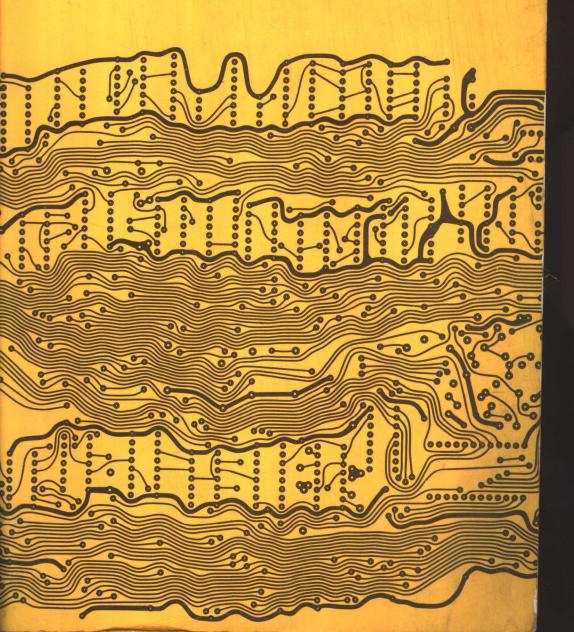
English for Electrical Engineers

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JMcA and GM

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Introduction

1 Purpose of this book

- 1.1 This book does two things. On the one hand, it gives an outline of electrical engineering and electronics, in English that is fairly simple at first but becomes more difficult. At the same time, it is an intermediate course in the English that electrical engineers will need.
- 1.2 The aim of this book is to help the non-English speaking student of electrical engineering to improve his knowledge of the English that he needs for his work. It will help him to read and understand English better, so that he can use technical books in English; and it will help him to write in English about electrical engineering.

2 Students who can use this book

- 2.1 The book can be used by students who have only a little knowledge of English, learnt over perhaps two or three years of part-time study.
- 2.2 It can be used in class with a teacher, and also by students who are working alone.

 The answers to all exercises and problems are included. (A dictionary is necessary, however; see 3.2.2 below.)
- 2.3 The book will be useful to students of electrical engineering and electronics in a university, polytechnic or professional (trade) school. It can also be used by qualified engineers and technicians who need to improve their understanding of the technical English that they meet in publications and at conferences.

3 The material in this book

- 3.1.1 The *technical* material can be used with a technical course (in the student's own language) that lasts for about two or three years. Each chapter in this book has enough technical material for between 4 and 6 hours' study.
- 3.1.2 The book has two parts. Part One deals with the most important topics of electrical engineering, and has 14 lessons. Part Two is on electronics; it has 10 lessons on many different topics, including basic circuit elements, television and digital computers.
- 3.2.1 The linguistic material in the first lessons is mainly on the correct forms of words. Later sections show how words are used in sentences, particularly 'logical links' – the connecting words that show the logical structure of a passage. The pronunciation of words and phrases is shown where there may be difficulties.
- 3.2.2 There are notes on difficult points, including vocabulary. But dictionaries are necessary for less difficult words that a student nevertheless may not know.

Every student should have an English dictionary, such as the Oxford Advanced Learner's Dictionary of Current English (OUP). A student who is working alone may also need a dictionary in English and his own language.

- 3.3.1 Each chapter begins with a reading passage that deals with one aspect of electrical or electronic theory, followed by notes and comprehension questions on the passage. The language work follows: it consists of notes on particular points of grammar, with exercises on those points and on other features (such as logical links) that are practised throughout the book. At the end of the chapter there is a summary of the reading passage, followed by the answers to the comprehension questions and language exercises.
- 3.3.2 In the first chapters, the reading passages have very short lines. Each grammatical part of a sentence comes on a new line. This helps the student to understand the structure of the sentence. Up to Chapter 10, the lines slowly become longer, with more sentence parts on each line. From Chapter 11, the material is presented in the ordinary way.
- 3.3.3 The summary of the passage can be used for revision of the technical content of the chapter, and (with a teacher) for language practice as dictation or pronunciation material.

4 How the book should be used

- 4.1 The technical material is complete in each lesson, and in most lessons the linguistic material is also complete; so it is not absolutely necessary to study the lessons in the order that they have in this book. However, both the technical and the linguistic topics move logically from one lesson to the next, so it is best to follow the book's order if possible.
- 4.2 If you are using this book without a teacher, you should work in the following way:

 Stage 1

Read the summary of the chapter (at the end, before the answers to the exercises). Use a 'bilingual' dictionary (that is, one that gives the meaning of English words in your language) for any words that you do not understand.

Stage 2

Read the reading passage once, quickly. This will give you some idea of what it contains. Then read it again, slowly and carefully. Read the notes as you do this. (Where a word in the notes is shown with a phonetic transcription, practise saying it aloud several times by reading the transcription. See paragraph 5.3 for the symbols used.)

Stage 3

Do the comprehension exercise and check your answers. Read the note after the answers. If your score is good enough, go on to stage 4; if not, do all (or part) of stages 2 and 3 again.

Stage 4

Study the language notes in the chapter that you are working on, and do the exercises that follow. Then stop: you should not do stage 5 in the same study period as stage 4.

Stage 5

(Do not do this on the same day as stage 4.) Repeat the language exercises that you

did in stage 4, then check your answers. If your score is below 80 per cent, study again the passage or the note on the language point that the exercise deals with. (This may be in an earlier chapter, as some language exercises are for revision.) Then do the exercises again before you go on to stage 6.

Stage 6

Read the summary at the end of the chapter again, and make sure that you understand all of it.

Stage 7

Go back to the chapter *before* the one that you have just finished. Read the reading passage once, then write your own summary of it in English. Compare your summary with the summary in the book, and if possible show it to someone who knows English well.

4.3 If you are working with a teacher of English, section 4.2 will help you to plan your home study. For the teacher himself, section 4.2 will serve as a guide to the use of the book – though the procedure can of course be varied to suit individual needs.

5 Pronunciation

- 5.1 The pronunciation that we represent is Received Pronunciation, or 'RP'. This accent is common among educated speakers in England, although not in most other parts of Britain.
- 5.2 The table shows the symbols that we use. The consonant symbols are the same as those in most British books. For the vowels, we use a new system. This will be used in the new *Dictionary of Contemporary English* (Longman), and a very similar system will be used in the fully revised edition of the *English Pronouncing Dictionary* (Dent).

We show this system in the first column of the vowels list. In the second column, for comparison, we show the symbols used in the Concise Pronouncing Dictionary of British and American English by J. Windsor Lewis (OUP); this system is also used in the new (3rd) edition of the Oxford Advanced Learner's Dictionary of Current English (OUP). In the third column, we show the older system that is used, for example, in the current edition of the English Pronouncing Dictionary.

5.3 In RP, final [r] is pronounced when the next word begins with a vowel sound, but not otherwise. To show this, a small [r] is printed *above* the ordinary line. For example:

far [fa:1]

This means that a phrase like far down is pronounced [fa: daon] while far away would be [fa: dwei].

5.4 The sounds [m, n, n, l, r] can be syllabic – that is, they can form a syllable without a vowel sound. For example, travel may be pronounced as either ['trævl] or ['trævəl]; in the former, the second syllable has [l] as a syllabic consonant without a vowel sound. We show this by printing the vowel in italic, [s]. For example:

travel ['trævəl]

memory ['meməri]

This means that the consonant following may either be syllabic or have the vowel [a] before it. In the case of *memory*, with a vowel after the consonant, the two-syllable pronunciation [memorized] is also possible. Pronunciations with a syllabic

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- consonant are recommended, but where this is difficult the other pronunciations may be used.
- 5.5 The mark [1] is placed before the syllable that has main stress in a word, and [1] comes before a syllable with secondary stress. For example:

 understand [1] Andə stænd]
- 5.6 Consonants are made in many different ways. Some of these differences are important because they decide which endings should be added to nouns and verbs in speech, and we shall study this in the language lessons. However, we should mention here that the VOCAL CORDS vibrate when some consonants are made but they do not vibrate for others. Consonants that are made with vibration are called voiced, and those without vibration are voiceless. The voiceless consonants are:

p t k f θ s \int t \int h All the other consonants, and all the vowels, are voiced. We shall mention this difference several times.

