ENGLISH IN FOCUS

# English in Physical Science

J.P.B. Allen H.G. Widdowson
TEACHER'S EDITION

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**OXFORD UNIVERSITY PRESS** 

#### Oxford University Press, Walton Street, Oxford 0x2 6DP

OXPORD LONDON GLASGOW

NEW YORK TORONTO MELBOURNE WELLINGTON

EUALA LUMPUR SINGAPORE JAKARTA HONG KONG TOKYO

DELHI BOMBAY CALGUTTA MADRAS KARACHI

IBADAN NAIROBI DAR ES SALAAM CAPE TOWN

18BN 0 19 437510 2 (Student's Book) 0 19 437504 8 (Teacher's Edition)

© Oxford University Press 1974

First published 1974 Reprinted 1978, 1979

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### Introduction

#### 1 General Aims

The aim of this book is to develop in students who are entering higher education an ability to handle the kind of written English that they will be concerned with as an integral part of their specialist subjects. The approach we have taken is one which recognizes that learning a language is not merely a matter of learning sentence patterns and vocabulary but must also involve an understanding of how people use these linguistic forms in order to communicate. Our purpose is to make students aware of the way English is used in written communication, and thereby to help them develop techniques of reading and to provide them with a guide for their own writing.

This book is based on the belief that intermediate and advanced students who are studying English as a necessary part of their specialist studies need a distinctive type of textbook: one which reflects the nature of the learning problems actually encountered at this stage, and which presents the language as an aspect of the subject they are studying. We feel that a textbook directed at students at this level should attempt to do more than simply repeat the formulas in elementary language teaching material. Most courses of English concentrate on teaching the language system and fail to show how this system is used in communication. As a result, students may know about such formal items as affirmative sentences or modal verbs, but not know how these items are put to use in the making of different kinds of statement and in the production of continuous pieces of discourse.

The principal purpose of English in Physical Science is not to teach more grammar, but to show students how to use the grammar they already know. In writing this book we have made two basic assumptions. Firstly, we assume that the students have had a good deal of instruction in grammar and that they have a considerable dormant competence in English. The book is directed at activating this competence, and extending it, by leading the reader to relate his previously-acquired linguistic knowledge to meaningful realizations of the language system in passages of immediate relevance to his specialist studies. Secondly, we assume that students already have a knowledge of basic science. Our aim is not to teach the subject-matter of science but to develop in the

reader an understanding of how this subject-matter is expressed through English. In designing the reading passages we have deliberately selected subject-matter which is easy to follow. In this way students can concentrate on the language being used without having to puzzle over unfamiliar or complex ideas at the same time. It should be emphasized that this book is not designed to teach either language in isolation or subject-matter in isolation but the manner in which both combine in meaningful communication. Our belief is that by relating content and expression in this way, the subject-matter takes on a new interest and the linguistic difficulties are reduced.

Although the subject-matter has been kept simple throughout, the degree of language complexity varies in a regular way. The presentation in each unit takes the form of a cycle, with a simpler treatment of the subject-matter at the beginning and working up to a more complex treatment at the end. In the earlier sections the material is presented in simple language in order to get the student to concentrate on the rhetorical features used in scientific writing. In the final section of each unit the language is more complex, and is intended to approximate to the kind of language that the student will find in his scientific textbooks.

In order to ensure the natural communicative function of language we have graded by focus rather than by exclusion. Since we assume that the readers of this book already have a fairly wide knowledge of English grammar, and also have access to a standard dictionary and other reference books, we have been able to avoid an unnatural step-by-step presentation of grammatical patterns and vocabulary, and have instead tried to show how a fluent writer uses the whole resources of the language in performing various acts of communication. At the same time, we have taken care not to overload the student with new material and we have avoided complex structures except where they are necessary in maintaining a natural use of language. We believe that the book will prepare the student to cope with greater linguistic complexity by developing in him a reading strategy which he can bring to bear on the material in the textbooks he has to read

In the exercises we have attempted to avoid mechanical drills and repetitive pattern practice. The users of this book will be people whose minds are directed towards rational thought and problem-solving and the exercises have been designed to take this fact into account: wherever possible, we have used exercises which require the same kind of mental activity as science students would naturally be engaged in as part of their specialist studies. It is hoped that this type of exercise will make the student see the relationship between expression and content, and will therefore persuade him of the relevance of English learning to his own speciality. In the last resort, we depend on the student being prepared to teach himself, to concentrate diligently on the features of language exemplified in the texts, and to approach the linguistic content of this book with the same spirit of enquiry and desire for knowledge as he would be expected to bring to his study of chemistry, physics or engineering.

