Writing Scientific English

John Swales

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A textbook of English as a
Foreign Language for students of
Physical and Engineering Sciences

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Nelson

THOMAS NELSON & SONS LIMITED
Nelson House, Mayfield Road
Walton-on-Thames, Surrey KT12 5PL
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P.O. Box 18123
Nairobi
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116-D JTC Factory Building
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Preface

I have attempted in this book to outline and give practice in a series of structured contexts through which foreign students of physical sciences and engineering can develop their ability to express their scientific and technical knowledge in English. In writing this course I have had two particular groups of students in mind. Firstly, it should be useful for students who are required to use English in the course of their higher studies in science and engineering, but whose knowledge of the language is limited to what they have learnt in a general school course—a course likely to have concentrated on spoken English and more 'literary' kinds of comprehension and composition, and to have dealt little, if at all, with the language of science and technology. Secondly, it should be of use and interest to students who are specialising in science in their last years at school. Obviously it is at school that preparation in the language skills necessary for coping with English-medium, or partly English-medium, scientific and technical instruction must be begun. I hope, therefore, that this course will do something to resolve the continuing crisis in the field of teaching non-native speakers of English how to communicate scientific and technical information in the most widely used language of science, because it is precisely in this area that the lack of *relevant* language preparation holds up so many students in their university and technical college work.

The scope of this book has been restricted in a number of ways. First, it is primarily designed to improve *written* English. I have excluded comprehension work because I have found that the way in which a comprehension passage is best handled depends principally on how much the students know of the scientific subject-matter. For this reason I believe that the selection and presentation of comprehension passages should be carried out within an actual teaching situation.

Secondly, I have restricted the 'register' to that of intermediate scientific text-books, and ignored features more typical of articles in journals. I have also tried to maintain a clear distinction between 'popular' journalistic writing on science topics and simple Scientific English. Similarly, I have limited the types of exercise to those requiring the student to produce no more than fairly short and fairly straightforward descriptions, explanations and interpretations. The work in this book, therefore, stops short of instructing the student how to write technical reports, reviews, discussions or theses.

Thirdly, I have tried to isolate the main grammatical difficulties likely to be encountered in descriptive work and give practice in them, both at an elementary and intermediate level. This has led to one or two unexpected omissions. The reader will not find, for example, any detailed discussion of Conditional Clauses. This is because the preliminary analysis suggested that the hypothetical and counter-factual types of condition are not, in fact, either typical or useful at the level of straightforward description. The 'simple' Conditional Clause is needed, but the factors affecting the choice of Present Simple or 'will' are highly complex and not fully understood at the present time. I have also decided that the customary distinction between 'defining' and 'non-defining' Relative Clauses is, for teaching purposes, arbitrary and largely irrelevant in so far as any study of scientific writing immediately throws up many examples of relative clauses that appear to be neutral in this respect.

Fourthly, the content of the examples and exercises has been limited to the fields of physics, chemistry and engineering because I feel that rather different syntactic and organisational difficulties confront foreign students of biology, agriculture, zoology, etc.

Finally, I have on many occasions proposed fairly precise ways of organising different kinds of written work. I do not want to imply that the procedures outlined are the only—or indeed the best—ways of approaching certain writing tasks. These models of sentence and paragraph organisation have been drawn up to help students, especially weaker students, to write more correctly, more coherently, and more within the style best suited to scientific and technical subjects.

I would like to thank all those colleagues at the University of Libya who tried out provisional drafts of the material with their classes. However, I owe a greater debt to Hugh Mildmay, who helped in so many ways, and to my wife for her continuing encouragement and critical interest.

John Swales,
The Institute of Education,
The University of Leeds.

Author's note

The exercises have been marked ○, △, or □.

○ exercises are simple and should give little difficulty if the explanations and examples have been studied carefully.

△ exercises usually require students to produce a certain amount of their own work. However, quite a lot of help is given in terms of example sentences and in the organization of the written material.

