

name : \_\_\_\_\_

section : 109

GSI : Charles Wang

(2 pts) Circle True or False. (+1 for correct, 0 for blank, -1 for incorrect)

1. (True False) Critical points only come from where the first derivative is zero.
2. (True False) A function with domain  $\mathbb{R}$  and range  $\mathbb{R}$  always has a global maximum.

(10 pts) For the following, you must **justify** your answer to receive credit. (Showing your work counts as justification.)

3. Air is escaping from a spherical balloon, initially at a radius of 200cm, at a rate of  $10\text{cm}^3$  per minute. The volume,  $V$ , of a sphere with radius  $r$  is  $V = \frac{4}{3}\pi r^3$ .

(a) (2 pt) Draw a diagram of the problem, indicating the given quantities, and compute the volume of the balloon when  $r = 20\text{cm}$ .

(b) (1 pt) Write a formula for the radius  $r(t)$  of the balloon at time  $t$  in terms of the volume  $V(t)$  at time  $t$ .

(c) (4 pts) Use implicit differentiation with your formula from above to obtain a formula for the rate of change of volume at time  $t$  in terms of the rate of change of the radius at time  $t$ .

(d) (3 pts) Determine the rate at which the radius of the balloon is decreasing when the radius of the balloon is 20cm.