Buffer solutions

Buffer solutions are used to minimise changes in pH value if small amounts of acid or alkali are added. Those mostly used in pharmacy are solutions of weak acids with their salts of strong bases. The pH of pharmaceutical preparations is controlled so that solubility can be increased, chemical instability minimised, product colour standardised and to protect the preparation from microbial contamination.

Phosphate buffers are generally used for adjustment of parenteral preparations, provided they are compatible with the substance to be injected. Phosphates react with calcium to form an insoluble precipitate of calcium phosphate. They exert their maximum buffer capacity at a pH value of about 6.8. For ophthalmic preparations, either phosphate or borate buffers may be used, depending on the pH value required and compatibility with the substances present. Borate buffers should not be used for injections or on abraded skin, where systemic absorption may occur.[1]

Buffer solutions may be adjusted to be isotonic with blood and lachrymal fluids by the addition of sodium chloride. Examples of buffers are given in Tables G.3 to G.8.[1]

Table G.3 Sorensen's phosphate buffer (0.067 M)

0.067 M disodium hydrogen phosphate: 2.39% $Na_2HPO_4.12H_2O$ in aqueous solution ($FD_{1\%}$ = 0.127 °C).
0.067 M potassium dihydrogen phosphate: 0.908% KH_2PO_4 in aqueous solution ($FD_{1\%}$ = 0.254 °C).
To obtain a solution with a particular pH value, these solutions are mixed in the following proportions.

0.067 M KH_2PO_4 (mL)	0.067 M $Na_2HPO_4.12H_2O$ (mL)	pH value at 25 °C
90.0	10.0	5.9
80.0	20.0	6.3
70.0	30.0	6.5
60.0	40.0	6.6
50.0	50.0	6.8
40.0	60.0	7.0
30.0	70.0	7.1
20.0	80.0	7.4
10.0	90.0	7.8
5.0	95.0	8.1

Table G.4 Walpole's acetate buffer (0.1 M)

0.1 M acetic acid: 0.6% w/v CH_3COOH in aqueous solution ($FD_{1\%}$ = 0.31 °C).

0.1 M sodium acetate: 1.36% $CH_3COONa.3H_2O$ in aqueous solution ($FD_{1\%}$ = 0.163 °C).

To obtain a solution with a particular pH value, these solutions are mixed in the following proportions.

0.1 M CH_3COOH (mL)	0.1 M $CH_3COONa.3H_2O$ (mL)	pH value at 25 °C
92.6	7.4	3.6
88.0	12.0	3.8
82.0	18.0	4.0
73.6	26.4	4.2
61.0	39.0	4.4
51.0	49.0	4.6
40.0	60.0	4.8
29.6	70.4	5.0
21.0	79.0	5.2
17.6	82.4	5.4
9.6	90.4	5.6

Table G.5 Isotonic phosphate buffer

0.067 M sodium acid phosphate: 1.04% $NaH_2PO_4.2H_2O$ in aqueous solution ($FD_{1\%}$ = 0.207 °C).

0.067 M disodium hydrogen phosphate (sodium phosphate BP): 2.39% $Na_2HPO_4.12H_2O$ in aqueous solution ($FD_{1\%}$ = 0.127 °C).

To obtain a solution with a particular pH value, these solutions are mixed in the proportions shown below, and to make the solution isotonic the specified amount of sodium chloride is added, as shown. Note that if a drug is to be dissolved in the buffer system, the amount of sodium chloride should be reduced appropriately. For pH calculations involving phosphoric acid, pKa2 is better expressed as the practical value of 6.8 at isotonic ionic strength, rather than the thermodynamic value of 7.1.

0.067 M $NaH_2PO_4.2H_2O$ (mL)	0.067 M $Na_2HPO_4.12H_2O$ (mL)	NaCl (g)	pH value at 25 °C	pH value at 37 °C
90	10	0.52	5.8	5.7
80	20	0.51	6.1	6.1
70	30	0.50	6.4	6.3
60	40	0.49	6.5	6.5
50	50	0.48	6.7	6.7
40	60	0.46	6.9	6.9
30	70	0.45	7.1	7.1
20	80	0.44	7.3	7.3
10	90	0.43	7.7	7.7
5	95	0.42	8.1	8.1