As Per PCI Regulations

First Year B. Pharm. . Semester-I

PHARMACEUTICAL ANALYSIS

Dr. Puspendra Kumar



A Text Book Of

PHARMACEUTICAL ANALYSIS

As Per PCI Regulations

FIRST YEAR B. PHARM. Semester I

Dr. Puspendra Kumar

M. Pharm., Ph.D. Associate Professor KIET School of Pharmacy, KIET Group of Institutions, Ghaziabad

Price ₹ 160.00



N4007

ISBN 978-93-86700-36-0 Pharmaceutical Analysis Second Edition : April 2018 Author The text of this publication, or any part thereof, should not be reproduced or transmitted in any form or stored in any computer storage system or device for distribution including photocopy, recording, taping or information retrieval system or reproduced on any disc, tape, perforated media or other information storage device etc., without the written permission of Author with whom the rights are reserved. Breach of this condition is liable for legal action. Every effort has been made to avoid errors or omissions in this publication. In spite of this, errors may have crept in. Any mistake, error or discrepancy so noted and shall be brought to our notice shall be taken care of in the next edition. It is notified that neither the publisher nor the author or seller shall be responsible for any damage or loss of action to any one, of any kind, in any manner, therefrom. Published By : Polyplate Printed By a NIRALI PRÁKASHAN **YOGIRAJ PRINTERS AND BINDERS** Abhyudaya Pragati, 1312, Shivaji Nagar, Works: Sr. No. 10\1,Ghule Industrial Estate, Off J.M. Road, PUNE – 411005 Nanded Village Road. TAL-HAVELI, DIT-PUNE 411041 Tel - (020) 25512336/37/39, Fax - (020) 25511379 Email : niralipune@pragationline.com Mobile - 9850046517, 9404225254 DISTRIBUTION CENTRES PUNE Nirali Prakashan : 119, Budhwar Peth, Jogeshwari Mandir Lane, Pune 411002, Maharashtra Tel : (020) 2445 2044, 66022708, Fax : (020) 2445 1538 Email : bookorder@pragationline.com, niralilocal@pragationline.com Nirali Prakashan : S. No. 28/27, Dhyari, Near Pari Company, Pune 411041 Tel: (020) 24690204 Fax: (020) 24690316 Email: dhyari@pragationline.com, bookorder@pragationline.com MUMBÁI Nirali Prakashan : 385, S.V.P. Road, Rasdhara Co-op. Hsg. Society Ltd., Girgaum, Mumbai 400004, Maharashtra Tel : (022) 2385 6339 / 2386 9976, Fax : (022) 2386 9976 Email : niralimumbai@pragationline.com **INTRIBUTION BRANCHES** JALGAON Nirali Prakashan : 34, V. V. Golani Market, Navi Peth, Jalgaon 425001, Maharashtra, Tel : (0257) 222 0395, Mob : 94234 91860 KOLHAPUR Nirali Prakashan : New Mahadvar Road, Kedar Plaza, 1st Floor Opp. IDBI Bank Kolhapur 416 012, Maharashtra. Mob : 9850046155 NAGPUR Pratibha Book Distributors : Above Maratha Mandir, Shop No. 3, First Floor, Rani Jhanshi Square, Sitabuldi, Nagpur 440012, Maharashtra Tel: (0712) 254 7129 DELHI Nirali Prakashan : 4593/15, Basement, Aggarwal Lane, Ansari Road, Daryaganj Near Times of India Building, New Delhi 110002 Mob: 09555778814 **BENGALURU** Pragati Book House : House No. 1, Sanjeevappa Lane, Avenue Road Cross, Opp. Rice Church, Bengaluru – 560002. Tel: (080) 64513344, 64513355, Mob: 9880582331, 9845021552 Email:bharatsavla@yahoo.com **CHENNAI** Pragati Books : 9/1, Montieth Road, Behind Taas Mahal, Egmore, Chennai 600008 Tamil Nadu, Tel : (044) 6518 3535, Mob: 94440 01782 / 98450 21552 / 98805 82331, Email : bharatsavla@yahoo.com Note: Every possible effort has been made to avoid errors or omissions in this book. In spite this, errors may have crept in. Any type of error or mistake so noted, and shall be brought to our notice, shall be taken care of in the next edition. It is notified that neither the publisher, nor the author or book seller shall be responsible for any damage or loss of action to any one of any kind, in any manner, therefrom. The reader

must cross check all the facts and contents with original Government notification or publications.

