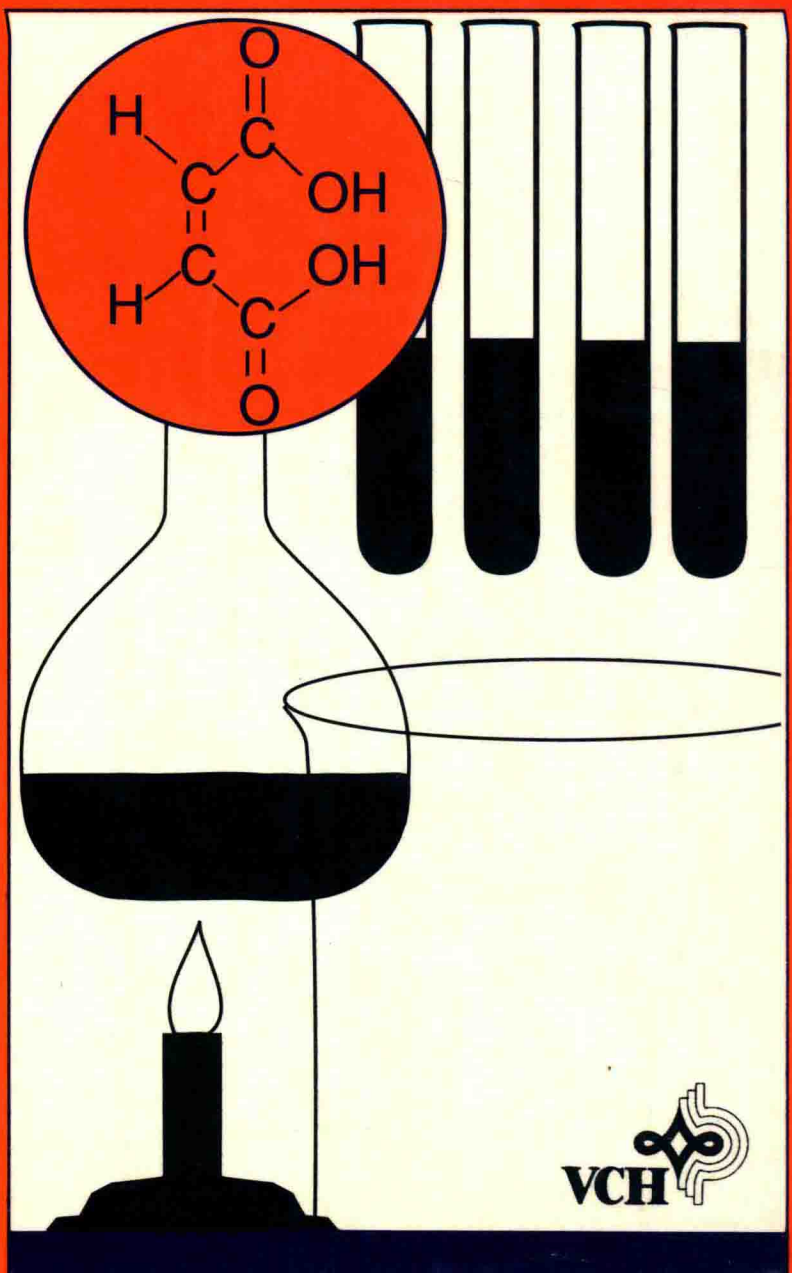
Organic Chemistry Made Easy

Joachim Nentwig, Manfred Kreuder,
& Karl Morgenstern



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PREFACE

In order to make the technique of programmed learning and our subject matter optimally compatible, we used a mixture of "linear programming" (after Skinner) and "branched programming" (after Crowder). Mixed programs of this type have been proven particularly effective. The term *hybrid program* was proposed for them at DIDACTA, an international conference on education and educational methods in Switzerland.

For us, programming the material meant the creation of an eticing stimulus and an educational aid for the reader. A programmed text requires the reader to complete one step before the next can be made, leading to an intensive absorption of the material. The reader is drawn into a question-and-answer game where the solution to every question must be found, thereby enabling the user to take control of the learning performance. The places the reader in a classroom-like situation, with the added advantage of solely determining the rate of progress. A well-programmed text is, to a large extent, capable of replacing a tutor. Therefore, this text is of particular value wherever the opportunity to attend classes or lectures does not exist (or was missed), and in cases where additional self initiative is desired.

We ascribe the huge successes of the original German editions of *General and Inorganic Chemistry Made Easy* and *Organic Chemistry Made Easy* to the fact that all the programs were thoroughly tested in classrooms and in face-to-face tests before they were published. Thus, they are not merely "desk programs," but are instead instructional and learning aids that have proven their value in practice.

