1. For each of the following, find the equations for the tangent plane at the given point P on the given surface. Decide whether z can be written as a function of x and y at the point P.
   (a) $x^2 + y^2 - z^2 = 18$, $P(3, 5, -4)$
   (b) $x^2 - xy - y^2 - z = 0$, $P(1, 1, -1)$
   (c) $x^3y^3 + z^3 = 0$, $P(0, 0, 1)$
   (d) $z = 4x^2 + y^2$, $P(1, 1, 5)$

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2. Suppose that at the point $(1, 2)$, the function $f(x, y)$ has a derivative of $9\sqrt{5}$ in the direction toward $(4, 6)$ and a derivative of $7\sqrt{5}$ in the direction toward $(6, 14)$. Find the derivative of f at $(1, 2)$ in the direction toward the point $(0, 6)$.

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3. (a) Suppose that a nonzero vector in the plane has coordinates (a, b). How many vectors are perpendicular to it? How many of these are of the same magnitude as (a, b)? Can you find the coordinates of those?
   (b) Suppose that a nonzero vector in space has coordinates (a, b, c). Can you describe the vectors that are perpendicular to it? Can you cook them up easily?

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4. For a differentiable function $f(x, y, z)$, how do you compute $D_{\mathbf{i}}f$, $D_{\mathbf{j}}f$, and $D_{\mathbf{k}}f$?

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5. What is the largest value that the directional derivative of $f(x, y, z) = xyz$ can have at the point $(1, 1, 1)$?

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6. Let $f(x, y) = x\cos(y) + e^x y$ and let P be the point $(2, 0)$.
   (a) Find the gradient ∇f at P.
   (b) For the vector $\mathbf{v} = (-3, 4)$, find the directional derivative of f at P in the direction of $\mathbf{v}$.
   (c) Find a vector that is tangent to the level curve $f(x, y) = 3$ at P.
   (d) Find a direction in which f neither increases nor decreases at P.
   (e) What is the maximal directional derivative at P? What is a direction corresponding to this?
