Tiny hydrogen bubbles are being used as tracers to visualize a flow. All the bubbles are generated at the origin ($x = 0$, $y = 0$). The velocity field is unsteady and obeys the equations:

$$u = 1 \text{ m/s} \qquad v = 1 \text{ m/s} \qquad 0 \leq t < 2 \text{ s}$$
$$u = 0 \qquad \qquad v = 1.5 \text{ m/s} \qquad 2 \leq t \leq 4 \text{ s}$$

Plot the pathlines of bubbles that leave the origin at $t = 0, 1, 2, 3,$ and 4 s. Mark the locations of these five bubbles at $t = 4$ s. Use a dashed line to indicate the position of the streakline passing through $(0, 0)$ at $t = 4$ s. What does the streamline passing through $(0, 0)$ look like at $t = 4$ s?

SOLUTION:

One could solve the differential equations describing the particle pathlines and streakline using the velocities given above, or, more easily, simply plot the positions of the fluid particles at different times. The plot below shows the particle positions, pathlines, and streakline.
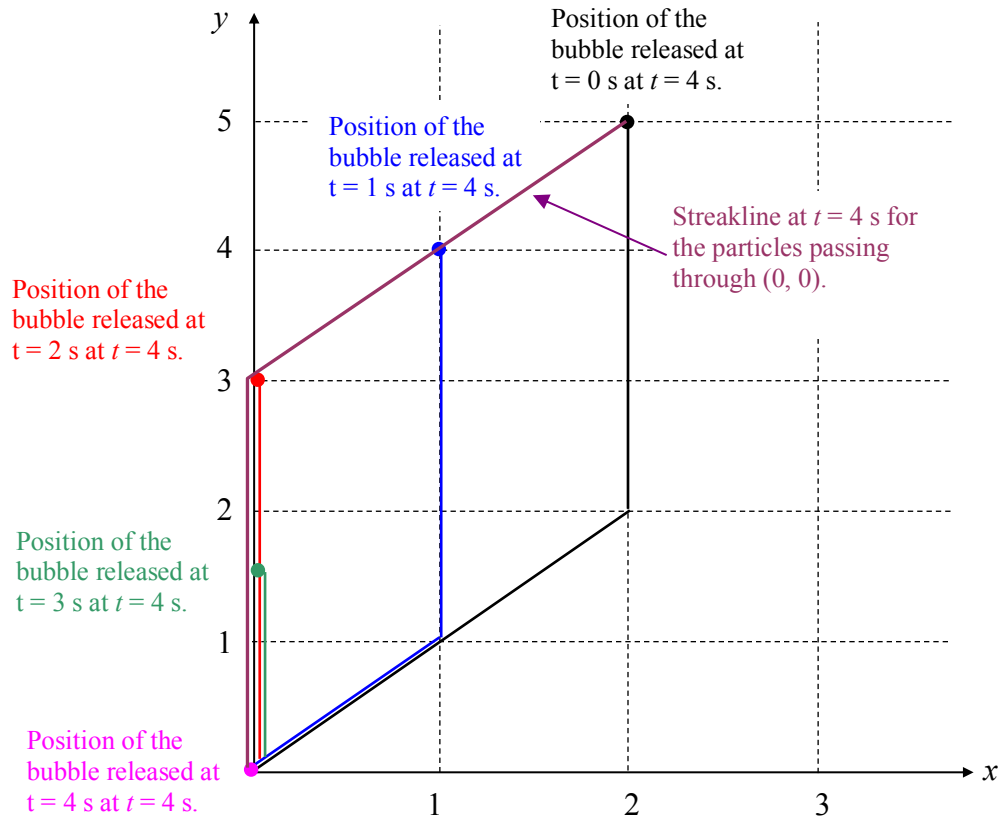
The streamline passing through (0, 0) at $t = 4$ s (or any other point for that matter) will be a vertical line since the velocity at $t = 4$ s is purely vertical.