Part I Problems

For each of the next three problems, solve the given linear DE. Give the general solution, and also the specific solution satisfying the initial condition.

Problem 1: 
\[ \frac{dy}{dx} + y = 2 \quad y(0) = 0 \]

Problem 2:  
\[ xy' - y = x \quad \text{and} \quad x(1) = 7 \]

Problem 3: 
\[ y' = 1 + x + y + xy, \quad y(0) = 0 \]

Problem 4:  Water flows into and out of a 100,000 liter (\(\ell\)) reservoir at a constant rate of 10 \(\ell/\text{min}\). The reservoir initially contains pure water, but then the water coming in has a concentration of 10 grams/liter of a certain pollutant. The reservoir is well-stirred so that the concentration of pollutant in it is uniform at all times.

a) Set up the DE for the concentration \(c = c(t)\) of salt in the reservoir at time \(t\). Specify units.

b) Solve for \(c(t)\) with the given initial condition, and graph the solution \(c\) vs. \(t\).

c) How long will it take for the concentration of salt to be 5 g/\(\ell\)?

d) What happens in the long run?
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