| Consonants Symbol Key Word | | Vowels | | Concise Pronoun- cing Dictionary | English Pronoun- cing Dictionary | Key Word |
|-----------------------------|--------------|------------|-----------|-------------------------------------|-------------------------------------|----------|
| | | Number | This Book | | (13th edition) | |
| p | pea | 1 | i: | i | i: | sheep |
| b | bay | 2 | I | I | i | ship |
| t | tea | 3 | e | e | e | bed |
| d | d ay | 4 | æ | æ | æ | bad |
| k | key | 5 | a: | a | a: | calm |
| g | gay | 6 | D | o | o | pot |
| | | 7 | o: | o | o: | caught |
| t∫ | cheer | 8 | ช | U | u | put |
| d3 | j ump | 9 | u: | u | u: | boot |
| | | 10 | ٨ | Λ | ٨ | cut |
| f | few | 11 | 3: | 3 | ə: | bird |
| v | view | 12 | ə | ə | э | cupboard |
| θ | thing | | | | | |
| ð | then | 13 | eı | eı | ei | make |
| S | soon | 14 | ອບ | θÜ | əu | note |
| z | z 00 | 15 | aı | tD | ai | bite |
| ſ | fishing | 16 | aυ | αυ | au | now |
| 3 | pleasure | 17 | IC | 10 | ic | boy |
| h | hot | 18 | | I9 | iə | here |
| | | 19 | еэ | еэ | 63 | there |
| m | sum | 20 | ບອ | ບອ | uə | poor |
| n | sun | <u> </u> | | | | |
| ŋ | sung | | era | eıə | eiə | player |
| | | | ອບອ | ວບວ | əuə | lower |
| | let | | aıə | GIĐ | aiə | tire |
| r | red | \ <u> </u> | auə | συο | auə | tower |
| | | | SIS | SIS | oiə | employer |
| j | yet | ļ. | | | | |
| w | wet | } | | | | |

6 Other symbols and abbreviations

The other symbols, not used for pronunciation, and abbreviations are used according to *British Standard 1991: Part 1* (1967) and the *List of Symbols and Abbreviations* published by the Institution of Electrical Engineers. This information is also contained in *SI units in electricity and magnetism*, HMSO, London.

7 Cross-references

Many notes contain references to other notes in the book. A single number refers to a line in the same chapter; two numbers with a dot between them refer first to another chapter and then to a line in that chapter. For example:

- (16) means 'look at line 16 in this chapter';
- (2.28) means 'look at Chapter 2, line 28';
- (6.184 and note) means 'look at chapter 6, line 184, and at the note for that line'.

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Part One – Electrical Engineering

Chapter 1

Electrostatic forces and the structure of matter

Before beginning this chapter, read carefully section 4.2 of the Introduction

| In 1785 | | and inversely proportional | |
|---------------------------------|----|----------------------------------|----|
| Coulomb | | to the square | |
| carried out | | of the distance | |
| a series | | between them. | 35 |
| of experiments | 5 | | |
| on small charged bodies. | | A knowledge | |
| He observed | | of the properties | |
| that two spheres, | | of electrostatic forces | |
| each with an electric charge, | | is fundamental | |
| attract each other | 10 | when we begin | 40 |
| when the two charges | | to study | |
| are of opposite sign, | | the problems | |
| and repel each other | | of electricity, | |
| when the charges | | and we cannot introduce | |
| are of the same sign. | 15 | the subject | 45 |
| Coulomb measured | | without considering | |
| the amount | | the structure | |
| of these forces | | of matter. | |
| - called electrostatic forces - | | In fact, | |
| and he proposed | 20 | to explain | 50 |
| the law | | macroscopic electrical phenomena | |
| now known as | | and their origin, | |
| Coulomb's law. | | we must examine | |
| This states | | the arrangement, | |
| that the force | 25 | electric charge, | 55 |
| acting | | mass, | |
| between two charged bodies | | motion | |
| in air | | and energy | |
| is proportional | | of the smallest particles | |
| to the product | 30 | of matter. | 60 |
| of the charges, | | The atom | |