□ exercises are rather more advanced and nearly always require students to produce passages of continuous scientific or technical English.

Contents

Unit 1 Introduction to scientific statements

Be and have in scientific statements

In scientific English the main verbs of sentences are usually in the Present Simple tense. It is not difficult to see why. Scientific textbooks contain information about the present state of scientific knowledge. They describe experiments showing how this knowledge can be obtained. They also show how this knowledge is used in the service of man. As a result, you will probably use the Present Simple in most of your scientific writing.

As the Present Tense is so common, it is important to make sure that the subjects and verbs agree.

○ **Exercise 1** Underline the subjects of these sentences and cross out the verbs which do *not* agree. (Underline all parts of the subjects, not just the nouns.) Here is an example:

This gas has/have a greater density than air.
This gas has/~~have~~ a greater density than air.

1 Water boils/boil at 100° centigrade.
2 Action and reaction is/are opposite and equal.
3 A thermometer measures/measure temperature.
4 Oxygen and hydrogen is/are gases.
5 Mathematics is/are an important subject for an engineer.
6 The light bulbs in this room produces/produce 100 watts each.
7 The liquid in those bottles is/are dangerous.
8 The results of the experiment proves/prove the law.
9 Everybody recognizes/recognize the importance of practical work.
10 On average, women lives/live longer than men.
11 Some substances, most of which are metal, is/are good conductors of electricity.
12 Most kinds of wood floats/float on water.
13 At least one kind of wood sinks/sink in water.
14 The average monthly rainfall figures for this area shows/show a small decline in annual total over the last thirty years.
15 The apparent loss of weight of a substance which is immersed in a liquid equals/equal the weight of the displaced liquid.

The last two sentences (14 and 15) are examples of an important fact about scientific writing: the main verb is often simple but the rest of the sentence complicated. In 14 and 15 the verbs consist of only one word. How many words do the subjects contain?

Compare sentences 14 and 15 with these two spoken sentences:

'I don't want to go and see him today.'
'What are you going to do tomorrow?'

In spoken English the noun parts of a sentence are often simple and the verb parts complicated. The opposite is true of written scientific English. In fact, about a third of all scientific statements have *is* or *are* as the main verb. This causes difficulty for students who speak languages in which it is not always necessary to use a verb like *be*.

The difficulty arises because English is one of those languages in which all written sentences must contain at least one main verb.

○ **Exercise 2** Rewrite these 15 sentences putting in the main verb *is* or *are*. (This is the first writing exercise in the book. Therefore you should try to get it right. This also means:

starting each sentence with a capital letter
finishing each sentence with a full stop
making sure you copy the words accurately.)

1 These test-tubes.
2 Cast-iron not as strong as steel.
3 Oxygen necessary for all growth.
4 Oxygen and hydrogen gases.
5 Oxygen, like hydrogen, a gas.
6 This solution a mixture of chlorine and sodium.
7 Angles measuring 90° right-angles.
8 The natural water in many parts of the world hard.
9 Gold and silver not radio-active elements.
10 One of the machines out of order.
11 Two of the three pieces of metal copper.
12 A beaker or a small glass necessary for this experiment.
13 The spiral motion of air above a low-pressure area always opposite in direction to the movement of the hands of a clock.
14 The breaking strain of the rope 200 kilos.
15 200 kilos the breaking strain of the rope (Be careful!)

The other very common verb in scientific statements is the main verb *have*. Again this can cause a problem because of the grammatical differences between English and many other languages.

○ **Exercise 3(a)** Put either *is* or *has* into the spaces.

1 Water ..... a boiling point of 100° C.
2 The boiling point of water ..... 100° C.
3 Stainless steel ..... a metal alloy.
4 Stainless steel ..... rust-proof.
5 This car ..... a maximum speed of 140 kilometers an hour.
6 The maximum speed of this car ..... 140 kilometers an hour.
7 The angle of reflection ..... 9°.
8 The simplest hydrocarbon ..... methane which ..... one carbon atom and four hydrogen atoms.
9 In chemistry each element ..... its own symbol, which ..... usually a capital letter followed by a small letter.
10 If a plane figure ..... three straight sides, it ..... a triangle.