It is appreciated that, even in a course whose primary concern is with the written language, the teaching process must inevitably bring in the spoken form as well. Therefore, in order to assist both teacher and learner, the texts have been recorded on tape, as also have those exercises containing additional vocabulary, the pronunciation of which might otherwise pose a problem.

#### 2 Guide to the Book

The book consists of eight units. The first seven of these are each divided into five sections:

I: Reading and Comprehension

II: Problems
III: Grammar

IV: Paragraph Writing

V: Free Reading

Unit 8 does not have this arrangement because it is designed to provide more general practice and to serve as a preparation for further work. This is why the section is called Summary and extension exercises.

Each of the five sections follows the same basic pattern.\* This is as follows:

#### SECTION I: READING AND COMPREHENSION

This section begins with a reading passage within which are inserted sets of comprehension checks in the form of statements which may or may not be correct. The learner has to decide on the correctness of each statement. These checks are inserted within the reading passage itself rather than at the end because we want to encourage the learner to think about what he reads as he reads and to pay close attention to what is actually expressed in the passage. Once he realizes that his understanding is going to be systematically checked in this way, he is likely to read more attentively for meaning and to treat his reading not simply as a language exercise relevant only to the English class but as a technique for acquiring information which will be useful in a wider field of study.

The comprehension checks require the learner to indicate whether a given statement is true or false according to the passage. But it is important that he should know why a statement is true or false and be able to recognize what it is in the passage that leads him to decide one way or the other. This is why each comprehension check is provided with a solution.

The solutions refer the learner to those features of the reading passage which provide evidence for the truth or falsehood of the statements in the

<sup>\*</sup>With the exception of Unit 8 and Section I in Unit 7 where it was necessary to organize the material differently in order to give emphasis to the teaching points with which this section is concerned.

comprehension checks. They are explanations in that they point out what the reader must notice and how he must reason in order to arrive at the correct decision. Explanations of this kind are of course not necessary for someone who already has an efficient reading ability in English. At first glance it might appear that the solutions are sometimes too elaborate and detailed. But it must be remembered that learners have to be made aware of what is involved in reading with understanding before this ability can become habitual. What we aim to do by means of the solutions is to develop in the learner a reading strategy which he can apply generally to the texts he has to deal with as part of his study of science.

Sometimes a solution will serve simply to remind the learner of the knowledge of English he already has. In Unit 1, for example, comprehension check (a) requires the learner to recognize that the same idea can be expressed by using either an active or a passive sentence, so the solution appears simply as follows:

The earth is surrounded by a layer of air (1)

= A layer of air surrounds the earth.

But the ability to recognize whether a given statement is true or not according to the passage does not come only from an understanding of the meaning of individual words and sentences. Very often it is a matter of recovering information which is implied rather than explicitly stated and of tracing the way in which what is expressed or implied in one sentence is related to what is expressed or implied in another. It is the function of many solutions, therefore, to make such implications explicit and to spell out the relationship between different statements.

Let us consider an example from Unit 2. In order to decide whether the statement 'A molecule of hydrochloric acid contains one atom of hydrogen' is true or not with reference to the passage (Comprehension check (e), Unit 2), it is necessary to relate what is expressed in three different sentences: 13, 15 and 17. This relating process is represented in the solution as follows (the symbols on the left indicate the kind of reasoning which is involved):

Hydrochloric acid is an example of an inorganic acid which is monobasic. (17)

i.e. Hydrochloric acid is BOTH inorganic and monobasic.