niralipune@pragationline.com | www.pragationline.com

Also find us on 🛽 🗴 www.facebook.com/niralibooks

Dr. Shivesh. Jha

Professor Dept. of Pharm. Sci. & Tech. Birla Institute of Technology Mesra, Ranchi

Foreword

Pharmaceutical analysis is backbone of drug industries and highly useful to standardize the modern medicinal agents. Basic analytical technique includes acid base titrations, redox titrations, precipitation titrations, complexometric titrations, gravimetric analysis, potentiometry, polarography and conductometric analysis. Hence, presenting all the basic and significant aspects of the vast area of knowledge within the limited space is indeed a stupendous job which **Dr. Puspendra Kumar** has been able to achieve with a fair degree of success in a commendable manner.

This book presents a rich text material which provides background information of various topics. Diagrammatic representation of the methodologies will be highly beneficial for the readers. Examples are cited in a simple manner which enhances the understanding of the topics. Dr. Kumar has taken great effort in compiling fundamentals of analysis in very simple and organized manner; which will be supportive in developing basics of students.

I am sure; this book will be a good and useful aid to those involved in teaching and learning of pharmaceutical analysis. I wish him for success and congratulate him for his excellent efforts.

With Best Wishes

Dr. Shivesh Jha

Preface

It gives me immense pleasure to present to pharmacy students my book entitled "**Pharmaceutical Analysis**". Writing a book is inspiring, often exciting, and sometimes very challenging work.

Pharmaceutical analysis plays a vital role in evaluation of various drug(s)/ compound(s) sample. Analysis of the compounds starts from basic analytical tools i.e. calibration of the glasswares, handling of the analytical balance, various titration methods, electrochemical methods etc. Thus, without basic analytical tools further advanced study is tedious and costly.

This book mainly guides students to get knowledge about basics of pharmaceutical analysis. All the contents are discussed in detail and suitable examples are explained whenever required. This book is highly useful for understanding of principle(s) involved in various volumetric methods and covers almost each category of volumetric analysis in a simplest way. Methodologies of various techniques are represented by diagrams/figure(s) for better understanding. The book contains calculations and important questions related to the topics to fulfill the requirements of students.

I am grateful to Dr. Shivesh Jha for his constant encouragement and suggestions given during completion of this book.

I record my sincere thanks to Dr. Jaya Dwivedi, Dr. Jagannath Sahoo, Dr. Sanjar Alam, Dr. Swapnil Sharma, Dr. Sunil Kumar Dubey, Dr. Avijit Mazumdar, Dr. Jainendra Jain, Dr. L. Baskar, Dr. Shekhar Verma, Dr. Rikeshwer, Dr. Abhishek for constant encouragement and suggestions to write this book.

I thank my wife Mrs. Durgawati Patel for her constant support to review the content of this book and moral support. I am thankful to my seniors, friends and students who gave me suggestions whenever I asked for betterment of this book.

I appreciate the co-operation and interest taken by Publisher Shri Dinesh Furia, Shri Jignesh Furia and Mr. Amit Jha, Mrs. Roshan Khan of Nirali Prakashan, Pune in bringing out this book.

I will be grateful to all the teachers and students who will be kind enough to point out my mistakes that have escaped my attention. Suggestions for future improvement are always welcome.

