秦荻辉 选注

EST 科技英语

阅读教程

EST

西安电子科技大学出版社

高等学校理工科教材

科技英语阅读教程

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内容简介

本书主要是为通过了大学英语四级考试的理工类本科高年级学生编选的，是与《科技英语语法高级教程》相配套的教材。

本书共分三大部分。第一部分为阅读材料，选自国外中学和大专院校使用的原版科技书籍；第二部分为对阅读材料的注释，涉及语法要点、词汇用法和翻译技巧等；第三部分为本书的总词汇表。

本书可供理工类大学学生使用，也可作为成人高等教育的阅读教材，亦可供科技人员参考。

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秦荻辉　选注
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编者的话

本教程主要是为通过了大学英语四级考试的本科学生编选的，是与《科技英语语法高级教程》相配套的教材。它作为学生向真正的“专业阅读”过渡的一种材料，以巩固并熟练应用在基础阶段所学的英语语言知识和阅读技能，并进一步深化、拓宽语言知识面，扩大词汇量为目的，同时使同学们获取对原版科技书籍的写作风格、常用句型和英译汉技巧的感性认识，为今后能比较顺利地阅读自己本专业的科技资料打下一个良好的基础。（关于英译汉的常用技巧，请参阅西安电子科技大学出版社出版的《大学英语基础语法新编》中附录Ⅵ“英译汉方法简介”。）

本书共分三大部分。第一部分为阅读材料；第二部分为对该材料的注释（为使本书能便于读者自学，全书共有925条注释，涉及语法要点、词汇用法、翻译技巧等）；第三部分为本书的总词汇表（阅读材料中共出现单词2 638个，词组304个，其中属于大学英语四级应掌握的词汇共1 601个，均用 * 号标出），之所以列出全部词汇也是为了便于读者阅读本书，以省去查阅多种词典的麻烦。

本教程的阅读材料选自美国、加拿大等国中学和大专院校使用的原版科技书籍。由于本阶段的英语学习目的尚不是利用英语知识来获取最新的科技信息，而仍然侧重于语言学习本身，同时考虑到理工类学校绝大多数专业的情况，本书所选的材料涉及数学、物理、电子学和计算机四个方面的内容，所述的概念是可以为同学们所理解的。另外，在最后还编入了三篇科技书籍的序言及六篇科技论文的文摘，目的在于使读者对这两种类型的材料的语言特点和写作风格有一个粗浅的了解。

在阅读本书过程中，读者应侧重于对科技英语语言特点的理解以及在头脑中英→汉自然转换的思维过程的养成（即所谓“语感”的形成）方面，也就是要努力做到读完一个句子后就应能理解其所述的内容而不再回过头去进行语法分析和逐词翻译，当然个别长句、难句除外）。本书供一个学期使用，每周平均阅读量应达15页。

本教材既可用于理工科大学学生，也可用作为成人高等教育的阅读教材，同时还可供厂所广大科技工作者使用。编者希望它能对读者提高阅读科技文献的能力起到一定的作用，同时恳切希望读者对本书提出宝贵的意见和建议，编者将不胜感激。

编　者

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于西安电子科技大学外语系

目　录

Part One Reading Material

I. Mathematics

I-1 NUMBERS AND LITERAL SYMBOLS

Mathematics has played a most[1] important role in the development and understanding of the various fields of technology, and in the endless chain of[2] technological and scientific advances of our time[3]. With the mathematics[4] we shall develop[5] in this text[6], many kinds of applied problems can and will be solved. Of course, we cannot solve the more advanced types of problems which arise, but we can form a foundation for the more advanced mathematics which is used to solve such problems. Therefore, the development of a real understanding of the mathematics presented in this text will be of[7] great value to you in your future work.

A thorough understanding of algebra is essential to the comprehension of any of the fields of elementary mathematics. It is important for[8] the reader to learn and understand the basic concepts and operations presented here, or[9] the development and the applications of later topics will be difficult to comprehend[10]. Unless the algebraic operations are understood well, the result will be a weak foundation for further work[11] in mathematics and in many of the technical areas where mathematics may be applied.

We shall begin our study of mathematics by reviewing some of the basic concepts and operations that deal with numbers and symbols. With[12] these we shall be able to develop the topics in algebra which are necessary for further progress into other fields of mathematics, such as trigonometry and calculus.

The way we represent numbers today[13] has been evolving for thousands of years. The first numbers used[14] were those which stand for whole quantities[15], and these[16] we call the positive integers. The positive integers are represented by the symbols 1, 2, 3, 4, and so forth.

Of course, it is necessary to have numbers to represent parts of certain quantities, and for this purpose fractional quantities are introduced. The name positive rational number *is given to any number that we can represent by the division of one positive integer by*[17] *another. Numbers that cannot be designated by the division of one integer by another are termed* irrational.

EXAMPLE A

The numbers 5, 18, and 1978 are positive integers. They are also rational numbers, since they may be written as $\frac{5}{1}$, $\frac{18}{1}$, and $\frac{1978}{1}$. Normally we do not write the 1's in the denominators.

The numbers $\frac{1}{2}$, $\frac{5}{8}$, $\frac{11}{3}$, and $\frac{106}{17}$ are positive rational numbers, since both the numerators and the denominators are integers.

The numbers $\sqrt{2}$, $\sqrt{3}$, and π are irrational. It is not possible to find any two integers which represent these numbers when one of the integers is divided by the other. For example, $\frac{22}{7}$ is not an *exact* representation *of* π; it is only an approximation.

In addition to the positive numbers, it is necessary to introduce negative numbers, not only because we need to have a numerical answer to problems such as $5-8$, but also because the negative sign is used to designate direction. *Thus*, -1, -2, -3, *and so on are the* negative integers. The number zero is an integer, but it is neither positive nor negative. *This means that the* integers *are the numbers* $\ldots, -3, -2, -1, 0, 1, 2, 3, \ldots$, *and so on.*

The integers, the rational numbers, and the irrational numbers, which include all such numbers which are zero, positive, or negative, constitute what we call the real number system[18]. We shall use real numbers throughout this text, with one important exception. In the chapter on the j-operator, we shall be using[19] imaginary numbers, *which is the name given to square roots of negative numbers.* The symbol j is used to designate $\sqrt{-1}$, which is not part of[20] the real number system.

EXAMPLE B

The number 7 is an integer. It is also a rational number since $7=\frac{7}{1}$, and it is a real number since the real numbers include all of the rational numbers.

The number 3π is irrational, and it is real since the real numbers include all of the irrational numbers.

The numbers $\sqrt{-10}$ and 7j are imaginary.

The number $\frac{1}{8}$ is rational and real. The number $\sqrt{5}$ is irrational and real.

The number $\frac{-3}{7}$ is rational and real. The number $-\sqrt{7}$ is irrational and real.

The number $\sqrt{-7}$ is imaginary.

The number $\frac{\pi}{6}$ is irrational and real. The number $\frac{\sqrt{-3}}{2}$ is imaginary.

A fraction *may contain any number or symbol representing a number in its numerator or in its denominator*. Thus, a fraction may be rational, irrational, or imaginary.

EXAMPLE C

The numbers $\frac{2}{7}$ and $\frac{-3}{2}$ are fractions, and they are also rational.

The numbers $\frac{\sqrt{2}}{9}$ and $\frac{6}{\pi}$ are fractions, but they are not rational numbers. It is not possible to express either[21] as the ratio of one integer to another[22].

The number $\frac{\sqrt{-3}}{2}$ is a fraction, and it is also imaginary.

The real numbers may be represented as points on a line. We draw a horizontal line and designate some point on it by O[23], which we call the origin (see Fig. 1 – 1). The number zero, which is an integer, is located at this point. Then equal intervals are marked off from this point toward the right, and the positive integers are placed at these positions. The other rational numbers are located between the positions of the integers. It[24] cannot be proved here, but the rational numbers do not take up all the positions on the line; the remaining points represent irrational numbers.

Now we can give the direction interpretation to negative numbers. By starting at the origin and proceeding to the left, in the negative direction, we locate all the negative numbers. As shown in Fig. 1 - 1, the positive numbers are to the right of the origin and the negative numbers to the left. Representing numbers in this way[25] will be especially useful when we study graphical methods.

