

Answer on Question #62599, Chemistry / General chemistry

If the mole fraction for H₂SO₄ in an aqueous solution is (0.325), what is the mass of water (by gram) in a 100 mL of solution??

Solution:

The mole fraction of H₂SO₄ equal to:

$$x(\text{H}_2\text{SO}_4) = \frac{n(\text{H}_2\text{SO}_4)}{\sum n_i} = \frac{n(\text{H}_2\text{SO}_4)}{n(\text{H}_2\text{SO}_4) + n(\text{H}_2\text{O})}$$

We know, that volume of solution is 100 mL, we assumed that mass of solution is approximately 100g.

$$m(\text{solution}) = m(\text{H}_2\text{SO}_4) + m(\text{H}_2\text{O})$$

$$m(\text{H}_2\text{O}) = n(\text{H}_2\text{O}) \cdot M(\text{H}_2\text{O})$$

$$m(\text{H}_2\text{SO}_4) = n(\text{H}_2\text{SO}_4) \cdot M(\text{H}_2\text{SO}_4)$$

$$m(\text{solution}) = n(\text{H}_2\text{SO}_4) \cdot M(\text{H}_2\text{SO}_4) + n(\text{H}_2\text{O}) \cdot M(\text{H}_2\text{O})$$

From the 1st equation:

$$n(\text{H}_2\text{SO}_4) = x(\text{H}_2\text{SO}_4) \cdot (n(\text{H}_2\text{SO}_4) + n(\text{H}_2\text{O}))$$

Assume that $n(\text{H}_2\text{SO}_4)$ is x , and $n(\text{H}_2\text{O})$ is y .

$$\begin{cases} m(\text{solution}) = x \cdot M(\text{H}_2\text{SO}_4) + y \cdot M(\text{H}_2\text{O}) \\ x = x(\text{H}_2\text{SO}_4) \cdot (x + y) \end{cases}$$

From 2nd equation of the system of equations we found that:

$$x = \frac{0.325y}{1 - 0.325}$$

If we put this equation to 1st from this system, we will find that:

$$100 = \frac{0.325y}{1 - 0.325} \cdot 98 + y \cdot 18$$

$$65.19y = 100$$

$$y = n(\text{H}_2\text{O}) = 1.53 \text{ moles}$$

The mass of water in this solution equal:

$$m(\text{H}_2\text{O}) = n(\text{H}_2\text{O}) \cdot M(\text{H}_2\text{O}) = 1.53 \text{ moles} \cdot 18 \frac{\text{g}}{\text{mol}} = 27.54 \text{ g}$$

Answer: the mass of water is 27.54 g.