(that is Acids which have only one replaceable hydrogen atom in each to say) molecule are known as monobasic acids. (13)

i.e. Monobasic acids have ONLY ONE replaceable hydrogen atom in each molecule.

but ALL the atoms of hydrogen in the molecules of inorganic acids are replaceable by a metal. (15)

.. Hydrochloric acid has ONLY ONE hydrogen atom in each (therefore) molecule.

A molecule of hydrochloric acid contains one atom of hydrogen.

What solutions of this kind do, then, is to spell out certain reasoning processes which are employed by the efficient reader as a matter of habit. Moreover, they are the sort of processes which are overtly employed in many fields of scientific enquiry. Their use here as a language exercise is intended to appeal to the particular cognitive inclination of science students, and to make them see that the 'content' and the 'expression' of scientific writing are dependent upon each other.

The first three exercises following the reading passage are a logical development from the solutions. Each focuses on a feature of language use which is frequently referred to in the solutions and which is particularly relevant to an understanding of how English is used in written communication.

#### EXERCISE A Contextual reference.

This exercise draws the learner's attention to the way pronouns and demonstratives are used to refer to something already mentioned and so serve to relate one statement to another. Very often there is more than one grammatically possible connection between noun phrases and the reader has to decide which reference makes sense in the context of the passage concerned. This is the case, for example, with Exercise A 5 in Unit 1:

In sentence 7, this pressure refers to:

- (a) The downward pressure of air
- (b) The pressure which air exerts in every direction
- (c) The pressure which air exerts upwards and sideways.

Exercise A, then, obliges the learner to scrutinize the passage to assign the correct referential 'value' to such 'anaphoric' language items as pronouns. demonstratives and so on. This exercise is not difficult, and it may sometimes seem obvious what a given item refers to. But again it must be remembered that we are not just concerned with getting the learner to recognize the contextual reference of a particular language item in a particular passage but with developing a general ability to handle this feature of language use. The point is that this exercise directs the learner's attention to the way anaphoric devices work and so prepares him for those cases where identification of the referent is not so easy.

#### EXERCISE B Rephrasing

Here again, the learner is made aware of how two different expressions may refer to the same thing. Whereas in Exercise A the problem is how to recognize that an expression like it or this may refer to a previous noun phrase like a substance which cannot be seen, in this exercise the problem is to recognize that the phrase a substance which cannot be seen is synonymous with the phrase an invisible substance (see Exercise B 3, Unit 1). Essentially the purpose of this exercise is to make the learner realize that writers commonly express the same idea in different ways and that there is no one-to-one correspondence

between one linguistic form and one meaning. It is important that the student should realize this because two phrases may mean the same thing only within the context of a particular passage and it is therefore only by studying the context that the equivalence can be established. For example, Exercise B 4 of Unit 1:

Air takes up space and has weight can be rephrased:

Air occupies space and has weight.

We know this because sentence 4 makes use of the phrase occupies space, and we know that sentence 6, in which takes up occurs, makes reference to sentence 4.

#### EXERCISE C Relationships between statements

Expressions like therefore, consequently, however, etc. indicate what function a particular sentence is meant to fulfil. A sentence which contains therefore is used to make a statement which follows logically from a previous statement. Similarly, for example indicates that the sentence is used to make a statement which illustrates a point made previously. Such expressions are explicit indicators of the communicative function of sentences. But writers do not use explicit indicators in every sentence. Very often a writer assumes that the reader will realize how a particular sentence is to be understood without the assistance of such indicators. It is of course crucial for the student learning to read a foreign language to understand which statements are meant to be illustrations, qualifications, conclusions and so on, and how statements are logically related to each other. The purpose of Exercise C is to make the learner aware of such communicative functions and of the way written discourse develops.

In Unit 1, the learner is provided with explicit indicators in the reading passage itself and he is required to replace them with others which have an equivalent function. Thus he is given:

consequently (3).

In this case the student has simply to refer to sentence 3, remove therefore and replace it with consequently. But it may not be a matter of simple replacement. Let us consider another example:

it follows that (7).