2 Electrostatic forces and the structure of matter

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| which surrounds a heavy core beauty core che nucleus. The nucleus composed of particles with a positive charge of about the same mass but with no resultant electric charge. These are called neutrons. The nucleus are arranged in the atom The electrons has no resultant electric charge, it exerts no electrostatic force on either protons or electrons. There is, however, and electrons. There is, however, a very strong mechanical force exerted by the neutrons on the protons the extremely short distances between them. are arranged in the atom 100 is so strong that a chemical reaction That a chemical reaction can never change revolve 130 140 140 140 145 | | | of the electron. | |
| a heavy core 85 it exerts 130 - the nucleus. no electrostatic force The nucleus on either protons is composed of or electrons. There is, with a positive charge 90 however, 135 called protons, a very strong mechanical force and other particles exerted of about the same mass by the neutrons but with no resultant electric charge. These are called 95 in an atom, 140 neutrons. The nucleus the extremely short distances and the electrons between them. are arranged This mechanical force in the atom 100 is so strong 145 like a very small planetary system. The electrons revolve the number | | | Since the neutron | |
| The nucleus on either protons is composed of or electrons. There is, with a positive charge 90 however, 135 called protons, a very strong mechanical force and other particles exerted of about the same mass but with no resultant electric charge. These are called 95 in an atom, 140 neutrons. The nucleus the electrons are arranged This mechanical force in the atom 100 is so strong 145 like a very small planetary system. The electrons can never change revolve the number | | | has no resultant electric charge, | |
| The nucleus is composed of or electrons. particles There is, with a positive charge 90 however, 135 called protons, a very strong mechanical force and other particles exerted of about the same mass but with no resultant electric charge. These are called 95 in an atom, 140 neutrons. The nucleus the extremely short distances and the electrons are arranged This mechanical force in the atom 100 is so strong 145 like a very small planetary system. The electrons can never change revolve the number | a heavy core | 85 | it exerts | 130 |
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| particles with a positive charge with a positive charge solutions, and other particles of about the same mass but with no resultant electric charge. These are called neutrons. The nucleus and the electrons are arranged in the atom like a very small planetary system. There is, however, a very strong mechanical force exerted by the neutrons on the protons 140 140 140 140 141 140 140 14 | | | on either protons | |
| with a positive charge 90 however, 135 called protons, a very strong mechanical force and other particles exerted by the neutrons but with no resultant electric charge. These are called 95 in an atom, 140 neutrons. because of the extremely short distances and the electrons are arranged This mechanical force in the atom 100 is so strong 145 like a very small planetary system. The electrons can never change revolve the number | is composed of | | or electrons. | |
| called protons, and other particles of about the same mass but with no resultant electric charge. These are called neutrons. The nucleus and the electrons are arranged in the atom The atom 100 is so strong That a chemical reaction The electrons The electrons The electrons The nucleus This mechanical force in the atom The atom The electrons The electrons The electrons The electrons The electrons The nucleus This mechanical force That a chemical reaction That a chemical reaction The electrons The electrons The number | particles | | There is, | |
| and other particles of about the same mass but with no resultant electric charge. These are called neutrons. The nucleus and the electrons are arranged in the atom The atom The electrons The electrons The electrons The nucleus are arranged to the extremely short distances between them. This mechanical force in the atom This mechanical reaction that a chemical reaction The electrons can never change revolve exerted by the neutrons the number | with a positive charge | 90 | however, | 135 |
| of about the same mass but with no resultant electric charge. These are called 95 in an atom, 140 neutrons. because of The nucleus and the electrons are arranged in the atom 100 is so strong 145 like a very small planetary system. The electrons revolve by the neutrons betheenenes 140 140 140 140 140 140 140 140 | called protons, | | a very strong mechanical force | |
| but with no resultant electric charge. These are called 95 in an atom, 140 neutrons. because of The nucleus the extremely short distances and the electrons between them. are arranged This mechanical force in the atom 100 is so strong 145 like a very small planetary system. that a chemical reaction The electrons can never change revolve them. | and other particles | | exerted | |
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| neutrons. The nucleus and the electrons are arranged in the atom The atom The electrons | but with no resultant electric charge. | | on the protons | |
| The nucleus and the electrons are arranged in the atom like a very small planetary system. The electrons revolve the extremely short distances between them. This mechanical force is so strong that a chemical reaction can never change the number | These are called | 95 | in an atom, | 140 |
| and the electrons are arranged This mechanical force in the atom 100 is so strong 145 like a very small planetary system. The electrons revolve that a chemical reaction can never change the number | neutrons. | | because of | |
| are arranged in the atom 100 is so strong 145 like a very small planetary system. The electrons revolve This mechanical force 145 that a chemical reaction can never change the number | The nucleus | | the extremely short distances | |
| in the atom 100 is so strong 145 like a very small planetary system. that a chemical reaction The electrons can never change revolve the number | and the electrons | | between them. | |
| in the atom 100 is so strong 145 like a very small planetary system. that a chemical reaction The electrons can never change revolve the number | are arranged | | This mechanical force | |
| The electrons can never change revolve the number | | 100 | is so strong | 145 |
| revolve the number | like a very small planetary system. | | that a chemical reaction | |
| | The electrons | | can never change | |
| | revolve | | the number | |
| around the nucleus of protons | around the nucleus | | of protons | |
| in fixed orbits. 105 in an atom. 150 | in fixed orbits. | 105 | | 150 |
| The nucleus | The nucleus | | | |
| has a positive electric charge In fact, | has a positive electric charge | | In fact, | |

