1. Find \( \frac{dz}{dt} \) for a) \( z = ye^{\frac{y}{x}} \quad x = e^{2t} \quad y = \sin t \)
   
b) \( z = xe^y + ye^{-x} \quad x = e^t \quad y = st^2 \)

2. Find \( \frac{\partial z}{\partial x} \) and \( \frac{\partial z}{\partial y} \) if \( xy^2z^3 + x^3y^2z = x + y + z \)

3. #34 S12.5 The radius of a right circular cone is increasing at a rate of 1.8 in/s while its height is decreasing at a rate of 3 cm/s. At what rate is the volume of the cylinder changing when the radius is 120 in and height is 140 in?

4. #38 S12.5 Car A is traveling north on Highway 16 at 90 km/h. Car B is traveling west on Highway 83 at 80 km/h. Each car is approaching the intersection of these two highways. How fast is the distance between the cars changing when car A is 0.3 km from the intersection and car B is 0.4 km from the intersection?

5. \( z = x^3y^2 \quad x = x(s,t) \quad y = y(s,t) \). Find
   
a) \( \frac{\partial z}{\partial s} \) and \( \frac{\partial z}{\partial t} \)
   
b) \( \frac{\partial^2 z}{\partial s^2} \)

6. \( z = e^{x^2y} \quad x = s^2 \cos t \quad y = s^2 \sin t \). Find \( \frac{\partial z}{\partial s} \) and \( \frac{\partial z}{\partial t} \).

7. For each function find \( \nabla f \), \( D_v f \) at \( P \), and the maximum rate of change of \( f \) at \( P \).
   
a) \( f(x, y) = e^{x/y} \quad P(2,1) \quad \vec{v} = \langle -3, 5 \rangle \)
   
b) \( f(x, y) = \arctan(x + 2y) \quad P(0,1) \quad \vec{v} = \langle 3, 2 \rangle \)
   
c) \( f(x, y, z) = x^2yz^3 \quad P(-2,1,-3) \quad \vec{v} = \langle -1, 3, 4 \rangle \)

8. Find the maximum rate of change of the given function at the given point and find the direction in which it occurs.
a) \( f(x, y) = xe^{x^2y} \quad P(1,1) \)

b) \( f(x, y) = \tan(x - y) \quad P(\pi/2, \pi/6) \)

c) \#22 S12.6 \quad f(x, y, z) = \frac{x}{y} + \frac{y}{z} \quad P(4,2,1) \)

9. \( T(x, y, z) = x^2 + yz + 12 \) degrees C is the temperature of the water in a pool. You are at the point (2,2,1). In what direction should you swim to get warmer the fastest?

10. Find the tangent plane and the normal line at \( P \) for each surface.

a) \( F(x, y, z) = 4x^2 + y^2 + 4z^2 = 36 \quad P(2,-2/3,2) \)

b) \( F(x, y, z) = xe^{yz} = 1 \quad P(1,0,3) \)

11. Find the local max and min of each function.

a) \( f(x, y) = \frac{3}{2}x^2 + 2y^2 - 4xy + 5x - 4y + 10 \)

b) \( f(x, y) = 2x^3 + xy^2 + 5x^2 + y^2 \)

12. \#50 S12.8 the base of an aquarium with given volume \( V \) is made of slate and the sides are made of glass. The cost per unit area for slate is 5 times as much as for glass. Find the dimensions of the aquarium that minimize the cost.

13. Use the method of Lagrange multipliers to find the absolute max and min of the function on the given domain.

a) \( f(x, y) = 4x^2 + 2y^2 + 5 \quad \text{on} \ D : x^2 + y^2 - 2y = 0 \)

b) \( f(x, y) = 2x^2 + x + y^2 - 2 \quad \text{on} \ D : x^2 + y^2 \leq 4 \)

c) \( f(x, y) = 2x^2 + 3y^2 - 4x - 5 \quad D : x^2 + y^2 \leq 16 \)