Dr. Puspendra Kumar

Syllabus

UNIT - I

(a) Pharmaceutical analysis: Definition and scope.

- (i) Different techniques of analysis.
- (ii) Methods of expressing concentration.
- (iii) Primary and secondary standards.
- (iv) Preparation and standardization of various molar and normal solutions Oxalic acid, sodium hydroxide, hydrochloric acid, sodium thiosulphate, sulphuric acid, potassium permanganate and ceric ammonium sulphate.
- (b) Errors: Sources of errors, types of errors, methods of minimizing errors, accuracy, precision and significant figures

(c) Pharmacopoeia, Sources of impurities in medicinal agents, limit tests.

UNIT - II

- Acid base titration: Theories of acid base indicators, classification of acid base titrations and theory involved in titrations of strong, weak, and very weak acids and bases, neutralization curves.
- Non-aqueous titration: Solvents, acidimetry and alkalimetry titration and estimation of Sodium benzoate and Ephedrine HCI.

UNIT - III

- Precipitation titrations: Mohr's method, Volhard's, Modified Volhard's, Fajans method, estimation of sodium chloride.
- Complexometric titration: Classification, metal ion indicators, masking and demasking reagents, estimation of magnesium sulphate and calcium gluconate.
- Gravimetry: Principle and steps involved in gravimetric analysis, Purity of the precipitate, Co-precipitation and post precipitation, Estimation of barium sulphate.
- Basic Principles, methods and application of diazotisation titration.

UNIT - IV

Redox titrations

- (a) Concepts of oxidation and reduction
- (b) Types of redox titrations (Principles and applications)

Cerimetry, Iodimetry, Iodometry, Bromatometry, Dichrometry, Titration with potassium iodate.

UNIT - V

Electrochemical methods of analysis:

- **Conductometry:** Introduction, Conductivity cell, Conductometric titrations, applications.
- Potentiometry: Electrochemical cell, construction and working of reference (Standard • hydrogen, silver chloride electrode and calomel electrode) and indicator electrodes (metal electrodes and glass electrode), methods to determine end point of potentiometric titration and applications.
- **Polarography:** Principle, Ilkovic equation, construction and working of dropping mercury ٠ electrode and rotating platinum electrode, applications.

[10 Hours]

[10 Hours]

[10 Hours]

[08 Hours]

[07 Hours]

Contents

UNIT I

1.	Pha	armaceutical Analysis	1.1 - 1.38
	1.1	Definition	1.1
		1.1.1 Types of Analytical Chemistry	1.2
		1.1.2 Steps in Chemical Analysis	1.2
		1.1.3 Factors Affecting the Choice of Analytical Technique	1.3
		1.1.4 Classification of Pharmaceutical Analysis Laboratories	1.4
		1.1.5 Scope of Analytical Chemistry	1.4
	1.2	Different Techniques of Analysis	1.5
	1.3	Methods of Expressing Concentration	1.5
	1.4	Primary and Secondary Standard Substances	1.8
		1.4.1 Primary Standard Substances	1.8
		1.4.2 Secondary Standard Substances	1.10
	1.5	Preparation and Standardization of Various Molar and Normal Solutions	1.10
	1.6	Errors	1.22
		1.6.1 Sources of Errors	1.23
		1.6.2 Types of Errors	1.23
		1.6.3 Methods of Minimizing Errors	1.25
		1.6.4 Accuracy and Precision	1.25
		1.6.5 Significant Figures	1.27
	1.7	Pharmacopoeia	1.28
	1.8	Sources of Impurities in Medicinal Agents	1.29
	1.9	Limit Tests	1.30
	•	Questions	1.36
		UNIT II	
2.	Aci	d Base Titrations	2.1 - 2.28
	2.1	Introduction	2.1
	2.2	Theories of Acid Base Titrations	2.2
	2.3	Law of Mass Action	2.3
	2.4	Role of Solvents	2.4
	2.5	Ionization	2.6
	2.6	Relative Strength of Acid and Bases	2.7
	2./	pH and pOH Jamia President of Western	2.8
	∠.ŏ 2 0	Hudrolucie of Salte	2.9
	2.7	Henderson Hesselbach Fauation	2.10
	2.10		2.12

- Role of Solvents
- lonization
- 2.4 2.5 2.6 2.7 Relative Strength of Acid and Bases pH and pOH 2.8 Ionic Product of Water
 2.9 Hydrolysis of Salts
 2.10 Henderson Hesselbach Equation 2.11 Buffer Solution
- 2.12 Classification of Acid Base Titrations 2.13 Theories of Indicators
- 2.14 Indicators of Acid Base Titrations

3. Non-aqueous Titrations

. No	on-aqueous Titrations	3.1 - 3.10	
3.1	Solvents	3.1	
3.2	Types of Solvents in Non-aqueous Titrations	3.2	
3.3	Levelling Effect	3.3	
3.4	Acidimetry and Alkalimetry Titration	3.4	
3.5	Indicators	3.4	
3.6	Estimation of Sodium Benzoate	3.7	
3.7	Estimation of Ephedrine HCl	3.8	
•	Questions	3.10	

2.12

2.15 2.23

2.24 2.26

UNIT III

4.	Pre	cipitation Titrations	4.1 - 4.18
	4.1	Precipitation Reaction	4.1
	4.Z 4.3	Effect on Solubility of Precipitate	4.2
	4.4	Argentometric Titrations	4.4
	4.5	Thiocyanatometric Titrations	4.7
	4.6	Mercurometric Titrations	4.7
	4.7	Gay Lussac's Method	4.9
	4.8 ∕/ 0	Monr's Method	4.10
	4.7	Egian's Method	4.11
	4.11	Estimation of Sodium Chloride	4.14
	•	Questions	4.16
5.	Cor	nplexometric Titrations	5.1 - 5.26
	5.1	Principle	5.1
	5.2	Complexing Agents	5.2
	5.3	Masking and Demasking Agents	5.3
		5.3.2 Demasking	5.5
	5.4	Indicators	5.7
	5.5	Instrumental Methods for End Point Detection in Complexometry	5.9
	5.6	Types of Complexometric Titrations	5.10
	5.7	Preparation and Standardization of 0.05 m Disodium Edetate Solution	5.11
	5.0 5.9	Determination of Calcium Gluconate	5.14
	5.9	Assay of Potassium Alum	5.19
	5.10	Determination of Hardness of Water	5.21
	•	Questions	5.24
6.	Gra	Ivimetric Analysis	6.1 - 6.12
	6.1	Precipitation Techniques	0.1
	6.3	Colloidal Precipitates	6.2
	6.4	Supersaturation	6.4
	6.5	Co-precipitation	6.5
	6.6	Gravimetric Methodology	6.5
	0./ 6.8	Cruciples	0.0 6.8
	6.9	Thermoaravimetric Analysis (TGA)	6.9
	6.10	Organic Precipitants	6.10
	6.11	Estimation of Barium Sulphate	6.10
_	•	Questions	6.11
7.	Dia 7 1	zotization Titration Principle	7.1 - 7.4
	7.2	Types of Diazotization Titrations	7.1
	7.3	Methododology	7.2
	7.4	Conditions for the Diazotization Titration	7.3
	7.5	Advantages and Disadvantages	7.3
	7.6	Applications of Diazotization Titration	7.4
	•	Questions	7.4