| | we need | | then this acquires | |
|---|---|-----|--------------------------------|-----|
| | an electrical apparatus | | a negative charge | |
| | of the power | | equal to | |
| | of a cyclotron | 155 | one or more times | 200 |
| | to overcome | | the electron charge. | |
| | this force. | | Then | |
| | | | we call it | |
| | Normally, | | a negative ion | |
| | atoms are | | or anion. | 205 |
| | electrically neutral systems | 160 | | |
| | because | | The property | |
| | the number | | of different atoms | |
| | of their electrons | | to lose | |
| | is equal | | or acquire | |
| | to the number | 165 | electrons | 210 |
| | of protons | 105 | depends on | 210 |
| | in the nucleus. | | the arrangement | |
| | Under particular conditions, | | of the electrons | |
| | however, | | in their orbits, | |
| | an atom | 170 | according to | 215 |
| | can lose | 170 | the theories | 213 |
| | | | of Sommerfeld and Pauli. | |
| | one, two, three or four electrons, and then | | Different amounts | |
| | | | | |
| | the system | 175 | of energy | 220 |
| | has a positive electric charge | 1/3 | are necessary | 220 |
| | respectively equal to | | to remove | |
| | one, two, three or four times | | an electron | |
| | the electron charge. | | from an atom, | |
| | In this case | 100 | according to | 225 |
| | we call it | 180 | the orbital arrangement | 225 |
| | a positive ion | | of the electrons | |
| | or cation | | in the atom. | |
| | and we say | | We call | |
| | it is | 105 | this energy | 220 |
| | monovalent, bivalent, | 185 | ionization energy. | 230 |
| | trivalent or tetravalent | | For example, | |
| | according to | | the rare gases | |
| | the number | | are chemically very inert | |
| | of electrons | | and this shows | |
| | t has lost. | 190 | they have | 235 |
| | In the same way, | | very stable atomic structures. | |
| | if one | | This stability | |
| | or more | | is also shown | |
| | electrons | | by the fact | |
| | are added | 195 | that the ionization energy | 240 |
| 1 | to a neutral atom, | | is greater | |
| | | | | |

