

Print Your Name Legibly: \_\_\_\_\_

Score: \_\_\_\_\_

**Instructions:** You must show supporting work to receive full and partial credits. No textbook, notes, cheat sheets, calculators allowed.

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1(15pts) Let  $f(x, y) = x^2 + 6y^3 + 18y^2 - 6xy + 18y - 18x$ .

(a) Find all critical points of the function.

(b) Verify that  $(3, -2)$  is a critical point and use the second derivative test to determine its type, a local max, or min, or saddle point.

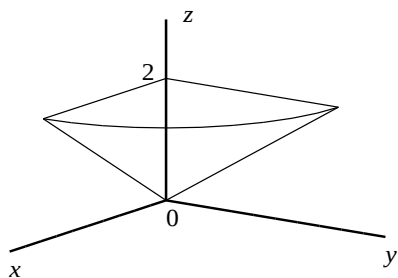
2(15pts) Use the Lagrange multiplier method to find the constraint minimum of function  $f(x, y) = x + y$  subject to  $x^2 + 2y^2 = 6$ .

3(15pts) (a) Sketch the region of the integral  $\int_0^4 \int_0^{\sqrt{x}} \delta(x, y) dy dx$ .

(b) Change the order of the iterated integral to  $dx dy$ .

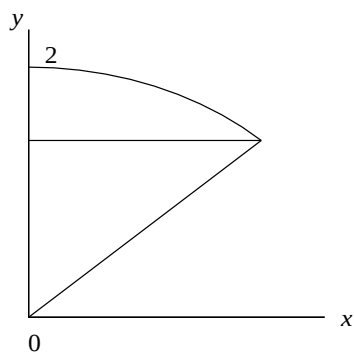
4(20pts) Let  $G$  be the solid which is in the first octant, bounded by the plane  $z = 2$  and the cone  $z = \sqrt{x^2 + y^2}$ .  
Let  $\delta(x, y, z) = x$  be the density function.

(a) Set up an iterated integral in the order of  $dz dy dx$  for the mass of the solid. Do not evaluate the integral.



(b) Set up an iterated integral in the spherical coordinate for the mass of the solid. Do not evaluate the integral.

5(15pts) The region  $R$  is bounded by the  $y$ -axis, the line  $y = x$ , and the circle  $x^2 + y^2 = 4$ . Set up an iterated integral in the polar coordinate for the integral  $\iint_R x dA$ . Do not evaluate the integral.



6(20pts) (a) Write a parameterized equation for the tangent line to the curve  $\vec{r}(t) = \langle t, 1, 2 + t^2 \rangle$  at  $t = 1$ .

(b) Write a parameterized equation for the circular motion around the center  $(1, 0)$ , going clockwise from  $(1, 1)$  to  $(1, -1)$ .