普通高等教育"十五"国家级规划教材

# 化学化工专业英语

# English for Chemistry and Chemical Engineering

主编　孙乃有　曹克广

高等教育出版社
Higher Education Press

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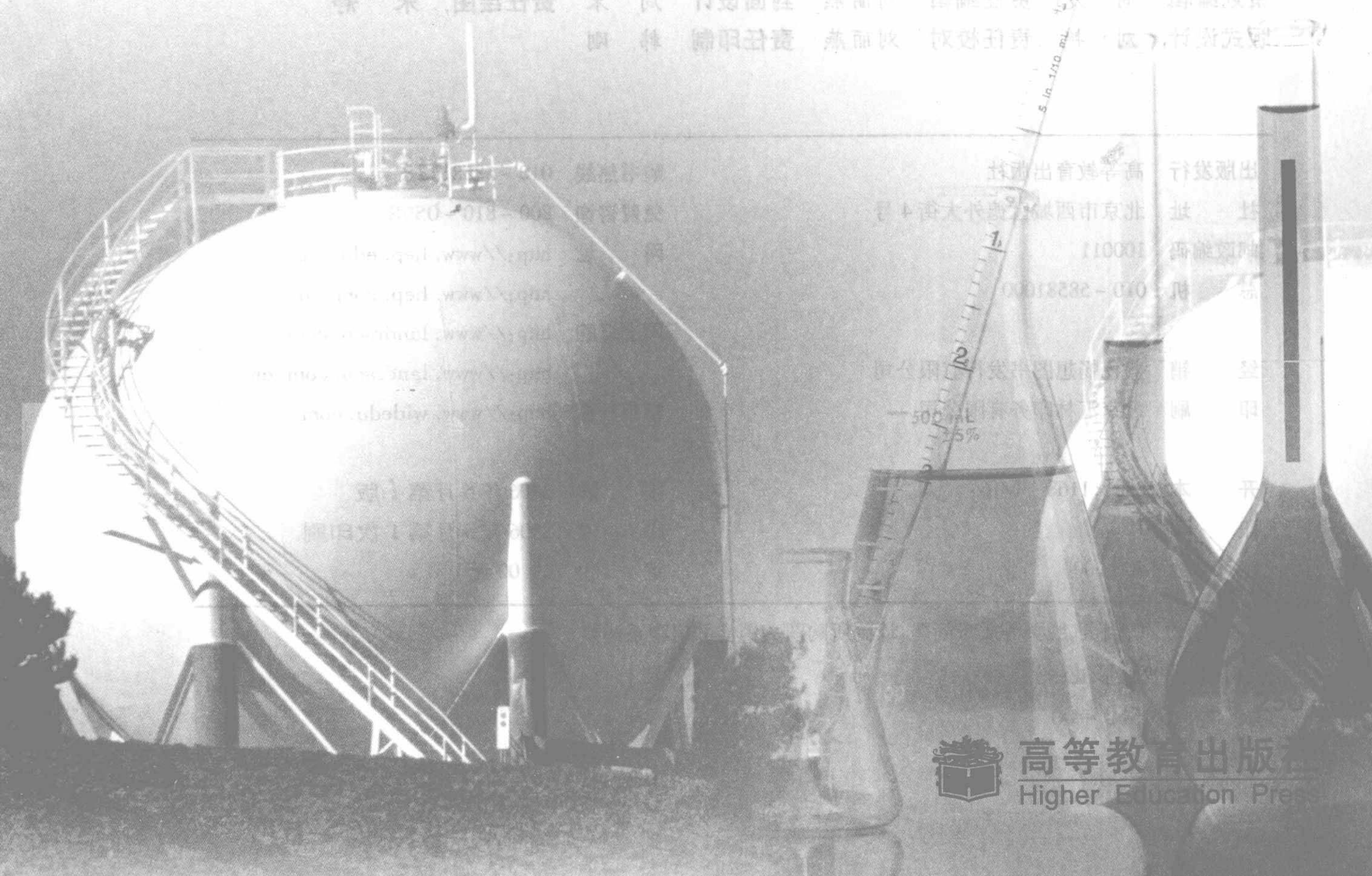
编 者　李爱红　王秀艳　杨夕强