4 Electrostatic forces and the structure of matter

| for the rare gases | | A molecule | |
|----------------------------------|-----|---|------|
| than for other elements. | | is the smallest particle | 270 |
| On the other hand. | | of any substance | 2, 0 |
| the ionization energy | 245 | which still has | |
| of the halogen elements | 213 | the original chemical properties | |
| is small. | | of the substance. | |
| If we have anions | | Therefore, | 275 |
| and cations | | a molecule | 2,5 |
| together, | 250 | consists of | |
| they attract | 230 | one or more atoms; | |
| neighbouring ions | | for example, | |
| of opposite sign | | molecules of helium. | 280 |
| because of | | neon and argon | 200 |
| the electrostatic forces | 255 | contain one atom each | |
| among them. | 200 | and are therefore called | |
| We call | | monatomic molecules. | |
| the force | | Molecules of hydrogen, | 285 |
| of attraction | | oxygen and nitrogen | 200 |
| between ions | 260 | consist of | |
| of opposite charge | 200 | two atoms each | |
| the ionic valence force. | | and are therefore called | |
| When these ions | | diatomic. | 290 |
| unite | | A molecule | 270 |
| because of | 265 | can also be | |
| these electrostatic forces. | 203 | a group of atoms | |
| they form | | of different elements, | |
| electrically neutral molecules. | | for example | 295 |
| olocationity moderate molecules. | | sulphuric acid (H ₂ SO ₄). | 2,5 |
| | | 54). | |
| | | | |

Notes

| Line | | |
|------|-----------------------------|--|
| 2 | Coulomb [ˈkuːlɒm] | Charles-Augustin de Coulomb (1736-1806), French scientist. |
| 4 | series [ˈsɪərɪz] | A set of things coming one after another. (Note that this word is the same in both singular and plural ('one series' and 'two series'): 'A series of experiments was carried out' and 'Two series of experiments were carried out'.) |
| 6 | charged body | Something that has an electric charge (9). |
| 8 | sphere [sfiə ^r] | Body shaped like a ball. |
| 9 | electric [ɪˈlektrɪk] | Worked by, or using, electricity. (Note that electricity [,1lek'trisəti] has two adjectives, electric and electrical; the second often means 'connected with the study of electricity'. So an 'electric light' is a light that works by electricity, but 'electrical engineering' is the part of engineering in which electricity is studied. We say 'electrical phenomena' (51) and 'electrical apparatus' (153), but 'electric charge' as on this line.) |
| 9 | charge [t∫a:dʒ] | Electricity on a body. |

