

1. 4 Please indicate **True** or **False**. Assume the vectors \mathbf{u} and \mathbf{v} are non-zero.

(a) T $\mathbf{F} : \mathbf{u} \times \mathbf{u} = \mathbf{0}$

(b) T $\mathbf{F} : \|\mathbf{u}_{\parallel\mathbf{v}} + \mathbf{u}_{\perp\mathbf{v}}\| = \|\mathbf{u}\|$ $\vec{u}_{\parallel\vec{v}} + \vec{u}_{\perp\vec{v}} = \vec{u}$

(c) T / F: The plane $2x + y - 3z = 0$ passes through the point $(2, 1, -3)$. The normal vector

(d) T $\mathbf{F} : \mathbf{k} \times (-\mathbf{j}) = \mathbf{i}$ use the Right Hand Rule is $\langle 2, 1, -3 \rangle$

2. 4 Find the decomposition of $\mathbf{u} = \langle 4, -7, 1 \rangle$ along $\mathbf{v} = \langle 2, 3, -1 \rangle$, i.e. find $\mathbf{u}_{\parallel\mathbf{v}}$ and $\mathbf{u}_{\perp\mathbf{v}}$.

$$\vec{u}_{\parallel\vec{v}} = \frac{\vec{u} \cdot \vec{v}}{\vec{v} \cdot \vec{v}} \vec{v} = \frac{8 - 21 - 1}{4 + 9 + 1} \vec{v} = \frac{-14}{14} \langle 2, 3, -1 \rangle = \langle -2, -3, 1 \rangle$$

$$\vec{u}_{\perp\vec{v}} = \vec{u} - \vec{u}_{\parallel\vec{v}} = \langle 6, -4, 0 \rangle$$

3. 6 Find an equation of the plane containing the points $P = (1, 2, 3)$, $Q = (2, 0, 1)$, and $R = (3, 2, 1)$.

$$\vec{PQ} = \langle 1, -2, -2 \rangle$$

$$\vec{PR} = \langle 2, 0, -2 \rangle$$

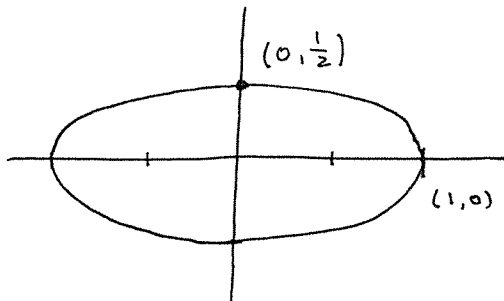
$$\vec{PQ} \times \vec{PR} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 1 & -2 & -2 \\ 2 & 0 & -2 \end{vmatrix} = \langle 4, -2, 4 \rangle$$

so $\vec{n} = \langle 2, -1, 2 \rangle$ is a normal vector

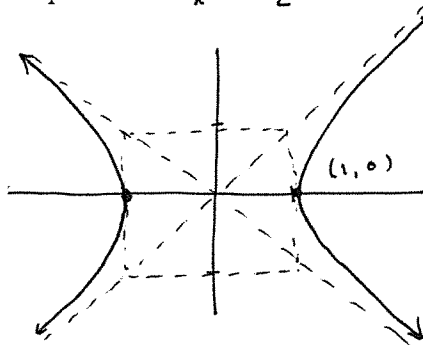
$$2(x-1) - (y-2) + 2(z-3) = 0 \quad \text{is the plane}$$

4. [4] Provide a reasonably clear sketch of the following traces for the quadric surface $x^2 + 4y^2 = z^2 + 1$ in the specified planes.

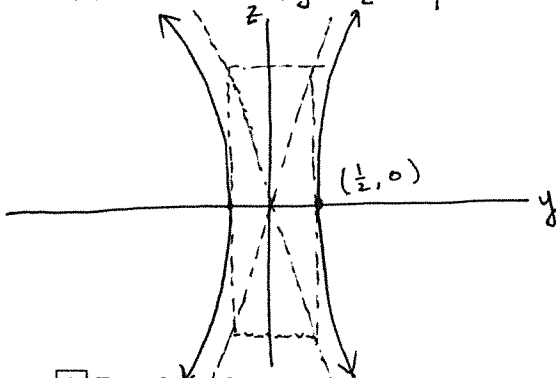
(a) xy -plane $x^2 + 4y^2 = 1$



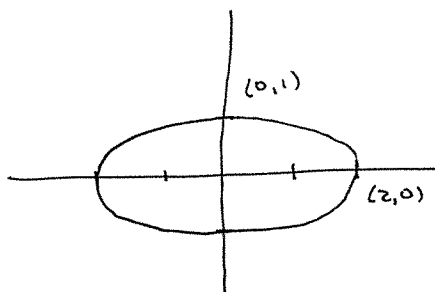
(c) xz -plane $x^2 - z^2 = 1$



(b) yz -plane $4y^2 - z^2 = 1$



(d) $z = \sqrt{3}$ $x^2 + 4y^2 = 4$ or $(\frac{x}{2})^2 + y^2 = 1$



5. [2] Based on the traces you found above, identify the graph of $x^2 + 4y^2 = z^2 + 1$ from the choices below by circling the Figure number.

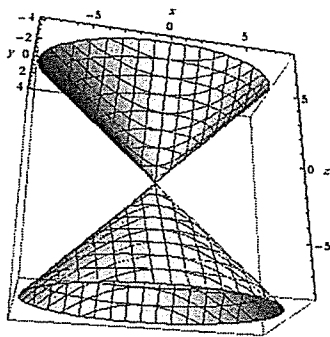


Figure 1:

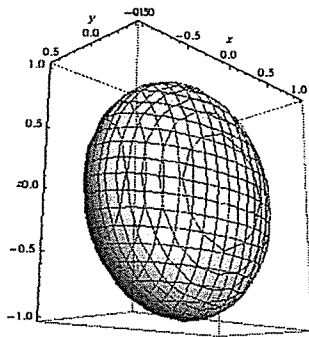


Figure 2:

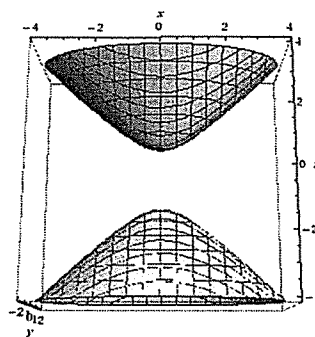


Figure 3:

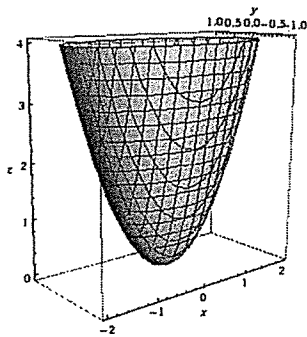


Figure 4:

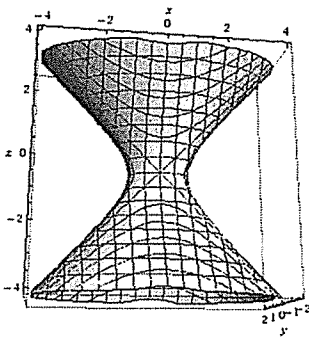


Figure 5:

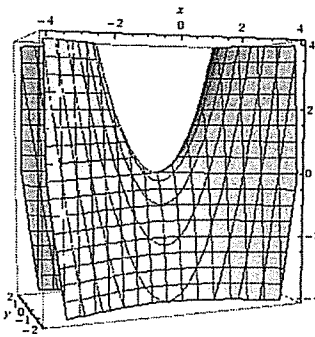


Figure 6: