INSTRUCTIONS: Solve $N-1$ of the N problems; choose one problem to skip and put a big **X** in the corresponding box below. If you do not indicate which problem you are choosing to skip, I will assume that I should skip problem N, which may hurt your grade. Show your work: even correct answers may receive little or no credit if a method of solution is not shown. You do not need to simplify your solutions. Graphing calculators, notes, cell phones, and other materials are not permitted.

Name:									
1	2	3	4	5	6	7	...	N	Total

Basics: $\mathbf{a} = \langle a_1, a_2, a_3 \rangle$ $\mathbf{b} = \langle b_1, b_2, b_3 \rangle$ $|\mathbf{a}| = \sqrt{a_1^2 + a_2^2 + a_3^2}$

Dots: $\mathbf{proj_b a} = \left(\frac{\mathbf{a}\cdot\mathbf{b}}{\mathbf{b}\cdot\mathbf{b}}\right)\mathbf{b}$ $\text{comp}_{\mathbf{b}}\mathbf{a} = \frac{\mathbf{a}\cdot\mathbf{b}}{|\mathbf{b}|}$ $\mathbf{a}\cdot\mathbf{b} = a_1b_1 + a_2b_2 + a_3b_3 = |\mathbf{a}|\,|\mathbf{b}|\cos\theta$

Crosses: $|\mathbf{a}\times\mathbf{b}| = |\mathbf{a}|\,|\mathbf{b}|\sin\theta$ $\mathbf{a}\times\mathbf{b} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ a_1 & a_2 & a_3 \\ b_1 & b_2 & b_3 \end{vmatrix}$ $\mathbf{a}\times\mathbf{b} = \langle a_2b_3 - a_3b_2, a_3b_1 - a_1b_3, a_1b_2 - a_2b_1 \rangle$

- Gradient vector of $F(x,y,z)$:

$$\nabla F(x,y,z) = \langle F_x(x,y,z), F_y(x,y,z), F_z(x,y,z) \rangle$$

- The plane tangent to $F(x,y,z) = k$ at the point (a,b,c):

$$\nabla F(a,b,c) \cdot \langle x-a, y-b, z-c \rangle = 0$$

- The plane tangent to $z = f(x,y)$ at (a,b) (linearization of f):

$$z = f_x(a,b)(x-a) + f_y(a,b)(y-b) + f(a,b)$$

- Directional derivative of $f(x,y)$ in the direction of unit vector $\mathbf{u}$ at (a,b):

$$D_{\mathbf{u}}f(a,b) = \nabla f(a,b) \cdot \mathbf{u}$$

- Differential of $z = f(x,y)$ at (a,b):

$$\Delta z \approx dz = f_x(a,b)dx + f_y(a,b)dy$$

- Second derivative test for a critical point (a,b) of $f(x,y)$: $D(a,b) = f_{xx}(a,b)f_{yy}(a,b) - [f_{xy}(a,b)]^2$.

  If $D > 0$ and $f_{xx}(a,b) > 0$, then $f(a,b)$ is a local minimum;

  If $D > 0$ and $f_{xx}(a,b) < 0$, then $f(a,b)$ is a local maximum;

  If $D < 0$, then (a,b) is a saddle point;

  If $D = 0$, then the test is inconclusive.