

Show all work. 5 points each.

1) Find the gradient of  $f(x, y) = y \ln(x)$  at the point  $P(1, -3)$  and find the rate of change of  $f$  at  $P$  in the direction of  $\mathbf{u} = \left\langle \frac{-4}{5}, \frac{3}{5} \right\rangle$ .

2) Find the critical point(s) of  $f(x, y) = 9 - 2x + 4y - x^2 - 4y^2$  and determine if they are local max, local min or saddle points.