1. Let $g(x, y) = 2x^2 \cos(2\pi y^2) + y^2$. You can use the fact that $Dg(2, 1) = [8 \ 2]$.

(a) Find an equation for the tangent plane to the graph $z = g(x, y)$ at the point $(2, 1)$.

(b) Use the linear approximation of $g(x, y)$ at the point $(2, 1)$ to find an approximate value for $g(1.9, 1.1)$.

2. Consider the function $f : \mathbb{R}^2 \to \mathbb{R}^3$ defined by

$$f(x, y) = \begin{cases} 
3x^2y + 2x^3 + 7y^3 & \text{for } (x, y) \neq (0, 0), \\
\frac{3x^2y + 2x^3 + 7y^3}{\sqrt{x^4 + y^4}} & \text{for } (x, y) = (0, 0).
\end{cases}$$

Use the limit definition to calculate the partial derivative $\frac{\partial f}{\partial y}(0, 0)$.
3. Let \( g : \mathbb{R}^2 \to \mathbb{R}^3 \) be given by \( g(u, v) = (uv^2, u^2 + v^2, 2u - v) \). Find \( Dg(1, 1) \).

4. Let \( g \) be defined as in question 3. Let \( f : \mathbb{R}^3 \to \mathbb{R}^2 \) be given by \( f(x, y, z) = (\sqrt{x^2 + 3} + \sqrt{z^2 + 3}, yz) \). Let \( h = f \circ g \). Using the Chain Rule, calculate \( Dh(1, 1) \).

5. Compute the value of \( x^2 \frac{\partial w}{\partial x} + y^2 \frac{\partial w}{\partial y} \) at the point \((1, -1)\) if \( w = f(\frac{z+y}{x+y}) \) and \( f'(0) = -2 \).
6. The temperature $T(x, y)$ at a point $(x, y)$ in the plane is a differentiable function such that \( \frac{\partial T}{\partial x} (3, -1) = 2 \) and \( \frac{\partial T}{\partial y} (3, -1) = 5 \).

(a) Find the directional derivative of \( T \) at the point $(3, -1)$ in the direction given by the unit vector $u = (1/\sqrt{2}, 1/\sqrt{2})$.

(b) A bug crawls along a level curve of the temperature function $T$ at speed one. What are the possible velocity vectors $v$ for the bug at the moment it crawls through the point $(3, -1)$?

7. Find a direction for which the directional derivative of the function $w(x, y, z) = y(x^2 + z^2) - z^3$ at the point $(1, 1/2, 1)$ is zero.

8. Calculate the directional derivative of $f(x, y, z) = x \cos(y) \sin(z)$ at the point $a = (1, \pi/4, 5\pi/6)$ in the direction of $u = (3, 0, 1)$.
9. For the following regions $R$, compute the specified regions.

(a) $R$ is the rectangle with vertices $(-2, 2), (0, 2), (0, 0), (-2, 0)$

\[
\iint_R (3x^2 + 2y^3) \, dA
\]

(b) $R$ is the region bounded by $x = y^2$ and $x = 5y$

\[
\iint_R ye^x \, dA
\]