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Chemistry

D. J. Shaw
and
H. E. Avery

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General Introduction

The Nature and Purpose of This Book

This book is primarily intended for students in the early stages of a chemistry degree or equivalent course. It covers most of the physical chemistry found in first-year syllabuses and much second-year material as well. The book should also prove useful for students of related subjects in the physical and life sciences and for ambitious 'A' Level students who wish to extend and broaden their knowledge of physical chemistry, particularly if intending to sit an 'S' Level chemistry examination.

It is not intended as a substitute for a textbook of physical chemistry. Following a short introductory chapter on units and methods of expression, the subsequent chapters cover the major areas of physical chemistry. Each chapter contains sections in which basic theory is set out in a concise fashion. Factual material and experimental detail are kept to a minimum. The text should provide not only a base for clarifying and consolidating the fundamentals of physical chemistry, but also a convenient revision aid. Most physical chemistry examinations are heavily weighted with numerical problems and this book seeks to give the reader familiarity and practice in methods of solving these. Simple examples are given in the main text to illustrate points as they arise. Each chapter contains a selection of worked examples, some covering a single topic and some of wider and more ambitious content. Students may care to attempt these before inspecting the worked answer. At the end of each chapter there are some unworked examples, with answers provided at the end of the book. Some of the numerical examples are taken from past examination papers. Since, in most cases, only part of the question is quoted, it would be misleading to assume that these questions always reflect the standard required in a particular examination.

The book builds on the physicochemical topics covered in *Work Out Chemistry 'A' Level*. The basic concepts of thermodynamics are extended and applied to phase equilibria and solutions. Chemical kinetics includes rate theory and an introduction to complex reactions. Electrochemistry is divided into a study of the nature of and processes in electrolyte solutions and a study of electrode processes. The book concludes with introductions to two topics that may be new to most students, 'Surface chemistry and colloids' and 'Molecular structure and spectroscopy'.

Background Knowledge

The reader is assumed to be reasonably familiar with the following topics:

- (a) Perfect (ideal) and real gases; perfect gas equation ($pV = nRT$). Dalton's law of partial pressures ($p_{\text{total}} = p_A + p_B + \dots$). Basic characteristics of solid,

- liquid and gaseous states. Existence and consequences of van der Waals' forces and hydrogen bonding.
- (b) Simple kinetic theory of gases; kinetic interpretation of thermodynamic temperature. Distribution of energy amongst molecules.
 - (c) Stoichiometric equations. Mole concept and Avogadro constant.
 - (d) Law of mass action and its use to formulate expressions for equilibrium constants. Le Chatelier's principle.
 - (e) Factors affecting the rate of a reaction.
 - (f) Acids and bases; dissociation of water; pH; buffer solutions; dissociation constants; solubility product. Oxidation and reduction. Electrolysis.
 - (g) Logarithms and exponentials. Basic calculus and algebra.

Revision

Obtain copies of your syllabus and a selection of past examination papers. Most universities/polytechnics/colleges have provision for this. Ascertain as far as you can the relevance of past questions to your year of study; there may have been syllabus and/or staff changes since then. Identify as clearly as possible the subject areas that you need to study and the breadth and depth of knowledge that is expected from you. Much of this should be self-evident, but if in any doubt do not hesitate to ask your lecturers, who, in general, will be only too pleased to help.

It is essential that you own a textbook of physical chemistry; there are several excellent ones available. Also on the market is a selection of monographs on specific areas of physical chemistry; you should purchase and/or make library use of some of these. In general, your choice of textbooks will be dictated by the recommendations of your lecturers.

It is essential that your study programme be spread over the whole of the academic year. An appropriate number of hours per week should be set aside for reviewing, understanding and, if necessary, supplementing your lecture material. Leaving this work to a concentrated effort during the last few weeks before the examination is a well known recipe for disaster. The final period of revision should be for 'fine tuning'. Work in a place where you are as free as possible from external distractions. One hour of solid, well organised work is far more useful than several hours of vague, uncoordinated effort. Remember that the brain has a limited capacity for reception during a long study period.

Resist the temptation to bias revision towards your favourite subject area, but strive for reasonably even coverage. If anything, you should bias your study time to your weaker subjects.

Spend a fair proportion of your study time in an active role, writing things down, attempting problems, etc., rather than in the more passive role of just reading. Where possible, have a very brief pre-read, without bothering too much about the detail, before you attend the lecture(s) on a particular subject. Do not attempt to take copious notes during a lecture; just get enough down on paper for future revision purposes and devote as much effort as possible actually to listening to and trying to understand the lecturer. You can then use this book plus your textbook(s) and your brief lecture notes to produce a clear and fuller set of notes. The act of writing is a very effective learning method.

Examinations

Make sure that you are familiar with the rules. Scan through the paper first and tick off or put a question mark against those questions you are likely to attempt.

Do the question that you feel you can answer best first; this should help to build up confidence.

Before writing your answer to a descriptive question, pencil in proposed sub-headings and formulate a suitable order. This should help at a very early stage to confirm your selection of the question. It should also make the resulting account easier to write, and it will read better. It may even save time and will act as a partial insurance against forgetfulness at a later stage.

Divide your time fairly evenly between questions, especially those of a descriptive nature. The first few marks in these questions tend to be quite easy to obtain, but for the last few marks a situation of diminishing returns usually exists. It follows that it is bad technique to spend excessive time on an already good answer for a possible extra mark or two if this puts at risk the award of several easy marks on another question.

The examination paper is likely to contain several calculations and may be constructed so that you are forced to attempt one or more of these. When it comes to a choice between calculation and descriptive material, confidence is the important factor. For the able and well prepared student, calculations allow high (even full) marks to be obtained and can often be done in a relatively short time. If you do get into a hopeless muddle, do not ponder over it for too long, but move on to another question. Many questions involve descriptive material followed by a calculation and if you feel uncertain about the calculation (especially if it carries a high mark) and need to test it out, it may be a good idea to try this part first. Sometimes you will know how to set about a calculation, but the detail defeats you. If you state clearly what you were trying to do and indicate the type of answer that you would have expected, a moderate mark is still possible. Alternatively, you might obtain the wrong answer because of an undetected arithmetic slip. If the answer is obviously wrong, say so and indicate, with reason(s) if possible, the type of answer that you would have expected. The loss of marks in such circumstances should be small. Finally, with calculations, be careful with powers of 10 and do not forget units.