Serial Dilution

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General Equations

Dilution Factor (*DF*)

The dilution factor represents how much the solution is diluted at each step. It is the ratio of the volume of the original solution to the volume of the diluted solution.

$$DF = \frac{\text{Volume of Original Solution}}{\text{Volume of Diluted Solution}} = \frac{\text{Volume of Original Solution}}{(\text{Volume of Diluent} + \text{Volume of Original Solution})}$$

Final Concentration (C_f)

The final concentration after a series of dilutions can be calculated using the initial concentration and the dilution factor. The units for the concentration will be the same for the final concentration as for the initial concentration.

$$C_f = C0 * (DF)^n$$

Where:
- C_f is the final concentration,
- C_0 is the initial concentration,
- DF is the constant dilution factor at each step,
- *n* is the number of dilutions.

Example Problems

Basic Serial Dilution

You have a stock solution of a chemical A with a concentration of 0.1 M. You want to prepare a series of 3 dilutions to create solutions with a dilution factor of 1:10. Each dilution will have a final volume of 20 mL. How would you prepare this serial dilution, and what are the final dilution factors for each dilution? What is the concentration of the final dilution?

Solution:

DF = 1:10 = 0.1

Volume of Diluted Solution = 20 mL

$$DF = \frac{\text{Volume of Original Solution}}{\text{Volume of Diluted Solution}} = \frac{\text{Volume of Original Solution}}{(\text{Volume of Diluent} + \text{Volume of Original Solution})}$$

Volume of Original Solution = DF * Volume of Diluted Solution = .1 * 20 = 2 mL

Volume of Diluent = Volume of Dilution – Volume of Original Solution = 20 - 2 = 18 mL

Withdraw 2 mL of stock solution and add to a new tube with 18 mL of diluent. Mix. From the first dilution, withdraw 2 mL of solution and add to a new tube with 18 mL of diluent. Mix. From the second dilution, withdraw 2 mL of solution and add to a new tube with 18 mL of diluent. Mix.

$C_0 = 0.1$ M

$n = 3$

$$C_f = C_0 * (DF)^n = 0.1 * (.1)^3 = 1 \times 10^{-4} \text{ M}$$

Calculating Initial Concentration

You want to calculate the concentration of bacteria in a sample. Plating the sample results in a solid lawn, so you perform a serial dilution on your sample using a 1:2 dilution factor resulting in 5 dilutions, each with a final volume of 1 mL. The 5th dilution has 43 colonies. Calculate the concentration of the original sample.

DF = 1:2 = .5

$n = 5$

$$C_0 = \frac{43 \text{ colonies}}{1 \text{ mL}} = 43$$

$$C_f = C_0 * (DF)^n$$

$$C_0 = \frac{C_f}{(DF)^n} = \frac{43}{(.5)^5} = \frac{1{,}376 \text{ colonies}}{\text{mL}}$$

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