**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 $P(-2, 2, 0)$, $Q(1, 3, -1)$ and $R(-4, 2, 1)$. Find the equation of the plane S throught the points P, Q and R and the area of the triangle $\triangle PQR$.

2. Find the center and radius of the sphere S given by the equation $x^2 + y^2 + z^2 - 4x + 6y - 2z = 2$. The graph of S intersects the xz-plane in a circle, what is its equation, its center and its radius.

3. A particle moving with speed S hits a barrier at an angle of $\pi/3$ and bounces off at at an angle of $\pi/3$ in the opposite direction with the speed reduced by 20 percent. (See the figure below). Find the velocity vectors of the object both before and after impact.
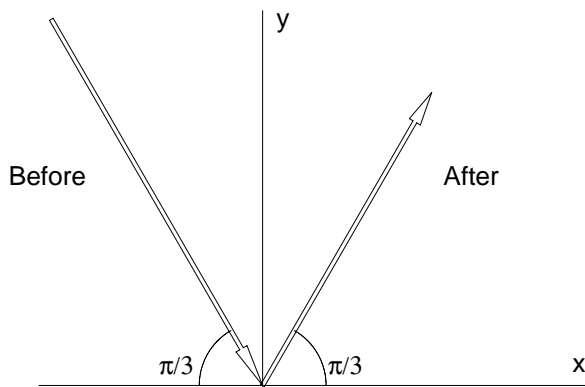
4. Using vector operations write $\vec{a} = \langle -3, 2, 5 \rangle$ as the sum of two vectors $\vec{w} + \vec{v}$, where $\vec{w}$ is parallel to $\vec{b}$ and $\vec{v}$ is perpendicular to $\vec{b}$, when $\vec{b} = \langle -1, 0, 2 \rangle$.

5. Find parametric equations of the line of intersection of the two planes $x - y - z = 1$ and $11x + 5y - 5z = 20$.