△ **Exercise 3(b)** Write five scientific statements using *has*:

1 giving the freezing point of a liquid
2 giving the melting point of a metal
3 giving the density of a substance
4 giving a property of a square
5 giving a property of a triangle

○ **Exercise 4** In the following sentences the main verbs have been left out. Rewrite the sentences putting in either *is*, *are*, *has*, or *have*.

1 A triangle a figure which has three straight sides.
2 The Dead Sea a high salt content.
3 There several types of pump.
4 Most kinds of stainless steel a small percentage of chrome.
5 Stainless steel the property of resisting corrosion.
6 Modern bridges often several kilometers long.
7 A modern bridge sometimes a length of several kilometers.
8 Isosceles triangles two equal angles.
9 The total population of the world about 3,500 million.
10 A hexagon a plane figure with six sides.

Read this description of a car.

The Moto 1100

The Moto 1100 is a small family car. It has a small engine which is in the front. The engine has a capacity of 1,100 cubic centimeters. It is a front wheel drive car. The gear lever is on the floor. There are seats for

four or five people. It has four forward gears and a reverse. It has a maximum speed of about 130 km an hour. One advantage of this car is that it has a very low fuel consumption.

Notice how it is possible to write a simple technical description using only *be* and *have*. Notice also that the sentences are short.

Exercise 5 Write a simple factual description of any vehicle you know about. Use mainly *be* and *have*. Keep most of your sentences short. (A *vehicle* is any car, bicycle, lorry, etc.)

Statements requiring the Present Simple

(a) The Present Simple is used for regular actions and regular processes:

He studies physics six hours a week.
The crude oil then passes down the pipe-line.

(b) It is used for general statements:

Water freezes at 0° C.
Area equals length times height.

(c) It is used for factual statements and observations:

This type of vinegar contains about 3% acid.
The liquid in the test-tube weighs 55 grams.

(d) It can be used in descriptions of experiments:

The filter paper then collects the impurities.
The temperature rises until it reaches 100°, but after that it remains constant.

In other words, always use the Present Simple unless there are good reasons for using another tense.

Form of the Present Simple

it *he* *she*	*produce* + S	*they* *we* *you* *I*	*produce*

A large S has been used for two reasons. First it is a reminder, so that you remember to add it on after a subject in the third person singular.

A large S has also been used because it is not always a simple matter of adding an *s* to the base form of the verb. Sometimes spelling changes are necessary:

Verbs ending in *ss*, *sh*, *ch*, *x*, and *o* add *es* to the base.

they pass	*he passes*
they push	*he pushes*
they watch	*he watches*
they mix	*he mixes*
they go	*he goes*

Verbs ending in *y* after a consonant change *y* to *i* and add *es*.

they hurry	*he hurries*
they magnify	*it magnifies*

Verbs ending in *y* after a vowel follow the main rule (add *s*.)

they obey	*it obeys*
they say	*he says*

○ **Exercise 6** Rewrite these sentences putting the verbs in brackets into the correct form.

1 He (study) biology.
2 The current (pass) along the wire.
3 This ring (weigh) 125 grams.
4 Sound (travel) at a speed of 333 meters a second.
5 Rain (wash) salt from the soil.
6 This factory (employ) thirty people.
7 This bird (catch) insects as it (fly).
8 Water (solidify) or (turn) into ice at 0° C.
9 Glue (fix) or (stick) two surfaces together.
10 The down-stroke of the piston (compress) the mixture until it (explode).

○ **Exercise 7** Write out the third person singular of the following verbs.