The student cannot just replace therefore in sentence 7 with the given phrase since this would result in an ungrammatical sentence:

The atmosphere, it follows that, weighs down on the surface of the earth. In this case he has to re-arrange the sentence as follows:

It follows that the atmosphere weighs down on the surface of the earth.

In Unit 1 full use of these indicators is made within the passage itself and Exercise C requires the learner to replace one indicator with another of equivalent function. Once the use of such indicators is made clear they figure less prominently in the reading passages of subsequent units. At a later stage the

learner is often required to insert indicators so as to give statements an explicitness they would not otherwise have. In Unit 2, for example, the learner is given the following:

can be defined as (1)

therefore (10).

Sentence 1 of the reading passage is:

An acid is a compound containing hydrogen which can be replaced, directly or indirectly, by a metal.

This can be shown explicitly as a definition by inserting the given indicator as follows:

An acid can be defined as a compound containing hydrogen which can be replaced, directly or indirectly, by a metal.

Similarly, sentence 10 can be made explicit as a conclusion deriving from what has been stated previously:

They are therefore inorganic acids.

The central purpose of this exercise, then, (notice then!) is to bring to the learner's notice the ways in which sentences are used to perform different acts of communication and how such acts are related to one another in the development of a discourse.

Exercises A, B and C are designed to make little demand on the learner's productive ability. Their purpose is to direct the learner to a discovery of what is involved in the comprehension of written communication. The remaining exercises are intended to extend comprehension into written work.

#### **EXERCISES D & E**

These exercises vary from unit to unit but they have the same basic aim. This aim is to guide the learner to use his understanding of the reading passage to perform for himself the communicative acts which appear to be of particular importance in science. Thus in Unit 1, the learner is required to complete a diagram by reference to his understanding of the passage. Once the diagram is complete it then serves as a model for the writing of definitions. In Unit 2, diagrams are used for producing definitions, generalizations and classifications, and in the following units these and other acts of communication are presented in a similar way.

Two kinds of activity are given particular emphasis in Exercises D and E. The first is what might be called *information transfer* and involves the use of written English to express facts and ideas presented in the form of diagrams. Science students are familiar with the use of non-verbal means of communication like formulae, graphs, diagrams and line drawings, and this activity of transferring information from a non-verbal to a verbal medium is intended to link the students' language learning with their main area of study. The second activity might be called *rhetorical transformation*. This involves changing one mode of communication into another. For example, as is shown in Unit 2, a definition like

An acid is a substance which contains at least one atom of hydrogen in each molecule which can be replaced by a metal

can be changed, or transformed, into a generalization:

An acid contains at least one atom of hydrogen which can be replaced by a metal.

Similarly, as is shown in Unit 5, the directions for carrying out an experiment together with the statement of its results can be transformed into inductive and deductive statements, or, as is shown in Unit 6, into descriptions.

Both information transfer and rhetorical transformation exercises are directed at showing the learner how he can use his knowledge of the formal properties of English to perform acts of communication which are of their nature scientific.

## SECTION II PROBLEMS

The problems are essentially a development of Exercises D and E. They bring the learner's attention to bear on problems which are related both to the subject matter and to the language use of the preceding reading passage and exercises. To solve the problems the learner has to call upon his experience of both English and science and in providing a solution he is necessarily integrating the two areas of knowledge in a meaningful way.

#### SECTION III GRAMMAR

As stated above, we assume that the student already has a knowledge of basic grammar. We also assume that this knowledge will be consolidated during the course of the book as the student experiences language used in meaningful contexts. For these reasons we have not attempted to provide a detailed review of English grammar. Instead, the exercises in this section are designed to focus on points of grammar which are particularly important in scientific writing, especially those which may represent continuing 'trouble spots' for many students.