| 10 | mades a construction | |
|-------|---|---|
| 10 | attract each other | The first sphere attracts the second and the second |
| 12 | opposite [ˈɒpəzɪt] sign | sphere also attracts the first. |
| 12 | opposite [upazit] sign | Not the same sign; one positive ['pozetty] (+) and the other negative ['negetty] (-). |
| 13 | repel [rɪˈpel] | Push away. The opposite is attract (10). |
| 15 | the same sign | Both positive (+) or both negative (-) (compare 12). |
| 18 | force [fois] | Capacity to attract (10) or repel (13). |
| 19 | electrostatic | Concerning electric charges. |
| | [ɪlektrəʊˈstætɪk] | |
| 21 | law [lo:] | (here) A generalization about related facts. |
| 29 | proportional [prəˈpɔːʃənəl] | Corresponding in size or amount (see also 32). |
| 30 | product ['prodakt] | (in mathematics) The result when two quantities are |
| | | multiplied; for example the <i>product</i> of 2×4 is 8, and |
| | | the product of $a \times a$ is a^2 . |
| 32 | inversely [in'va:sli] | When one quantity becomes smaller as the other |
| 22 | proportional | becomes greater. |
| 33 | square [skweə ^r] | (here) As in 'The square of 3 is $9(3^2 = 9)$ '; see |
| 37 | | Language notes, 'Operations'. |
| 39 | property ['propett] | What something can do; quality or characteristic. |
| 47 | fundamental [¡fʌndəˈmentl] structure [ˈstrʌktʃər] | Basic; coming before anything else. The way parts are joined together. |
| 48 | matter ['mætə'] | That of which all things are made. |
| 51 | macroscopic | As seen without a microscope (compare |
| | [,mækrəʊ¹skɒpɪk] | microscopic [maikrau skopik], so small that a |
| | [i | microscope is needed). |
| | phenomena [fi nominə] | Things whose cause is not clear. (Note singular |
| | | phenomenon [fi ¹ nominan] US [fa ¹ nomanon]: 'a |
| | | phenomenon' but 'two phenomena'.) |
| 54-58 | arrangement and | This is a list; note how it is written, especially and |
| | energy | with no comma before the last word. |
| 59 | particle [ˈpɑːtɪkəl] | A very small part. |
| 63 | element [ˈelɪmənt] | The simplest form of a substance; an element cannot |
| | | be separated into simpler substances by ordinary |
| " | | chemical means. |
| 66 | still [stɪl] | Even at present – in the past and now. Do not |
| | | confuse still and always (compare line 108): |
| | | 'The theory is <i>still</i> in evolution' – it is not perfect yet; |
| | | 'Thermionic valves are <i>still</i> used' – we have not stopped using them; |
| | | 'The law is always called Coulomb's law' – we do not |
| | | call it anything else; |
| | | 'Thermionic valves are always used in this circuit' – we |
| | | cannot use anything else. |
| | | (Note: the opposite of always is never, and the |
| | | opposite of still is no longer). |
| 67 | evolution [ˌiːvəˈluːʃən] | Development. |
| 68 | interpret [ɪnˈtɜːprɪt] | (here) Explain. |
| 73 | Niels Bohr [bəuə ^r] | Danish physicist (1885–1962), winner of Nobel Prize 1922. |
| 74 | Lord Ernest Rutherford | British physicist, winner of Nobel Prize 1908. |
| 77 | [lrʌðəfəd] (1871–1937) | Norman and amount |
| 1 / | approximate [ə¹proksimət] one [wʌn] | Near; not exact. |
| | one [waii] | Refers back to 'model' in line 75: 'This model is only an approximate <i>model'</i> . |
| 86 | nucleus [ˈnjuːklɪəs] | • • |
| • | mercus [njurknes] | Note plural nuclei ['nju:kli-ai] (one nucleus, two or more nuclei). |
| | | MOIS muchtif. |

| 88 | composed (of) | Made up (of). |
|--------------|---|--|
| 94 | no resultant electric charge | With the positive and negative charges of the same size so that no charge can be observed from outside. |
| 96 | neutron ['nju:tron] | Note spelling <i>neutron</i> ; the word comes from <i>neutral</i> (line 160), not <i>nucleus</i> . |
| 101 | planetary system ['plænitri 'sistəm] | An arrangement like that of the <i>planets</i> (Earth, Mars, Venus etc.) round the Sun. |
| 105 | orbit [ˈɔːbɪt] | The path of a planet round the Sun, or electrons round the nucleus. |
| 109 | multiple [ˈmʌltɪpəl] | A number that contains another number an exact number of times (for example 4 is a multiple of 2 $(2 \times 2 = 4)$, 12 is a multiple of 2, 3, 4 or 6). |
| 130-2 | exert [ɪgˈzɜːt] no force on | Have no effect on. |
| 132–3 | on either protons or electrons | 'On protons or on electrons'; note the form either or for relating two things. |
| 146 | chemical reaction | The result of two or more substances coming together |
| | | and producing a change. |
| 153 | apparatus [¡æpə¹reɪtəs] | Either a piece of equipment (Countable noun) or |
| | | equipment in general (Uncountable noun) – note that |
| | | this word can be used in these two ways: 'It's a very heavy apparatus' (Countable, one thing); |
| | | 'We've some new apparatus' (Uncountable, perhaps |
| | | many single things). |
| 154-5 | of the power of a cyclotron | 'That has as much power as a cyclotron.' |
| 155 | cyclotron [ˈsaɪklətron] | An accelerator (an apparatus that makes the particles accelerate – go faster and faster) that gives energies of |
| | | several million electron-volts to atomic-sized particles. (An <i>electron-volt</i> (eV) is a unit to describe |
| | | the energy of a moving electron. For example, if one |
| | | plate is 1,000 volts higher in potential than another |
| | | and an electron is pulled from the second to the first, |
| | | its energy when it reaches the first plate will be 1,000 |
| | | electron-volts.) |
| 160 181 | electrically neutral | With no charge – not positive (+) or negative (-). |
| 101 | ion [aɪən] | An atom, group of atoms or a molecule that lacks its full number of electrons (positive) or has too many |
| | | electrons (negative). |
| 182 | cation [ˈkætaɪən] | Positive ion. |
| 185-6 | monovalent | An ion that has lost one electron; mono- = 1. So also |
| | ['monəuveilənt], also | bivalent [baiveilant], trivalent [traiveilant] and |
| | [-vælənt] in US | tetravalent [tetraverlant]: $bi-=2$, $tri-=3$, $tetra-=4$. |
| 187–9 | according to the number of electrons | 'Depending on how many electrons' (compare 215-6: according to the theories, 'as the theories |
| | | state'). |
| 197 | acquire [əˈkwaɪər] | Obtain, get. |
| 205 215–6 | anion [ˈænaɪən] according to the theories | Negative ion (see note to 181). See note to 187-9. |
| 217 | Arnold Sommerfeld | German physicist, winner of Nobel Prize 1924. |
| | ['zpməfelt] (1868–1951) | The state of the s |
| | Wolfgang <i>Pauli</i> ['volfgæŋ 'pauli] (1900–1958) | Austrian atomic physicist, winner of Nobel Prize 1945. |
| 230 | ionization energy [ˌaɪənaɪˈzeɪ∫ən ˌenədʒɪ] | (Explained in lines 218–227.) |
| 232 | the rare [reə ^r] gases | Helium, neon, argon, krypton and radon. |