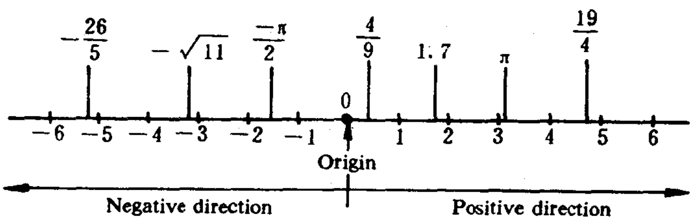

Figure 1 - 1

Another important mathematical concept we use in dealing with numbers[26] is the absolute value of a number. By definition[27], *the absolute value of a positive number is the number itself, and the absolute value of a negative number is the corresponding positive number (obtained by changing its sign)*. We may interpret the absolute value as[28] being the number of units a given number is from the origin[29], regardless of direction. The absolute value is designated by | | placed around the number.

1 - 2 FUNDAMENTAL LAWS OF ALGEBRA

In performing the basic operations with numbers[30], we know that certain basic laws are valid. These basic statements are called the fundamental laws of algebra.

For example, we know that if two numbers are to be added[31], it does not matter in which order they are added[32]. Thus $5+3=8$, as well as $3+5=8$. For this case we can say that $5+3=3+5$. This statement, generalized and assumed correct for all possible combinations of numbers to be added[33], is called the commutative law for addition. The law states that *the sum of two numbers is the same, regardless of the order in which they are added.* We make no attempt to[34] prove this in general, but accept its validity.

In the same way we have the associative law for addition, which states that *the sum of three or more numbers is the same, regardless of the manner in which they are grouped for addition.* For example,

$$3+(5+6)=(3+5)+6$$

The laws which we have just stated for addition are also true for multiplication. Therefore, *the product of two numbers is the same, regardless of the order in which they are multiplied*, and *the product of three or more numbers is the same, regardless of the manner in which they are grouped for multiplication.* For example, $2\times 5=5\times 2$ and $5\times(4\times 2)=(5\times 4)\times 2$.

There is one more[35] important law, called the distributive law. It states that *the product of one number and the sum of two or more other numbers is equal to the sum of the products of the first number and each of the other numbers of ther sum.* For example,

$$4(3+5)=4\times3+4\times5$$

In practice these laws are used intuitively. However, it is necessary to state them and to accept their validity, so that we may[36] build our later results with them.

Not all operations are associative and commutative. For example, division is not commutative, since the indicated order of division of two numbers does matter[37]. For example, $\frac{6}{5}\neq\frac{5}{6}$ ($\neq$ is read "does not equal").

Using literal symbols[38], the fundamental laws of algebra are as follows:

Commutative law of addition: $a+b=b+a$

Associative law of addition: $a+(b+c)=(a+b)+c$

Commutative law of multiplication: $ab=ba$

Associative law of multiplication: $a(bc)=(ab)c$

Distributive law: $a(b+c)=ab+ac$

Having identified the fundamental laws of algebra[39], we shall state the laws which govern the operations of addition, subtraction, multiplication, and division of signed numbers. These laws will be of primary and direct use in all of our work.

1. *To add*[40] *two real numbers with like signs, add their absolute values and affix their common sign to the result.*

EXAMPLE A

$$(+2)+(+6)=+(2+6)=+8$$
$$(-2)+(-6)=-(2+6)=-8$$

2. *To add two real numbers with unlike signs, subtract the smaller absolute value from the larger and affix the sign of the number with the larger absolute value to the result.*

EXAMPLE B

$$(+2)+(-6)=-(6-2)=-4$$
$$(+6)+(-2)=+(6-2)=+4$$

3. *To subtract one real number from another, change the sign of the number to be subtracted, and then proceed as in addition.*

EXAMPLE C

$$(+2)-(+6)=+2+(-6)=-(6-2)=-4$$
$$(-a)-(-a)=-a+a=0$$

The second part of Example C shows that subtracting a negative number from itself results[41] in zero. *Subtracting the negative number is equivalent to adding a positive number of the same absolute* *value*. This reasoning is the basis of the rule which states, "the negative of a negative number is a positive number."[42]

4. *The product (or quotient) of two real numbers of like signs is the product (or quotient) of their absolute values. The product (or quotient) of two real numbers of unlike signs is the negative of the product (or quotient) of their absolute values.*

