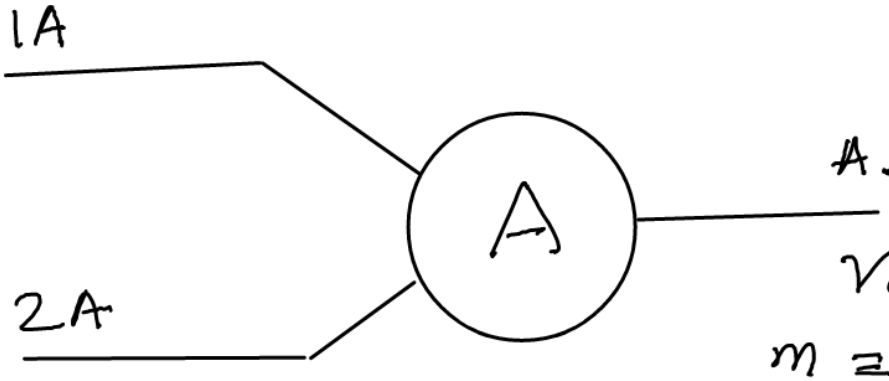
Problem statement

A solution of sodium chloride in water, 10% by mass, is diluted with pure water to produce a solution containing 8% of NaCl by mass. Calculate the mass of pure water per unit mass of the feed solution and the mass of product per unit mass of the feed solution.

Assume that the process is steady state.



Variables:

m = total mass flow rate

x = mass fraction.

	1A	2A	A3
Total	m_1	m_2	m_3
NaCl	0.1	0	0.08
H_2O	$x_1 = 0.9$	m_2	$x_2 = 0.92$

All mass balance equations:

$$m_1 + m_2 = m_3 \quad \text{--- (1)}$$

$$0.1 m_1 + 0\, m_2 = 0.08\, m_3 \quad \text{--- (2)}$$

$$0.9 m_1 + m_2 = 0.92\, m_3 \quad \text{--- (3)}$$

Only Two of the above three equations are independent. 2 equations & 3 unknowns.

To find :- 1) $\frac{m_2}{m_1}$ and 2) $\frac{m_3}{m_1}$

(m_1 can be considered as a basis of calculation because we want m_2 & m_3 in terms of m_1).

Start from the equation containing the least number of unknowns. $\Rightarrow$ Eq (2)

$$\Rightarrow \frac{m_3}{m_1} = \frac{0.1}{0.08} = \frac{10}{8} = \frac{5}{4}$$

Next simplest equation is Eq (1).

Therefore, putting the value of $\frac{m_3}{m_1} = \frac{5}{4}$ in Eq (1), we get

$$m_1 + m_2 = \frac{5}{4} m_1 \Rightarrow \underline{\frac{m_2}{m_1} = \frac{1}{4}}$$

Results : Considering the number of significant digits, the ratios are. $\underline{\frac{m_3}{m_1} \simeq 1.0}$ & $\underline{\frac{m_2}{m_1} \simeq 0.2}$.