Answer all of the following questions in the space provided. Show all work as partial credit may be given. Answers without justification, even if they are correct, will earn no credit.

1. (4 pts.) Find the linearization of the function  $f(x, y, z) = \frac{xy^2}{z^3}$  at the point (3, 2, 1).

2. Suppose that a right circular cylinder has height h = 25 cm and radius r = 5 cm. Also assume that the volume, V, of a cylinder with height h and radius r is  $V = \pi r^2 h$ .

(a) (2 pts.) Find the differential dV of the volume V in terms of the differentials dr and dh of radius and height respectively.

(b) (1 pt.) Using the differential you found in part (a), estimate the maximum error in the volume of the cylinder if the maximum possible error in height h is .2 cm and the maximum possible error in radius is .1 cm. Be sure to give your answer in correct units.

3. (4 pts.) Given that the function  $f(x, y) = 2x^2 + 4xy + y^4$  has critical points (-1, 1), (0, 0), and (1, -1), identify each as a local maximum, local minimum, or saddle point.