1 study	6 analyze	11 convert	16 lay
2 reach	7 do	12 possess	17 employ
3 try	8 design	13 mix	18 qualify
4 think	9 apply	14 assemble	19 draw
5 stretch	10 weigh	15 exchange	20 supply

△ **Exercise 8** The ten sentences below have been mixed up. Study them and write out the ten correct sentences, choosing one item from each column each time. Do not use any item more than once. (–) means that no preposition is required.

Fresh water	freezes	at	78° C.
Alcohol	equals	about	an average of 70 years.
Copper	liquefies	at	10 per cent alcohol.
Oxygen	weighs	-	0·9104 meters.
Wine	consists	at	–183° C.
A yard	contains	at	one kilogram per litre.
Sound	live	–	2 oxygen atoms and 1 carbon atom.
Mercury	travels	of	1083° C.
Men	melts	for	760 mph at sea level.
A carbon dioxide molecule	boils	at	- 39° C.

○ **Exercise 9** Rewrite putting the verbs in brackets into the correct forms.

Around the earth there (be) a large area of gas which (form) the atmosphere. This layer of gas—or more accurately, gases (provide) some of the chemical materials which man (need). The other raw materials (come) from the earth and the sea.

About four-fifths of the atmosphere (consist) of nitrogen. The remainder (be) mostly oxygen. The other five gases (be) very rare and, in fact, (make up) less than 1 per cent of the total atmosphere. Although these gases (be) rare, at least two of them (have) common uses in the field of electrical lighting. Electric light bulbs usually (contain) argon. Neon (be) also useful because it (give) out light when an electrical current (pass) through it.

○ **Exercise 10(a)** Rewrite the passage below putting in the six verbs which follow it. Use each verb-form once only. Make sure that the verbs agree with the subjects.

Colour

When sunlight strikes an object the colour of the object depends upon the wavelengths which the object ..... . If, for example, grains of sugar ..... equally all the wavelengths of the spectrum the grains ..... white. If a surface reflects only the wavelength which produces red and .....

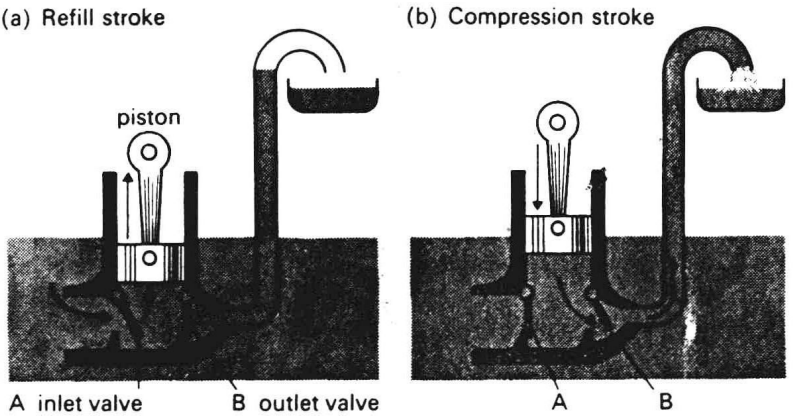
the other waves of the spectrum. the surface ..... red. Black is the absence of colour because black objects .... all the light of the spectrum.

absorb *absorbs* *appear* *appears* *reflect* *reflects*

△ **Exercise 10(b)** Write sentences in answer to these questions:

1 What colour surface absorbs the greatest amount of heat?
2 What does a mirror do?
3 How fast do light rays travel?
4 Some rays are invisible–give at least two examples.

△ **Exercise 11** The figures show a force pump in operation. The statements which follow describe the two stages of the cycle. However, the sentences are in the wrong order. Study the diagrams, decide the correct order of the sentences and write them out in two continuous passages. (If you like, also use linking-words like *first*, *then*, *next*, etc.)