This edition was revised, updated, and rearranged. Naturally, we would be grateful for any critical comments or suggestions.

January 1992

J.N.
M.K.
K.M.

How to use this book

For those interested in acquiring a thorough grounding in the fundamentals of chemistry, this book provides an effective and simple means. The method of teaching utilized here is based on the proven approach of

programmed instruction.

The material we cover is presented in the form of 25 separate Programs. Although at the outset relatively light demands are made on the student, the situation changes as the student begins to advance through the book. Because our method is rather a specialized one, we outline below details of the techniques employed.

The material in each Program has been divided up into numerous small units or *frames.* At the end of every frame you, the student, are asked to answer one or more questions. The intention is to check whether you have really understood the content of the particular frame. Such questions may involve the setting up of a formula or an equation, the calculation of some quantity, the insertion of missing words into sentences and so on. After answering, you are advised to proceed to another frame where the correct answer is to be found or where any mistakes you may have made are analyzed. Only at this stage should you consider moving on to learn something new. By following this procedure you will be conducted step by step through all of the Programs.

To illustrate our approach more fully, we now present two very simple sample frames. These demonstrate the two basic ways in which questions will be posed. We mention in passing that you will continually have need of a pen (or pencil) and paper as you work your way through each Program.

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1 Chemistry may be studied by an effective technique known as programmed instruction. The material covered in this volume is presented in the form of 25 separate Programs.

Now write out the completed version of the following sentence: We shall be studying chemistry here by means of ..... instruction.

Continue your reading at 11 .

You would then be required to write down: "We shall be studying chemistry here by means of *programmed* instruction."

Please do *not* write your answer within the actual frame itself. That would make it impossible for you to revise the material at some later stage! Be sure

to write all of your answers and notes on separate sheets of paper and not directly into the book.

After writing down your answer, turn to the next frame indicated; in the above case you would turn to frame number [11] . There you will be able to check your answer. (Do please make sure that in turning up the relevant frame you do not jump over into some other Program!)

The route to be followed through any given Program is indicated not by the page number but rather by the frame number located at the top left hand corner of each frame. Thus, you would check your answer here against the correct solution given in frame [11] . Filled-in words are always *italicized* in our solutions.

---

11 We shall be studying chemistry here by means of *programmed* instruction.

It has been demonstrated that programmed instruction is a more effective technique than learning from a conventional textbook.

A Program can facilitate learning by covering the material in small stages, by enabling the student to check each answer instantly and by permitting the student to work at his own individual pace throughout.

What is the most effective way of learning?

- By making use of a conventional textbook → [3]
- By making use of a Program → [18]
- There is no difference between the two ways → [34]
- I cannot answer this question → [54]

The student should now decide in favor of one of the four possible options and then turn to the frame indicated for the option chosen.

If the student had chosen frames [3] or [34] , he would discover that his answer was *not correct.* No one should feel too bad about that: additional help is always provided elsewhere as indicated. The correct answer is, of course, given in frame [18] .

Whenever you feel rather uncertain about how to answer a particular question and would appreciate having some further explanation on it, you are advised to choose a frame such as 54 . It is always wiser to follow this route than simply to guess at an answer.

During the coming weeks you will begin to realize that learning by means of programmed instruction is not only much easier and more enjoyable than conventional textbook learning, but also that you can progress through the material more rapidly. However, you should not look upon programmed instruction as a miracle method to attain your goal without any real work on your part being necessary! You will certainly *not* be able to learn chemistry "in your sleep" by this means. It is only by conscientiously working your way through each and every Program that success can be achieved.

Below we give some tips which should help to speed you on your way:

1. When commencing work on a Program you should be in a relaxed state and have sufficient time to complete the Program. It is best to work through a Program in *one* sitting if possible and then to re-work it again several times over the next few days. Of course, if you do have to interrupt working your way through a Program, simply jot down the number of the last frame you studied.

2. The individual frames are intended to be *worked* through and not merely *read* through. Do not leave a frame until you are quite certain you have grasped its content. A Program is not designed in such a way that you can work backwards through it again! Check all your answers very carefully against those given in the next frame and correct any errors you may have made. Do not get upset if you make mistakes the first time you work through a Program. However, it would be a great pity if you did not learn from the mistakes you make!

3. Absolute *honesty* is called for at those points where you are asked to select one out of several possible answers to a question. We recognize, of course, that it would be only too easy to cheat here. Our advice, however, is always to make a serious attempt to arrive at the correct answer. Cheating will certainly *not bring* the kind of *success* you could otherwise expect. From time to time you will have the opportunity of choosing as your answer some such phrase as "I do not understand the question" or, simply, "I do not know". Never hesitate to select this answer if you genuinely feel uncertain. You will then be guided to a frame where additional help is available.

