Directions: Show ALL work for credit; Give EXACT answers when possible; Start each problem on a SEPARATE page; Use only ONE side of each page; Be neat; Leave margins on the left and top for the STAPLE; Calculators can be used for graphing and calculating only; Nothing written on this page will be graded;

1. Let $P(1,0,2)$, $Q(1,4,0)$ and $R(0,2,2)$. Find the equation of the plane through the points $P$, $Q$ and $R$ and the area of the parallelogram with sides $PQ$ and $PR$.

2. Determine whether the lines $L_1$ and $L_2$ are parallel, skew or intersecting. If they intersect find the point of intersection.

$L_1: x = 2 - 2t, y = 4t, z = 2$

$L_2: x = -1 + 3s, y = 3s, z = -2 + 6s$

3. A woman walks due southeast on the deck of a huge airship at 2 km/h. The ship’s horizontal motion is northeast at a speed of 4 km/h and its vertical motion is climbing at a rate of 2 km/h. Find the velocity vector of the woman relative to the ground. Find her speed and a unit vector in the direction of the velocity. (The $x$-axis points East, the $y$-axis points North, and the $z$-axis points up.)

4. Using vector operations write $\vec{a} = \langle -1, 3, 1 \rangle$ as the sum of two vectors $\vec{w} + \vec{v}$, where $\vec{w}$ is parallel to $\vec{b}$ and $\vec{v}$ is perpendicular to $\vec{b}$, when $\vec{b} = (2, -1, 0)$.

5. True or False and a brief reason why or why not.

(a) The equation $x^2 + 2x + y^2 + z^2 = 3$ is an equation of a sphere with radius 2.

(b) The vectors $(1, -2, 3)$ and $(-2, 4, -6)$ are parallel.

(c) The equation $x^2 - y^2 - z^2 = -1$ is a hyperboloid of two sheets.

(d) The equation $x^2 + y^2 - z^2 = 0$ is a hyperboloid of one sheet.

(e) $(1, 0, 3)$ is normal to the plane $z = 3 - x/3$.

(f) $\vec{i} \times \vec{k} = \vec{j}$

(g) $\langle \sqrt{3}, 1 \rangle$ makes an angle of $\pi/6$ with respect to the $x$-axis.

(h) The ellipsoid $x^2 + 4y^2 + 9z^2 = 1$ intersects the $z$-axis at the points $(0, 0, \pm 3)$.

(i) $\vec{i} + \vec{k} = (1, 1)$

(j) Two distinct lines are either parallel or they intersect.