Show your work for credit.

1. (2 pts) Each of these graphs has a critical point somewhere in the window. For each, state where it occurs and if it corresponds to a max/min/saddlepoint. **Justify your answers.**

   (a) \((0,0)\) is a local \textbf{min}: walk in \textbf{x-direction}: \(3, 0, 1, 2\)
   \quad \textbf{walk in y-direction}: \(4, 3, 2, 0, 1, 2, 3, 4\)

   (b) \((0,0)\) is a \textbf{saddle point}: \textbf{x-direction}: increase, decrease
   \quad \textbf{y-direction}: decrease, increase

2. (3 pts) Suppose \(f(d, s)\) measures a distance runner's fatigue after covering \(d\) km at \(s\) km/h.

   (a) Argue that \((0, 0)\) is a critical point of \(f\).

   It is a local \textbf{min}, because fatigue is surely zero (haven't started running yet!)

   (b) Suppose \(f_{dd} = 1.8d - s\), \(f_{ds} = -d + 12\), and \(f_{ss} = 10\). Assuming \((10, 15)\) is a critical point of \(f\), determine if it corresponds to a local max, local min, neither, or not-enough-info.

   \[ D(10, 15) = \left| \begin{bmatrix} f_{dd}(10, 15) & f_{ds}(10, 15) \\ f_{ds}(10, 15) & f_{ss}(10, 15) \end{bmatrix} \right|^2 \]
   \[ = \left| \begin{bmatrix} 18 & 3 \\ 3 & 10 \end{bmatrix} \right|^2 = 30 - 4 = 26 \quad \text{positive} \]

   \[ f_{dd}(10, 15) = 3 \quad \text{positive} \quad \text{so} \quad (10, 15) \text{ is a local min} \]
3. (5 pts) Compute the indicated partial derivatives for the function \( f(x, y) = e^{2xy} \).

- \( f_x = 2y e^{2xy} \)
- \( \frac{\partial f}{\partial y} = 2xe^{2xy} \)
- \( f_{xx} = (2y)^2 e^{2xy} \)
- \( \frac{\partial^2 f}{\partial x \partial y} = 2e^{2xy} + (2x)(2y)e^{2xy} = (1 + 2xy)2e^{2xy} \)
- \( \frac{\partial^2 f}{\partial y^2} = (2x)^2 e^{2xy} \)