Please work the problems in the white space provided and clearly box your solutions. You are allowed one $3'' \times 5''$ notecard. Enjoy! This quiz has 3pts of bonus credit.

Problem 1 Calculate the limit below (if it doesn't exist then explain why)

$$\lim_{(x,y)\to(0,0)} \frac{2xy}{x^2 + y^2}$$

Problem 2 Let $f(x,y) = x^3 + xy^2$. Find the rate of change in f at (1,2) in the (3,4) direction.

Problem 3 Explain how to express $\frac{\partial f}{\partial x}$ at (x_o, y_o) as a directional derivative of f.

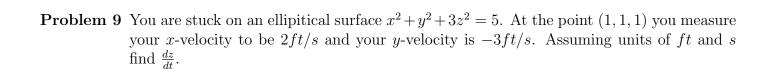
Problem 4 Explain which directions the function $f(x,y) = x^3 + y\sin(y)$ is locally constant at $(1,\pi)$.

Problem 5 Calculate ∇f for $f(x, y, z) = x^y + \cos(z^2)$

Problem 6 Let $z = \cos(xy^2)$. Furthermore, $x = u^2 + v$ and $y = ve^v$. Calculate $\frac{\partial z}{\partial v}$ and $\frac{\partial z}{\partial u}$.

Problem 7 Consider the surface which is the solution set of the equation $x^2 + y^3 + z^4 = 10$. Find the equation of the tangent plane to this surface at (-1, 2, 1).

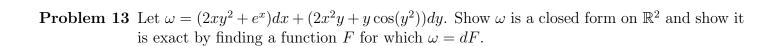
Problem 8 Let $\vec{r}(s,t) = \langle s\cos(t), s\sin(t), s \rangle$ be the parametrization of a surface M. Find the normal vector field to M.



Problem 10 Ron Swanson is holding a barbeque of epic size in a heavily misty park. At the same time a bagpipe club is playing at an embarrassing volume. You can't see or hear in effect. The smell of meat is measured to roughly follow $M(x,y) = x^2 - 2xy$ at (1,1). In which direction should you travel to join the feast?

Problem 11 Suppose $w = x^2 + y^3 + z^4$ and xyz = 1. Calculate $\left(\frac{\partial w}{\partial x}\right)_y$ and $\left(\frac{\partial w}{\partial x}\right)_z$

Problem 12 If $dw = (2x^2 + 3y)dx + (e^z + \cos(y) - 4)dy + dz$ then calculate $\frac{\partial w}{\partial x}$, $\frac{\partial w}{\partial y}$ and $\frac{\partial w}{\partial z}$.



Problem 14 Solve $(2xy^2 + e^x)dx + (2x^2y + y\cos(y^2))dy = 0$.

Problem 15 Let $\frac{dy}{dx} + Py = Q$ be a differential equation where P,Q are continuous functions of x. Show that the corresponding Pfaffian equation is not exact. Then, assume I = I(x) and find a formula for I for which $I\frac{dy}{dx} + IPy = IQ$ is an exact equation.