Answer on Question #57243 – Chemistry - Physical Chemistry

Question 1:

I need to prepare 50 mM of sodium acetate buffer at pH 5.4 and then adjust its molarity to 0.1, 0.2 and 0.5 M using NaCl alone. Suppose I prepare 1 L of the buffer, I should add 4.1 grams of sodium acetate to get a molarity of 50 mM. Now how do I calculate the amount of NaCl to be added to the buffer to get the desired molarities?

Solution:

If to dissolve in water only sodium acetate, pH the received solution will be more than 7 because of hydrolysis (sodium acetate is salt of weak acid and the strong basis). For receiving pH 5,4 it is necessary to add acetic acid to buffer solution.

Size pH, created by buffer solution is determined by Henderson--Hasselbakh's equation. For the buffer solutions formed by weak acid and it I will merge:

$$pH = pK_{acid} - lg\frac{C_{acid}}{C_{salt}},,$$

where a $pK_a = -\lg K_a$, C_{acid}, C_{salt} – concentration of acid and salt respectively.

rka of acetic acid it is equal 4,76. Having substituted this value in Gendersona-Hasselbakh's equation, we will receive:

$$5{,}4 = 4{,}76 - lg\frac{C_{acid}}{C_{salt}}$$

Then

$$lg\frac{C_{acid}}{C_{salt}} = 4{,}76 - 5{,}4 = -0{,}64$$

$$\frac{C_{acid}}{C_{salt}} = 10^{-0{,}64} = 0{,}229$$

$$C_{acid} = 0{,}229 \cdot C_{salt}$$

The total molyarity of solution is equal

$$C_{acid} + C_{salt} = 0{,}229 \cdot C_{salt} + C_{salt} = 1{,}229 \cdot C_{salt} = 0{,}050\text{M}$$

Then $$C_{salt} = \frac{0{,}050}{1{,}229} = 0{,}0407\text{M}$$

$$C_{acid} = 0{,}0407 \cdot 0{,}229 = 0{,}0093\text{M}$$

The molar mass of acetic acid and acetate of sodium is equal respectively 60 g/mol and 82 g/mol. Then for preparation of 1 l of the buffer it is necessary to take 0,0407·82 = 3,337 g of acetate of sodium and 0,093·60 = 0,559 g of acetic acid.

For preparation of solution with the general molarity 0,1M it is necessary to add 0,1 – 0,05 = 0,05 mol of NaCl on 1 l of buffer solution. The molar mass of NaCl is equal 58,5 g/mol, then for preparation of solution with the general molarity 0,1M it is necessary to add 0,05·58,5 = 2,925 g of NaCl on 1 l of the buffer.

Similarly for preparation of solution with the general molarity 0,2M it is necessary to add (0,2 – 0,05) ·58,5 = 8,775 g of NaCl on 1 l of the buffer, and for preparation of solution with the general molyarity 0,2M it is necessary to add (0,5 – 0,05) ·58,5 = 26,325 g of NaCl on 1 l of the buffer

Question 2:

I am trying to reproduce a research paper and the amount of protein (bovine serum albumin) mentioned in the paper is in volume fractions 0.1, 0.2, 0.3 and 0.4 added to the sodium acetate buffer. I am having trouble calculating the amount of protein which needs to be added. I have 10 grams of the protein. Is there any formula to convert volume fraction into the weight in mg?

Solution:

Density the globulyarnykh of proteins is considered equal 0,72 g/cm3. Then weight of 1 ml of protein is equal 0,72 g, and the volume of 1 g of protein is equal 1,0/0,72 = 1,39 ml.

For preparation of 10 ml of solution with a volume share of protein 0,1 it is necessary to take 0,72 g of protein and to bring total amount the buffer to 10 ml (for example, in the graduated test tube).

Similarly, for preparation of solution with a volume share of protein 0,2 it is necessary to take 0,72*2 = 1,44 g of protein; for preparation of solution with a volume share of protein 0,2 it is necessary to take 0,72*2 = 1,44 g of protein; for preparation of solution with a volume share of protein 0,3 it is necessary to take 0,72*3 = 2,16 g of protein; for preparation of solution with a volume share of protein 0,2 it is necessary to take 0,72*4 = 2,88 g of protein.