| 233 | chemically inert [1 ¹ n3:t] | Not reacting chemically with other things (these 'inert gases' do not easily form any chemical compounds). |
|--------|---|--|
| 236 | stable [ˈsteɪbəl] | Not easily changed. |
| 237 | stability [stəˈbɪlətɪ] | (noun) Being stable. |
| 244 | on the other hand | 'In contrast'; 'by comparison'. |
| 246 | the halogen [ˈhæləʊdʒən] elements | Fluorine, chlorine, bromine, iodine and astatine. |
| 252 | neighbouring [ˈneɪbərɪŋ] ions | Ions that are in the same general position, close to each other (spelt neighboring in America). |
| 254 | because of | Due to; owing to. |
| 257–62 | We call ionic valence [a1,0n1k 'verlens] (also ['vælens] in US) force | This name is given to the force by which ions of opposite charge attract each other. |
| 264 | unite [juːˈnaɪt] | Come together to make a single molecule. |
| 271 | substance ['sabstans] | Element or compound. |
| 277 | consist [kənˈsist] (of) | Be made (of); see also be composed of (88). |
| 284 | monatomic [mpnə/tpmɪk] | Having one atom (see 185-6 note for mono-). |
| 290 | diatomic [darəˈtɒmɪk] | Having two atoms (see 185-6 note for di-). |
| 293–4 | a group of atoms of different elements | This is a short way of saying 'a group of atoms that consist of different elements'. |
| 296 | sulphuric acid [sʌlʰfjʊərɪk ˈæsɪd] | (H ₂ SO ₄) (US sulfuric) |

Comprehension

Read section 4.2 of the Introduction before beginning this exercise.

Complete the following statements by choosing a, b or c from the three suggested possibilities. The correct answers are on page 14.

- 1 The molecule of an element is:
 - a one atom or a group of atoms.
 - b a group of ions.
 - c a group of electrons.
- 2 The nucleus of an atom is composed of:
 - a neutrons, electrons and protons.
 - b protons and electrons.
 - c neutrons and protons.
- 3 The force acting between two charged bodies in air is:
 - a proportional to the product of the charges.
 - b inversely proportional to the product of the charges.
 - c proportional to the square of the charges.
- 4 The mass of an electron is:
 - a smaller than the mass of a proton.
 - b greater than the mass of a proton.
 - c the same as the mass of a proton.
- 5 A cation is an atom which has:
 - a lost one, two, three or four electrons.