particle: $\mathbf{r}_1(t) = t\mathbf{i} + (1 - t)\mathbf{j} + (t - t^2)\mathbf{k}$
   - Second Particle: $\mathbf{r}_2(t) = t\mathbf{i} + t\mathbf{j} + \sqrt{2}t^{3/2}\mathbf{k}$

(a) (9 points) Determine the rate of change of speed for the **First Particle** at time $t = 2$. (Include the correct units in your final answer.)

(b) (9 points) Determine the curvature of the **First Particle** at the point $(1, 0, 0)$. (Include the correct units in your final answer.)

(c) (9 points) How far does the **Second Particle** travel along its trajectory from $t = 0$ seconds to $t = \dfrac{4}{9}$ seconds? (Include the correct units in your final answer.)

(d) (9 points) Do the two particles collide? If so, at what time **and** at what point?