

Answer on Question #44099 - Chemistry - Other

Question:

Three solutions X, Y, Z of HCl are mixed to produce 100ml of 0.1 M solution. The molarities of X, Y, Z are 0.07M, 0.12M and 0.15 M respectively. What respective volumes of X, Y and Z should be mixed?

Solution:

1. The amount of HCl in the resulting solution is the following:

$$c(\text{HCl}) = \frac{n(\text{HCl})}{V(\text{solution})}$$

Consequently

$$n(\text{HCl}) = c(\text{HCl}) \cdot V(\text{solution}) = \frac{100 \text{ mL}}{1000} \cdot 0.1 \frac{\text{mol}}{\text{L}} = 0.01 \text{ mol}$$

2. The volume of HCl in every solution is marked with x , y and z . We can write the equation:

$$V_{\Sigma}(\text{HCl}) = V_x(\text{HCl}) + V_y(\text{HCl}) + V_z(\text{HCl}) = x + y + z = 0.1 \text{ L}$$

Or

$$x + y + z = 0.1$$

3. Then we write the formula for total amount of HCl:

$$\begin{aligned} n_{\Sigma}(\text{HCl}) &= n_x(\text{HCl}) + V_y(\text{HCl}) + n_z(\text{HCl}) = c_{\Sigma}(\text{HCl}) \cdot n_{\Sigma}(\text{HCl}) \\ &= c_x(\text{HCl}) \cdot n_x(\text{HCl}) + c_y(\text{HCl}) \cdot n_y(\text{HCl}) + c_z(\text{HCl}) \cdot n_z(\text{HCl}) \\ &= 0.07x + 0.12y + 0.15z = 0.01 \text{ mol} \end{aligned}$$

Or

$$0.07x + 0.12y + 0.15z = 0.01$$

Or

$$7x + 12y + 15z = 1$$

4. The elimination of variable x it can be expressed by y , that is the solution Z is substituted by Y by way of coefficient expressed by ratio of respective molarities:

$$\frac{c_z(\text{HCl})}{c_y(\text{HCl})} = 1.25$$

Consequently,

$$z = 1.25y$$

5. The set of equations can be composed:

$$\begin{cases} x + y + z = 0.1 \\ 7x + 12 + 15z = 1 \end{cases}$$

If $z = 1.25y$, then

$$\begin{cases} x + y + 1.25y = 0.1 \\ 7x + 12y + 18.75y = 1 \end{cases}$$

Then

$$\begin{cases} x + 2.25y = 0.1 \\ 7x + 30.75y = 1 \end{cases}$$

$$\begin{cases} x = 0.1 - 2.25y \\ 7x + 30.75y = 1 \end{cases}$$

Then

$$7 \cdot (0.1 - 2.25y) + 30.75y = 1$$

$$0.7 - 15.75y + 30.75y = 1$$

$$15y = 0.3$$

$$y = 0.02$$

$$z = 1.25y = 0.025$$

$$x = 0.1 - y - z = 0.1 - 0.02 - 0.025 = 0.055$$

6. The volumes of solutions X, Y, Z are:

$$V_x(\text{HCl}) = 0.055 \text{ L} = 55 \text{ mL}$$

$$V_y(\text{HCl}) = 0.025 \text{ L} = 25 \text{ mL}$$

$$V_z(\text{HCl}) = 0.020 \text{ L} = 20 \text{ mL}$$

Answer: The volumes of X, Y, Z solutions are 0.055 L, 0.025 L and 0.020 L respectively.