



## pH Properties of Buffer Solutions

### AP Chemistry Laboratory #19

#### Introduction

One of the most important applications of acids and bases in chemistry and biology is that of buffers. A buffer solution resists rapid changes in pH when acids and bases are added to it. Every living cell contains natural buffer systems to maintain the constant pH needed for proper cell function. Many consumer products are also buffered to safeguard their activity. What are buffers made of? How do buffers maintain the delicate pH balance needed for life and health?

#### Concepts

- Buffer
- Weak acid–weak base
- Conjugate acid–base pair
- Dissociation constant
- Ideal buffer

#### Background

The ability of buffers to resist changes in pH when acid or base is added is a result of their chemical composition. All buffers contain a mixture of a conjugate acid–base pair; either a weak acid (HA) and its conjugate base ( $A^-$ ), or a weak base (B), and its conjugate acid ( $BH^+$ ). Weak acids and weak bases both dissociate slightly in water (Reactions 1 and 2).



These reactions are reversible and both the weak acid and its conjugate base or the weak base and its conjugate acid are present in solution.

The equilibrium constant expressions for these dissociation reactions are:

$$K_a = [\text{H}_3\text{O}^+][\text{A}^-]/[\text{HA}] \quad \text{Equation 1}$$

$$K_b = [\text{OH}^-][\text{BH}^+]/[\text{B}] \quad \text{Equation 2}$$

Buffers control pH because the two buffering components, either HA and  $A^-$  or B and  $BH^+$ , are able to neutralize both acids and bases added to the solution.



# Chemfax Ph Buffer Solutions Lab Answers

**L Reisser**



## Chemfax Ph Buffer Solutions Lab Answers:

**Measurement of PH** Richard E. Lawn, Florence Elizabeth Prichard, 2003 Whether pH is being used to test a sample against a legal requirement or specification as part of an analytical method for monitoring and controlling a reaction as a process control in the chemical industry or for the environmental monitoring of waste and effluents it is important that all pH measurements are carried out in a logical and consistent manner paying careful attention to experimental procedures in order to obtain reliable results This guide provides scientists with the knowledge of how to do just that first by outlining the principles of pH measurement and buffer solutions pH meters and electrodes are then discussed including selection criteria and the care of electrodes Finally sections on making pH measurements and uncertainty are followed by a set of practical exercises Measurement of pH is one of the Practical Laboratory Skills Training Guides a series that aims to make achieving best practice easy These invaluable manuals will enable both experienced and inexperienced staff to get the essential basics of any experiment right simply by following the clear and easy to use instructions provided The guides are written by experienced scientists and include minimal theory plenty of practical exercises in order to assess competence and trouble shooting information Other titles are Measurement of Mass Measurement of Volume High Performance Liquid Chromatography and Gas Chromatography Buffers for PH and Metal Ion Control ,1974 The theory of buffer action Applications of pH buffers Practical limitations in the use of buffers New pH buffer tables and systems Buffers for use in partially aqueous and non aqueous solvents and heavy water Metal ion buffers Purification of substances used in buffers Preparation of buffer solutions Buffer Solutions Professor Rob Beynon, J Easterby, 2004-03-01 An indispensable guide to buffers and to understanding the principles behind their use Helps the user to avoid common errors in preparing buffers and their solutions A must for researchers in the biological sciences this valuable book takes the time to explain something often taken for granted buffers used in experiments It answers the common questions such as which buffer should I choose What about the temperature effects What about ionic strength Why is the buffer with the biggest temperature variation used in PCR It provides even the most experienced researchers with the means to understand the fundamental principles behind their preparation and use an indispensable guide essential for everyone using buffers *Colorimetric Determination of PH Without Buffer Solutions* P. H. Symons, 1934 *Studying the Ph of Strong Acid, Weak Acid, Salt & Buffer Solutions* Marcia L. Gillette, Norma Robinson North, 1998-01-01 *Standard Buffer Solutions* George G. Manov, 1947 For the purpose of calibrating pH meters such as the hydrogen calomel and the glass calomel type it is necessary to have on hand a number of buffer solutions of certified pH value covering the ranges of temperature and pH over which it is desired to work Of the large number of compounds both organic and inorganic known to the chemist comparatively few however have the requisite properties such as uniformity and reproducibility of composition freedom from deliquescence or efflorescence ease of preparation and purification and good buffer capacity which would make them acceptable as buffer materials In the past

thirty years the concept of the term pH underwent a change from that of the simple definition of  $\text{pH} = -\log C_{\text{H}^+}$  to the more modern definition of  $\text{pH} = -\log a_{\text{H}^+}$  when it was realized that the potential of the hydrogen electrode was a measure of the activity of the hydrogen ion rather than of its concentration. Paradoxically however the activity of single ions cannot be determined from experiment without the use of some simplifying assumptions it is therefore impossible to establish a pH scale on a rigorous thermodynamic basis. This point will be discussed later. The problem of purification of salts is one primarily of analytical chemistry and the materials can be tested to determine their relative purity and reproducibility by any self consistent method.

**Crystallization-related PH Changes During Freezing of Sodium Phosphate Buffer Solutions** Gerardo Gómez,1995     DIN 19266 ,2000     **A Comparison of Common Methods of Measuring PH Using Three Different Sets of Buffer Solutions** Roy Ernest Sjogren,1941     **A Study of the PH Values of Buffer Solutions, Using the Hydrogen Electrode and Free Diffusion Liquid Junctions** J. J. Greczek,1965

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