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## 内 容 提 要


本书是普通高等教育“十五”国家级规划教材。

教材由五个单元内容组成：第一单元是化学基础知识；第二单元是化工基本原理；第三单元是化学工业与技术；第四单元是相关知识；第五单元是化工产品与检测。每个单元均由4组（第五单元为2组）课文与阅读材料构成并配有相应的习题、短文翻译，书后附有练习答案与参考译文。

本教材是基于高职高专教育并适应本科教育的教学特点和人才培养模式及其课程体系改革的需要编写的，适用于高职高专院校和其他院校化学、化工类专业及其相关专业的专业英语教材，也可作为有关工程技术人员的参考用书。



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# 前　言

随着我国加入世界贸易组织以及中国石油和化学工业的快速发展，社会对化学化工人才的需求更加严格，不仅需要掌握化学化工专业知识、技能与素质的人才，而且还迫切需求熟悉和掌握化学化工专业英语的复合性人才，以满足大中型化工企业尤其是中外合资企业的生产、经营与涉外贸易需要。本教材正是基于这一现状以及化学化工类专业教学改革的要求，在多年的专业外语教学实践和广泛搜集与整理大量的原始文献基础上编写而成的。

教材共由五个单元内容组成：第一单元是化学基础知识；第二单元是化工基本原理；第三单元是化学工业与技术；第四单元是相关知识；第五单元是化工产品与检测。每个单元均由4组（第五单元为2组）课文与阅读材料（共36篇文章）构成并配有相应的习题、短文翻译，书后附有练习答案与参考译文。

本教材的特点有以下三个方面：

1. 所选资料体裁多样、内容丰富、专业性强。组成课本内容的所有素材，基本涵盖了化学化工各个领域，其中包括：化学基础知识及其实验操作与安全防范、催化反应与催化剂，化工原理及其单元操作、化工技术及其设备与流体介质，无机和有机化工及其生产工艺、石油化工及其燃料生产与应用、精细化工及其产品生产与添加剂，高分子材料及其加工与应用、医药用品、金属材料生产与防腐、环境保护与污（废）水处理，化工原料和产品及其质量检测等。

2. 教材内容题材新颖、图文并茂、可读性强。为克服以往学生对专业英语兴趣不高和压力较大的弊端，本书在通篇的内容架构与筛选上，刻意选择并安排了一些富具现代化学化工气息与应用背景的阅读材料或生动有趣的笔译短文：如特殊化学品、火箭推进剂、抗生素、维C测定、索氏萃取、生命过程、超临界流体、生物燃料、复合材料、螯合疗法等。既反映出化学化工科技领域的先进性、又体现出知识链条的新颖性。寓教于乐、尝试并探究，也是本书编者期望学生在专业英语的学习中应当造就的内在动力。

3. 单元内容由浅入深、循序渐进、可选性强。每个单元各自构成了内容紧密相关且较为丰富的独立体系，各组课文与阅读材料有机结合、相辅相成，可供任课教师在40—60学时授课计划内灵活选用、机动安排，学有余力的同学可将课上教师不讲的阅读材料在课下自行研习。在课时不足40学时或特别强调具体专业教学内容的针对性时：或侧重讲授本书某几个单元（含阅读材料），抑或以某

些单元为主兼顾其它单元的内容来组织教学，达到因时、因材施教的效果。为方便“教”与“学”以及学生课余自学，在每组课文和阅读材料之后，附有生词（带音标并加注在专业领域中对应的词性与词义）、短语与术语的中文释义，对课文和阅读材料中出现的部分疑难问题（如难句、人物、工艺、计量单位等）还进行了课后或页脚诠释。

本教材针对化学化工类专业的专业英语教学实际情况，本着“重在取材、强调新颖、利于教学、突出实用”的原则构建课程内容体系，集灵活性和趣味性、先进性、实用性于一体，既方便于“教”、又有利于“学”，适用于高职高专院校和其他院校化学、化工类专业及其相关专业的专业英语教材，也可作为有关工程技术人员的参考用书。

