1. Consider the vectors: $\mathbf{a} = \langle 1, 0, -1\rangle$ $\mathbf{b} = \langle 1, 1, 1\rangle$ $\mathbf{c} = \langle -1, 1, 0\rangle$.

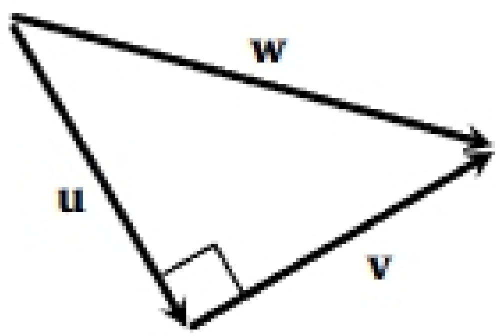
(a) Compute $\mathbf{a} \times \mathbf{b}$. **(3 points)**

$\mathbf{a} \times \mathbf{b} = \langle \quad , \quad , \quad \rangle$

(b) Compute the volume of the parallelepiped determined by the vectors **a**, **b**, and **c**. **(2 points)**

Volume =

2. Given that **u** and **v** in the picture at left have length 1, compute $\mathbf{u} \cdot \mathbf{v}$, $\mathbf{u} \cdot \mathbf{w}$, and $\text{proj}_{\mathbf{v}}\mathbf{w}$. **(1 point each)**



$\mathbf{u} \cdot \mathbf{v} =$ | $\mathbf{u} \cdot \mathbf{w} =$ | $\text{proj}_{\mathbf{v}}\mathbf{w} =$

3. A particle moves with constant velocity $\langle 3, 1, -1\rangle$ starting from the point $(3, 2, 4)$ at time $t = 0$. When and where will it cross the xy-plane? **(3 points)**

When: $t =$ | Where: $(\quad , \quad , \quad)$

4. Let A be the plane given by $x - z = 1$ and B the plane given by $x + y + z = 2$.

(a) Find a normal vector **n** for the plane A. **(1 points)**

$\mathbf{n} = \langle \quad , \quad , \quad \rangle$

(b) Find the angle between the two planes. **(2 points)**

$\theta =$

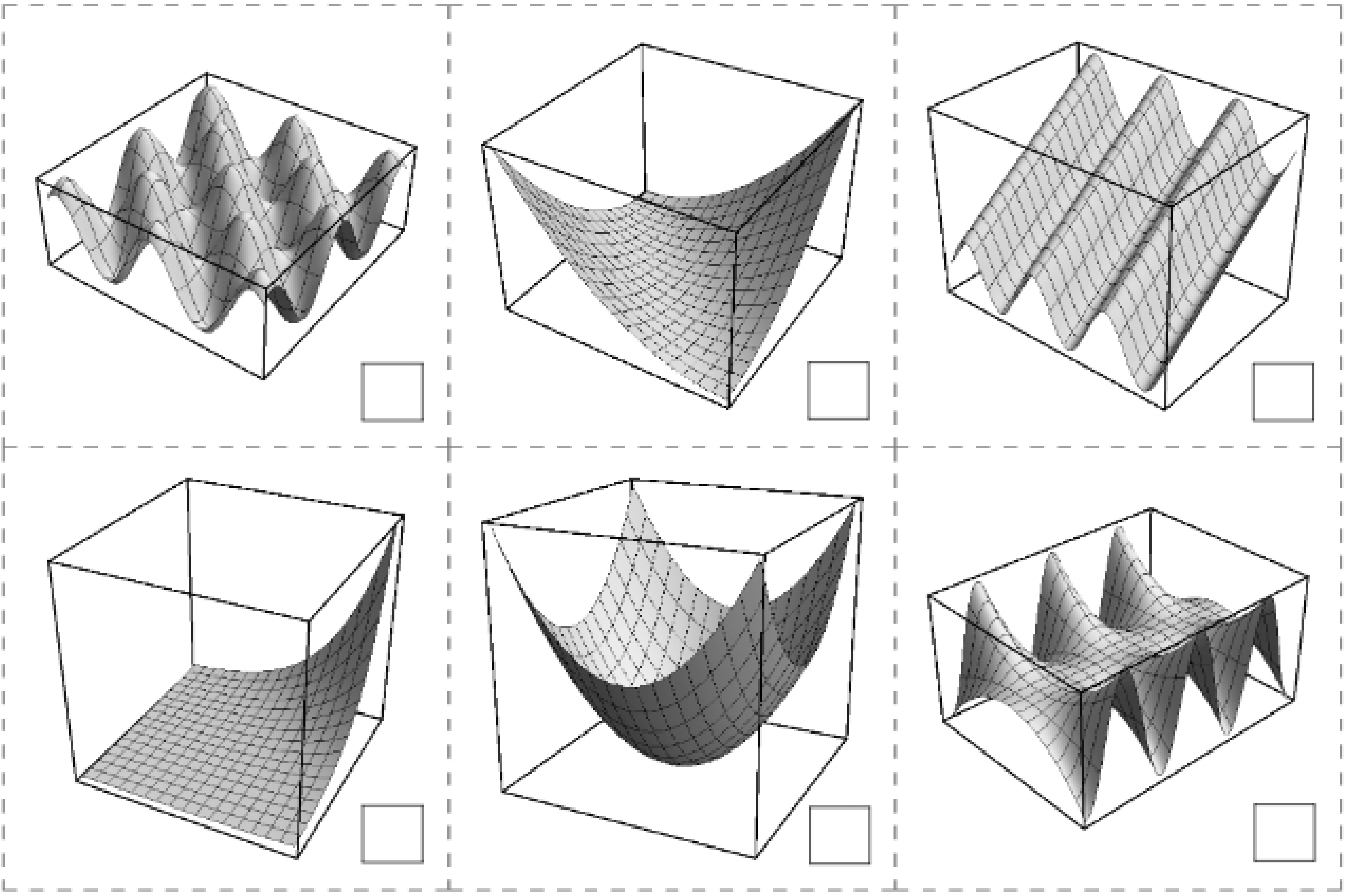
(c) Find the equation of a plane C which is perpendicular to both A and B. **(3 points)**

Equation: $\square\, x + \square\, y + \square\, z = \square$

5. Exactly one of the following two limits exists. Circle the one that exists and justify your answer. **(5 points)**

$$\lim_{(x,y)\to(0,0)} \left(\frac{x^2 - y^2}{\sqrt{x^2 + y^2}} \right) \qquad\qquad \lim_{(x,y)\to(0,0)} \left(\frac{xy}{\left(x^2 + y^2\right)^2} \right)$$

6. For each function label its graph from among the options below: (a) $(x+y)^2$ (b) $x+\cos(y)$
(3 points each)



7. Circle the equation for the quadratic surface shown at right. **(3 points)**

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

(b) $x^2-y^2-z^2=-1$

(c) $x^2+y^2-z^2=-1$

(d) $x^2-y^2-z^2=1$

(e) $x-y^2-z^2=1$