Answer on Question #54725 – Chemistry – Inorganic Chemistry

Question:

It is your first day of work in your new laboratory job. You are asked to prepare 700 mL of PBS (phosphate buffered saline). The PBS needs to be pH 7.40, with 25 mM phosphate and 140 mM NaCl. You are given a bottle of NaCl (FW = 58.45), a 1.00 M Na_2HPO_4 stock solution, and a 1.00 M NaH2PO4 stock solution. Describe how to prepare this buffer. (For H3PO4: pK1 = 2.12, pK2 = 7.21, pK3 = 12.66)

Answer:

The pH of the buffer is defined by the ratio of NaH_2PO_4 and Na_2HPO_4:

$pH = 6.86 – lg[NaH_2PO_4]/[Na_2HPO_4]$,

Thus, $lg[NaH_2PO_4]/[Na_2HPO_4] = 6.86 – pH = 6.86 - 7.40 = -0.54$,

and

$[NaH_2PO_4]/[Na_2HPO_4] = 0.2884$

At the same time the total amount of phosphate anions, which should be in 700 ml, equals:

$\nu(Total) = \nu(NaH_2PO_4) + \nu (Na_2HPO_4) = 25\ mM \times 700\ ml = 0.0175\ mol$

If $\nu(NaH_2PO_4) = 0.2884 \times \nu (Na_2HPO_4)$, then

$0.2884 \times \nu (Na_2HPO_4) + \nu (Na_2HPO_4) = 0.0175\ mol$

$\nu (Na_2HPO_4) = 0.01358$ mole

and

$\nu(NaH_2PO_4) = 0.2884 \times \nu (Na_2HPO_4) = 0.00392\ mol$

The volumes of 1M solutions needed to get the mentioned above amounts of phosphates are:

$\nu (Na_2HPO_4) = 0.01358$ mole corresponds to 13.58 ml of 1M Na_2HPO_4

$\nu(NaH_2PO_4) = 0.00392$ mol corresponds to 3.92 ml of 1M NaH_2PO_4

After mixing the portions of phosphates NaCl is added. Its amount in 700 ml should be:

$\nu(NaCl) = 140\ mM \times 700\ ml = 0.098\ mol.$

Thus, the needed mass is:

$m(NaCl) = \nu(NaCl) \times FW = 0.098 \times 58.45\ g = 5.7281\ g$

In the end, after mixing appropriate volumes of phosphates and solid NaCl, the final mixture is diluted with water to 700 ml.