2.56. Model:  The cars are represented as particles.

Visualize:

- Known:
  - \( x_{A0} = 0 \)  \( t_{A0} = 0.5 \text{ hr} \)
  - \( \alpha_A = 0 \)  \( v_{A0} = v_A = 50 \text{ mph} \)
  - \( x_{CD} = 2.4 \text{ mi} \)  \( t_{CD} = 0 \)
  - \( \alpha_C = 0 \)
  - \( v_{CD} = v_C = 36 \text{ mph} \)

- Solve:  
  (a) Ann and Carol start from different locations at different times and drive at different speeds. But at time \( t \), they have the same position. It is important in a problem such as this to express information in terms of positions (that is, coordinates) rather than distances. Each drives at a constant velocity, so using constant velocity kinematics gives

\[
x_{A1} = x_{A0} + v_A(t_1 - t_{A0}) = v_A(t_1 - t_{A0})
\]

\[
x_{C1} = x_{CD} + v_C(t_1 - t_{CD}) = x_{CD} + v_C t_1
\]

The critical piece of information is that Ann and Carol have the same position at \( t_1 \), so \( x_{A1} = x_{C1} \). Equating these two expressions, we can solve for the time \( t_1 \) when Ann passes Carol:

\[
v_A(t_1 - t_{A0}) = x_{CD} + v_C t_1
\]

\[
\Rightarrow (v_A - v_C) t_1 = x_{CD} + v_A t_{A0}
\]

\[
\Rightarrow t_1 = \frac{x_{CD} + v_A t_{A0}}{v_A - v_C} = \frac{2.4 \text{ mi} + (50 \text{ mph})(0.5 \text{ h})}{50 \text{ mph} - 36 \text{ mph}} = 2.0 \text{ h}
\]

(b) Their position is \( x_1 = x_{A1} = x_{C1} = x_{CD} + v_C t_1 = 74 \text{ miles} \).
(c) Note that Ann’s graph doesn’t start until \( t = 0.5 \) hours, but her graph has a steeper slope so it intersects Carol’s graph at \( t \approx 2.0 \text{ hours} \).