4. The continual checking of your progress and the choices you have to make in answering questions serve to introduce a certain excitement into the learning process. The learning process is thereby transformed into something resembling the playing of a game. This effect is an intended one and is highly desirable, even though there is a potential danger that students may thereby be encouraged to work through Programs too fast and perhaps even start guessing at answers. Be on your guard against this possible disadvantage! You should always endeavor to work slowly, to remain calm and to maximize your concentration.

Success in learning requires *active participation* on the part of the student, *immediate checking* of all answers and progression through the material at an *individually paced speed.* Programmed instruction satisfies all of these requirements.

Organic Chemistry Made Easy

Contents

Program 1

Organic Chemistry (Introduction I)

1

This and the following program provide a first glimpse in the fascinating world of organic chemistry.

The emphasis of the book lies in the programs 7 to 23. In the 17 chapters we present a much fuller coverage of organic compounds.

Programs 3 to 6 will give you the theoretical background for the better understanding of the subject matter.

In general terms it may be said that:

Organic chemistry is the chemistry of carbon compounds. The only exceptions to this are a few simple carbon compounds, namely the oxides of carbon and carbonic acid and its salts.

The compounds formed by all the remaining elements belong to the realm of inorganic chemistry.

Examples for such simple carbon compounds are

Carbon monoxide	CO
Carbon dioxide	CO_2
Carbonic acid	H_2CO_3
Sodium carbonate	Na_2CO_3
Calcium carbonate	$CaCO_3$

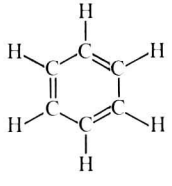
Write down now chemical formulas for these compounds.

Continue your reading at 9

2

Possibly you got confused here by the shorthand way we used of writing down the phenyl group. To avoid any further confusion, we now present the shorthand notation for both the phenyl group and benzene with the full chemical formula in each case:

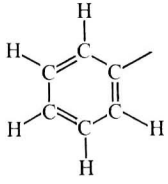
Benzene:



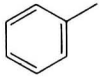
or

Note that all vertices in the hexagon are identical and are depicted as

Phenyl group



or



Note that here only five of the vertices forming the hexagon are identical () whereas a hydrogen atom is missing from the remaining vertex.

What is the molecular mass of the phenyl group?

- The same as that of benzene → [17]
- The same as that of benzene minus 1 → [26]
- The same as that of benzene plus 1 → [23]

---

3 Your answer is wrong. The compounds listed in this particular answer include carbon monoxide and pyrites which belong to the domain of inorganic chemistry.

Read through [9] again, and then attempt this question once more.

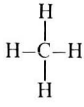
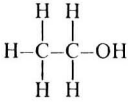
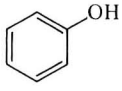
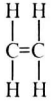
---

4 1. Organic chemistry is the chemistry of carbon compounds. The only exceptions to this are certain simple carbon compounds, namely the oxides of carbon and carbonic acid and its salts.

2. There are aliphatic compounds (i.e. chain-like compounds) and aromatic compounds (i.e. benzene and similar compounds).

3. Hydrocarbons; these consist of carbon and hydrogen.

4. The methyl, ethyl and phenyl groups.

5.     

6. Ethane, acetylene, methanol and diethyl ether.

7. From sugar by means of alcoholic fermentation.

8. Ether and benzene are highly flammable. When working with these and other organic solvents, care must be taken to ensure that there are no naked flames in the vicinity. Methanol is very poisonous.

End of Program 1.

---

5 We are going to demonstrate here how the structural formulas asked for may be drawn in simple stages.

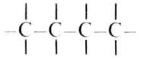
Start by writing down a row of four carbon atoms thus:

C C C C

The four carbon atoms are then joined together to form a chain:

C–C–C–C

Next, draw in the remaining valence bonds for each of the carbon atoms:



From this structural skeleton it should be evident that the end carbon atoms can combine with three hydrogen atoms each, whereas the two middle carbon atoms can combine only with two hydrogen atoms each. In all, therefore ten hydrogen atoms can be attached to this particular skeleton.

Write out now the complete structural formula with the hydrogen atoms. Give also the chemical formula which this structure represents. Check your answers at **43** .

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6 Your answer is wrong, probably because of a mistake in your calculation.

Work your way through the problem in **37** once again.

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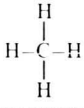
7 Methane has the structural formula



If the four atoms of the methane molecule are replaced by chlorine atoms, we obtain the structural formula for carbon tetrachloride thus: