



Peter Atkins

CHEMISTRY

A Very Short Introduction

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Preface

I hope to open your eyes and show you a fascinating, intellectually and economically important world, that of chemistry. Chemistry, I have to admit, has an unhappy reputation. People remember it from their schooldays as a subject that was largely incomprehensible, fact-rich but understanding-poor, smelly, and so far removed from the real world of events and pleasures that there seemed little point in coming to terms with its grubby concepts, spells, recipes, and rules. In later life that unhappy reputation is often rendered unhappier still by an awareness of the environmental impact of nasty chemicals escaping into the wild and bringing disaster to softly green clover-clad bucolic meadows that were home to the glowing poppy and the dancing butterfly, rendering into inhospitable mud the banks where the wild thyme once grew, generating toxic sludge and noxious slime where limpid streams had rippled, replacing air fragrant with aeolian delight with pungency, and generally messing things up.

I want to change all that. I want to encourage you to look anew at chemistry, through modern unprejudiced eyes, with those memories and attitudes swept away and replaced by comprehension and appreciation. I want to show you the world through a chemist's eyes, to understand its central concepts, and see how a chemist contributes not only to our material comfort but also to human culture. I want to explain how chemists think

and how what they reveal about matter—all forms of matter, from rocks to humans—adds pleasure to our perception of the world. I want to show you how chemists take one form of matter, perhaps sucked or dug from the ground or plucked from the skies, and turn it into another form, perhaps to clothe us, feed us, or comfort us.

I want to share with you the thought that chemistry provides the infrastructure of the modern world. There is hardly an item of everyday life that is not furnished by it or based on the materials it has created. Take away chemistry and its functional arm the chemical industry and you take away the metals and other materials of construction, the semiconductors of computation and communication, the fuels of heating, power generation, and transport, the fabrics of clothing and furnishings, and the artificial pigments of our blazingly colourful world. Take away its contributions to agriculture and you let people die, for the industry provides the fertilizers and pesticides that enable dwindling lands to support rising populations. Take away its pharmaceutical wing and you allow pain through the elimination of anaesthetics and deny people the prospect of recovery by the elimination of medicines. Imagine a world where there are no products of chemistry (including pure water): you are back before the Bronze Age, into the Stone Age: no metals, no fuels except wood, no fabrics except pelts, no medicines except herbs, no methods of computation except with your fingers, and very little food.

Advances in technology demand the availability of materials with new and sophisticated properties, be it better electrical, magnetic, optical, or mechanical properties or just greater purity. Advances in the maintenance of human health that can reduce the demand on the physical infrastructure of hospitals and their sophisticated, expensive equipment depend on the discovery and manufacture of better, more sophisticated medicines. There will be no advances in the generation, deployment, and conservation of energy without chemistry to provide its material infrastructure.

It goes without saying, however, that the extraordinary difference between raw nature and what chemistry transforms it into to enhance and extend our lives comes at a price, and it is that price that disconcerts us and is rightly the basis of our apprehension of chemistry's environmental impact. At its crudest, the products of chemistry enhance our ability to kill and maim, for weaponry is improved when new explosives and other agents are perfected. Often of more permanent and vocal concern is the undeniable environmental impact of what is produced and the processes of production. Chemistry puts into societies' hands the ability by governmental choice to wage war more effectively, through commercial pressures to produce artefacts more aggressively, and through personal choice to squander more profligately and thereby harm our unique and irreplaceable ecosystem.

I shall confront that concern in these pages, for it has been a corollary of progress in chemical manufacturing and the presence not only of its products but also of its manufacturing waste in the environment. It is important, though, to bear in mind a rounded picture of chemistry, not a single black facet. Without chemistry life would be nasty, brutish, and short. With chemistry, it can be comfortable, entertaining, and well fed. Transport can be efficient; clothes alluring. Lives can be longer. Without ignoring the dark and negative side of chemistry, I shall encourage you to appreciate the illuminating and positive side, too.

There is another dimension to all these contributions: understanding. Chemistry provides insight into the heart of matter by showing how things are. A chemist can look on a rose and understand why it is red and look on a leaf and understand why it is green. A chemist can look on glass and understand why it is brittle and look on a fabric and understand why it is supple. The glories of Nature, of course, can be experienced without this inner knowledge, just as music can be enjoyed without analysis; but the insight that chemistry brings into the properties of matter, in all its forms, can be brought to bear if the moment is apt, and deeper

enjoyment thereby achieved. I seek to share some of this insight with you and show that even a little chemistry will add to your daily pleasure.

That, in broad terms, is the journey I shall take you on. I shall try to dislodge you from your half-remembered, perhaps unpleasant memories of your early encounter with chemistry. You will not have a degree in chemistry when you have read through these chapters, for chemistry is deep as well as wide, it is quantitative as well as qualitative, it is subtle as well as superficial. You will, however, I hope, appreciate its structure, its core concepts, and its contributions to culture, pleasure, economy, and the world.

In conclusion, I would like to thank Professor David Phillips, Imperial College, for a number of helpful remarks.

Peter Atkins
Oxford, 2014

Contents

Preface xiii

- 1 Its origins, scope, and organization 1
- 2 Its principles: atoms and molecules 13
- 3 Its principles: energy and entropy 27
- 4 Its reactions 38
- 5 Its techniques 53
- 6 Its achievements 66
- 7 Its future 86

Periodic table 95

Glossary 97

Further reading 101

Index 103