### SECTION IV PARAGRAPH WRITING

The aim of the paragraph writing exercises is integrative rather than analytic; that is, the student uses a wide range of grammatical devices and sees how they combine to produce an integrated piece of writing. Each paragraph writing exercise is done in four stages. At the first stage the student examines various groups of words and combines each group into a sentence by following the clues provided. Some sentences are easy to write, some are more difficult; this reflects the situation in actual writing, where simple sentences alternate with more complex structures according to the nature of the message

the writer wishes to convey. At the second stage the student creates a coherent paragraph by rewriting the sentences in a logical order, adding various 'transitional' features where necessary. Thirdly, the student checks his work against a version of the paragraph incorporated into the Free Reading passage in Section V. The paragraph writing is designed to allow some scope for the student to exercise his own judgement, so there is no reason why the student's version should be identical to the one in the book. If the paragraphs differ, the student should try to evaluate the relative merits of the two versions. At the fourth stage the student writes the paragraph again in a 'free style' of his own devising, based on a set of notes which are similar to the rough jottings made by an author when he is sketching out a plan for a paragraph. Thus the student is led by stages to the point where he can write a paragraph of his own, in a way which seeks to imitate some of the processes of real-life composition.

#### SECTION V FREE READING

This section consists of a passage of prose, longer than that in Section I and incorporating a version of the paragraph resulting from the exercise in the previous section. The reason why we have included this section is that we feel that students should have an opportunity to learn for themselves. The previous sections impose a fairly strict control over the student's activities: this section enables him to try out what he has learnt in his own way and his own time. No matter how carefully we develop our teaching procedures, it appears that learners develop their own individual way of learning, and these free reading passages are meant to give the reader a chance to think for himself without being imposed upon. We are making the assumption that the reader's interest in the way language is used in scientific discourse will have been sufficiently aroused in the preceding sections for him to be ready to apply his own intensive reading techniques without specific directives in the form of further exercises.

#### 3 Teaching suggestions

The following notes indicate how the first unit might be dealt with in the classroom. The other units can be handled in a similar way. These notes are intended to be suggestions only. It is expected that the teacher will develop his own procedures according to the needs of his students. A particular teacher, for example, may find that he needs to place greater emphasis on one type of exercise than on another. He may wish to pay more attention to oral than to written work, or the reverse. It will also be up to the teacher to decide, according to his own circumstances, how the work is to be divided into class sessions, and which part of it can most appropriately be done as homework.

#### 1. READING AND COMPREHENSION

#### (i) Reading the text

Get the class to read sentences 1-5 by themselves.

Take the class through the explanation and do questions (a) and (b) with them so that it is clear what they have to do.

Get the class to do questions (c) and (d) on their own.

Choose one student. Ask him whether he has put 'true' or 'not true' against question (c). Get him to justify his decision with reference to the appropriate parts of the text. Ask other students whether they agree, and if not why not. Get the class to turn to the relevant solution. Read it aloud to the class while the students follow it in their books.

Choose another student, and do the same with question (d).

Read sentences 1-5 aloud to the class, while they follow in their books.

Get the class to read sentences 6-9 by themselves.

Get the class to do questions (e)-(h) on their own, and repeat the process as for questions (c) and (d).

Read the whole passage aloud to the class, without the questions, while the students follow in their books.

#### (ii) Exercises

#### EXERCISE A Contextual reference

Get the class to do the exercise in their notebooks.

Ask the class to show which choices they have made in question 1 by putting up their hands.

Ask students to replace the underlined item with the phrase they have chosen, and read out the sentence which results.

For example, a student choosing 1(a) will read out 'The earth is between 150 and 200 km thick', and a student choosing 1(b) will read out 'The layer of air is between 150 and 200 km thick and is called the atmosphere'.

Ask the class to judge which statement is correct.

Repeat the process for questions 2-5.

#### EXERCISE B Rephrasing

Get the class to do the exercise in their notebooks.

When the class have finished the exercise, write the first sentence on the board. Underline the expression which is to be replaced.

Select a volunteer to come to the board and write in the replacing expression above the words which are underlined.

Ask the class to judge whether the rephrasing is appropriate. Consider alternatives if necessary.

Bracket together the appropriate replacement(s) with the original expression as follows:

 $\left\{ \begin{array}{c} \text{The atmosphere} \\ \text{The layer of air which surrounds the earth} \end{array} \right\} \text{ is between 150 and 200 km thick.}$ 

Do the remaining sentences in the same way.

#### EXERCISE C Relationships between statements

Get the class to do the exercise in their notebooks.

