At $t=0$, $Q_0$ lb. of salt in 100 gal. of water in the tank

Let $Q(t) = 16$ lb. of salt in the tank at time $t$
Use integrating factors to find the solution.

\[ Q = 25 + (Q_0 - 25)e^{-\frac{t}{100}} \]
Suppose $Q_0 = 30$ and $r = 4$

At what time $T$ is $Q(T) = 25.1$
Compound Interest:

Let \( S(t) \) be the investment at time \( t \).

If \( r \) is the interest rate, then the rate of increase of the investment is \( rS(t) \).

\[
(*) \quad \frac{dS}{dt} = rS(t) \quad \text{[continuous model]}
\]

If \( S_0 \) is the initial investment, then

\[
S = S_0 e^{rt}
\]

How do we get this solution?

Why is (*) a valid model?
Suppose we deposit or withdraw at constant rate $k$. (Continuous) Model is now

$$\frac{dS}{dt} = rS + k$$

$$S(0) = S_0$$

Specific Example:
Interest rate 8%
Deposits - $2000/year
Starting investment - $S_0 = 0

What is the investment after 30 years.
Chemicals in a Pond:

\[ \frac{dQ}{dt} = \text{rate in} - \text{rate out} \]

At time \( t = 0 \), no chemical in water \( Q(0) = 0 \)

Pond contains 10 million gallons

Flow into pond - 5 million gallons/yr

\( C(t) = (2 + \sin 2t) \text{grams/gallon} \)

rate in =

Flow out of pond - 5 million gallons/yr.

rate out =

\[ \frac{dQ}{dt} = \]

Let \( q = \frac{Q(t)}{10^6} \)

\[ \frac{dq}{dt} + \frac{1}{2} q = 10 + 5 \sin 2t \]

\( q(0) = 0 \)
Diff. Eq.

Solve this set of equations using integrating factors.