UNIT IV

3.	Rec	lox Titrations	8.1 - 8.22
	8.1	Introduction	8.1
	8.2	Redox Reactions	8.2
	8.3	Oxidation Number or Oxidation State (OS)	8.2
	8.4	Balancing Simple Redox Reactions	8.3
	8.5	Strength and Equivalent Weights of Oxidizing and Reducing Agents	8.3
	8.6	Theory of Redox Titrations	8.4
	8.7	Redox Indicators	8.5
		8.7.1 Types of Indicators	8.5
	8.8	Cell Representations	8.6
	8.9	Measurement of Electrode Potential	8.6
	8.10	Oxidation Reduction Curves	8.7
		8.10.1 Cerimetric Titration	8.8
	8.11	lodimetry and lodometry	8.11
	8.12	Bromatometry	8.13
	8.13	Dichrometry	8.13
	8.14	Titration with Potassium Iodate	8.14
	8.15	Some Common Oxidants and Reductants	8.15
	8.16	Preparation and Standardisation of 0.1 N KMNO ₄ Solution	8.15
	8.17	Assay of Ferrous Sulphate	8.17
	8.18	Assay of Copper Sulphate	8.19
	•	Questions	8.20

9. El€	ectrochemical Methods of Analysis	9.1 - 9.18
9.1	Conductometry	9.1
	9.1.1 Introduction	9.1
	9.1.2 Fundamentals of Conductometry	9.2
	9.1.3 Instrumentation	9.3
	9.1.4 Types of Conductometric Titrations	9.4
	9.1.5 Advantages and Disadvantages of Conductometric Titration	s 9.7
	9.1.6 Applications of Conductometry	9.7
9.2	Potentiometry	9.7
	9.2.1 Introduction	9.7
	9.2.2 Electrochemical Cell	9.8
	9.2.3 Reference Electrodes	9.9
	9.2.4 Indicator Electrodes	9.12
	9.2.5 Instrumentation	9.13
	9.2.0 Types of Folemiometric Tiltations 9.2.7 Applications and Advantages of Potentiometric Titrations	9.14
03	Polaroaraphy	9.15
/.0	9.3.1 Principle	9.15
	9.3.2 Ilkovic Equation	9.15
	9.3.3 Dropping Mercury Electrode (DME)	9.16
	9.3.4 Rotating Platinum Electrode (RPE)	9.17
	9.3.5 Applications and Advantages of Polarography	9.17
•	Questions	9.17
Inc	lex	1.1 - 1.4
Ар	pendix	A.1 - A.4
-	***	

Preliminaries and Definitions:

- **1. Volumetric or Titrimetric Analysis:** It consists of determination of volume of solution of accurately known concentration required to react completely with the solution of substance to be determined.
- **2. Standard Solution:** The solution of accurately known concentration is called as the standard solution.
- **3. Standardization:** Standardization is the method of analysis to determine and ensure the claimed quantity of the compounds or chemicals.
- **4. Titrate/Titrand:** The solution of unknown concentration and the substance being titrated is called titrate.
- **5. Titrant:** The solution of known concentration is used in titration (usually added from burette).
- **6. Equivalence point of stoichiometric end point:** The point at which the reaction between titrant and titrate (titrand) is just completed.
- **7. End-point:** The point at which the reaction between titrant and titrate (titrand) is showing some changes in terms of colour, pH etc. during experiment.
- **8. Indicator:** It is an auxiliary substance which shows clear viral change after the reaction between titrant and titrates is particularly complete.
- **9. Titration Error:** In practice, usually there is very small difference between theoretical end-point and actual end-point. This is called as titration error.
- **10. True Value:** Actual or correct value is considered as true value. True values are known only when we count objects or when a quantity is assigned a particular value. In other cases the true value of a quantity is never known.
- **11. Standard Value:** Standard values are representative values based on the experience record of the process. If an expert using a suitable method and a good quality apparatus carefully determine the percentage value, then it is called standard value.
- **12. Observed Value:** The observed value is the value truly measured as the test is performed in the laboratory.
- **13. Error:** The difference between the true value or standard value and observed value is called error.

