1. Suppose \( y'(t) = f(y) \), where the graph of \( f(y) \) is given below. Carefully draw the integral curves for this equation. What are the equilibrium solutions? What are their stability types? Describe the initial concavity of the solution curves. Assume \( y(t) \) and \( t \) are nonnegative.

2. Match the differential equation with its direction field. (You get 4 points for each correct match, -2 for each wrong match.)

   1. \( y' = y - 2 \)
   2. \( y' = 2 - y \)
   3. \( y' = |y - 2| \)
   4. \( y' = y + x \)
   5. \( y' = x - y \)
# 2 The given equations are wrong due to a computer mishap. So, I just figured out what the equations had to be.

# 3 \(0 \leq t \leq 1\) \(y' + y = 0\). Thus \(y = e^{-t}\). Since \(y(0) = 1\),
\[ y = e^{t} \]

\(1 < t \leq 2\) \(y' = 0\). \(y = \text{constant.} = \frac{1}{2}\)

to make solution cont. at \(t = 1\).

\(t > 2\) \(y' = 1\), steady growth.

\(y = t + C\).

\(y(2) = ye\) so \(C = \frac{1}{2} - 2\).

\[ y(t) = \begin{cases} e^{-t} & t \in (0, 1) \\ e^{t} & t \in [1, 2) \\ t + e^{-2} & t \in [2, \infty) \end{cases} \]

[Graph: A graph showing the function over different intervals with marked points and slopes.]
4. \( \frac{d}{dx} \left( x^2 + y \right) + \frac{2xy - 6x}{y} = 0 \)

- \( M = 2x \)  \( N_x = 2x \) exact!
- \( \Psi = \int (2xy - 6x) \, dx = x^2y + 3x^2 + C_1(x) \)
- \( 
\Psi = \int x^2 + y \, dy = x^2y + \frac{1}{2}y^2 + C_2(x) \)

Let \( \Psi = x^2y - 3x^2 + \frac{1}{2}y^2 \)

General solution is \( x^2y - 3x^2 + \frac{1}{2}y^2 = C \)

5. \( Q(0) = 15 \times 200 = 100 \text{ lb} \)

- \( Q' = \frac{7}{5} \times \frac{Q}{5} = -0.3 \times \frac{Q}{V} \quad V = 200 - t \)

- \( Q' = \frac{-1.5 \times Q}{200 - t} \quad \ln Q = \int \frac{-1.5}{200 - t} \, dt \)

- \( \ln Q = 1.5 \ln (200 - t) + C \)

- \( Q = C (200 - t)^{1.5} \quad C = \frac{100}{(200)^{1.5}} \)

- \( Q(200) = 6. \)