When the class have finished the exercise, write sentence 3 on the board.

Select a volunteer to come to the board and indicate the change as follows:

#### consequently

Air is invisible and therefore it cannot be seen.

Ask the class to judge whether the change is correct.

Do the remaining sentences. The following method of indicating a change may also be used:

Since

Air is invisible and therefore it cannot be seen.

#### EXERCISE D Statements based on diagrams

Get the class to complete the diagram in their textbooks, and use it to write out sentences in their notebooks as instructed.

Put the diagram on the board and complete it with the students' help. Get the students to correct their own diagrams.

Get individual students to read out the sentences they have written. Indicate by pointing to the diagram on the board whether you want the student to give an (a)  $\rightarrow$  (b)  $\rightarrow$  (c) or an (a)  $\rightarrow$  (c) sentence.

Ask the students to write a definition as instructed.

#### EXERCISE E The writing of definitions

Do one or two examples orally.

Tell the students to write the remaining definitions in their notebooks.

#### 2. PROBLEMS

#### THE DESCRIPTION OF SIMPLE EXPERIMENTS

Ask the students to read problem A carefully, and to write out a complete version of sentence 3 in their notebooks.

Get individual students to read out the sentence they have written. Write the correct sentence on the board.

Get the students to write down the correct order of the diagrams in their notebooks. Ask individual students to state what they think is the correct order.

Continue with problems B and C. Get the students to draw the illustrations in their notebooks. Ask individual students to copy their illustrations on to the blackboard.

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Encourage the class to suggest improvements where necessary.

Get the students to write out the answer to problem D in their notebooks. Select students to read out their versions. Use the students' answers to write a correct version on the board.

#### 3. GRAMMAR

#### **EXERCISE A**

Get the students to read the grammatical explanation carefully.

Allow them several minutes to study the two columns of sentences.

Do the sentences orally.

Get the students to write the sentences in their notebooks. While they are doing this, go round the class and give individual help where necessary.

#### **EXERCISE B**

Proceed as in Exercise A.

#### 4. PARAGRAPH WRITING

#### STAGE 1 Sentence building

Do the first two or three sentences orally.

Get the students to write all the sentences in their notebooks. Give individual help where necessary.

Taking the sentences one by one, get individual students to read out what they have written. Write the correct version of each sentence on the board.

#### STAGE 2 Paragraph building

Get the class to suggest how the additional material should be incorporated into the sentences. Make the appropriate changes on the board.

Get the students to write a paragraph in their notebooks, following the instructions.

After the students have written their paragraphs, get the class to number the sentences on the board in the correct order.

Get the class to suggest a suitable title.

Discuss any differences between the version on the board and the version of the paragraph in the Free Reading passage.

Give the students time to change their own paragraphs where necessary.

#### STAGE 3 Paragraph reconstruction

Give the students a few minutes to read through their paragraphs. Discuss the meaning of any unknown words.

Tell the students to close their notebooks or hand them in, and to rewrite the paragraph on a separate piece of paper, using the notes provided. Tell the students that they may use whatever they can remember of the original, combined with their own words. Go round the class and give individual help where necessary.

Take in the students' work and correct it. This correction will indicate the students' progress and suggest areas of difficulty for future treatment.

#### 5. FREE READING

Tell the students to read the passage in their own time. Encourage them to look for points of interest in the text and to relate them to the problems and exercises dealt with in this unit.

Some teachers may feel that comprehension questions should be asked on these passages. A set of questions for each passage is provided in Unit 8. Some of these questions require only short oral responses; some require detailed written statements which may be prepared orally in the classroom.

#### 6. RECORDING

Recordings of the reading passages and of the answers to the grammar exercises are available on cassette from Oxford University Press.

A useful revision exercise is to play the recordings of the reading passages while the students follow the text in their books. If it is necessary to develop the learners' ability to comprehend spoken English, play the recordings of the reading passages and give comprehension questions orally. (See Unit 8 for comprehension questions relating to the free reading sections.) Recordings of answers to the grammar questions will serve as a model if the teacher wishes to do these exercises orally.

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