本书第一单元由曹克广编写；第二单元由李爱红编写；第三单元由孙乃有编写；第四单元由王秀艳编写；第五单元由杨夕强编写。全书由承德石油高等专科学校曹克广、孙乃有教授统稿，人文社科系崔秀敏主任担当主审。孙乃有、曹克广为主编。

由于编者水平有限、加之时间仓促，疏漏与不妥之处在所难免，敬请广大读者不吝赐教，以便完善。

编　者

2006年5月



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# Contents

# Unit 1

# BASIC KNOWLEDGE OF CHEMISTRY

# Lesson 1

# Acid, Base, and Salt

We typically talk about acid-base reactions in aqueous-phase **environments**—that is, in the presence of water. The most fundamental acid-base reaction is the **dissociation** of water:

$$H_2O \rightleftharpoons H^+ + OH^-$$

In this reaction, water breaks down to form a hydrogen ion ($H^+$) and a hydroxyl ion ($OH^-$). In pure water, we can define a special **equilibrium constant** ($K_w$) as follows:

$$K_w = [H^+][OH^-] = 1.00 \times 10^{-14} \quad (1\text{-}1)$$

Where: $K_w$ is the equilibrium constant for water;

$[H^+]$ is the **molar concentration** of the hydrogen ion;

$[OH^-]$ is the molar concentration of the hydroxyl ion.

An equilibrium constant less than 1 suggests that the reaction prefers to stay on the side of the **reactants**. In this case, water likes to stay as water. Because water hardly ionizes, it is a very poor conductor of electricity.

## 1 pH value

What is of interest in this reading, however, is the acid-base nature of a substance like water. Water actually behaves both like an acid and a base. The acidity or basicity of a substance is **defined** most typically by the pH value **as**:

$$pH = -\log[H^+] \quad (1\text{-}2)$$

The lower-case letter "p" in pH stands for the negative **common logarithm** (base ten), while the upper-case letter "H" stands for the element hydrogen. Thus, pH is a logarithmic measurement of the number of moles of hydrogen ions ($H^+$) per **liter** of solution.

At equilibrium, the concentration of $H^+$ is $10^{-7}$, so we can calculate the pH of water at equilibrium as:

$$pH = -\log[H^+] = -\log[10^{-7}] = 7 \quad (1\text{-}3)$$

Solutions with a pH of 7 are said to be neutral, while those with pH values below 7 are defined as acidic, and those above pH of 7 as being basic.

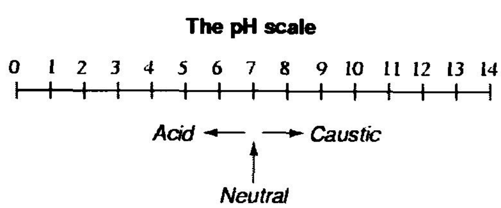


Figure 1.1 The pH of a solution and its corresponding ranges

## 2 Definitions of acids and bases

### (1) Arrhenius theory

Acid: generates $[H^+]$ in solution;

Base: generates $[OH^-]$ in solution.

Normal Arrhenius equation: acid + base = salt + water

Example: $HCl + NaOH = NaCl + H_2O$

### (2) Brϕnsted-Lowery theory

Acid: anything that donates a $[H^+]$ (**proton** donor);

Base: anything that accepts a $[H^+]$ (proton acceptor).

Normal Brϕnsted-Lowery equation: acid + base = acid + base

Example: $HNO_2 + H_2O = NO_2^- + H_3O^+$

Each acid has a **conjugate base** and each base has a **conjugate acid**. These conjugate pairs only differ by a proton.

In this example: $HNO_2$ is the acid, $H_2O$ is the base; $NO_2^-$ is the conjugate base, and $H_3O^+$ is the conjugate acid.

### (3) Lewis theory

Acid: accepts an electron pair;

Base: donates an electron pair.

The advantage of the Lewis theory is that many more reactions can be considered acid-base reactions because they do not have to occur in solution.

## 3 Acid-base properties

### (1) Properties of acids

All acids in the conventional sense contain hydrogen, which may be replaced by metals. When an acid is dissolved in water, ions are formed as a result of the transfer of a hydrogen ion (proton) from the acid molecule to the water molecule. In general, aqueous solutions of acids are characterized by the following properties:

① They have a sour taste. Lemons, oranges and other citrus owe their sour taste to the presence of **citric acid**. The taste of sour milk is due to the presence of **lactic acid**.

② They turn blue **litmus paper** red. Litmus is a dye which has a red color in acid solution and a blue color in basic solution; paper which has been soaked in litmus is referred to as litmus paper. Substances of this type, which enable us to determine whether a given solution is acid or basic, are called **indicators**[①]. **Methyl orange** and **phenolphthalein** are other indicators frequently used by chemists.

③ They react with certain metals to produce hydrogen. Reactions of this type were studied in connection with the preparation of hydrogen.

④ They react with bases to produce salts and water.

### (2) Properties of bases

All metallic hydroxides are classed as conventional bases. If these compounds are dissolved in water, the $OH^-$ is common to all of their solutions. An aqueous solution of $NH_3$ is also classed as a base, since $OH^-$ ions are present in the solution. In general, water solutions of bases exhibit the following properties:

① Bitter taste.

② Soapy or **slippery** feeling.

③ Turn red litmus paper blue.

④ React with acids to form salts and water.

⑤ Most metallic hydroxides are insoluble in water.

For a molecule with an X–O–H bond (also called an **oxyacid**) to be an acid, the XO–H must again ionize to form $H^+$. To be a base, the X–OH must break off to form the hydroxyl ion ($OH^-$). Both of these happen when dealing with oxyacids.

The most common type of acids follow the equation:

$$HA(aq) \rightleftharpoons H^+(aq) + A^-(aq)$$

The equilibrium constant for the dissociation of an acid is known as $K_a$. The larger the value of $K_a$, the stronger the acid[2].

$$K_a = \frac{[H^+][A^-]}{[HA]} \qquad (1\text{-}4)$$

## 4 Acid-base titration

An acid-base titration is when you add a base to an acid until the stoichiometric (equivalence) point is reached which is where the moles of acid equals the moles of base[3]. For the titration of a strong base and a strong acid, this point is reached when the pH of the solution is 7.

For the titration of a strong base with a weak acid, the point is reached when the pH is greater than 7. It is at this point where the pH = p$K_a$ of the weak acid[4].

In an acid-base titration, the base will react with the weak acid and form a solution that contains the weak acid and its conjugate base until the acid is completely gone. To solve these types of problems, we will use the weak acid's $K_a$ value and the **molarities** in a similar way as we have discussed before. In order to demonstrate this process, let us first examine a short cut, called the Henderson-Hasselbalch equations[5]. This can ONLY be used when you have some acid and some conjugate base in your solution. If you only have acid, then you must do a pure $K_a$ problem and if you only have base (Such as when the titration is complete) then you must do a $K_b$ problem.

$$pH = pK_a + \log \frac{[base]}{[acid]} \qquad (1\text{-}5)$$



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Where: $pK_a$ is the equilibrium dissociation constant for an acid;
[base] is the molar concentration of a basic solution;
[acid] is the molar concentration of an acidic solution.

This equation is used frequently when trying to find the pH of **buffer solutions**. A buffer solution is one which resists changes in pH upon the addition of small amounts of an acid or a base. They are made up of a conjugate acid-base pair such as $HC_2H_3O_2/C_2H_3O_2^-$ or $NH_4^+/NH_3$. They work because the acidic species **neutralize** the $OH^-$ ions while the basic species neutralize the $H^+$ ions. The buffer capacity is the amount of acid or base the buffer can neutralize before the pH begins to change to an **appropriate** degree. This depends on the amount of acid or base in the buffer. High buffering capacities come from solutions with high concentrations of the acid and the base and where these concentrations are similar in value.

## New Words

| | |
|---|---|
| environment / ɪn'vaɪərənmənt / *n.* | 环境，外界，周围 |
| dissociation / dɪˌsəuʃɪ'eɪʃən / *n.* | 离解，分解（离、裂） |
| reactant / riː'æktənt / *n.* | 反应物 |
| liter / 'liːtə / *n.* | 公升（也拼写为 litre） |
| proton / 'prəutɒn / *n.* | 质子 |
| indicator / 'ɪndɪkeɪtə / *n.* | 指示剂（也可用 indicating agent 表示） |
| phenolphthalein / ˌfɪnɒl'fθæliːn / *n.* | 酚酞 |
| slippery / 'slɪpəri / *adj.* | 滑溜的，易变的，含糊的， |
| oxyacid / ˌɒksɪ'æsɪd / *n.* | 含氧（羟基）酸 |
| molarity / məu'lærɪti / *n.* | 摩尔浓度 |
| neutralize / 'njuːtrəlaɪz' (uʃ) nuː- / *vt.* | 使中和，抵消，平衡，压制 |
| appropriate / ə'prəuprɪɪt / *adj.* | 适当的，专属的 |
| *vt.* | 占用，充当 |

## Expressions and Terminology

| | |
|---|---|
| define...as | 将……定义为…… |
| equilibrium constant | 平衡常数 |
| molar concentration | 摩尔浓度 |
| common logarithm | 常用对数 |
| conjugate base/acid | 共轭碱/酸 |
| citric/lactic acid | 柠檬/乳酸 |
| litmus paper | 石蕊试纸 |
| methyl orange | 甲基橙 |
| buffer solution | 缓冲溶液 |

## Notes

① Substances of this type, which enable us to determine whether a given solution is acid or basic, are called indicators.

句中主语、谓语分别是 Substances 和 are called，which 引导的是非限制性定语从句。

② The larger the value of $K_a$, the stronger the acid.

此句为常见的比较级，其完整句型是The larger the value of $K_a$ is，the stronger the acid is.

③ An acid-base titration is when you add a base to an acid until the stoichiometric (equivalence) point is reached which is where the moles of acid equals the moles of base.

句中出现两处从句：when 引导的是表语从句；which 引导的限制性从句是修饰主句的。

④ It is at this point where the pH = p$K_a$ of the weak acid.

这是一个强调句，其一般结构为 It is (was)...that...

⑤ Henderson-Hasselbalch equation 韩氏方程：即缓冲溶液计算公式。

## Reading Material

### Names, Symbols, and Atomic Numbers/Masses of the Elements

In each "block" of the **periodic chart** you will find at the top a number, then in the middle a letter or two letters, and at the bottom another number.

Consider for a moment the number at the top which is called the **atomic number** of the element represented in that block. It is the **identifying** number of the element. Just as you have a name and a Social Security Number[①], either of which could be used to identify you; so the elements have names and atomic numbers, either of which can be used to identify a given element.

The one or two letters found in each block below the atomic number represent an **abbreviation** for the name of that element. Such an abbreviation for an element's is called the chemical symbol for that element. This is **analogous** to the use of **initials** to represent names of people.

We will generally not concern ourselves with the number at the bottom of each block. This number (usually not a whole number) is called the **atomic mass** of the element represented in the block.

It is most important that you begin to learn the names of 43 of the most common chemical elements along with the chemical symbols for them (You are not expected to memorize the atomic numbers or atomic masses). While this seems to be a **dull**, unexciting way to spent a few hours, there is absolutely no way you can understand chemistry without learning this fundamental **alphabet**. After all, you did have to memorize the alphabet before you could learn to spell and read, and you did have to memorize numbers from zero to nine before you could count, add, and subtract. The names along with the symbols of 43 of the most often used elements are given in Table 1.1.

① Social Security Number [美国] 社会保障号码。

Table1.1 Symbols and names guide for selected elements

| Name | Symbol | Name | Symbol | Name | Symbol |
|---|---|---|---|---|---|
| aluminum | Al | **gold** | Au | platinum | Pt |
| argon | Ar | helium | He | **potassium** | K |
| arsenic | As | hydrogen | H | radium | Ra |
| barium | Ba | iodine | I | rubidium | Rb |
| beryllium | Be | **iron** | Fe | selenium | Se |
| boron | B | **lead** | Pb | silicon | Si |
| bromine | Br | lithium | Li | **silver** | Ag |
| cadmium | Cd | magnesium | Mg | **sodium** | Na |
| calcium | Ca | manganese | Mn | strontium | Sr |
| carbon | C | **mercury** | Hg | sulfur | S |
| cesium | Cs | neon | Ne | tellurium | Te |
| chlorine | Cl | nickel | Ni | **tin** | Sn |
| chromium | Cr | nitrogen | N | zinc | Zn |
| **copper** | Cu | oxygen | O | | |
| fluorine | F | phosphorus | P | | |

Given the names of these elements, you should be able to write the symbols; given the symbols, you should be able to write the names.

Your efforts to learn the symbols of the elements will be simplified if you remember that the vast majority of the symbols are nothing more than (i) The first letter; (ii) The first two letters; (iii) The first and third letters of the name of the element being considered. To illustrate here:

(i) boron = B  carbon = C  fluorine = F

(ii) aluminum = Al  barium = Ba  calcium = Ca

(iii) arsenic = As  cadmium = Cd  chlorine = Cl

The names of many of the elements are derived from Latin or Greek terms usually describe one of their properties. Chlorine comes from the Greek "*chloros*", which means "greenish yellow", the color of chlorine gas. Phosphorus comes from the Greek "*phosphoros*", meaning "**light bearing**", for its "glow in the dark" property. Other elements are names after people or places such as einsteinium (for Albert Einstein), curium (for Madame Curie①), californium (for the state), and uranium (for the planet Ura-

① Madame Curie 居里夫人（Madame 是法国式的对女士的尊称）。

nus), and so on.

Most symbols suggest the names of the element they represent, while others seem unrelated to their English names. The symbols for this latter class of elements are derived from their early names (often Latin), which were widely used in the past.

Table 1.2 Some familiar elements with their Latin names

| Element | Latin Name | Symbol | Element | Latin Name | Symbol |
|---|---|---|---|---|---|
| antimony | stibium | Sb | potassium | kalium | K |
| copper | cuprum | Cu | silver | argentum | Ag |
| gold | aurum | Au | sodium | natrium | Na |
| iron | ferrum | Fe | tin | stannum | Sn |
| lead | plumbum | Pb | tungsten | **wolfram** | W |
| mercury | hydragyrum | Hg | | | |

Tungsten is one of those elements with a symbol that doesn't correlate to its English or Latin name. The symbol "W" comes from the word—**wolfram**, which you will find on German and certain other **periodic tables**. A man named Peter Woulfe determined that tungsten was a new substance, but the element's name doesn't derive from his name. Rather, it comes from the Swedish "*wolf rahm*", which refers to the **wolframite mineral**—(Fe, Mn)$WO_4$.

It is most important to note that the first letter of every chemical symbol is capitalized (Although the first letter of the name of the element is not capitalized). But, if the symbol consists of two letters, the second letter is not capitalized when written or printed. Thus:

For aluminum. Al but not AL

For chlorine. Cl but not CL

For gold. Au but not AU

**Carelessness** in writing symbols can lead to **utter** confusion. For example: the symbol for nickel is Ni, but if it were written NI it would indicate a substance formed from the elements nitrogen (N) and iodine (I), no such substance exists; if one writes CS for cesium (instead of Cs) this implies to the reader a compound of carbon (C) and sulfur (S), rather than the symbol of the element cesium which is correctly written Cs; if CO were written for the element cobalt (Co), it would be taken to mean **carbon monoxide**, a toxic gas made from carbon (C) and oxygen (O).

It is advisable to write or print a small letter differently from the capitalized form of the same letter. Thus if "L" represents a capital letter, the better way to write the small letter is not "L" but "l". In other words, a small letter is not a capital letter just written smaller, but an entirely different written character. Therefore it is best to avoid such habits as writing $C_L$ rather than Cl and $A_G$ rather than Ag.

Some elements exists as **diatomic** molecules, you should **commit** the names of these elements to memory. They are hydrogen, nitrogen, oxygen, and the elements of group VII A: fluorine, chlorine, bromine, and iodine. The diatomic molecules of these elements could possibly be indicated in writing by showing the symbols of two atoms "**hooked**" together. For example, the oxygen molecule could **conceivably** be shown as O–O. However it is less trouble to write $O_2$ and that is what we do. The **subscript** 2 implies that two atoms of oxygen are joined in some way. Thus when you are speaking of free uncombined oxygen, the molecule $O_2$ is written, not the atom O, because only the molecule of oxygen has a stable independent existence. The atom of oxygen does not. In like manner the diatomic molecules of the other elements mentioned should be written $H_2$, $N_2$, $F_2$, $Cl_2$, $Br_2$, $I_2$, when the free uncombined element is intended.

Symbols for the elements may be used merely as abbreviations for the name of the element, but they are used more commonly in formulas and equations to represent a fixed relative quantity of the element; often the symbol stands for one atom of the element. Atoms, however, have fixed relative weights, called atomic masses, so the symbols often stand for one atomic mass of the element.

## New Words

identify / aɪ'dentɪfai / *vt.* 鉴（识）别，辨认，验明
abbreviation / ə,briːvɪ'eɪʃən / *n.* 缩写（词），省略，略语
analogous / ə'næləgəs / *adj.* 类（相）似的，可比拟的
initial / ɪ'nɪʃəl / *n.* 词首大写字母；
*adj.* 开始的，初期的
dull / dʌl / *adj.* 枯燥的，沉闷的，呆笨的，阴暗的
alphabet / 'æːlfəbɪt / *n.* 字母表，初步
wolfram / 'wʊlfrəm / *n.* 钨，钨锰铁矿
wolframite / 'wʊlfrəmaɪt / *n.* 钨锰铁矿，铁锰重石
carelessness / kɛəlɪsnɪs / *n.* 粗心大意，漫不经心
utter / 'ʌtə / *adj.* 完全的，绝对的，外边的
diatomic / ,daɪə'tɒmɪk / *adj.* 双原子的
commit/ kə'mɪt / *n.* 干坏，弄错，判处
hook/ hʊk / *vt.* ; *vi.* ; / *n.* 钩住；钩
conceivably/ kən'sivəblɪ, kən'siːvəbli / *adv.* 想得到地，想象上
subscript / 'sʌbskrɪpt / *adj.* 写在下方的；
*n.* 下标

## Expressions and Terminology

periodic chart/table （元素）周期图/表
atomic number/mass 原子序数/质量
light bearing 发（带）光物体
carbon monoxide 一氧化碳

## Exercises

**1. Translate the following words/phrases into English or Chinese:**

① ______________________ 氢离子的摩尔浓度

② ______________________ 物质的酸/碱度

③ ______________________ 这一理论的优越性

④ ______________________ 酸碱滴定法

⑤ ______________________ 缓冲容量

⑥ the most fundamental acid-base reaction ______________

⑦ poor conductor of electricity ______________

⑧ conjugate pairs ______________

⑨ turn blue litmus paper red ______________

⑩ stoichiometric point ______________

**2. Match the items listed in the following two columns:**

| | |
|---|---|
| ① lead/plumbum | A. 钨 |
| ② tungsten/wolfram | B. 铅 |
| ③ a toxic gas | C. 化学符号 |
| ④ chemical symbol | D. 描述它们的性质之一 |
| ⑤ diatomic molecules | E. 与它们的英文名称无关 |
| ⑥ lead to utter confusion | F. 导致彻底的混淆 |
| ⑦ to describe one of their properties | G. 一种有毒气体 |
| ⑧ unrelated to their English names | H. 双原子分子 |

**3. Translate the following English into Chinese:**

### *Demineralization*

Demineralization, also known as deionization, is the process of removing dissolved minerals from water to make it suitable for industrial or municipal uses. There are two main techniques to demineralize water: chemically-regenerated ion exchange resins and electrically-driven membrane devices.

Ion exchange purifies water by filtering it through a tank containing small beads of synthetic resin. The beads are chemically treated to absorb either positively charged cations or negatively charged anions, and exchange these ions for hydrogen ($H^+$) or hydroxyl ions ($OH^-$) based on their relative activity compared to the resin.

Membrane type demineralizer systems use physical separation, and in some processes electrical energy, to produce purified water. The most common form of membrane demineralization is reverse osmosis (RO), which produces pure water by passing it under pressure through a semi-permeable membrane. Pure water is formed on one side of the membrane, and the impurities are concentrated on the other side where they are removed to waste.



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