UNIT I

Chapter ... **1**

PHARMACEUTICAL ANALYSIS

♦ LEARNING OBJECTIVES ♦

- The course intends to impart knowledge of the basic analytical techniques involved in determining unknown concentrations of different constituents present in solutions or solids using volumetric titrations or gravimetric methods.
- To study the preliminaries and definitions used in analysis.
- To study the accuracy and precision parameters and minimization of errors during analytical experiments.

OUTCOMES

On satisfying the requirements of this course, students will have the knowledge and skills to:

- Understand that all measurements involve errors and that the analytical procedure is only as accurate as the least accurate measurement.
- Understand that for each technique the sources and magnitudes of errors can be identified and quantified (If possible); and finally errors can be reduced upto great extent.
- Understand that the magnitude of the error in the analysis can be reflected using the correct significant figures when reporting results.
- Have complete knowledge of basic terms like molarity, molality, normality, weight percentage calculation and applications based on them.

1.1 DEFINITION

Pharmaceutical analysis or chemical analysis is 'a technique to identify and/or quantify any sample, substance, compound by using manual, chemical or instrumental techniques by qualitative or quantitative method(s)'. Analytical chemistry is apprehensive with the theory and practice of techniques used to determine the composition of substance(s). Analytical chemistry is very broad and squeezes a wide range of techniques. Chemical analysis is applied in daily life i.e. soaps and detergents act as emulsifiers to surround dirt and grime so it can be washed away from clothing, dishes and our bodies. Analytical chemistry can be classified into qualitative and quantitative analysis. 1.2

1.1.1 Types of Analytical Chemistry

1. Qualitative Analysis: Completely unknown sample is analysed to determine the presence or absence of the particular substance(s) in the sample, and the technique is known as qualitative analysis. Qualitative analysis is based on either present or absent phenomenon. Identification of the compounds or substances takes place in this technique.

Example: Phenolphthalein indicator gives light pink colour in alkaline medium; light pink colour in the alkaline solution will be either present or absent. The technique is qualitative analysis because we are not determining the intensity of colour present.

2. Quantitative Analysis: Determination of the quantity in numbers, weight, length or any other measurement parameter is carried out under quantitative analysis. Specified components are quantified in the sample by using quantitative methods. Various quantitative methods are available to determine the samples(s). i.e.: Titrimetry, volumetry, gravimetry, thermal, electro-chemical, spectral analysis etc.

Example: Assay of NaCl is carried out by volumetric method and the accurate percentage purity of the given sample is determined by volumetric analysis.

1.1.2 Steps in Chemical Analysis

1. Sampling

An analyst has to determine the nature of a large quantity of substances(s). In ideal condition analyst should analyze every part of the substance(s) to get the accurate result, but it is not possible every time. So, according to the physical nature and size of the substance(s) available sampling is carried out.

2. Sample preparation

Sample preparation includes the dealing of the samples prior to its analysis i.e. reduction of the particle size, mixing of the samples to get homogeneity, drying of the samples, determination of quantity of the sample in terms of weight or volume etc.

3. Processing of sample for analysis

Accurate and above selected sample(s) are processed to carry out the analysis i.e. heating, fusion or ignition of the sample(s), use of the solvent(s) to dissolve the sample(s), dilution of the sample(s) etc. In second step of the sample processing the prepared sample(s) are treated by suitable method to purify, to get better and accurate results i.e. filtration, solvent extraction, ion exchange methods, chromatographic separations etc.

4. Selection of analytical technique(s)

Selection of appropriate method was done by the analyst, and basis of the selection is nature of the sample and required output. Various analytical methods are available for analysis of the samples. i.e. volumetric, gravimetric, spectroscopic, electro-chemical etc.

5. Analysis of sample by selected technique

Appropriate analytical method is selected and samples are analysed by selected method to get the result(s). Analysis of the sample involves calibration, optimization, standardization

Pharmaceutical Analysis



Publisher : Nirali Prakashan

ISBN : 9789386700360

Author : Dr. Puspendra Kumar

Type the URL : http://www.kopykitab.com/product/20549