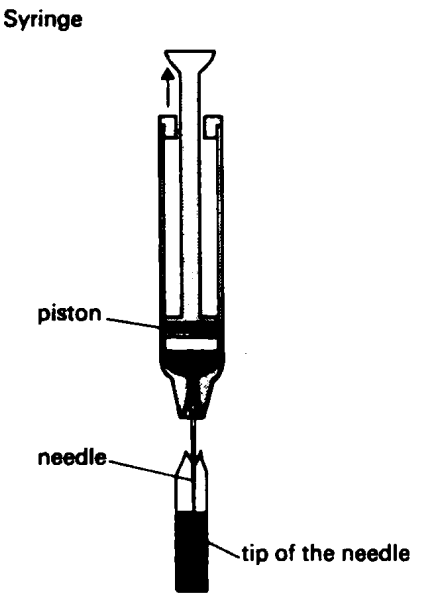
Refill stroke

1 A mechanical force pulls the piston upwards.
2 The reduced pressure causes the inlet valve (*A*) to open.
3 Water enters the cylinder and fills the space beneath the piston.
4 The outlet valve (*B*) remains closed because of the pressure of water in the outlet pipe.
5 The pressure in the cylinder beneath the piston begins to fall.

Compression stroke

1 Water continues to flow up the tube until the piston reaches its lowest point.
2 A mechanical force pushes the piston downwards.
3 The cycle starts again.
4 This causes the inlet valve to close.
5 The high pressure water is forced up the outlet tube.
6 The cylinder now traps the water because it cannot escape back through *A*.
7 When the pressure is sufficiently high the outlet valve opens.
8 The pressure beneath the piston begins to rise.

□ **Exercise 12** Write a short description of how the syringe works. (You may be able to get some help from the previous exercise.)



Negative statements and questions are much less common in written scientific English than in other varieties of English. With regard to the Present Simple, the important thing to remember is that both negatives and questions are formed with the help of the verb *do*, which is 'empty' of meaning.

statement	negative	question
Wood floats	*Iron does not float*	*Does wood float?*
Sticks burn	*Stones do not burn*	*Do stones burn?*

○ **Exercise 13** If you think that certain of the following statements are not true, write them out as negative statements. If you think they are true, leave them.

1 Iron floats on water.
2 The opposite angles of a parallelogram equal 180°.
3 Water boils at 100° centigrade.
4 A piece of iron corrodes when it is buried under the ground.
5 Parallel straight lines meet.
6 A gold coin corrodes when it is buried under the ground.
7 Steel melts at 600° centigrade.
8 The weight of a metal varies with the temperature.
9 In a right-angled triangle the length of the hypotenuse equals the sum of the lengths of the other two sides.
10 A scientist uses the Present Continuous tense when he writes about observable facts.
11 A barometer enables scientists to measure pressure.
12 We make drills and cutting tools from low carbon steel.
13 The volume of a gas varies with its pressure.
14 At the top of its stroke the piston comes into contact with the cylinder cover.
15 A black surface reflects sunlight well.
16 An electric shock of a hundred volts usually causes death.
17 The magnetic needle of a compass points towards the South Pole.
18 Aluminium dissolves in water.
19 A mixture of concentrated nitric and hydrochloric acid (1 to 4 by volume) dissolves gold.
20 Sentence 17 contains a spelling mistake.

△ **Exercise 14** Look at this example:

A man leaves A at 10.00 A.M. for B which is 4 km from A. He walks at 6 kph.
When does he arrive at B?

Now write suitable questions for the following:

1 A train leaves *A* at 10.00 A.M. for *C*, 20 km away. It arrives at 10.25 A.M.
(a) How fast .....?

2 A train leaves A for D, which is 35 km away. It travels at an average speed of 70 kph.
(a) When .....?
(b) How long .....?
3 A train leaves A for E. It travels at 80 kph and arrives at E one hour and twenty minutes later.
(a) How far .....?
4 x weighs 2·5 kilos a liter and y weighs half as much as x.
A can weighing half a kilo contains 6 liters of y.
(a) How much .....?
5 Make up a problem about distance/speed/time.
6 Make up a problem about weight/cost.
7 Make up a problem about length/width/area.

If your problems are in correct English perhaps the teacher will try and work out the answers.