1. Find an equation for the plane containing the point $P = (1,2,3)$ and the line L parametrized by $x = 1 + t,\ y = 2t$, and $z = 2 - t$. **(5 points)**

Equation: $\boxed{}\, x + \boxed{}\, y + \boxed{}\, z = \boxed{}$

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

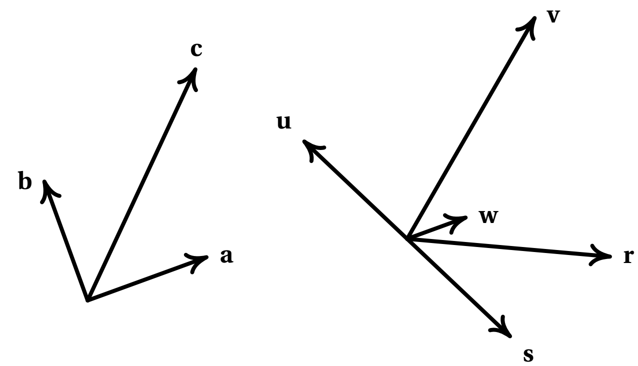
(a) Find $\text{proj}_{\mathbf{a}}\,\mathbf{b}$, the vector projection of $\mathbf{b}$ onto $\mathbf{a}$. **(2 points)**

$\text{proj}_{\mathbf{a}}\,\mathbf{b} = \Big\langle \quad , \quad , \quad \Big\rangle$

(b) Find the distance from the point $(-1, 0, 1)$ to the line through the origin whose direction vector is $\mathbf{a}$. Hint: Use part (a)! **(3 points)**

distance =

3. Consider the vectors **a**, **b**, and **c** shown at right. Their lengths are $|\mathbf{a}| = |\mathbf{b}| = 1$ and $|\mathbf{c}| = 2$.
(1 point each)



(a) Circle the vector that best represents $\frac{1}{2}\mathbf{a} - \mathbf{b}$.

u	**v**	**w**	**r**	**s**

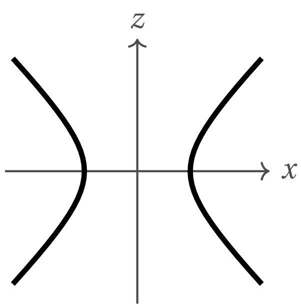
(b) Circle the number closest to $\mathbf{a} \cdot \mathbf{c}$.

0	1	$\sqrt{2}$	$\sqrt{3}$	2

(c) A nonzero vector **n** is pointing directly up out of the page. Circle the best description of $\mathbf{b} \times \mathbf{c}$.

it is a positive multiple of **n**	it is a negative multiple of **n**	it is not a multiple of **n**

4. Consider the quadric surface Q defined by the equation $x^2 + y^2 - z^2 = 1$. Check the box below the picture of the curve formed by intersecting Q with the xz-plane. **(2 points)**



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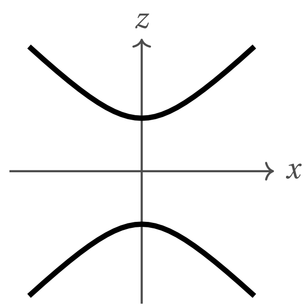

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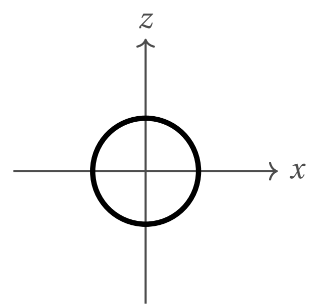

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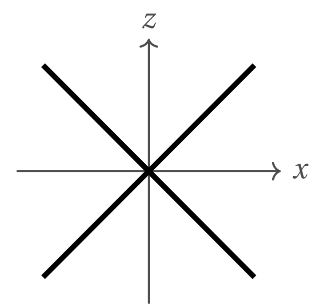

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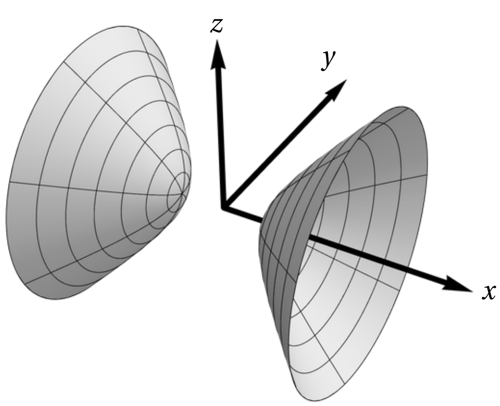
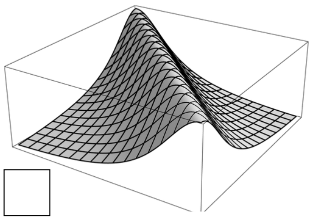
5. Consider the hyperboloid H of two sheets shown below. Circle the equation of H. **(2 points)**

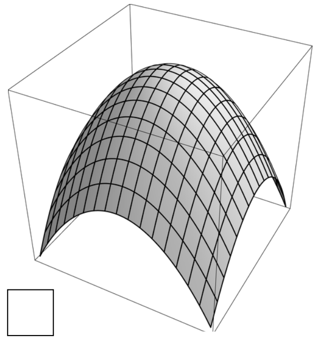


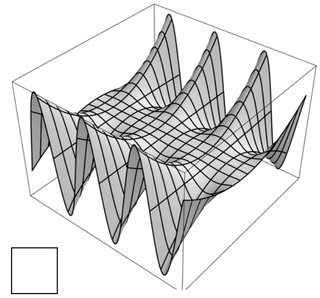
$y^2 + z^2 - x^2 = 1$	$x = y^2 + z^2 + 1$
$x^2 + y^2 + z^2 = -1$	$x^2 - y^2 - z^2 = 1$

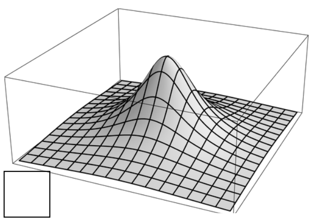
6. For each function, label its graph from among the options below by writing the corresponding letter in the box next to the graph. **(2 points each)**

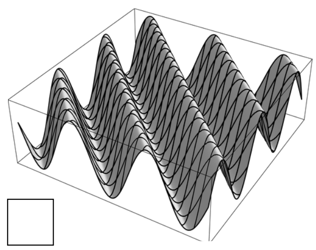
(A) $-y^2\sin(x)$ (B) $\dfrac{1}{1+x^2+y^2}$

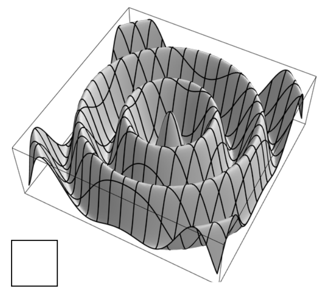




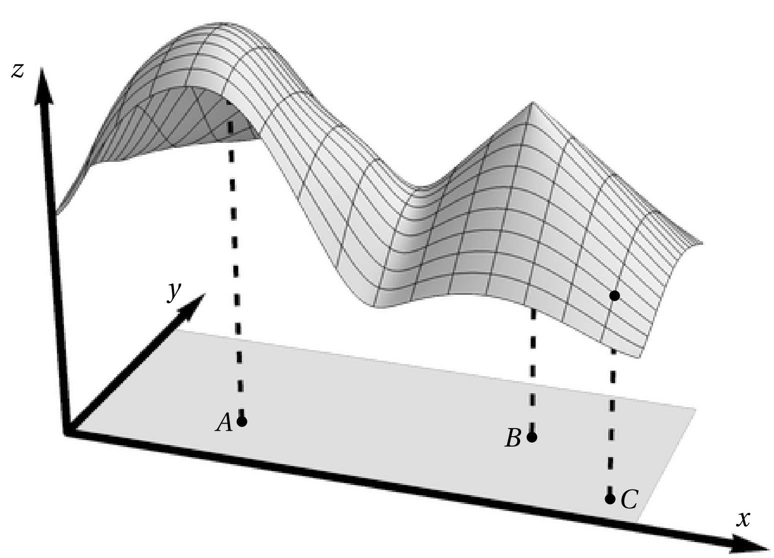








7. Consider the function $g\colon \mathbb{R}^2 \to \mathbb{R}$ whose graph is shown at right. Let A and B be the points in $\mathbb{R}^2$ corresponding to two "peaks" of the graph, and C be the point in $\mathbb{R}^2$ corresponding to the dot on the graph. For each part, circle the answer that is most consistent with the picture. **(1 point each)**



(a) At the point A, the function g is: continuous differentiable both neither

(b) At the point B, the function g is: continuous differentiable both neither

(c) At the point C, the function $\dfrac{\partial g}{\partial x}$ is: negative zero positive

8. A differentiable function $f\colon \mathbb{R}^2 \to \mathbb{R}$ takes on the values shown in the table at right.

		x				
		0.2	0.6	1.0	1.4	1.8
	1.8	3.16	3.88	4.60	5.32	6.04
	1.4	2.68	3.24	3.80	4.36	4.92
y	1.0	2.20	2.60	3.00	3.40	3.80
	0.6	1.72	1.96	2.20	2.44	2.68
	0.2	1.24	1.32	1.40	1.48	1.56

(a) Estimate the partials $f_x(1,1)$ and $f_y(1,1)$. **(2 points)**

$f_x(1,1) \approx$ $\qquad$ $f_y(1,1) \approx$

(b) Use your answer in (a) to approximate $f(1.1, 1.2)$. **(2 points)**

$f(1.1, 1.2) \approx$

(c) Determine the sign of $f_{xy}(1,1)$. **(1 point)**

negative $\quad$ zero $\quad$ positive

Scratch Space

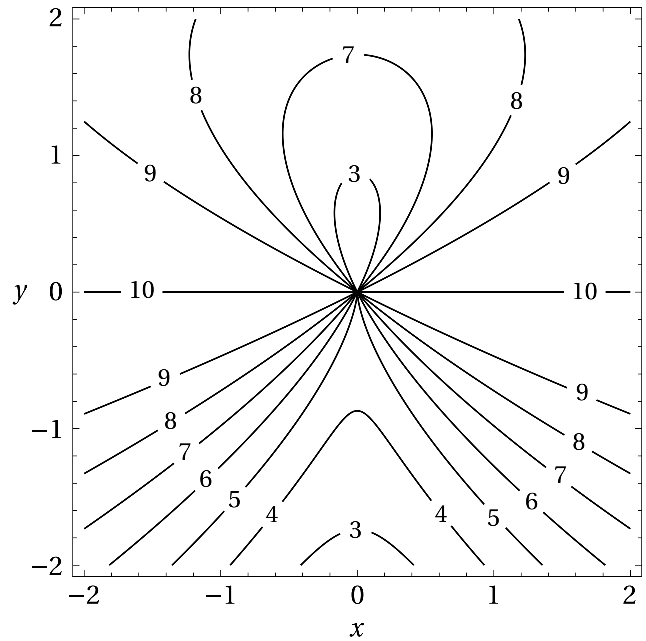
9. Suppose $f\colon \mathbb{R}^2 \to \mathbb{R}$ has the table of values and partial derivatives shown at right. For $x(s,t) = s+2t$ and $y(s,t) = s^2 - t$, let $F(s,t) = f\big(x(s,t), y(s,t)\big)$ be their composition with f. Compute $\dfrac{\partial F}{\partial t}(2,1)$. **(4 points)**

(x,y)	$f(x,y)$	$\dfrac{\partial f}{\partial x}$	$\dfrac{\partial f}{\partial y}$
$(2,1)$	0	7	6
$(2,-1)$	-12	7	-1
$(3,3)$	19	-8	5
$(4,3)$	7	3	2

$\dfrac{\partial F}{\partial t}(2,1) =$

Scratch Space

10. Consider the function $f(x, y)$ whose contour map is shown at right, where the value of f on each level curve is indicated by the number along it. For each part, give the answer that is **most consistent** with the given data. **For (a) and (b) be sure to explain your reasoning in the space provided.** If the limit does not exist, write "DNE" in the answer box.



(a) Determine $\lim_{x\to 0} f(x,0)$. **(2 points)**

$\lim_{x\to 0} f(x,0) =$

(b) Determine $\lim_{(x,y)\to(0,0)} f(x,y)$. **(2 points)**

$\lim_{(x,y)\to(0,0)} f(x,y) =$

(c) Determine $\lim_{(x,y)\to(1,-1)} f(x,y)$. **(1 point)**

$\lim_{(x,y)\to(1,-1)} f(x,y) =$

Scratch Space