1. (3 points each) Determine whether each of the following statements is true or false. No justification necessary, no partial credit available.

   (a) If \( f_x(0,0) \) and \( f_y(0,0) \) exist, then \( f \) must be differentiable at \( (0,0) \).

   (b) A partial derivative is a specific example of a directional derivative.

   (c) \( \nabla f(a,b) \) is perpendicular to the graph of \( z = f(x,y) \) at the point \( (a,b) \).

   (d) Vectors \( \vec{a} \) and \( \vec{b} \) are as pictured in the diagram, both are in the \( xy \)-plane. True/False: \( \vec{a} \times \vec{b} = t\hat{k} \), where \( t \) is a positive number.

2. (5 points) Consider the function \( g(x,y) \) with contour diagram below. Sketch a vector that points in the direction of \( \nabla g(1,0.75) \).
3. (8 points) The consumption of beef by one household, $C$ (in pounds per week) is given by the function $C = f(I, p)$, where $I$ is the annual household income in thousands of dollars, and $p$ is the price of beef in dollars per pound. Explain the meaning of the statement: $f_I(80, 3) = 0.022$, include units in your answer.

4. (12 points) The table of some values of $C = f(I, p)$ is given below. Find a linearization of $f$ at $(40, 3)$.

<table>
<thead>
<tr>
<th>Price of beef, $p$ ($/lb$)</th>
<th>3</th>
<th>3.5</th>
<th>4</th>
<th>4.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household income per year, $I$ ($1000$)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>2.65</td>
<td>2.59</td>
<td>2.51</td>
<td>2.43</td>
</tr>
<tr>
<td>40</td>
<td>4.14</td>
<td>4.05</td>
<td>3.94</td>
<td>3.88</td>
</tr>
<tr>
<td>60</td>
<td>5.11</td>
<td>5.00</td>
<td>4.97</td>
<td>4.84</td>
</tr>
<tr>
<td>80</td>
<td>5.35</td>
<td>5.29</td>
<td>5.19</td>
<td>5.07</td>
</tr>
</tbody>
</table>

5. (15 points) Find the equation of the plane tangent to $z^2 + 2zy + 4y = x^2 + 3$ at the point $(3, 1, -4)$. 
6. (15 points) Let \( w = 3x \cos y \). If \( x = u^2 + v^2 \) and \( y = \frac{v}{u} \), find \( \frac{\partial w}{\partial u} \) at the point \( (u, v) = (2, 3) \). Give
your answer to 2 decimal places. (Set your calculator to radians.)

7. (12 points) Suppose that \( f_x(x, y) = \frac{1}{2}(x + 2y)^{-1/2} \) and \( f_y(x, y) = (x + 2y)^{-1/2} \). Also suppose that
\( f(1, 0) = 1 \). Find the quadratic Taylor polynomial (i.e., the quadratic approximation) of \( f(x, y) \) at
\( (1, 0) \).
8. (10 points) Using the contour diagram for \( f(x, y) \), find the sign of \( f_{yy}(P) \) given that \( f_{xx}(P) < 0 \). Justify your answer.

9. (8 points) Select ALL the planes that could NOT be tangent planes to the graph of a function \( f(x, y) = z \) that is differentiable everywhere. (Briefly justify your choices.)

   (a) \( 3x - 5y - z = 2 \)
   (b) \( 5x + 3y = 2 \)
   (c) \( 3x + 5y = 2 \)
   (d) \( 3x + 5y + z = 2 \)
   (e) \( 5y = 2 \)

10. (3 points) What is your favorite food?