EXAMPLE D

$$\frac{+3}{+5}=+\left(\frac{3}{5}\right)=+\frac{3}{5}$$

$$(-3)(+5)=-(3\times5)=-15$$

$$\frac{-3}{-5}=+\left(\frac{3}{5}\right)=+\frac{3}{5}$$

When we have an expression in which there is a combination of the basic operations, we must be careful to perform them in the proper order. Generally it[43] is clear by the grouping of numbers as to the proper order of performing these operations. However, *if the order of operations is not indicated by specific grouping, multiplications and divisions are performed first, and then the additions and subtractions are performed.*

EXAMPLE E

The expression $20\div(2+3)$ is evaluated by first adding $2+3$ and then dividing 20 by 5 to obtain[44] the result 4. Here, the grouping of $2+3$ is clearly shown by the parentheses.

The expression $20\div2+3$ is evaluated by first dividing 20 by 2 and adding this quotient of 10 to 3 in order to obtain the result of 13. Here no specific grouping is shown, and therefore the division is performed before the addition.

EXAMPLE F

$$(-6)-2(-4)+\frac{25}{-5}=(-6)-(-8)+(-5)=-6+8-5=-3$$

$$\frac{40}{(+7)+(-3)(+5)}=\frac{40}{+7+(-15)}=\frac{40}{7-15}=\frac{40}{-8}=-5$$

$$\frac{(-8)(+3)}{2}-(-5)(+2)(+3)=\frac{-24}{2}-(-10)(+3)$$

$$=(-12)-(-30)=-12+30=18$$

In the first illustration, we see that the multiplication and division were performed first, and then the addition and subtraction were performed. Also, it can be seen that[45] the addition and subtraction were changed to operations on[46] unsigned (equivalent to positive) numbers. This is generally more convenient, especially when more than one addition or subtraction is involved. In the second illustration, the multiplication in the denominator was performed first, and then the addition was performed. It was necessary to evaluate the denominator before[47] the division could be performed. In the third illustration, the left expression can be evaluated by performing either the multiplication or division first. Also, the order of multiplication in the right expression does not matter. However, these multiplications and divisions must be performed before the subtraction.

I - 3 OPERATIONS WITH ZERO

Since the basic operations with zero tend to cause some difficulty, we shall demonstrate them separately in this section.

If a represents any real number, the various operations with zero are defined as follows:

$a \pm 0 = a$ (the symbol $\pm$ means "plus or minus")

$a \times 0 = 0$

$\frac{0}{a} = 0$ if $a \neq 0$

Note that there is no answer defined[48] for division by zero. To understand the reason for this, consider the problem of $4/0$. If there were an answer to[49] this expression, it would mean that the answer, which we shall call b, should give 4 when multiplied by 0. That is, $0 \times b = 4$. However, no such number b exists, since we already know that $0 \times b = 0$. Also, the expression $0/0$ has no meaning, since $0 \times b = 0$ for any value of b which may be chosen. Thus division by zero is not defined. All other operations with zeo are the same as for any other number.

EXAMPLE A

$5+0=5,\quad 7-0=7,\quad 0-4=-4,$

$\frac{0}{6}=0,\quad \frac{0}{-3}=,\quad \frac{5\times 0}{7}=0,$

$\frac{8}{0}$ is undefined, $\frac{7\times 0}{0\times 6}$ is undefined

There is no need[50] for confusion in the operations with zero. They will not cause any difficulty if we remember that division by zero is undefined and that this is the only undefined operation.

I - 4 EXPONENTS

We have introduced numbers and the fundamental laws which are used with them in the fundamental operations. Also, we have shown the use of literal numbers to represent numbers[51]. In this section we shall introduce some basic terminology and notation which are important to the basic algebraic operations developed in the following sections.

In multiplication we often encounter a number which is to be multiplied by itself several times[52]. Rather than[53] writing this number over and over repeatedly, we use the notation a^n, where a is the number being considered[54] and n is the number of times it appears in the product[55]. *The number a is called the* base, *the number n is called the* exponent, *and, in words*[56], *the expression is read as the* "nth power of a".

EXAMPLE A

$4\times 4\times 4\times 4\times 4=4^5$ (the fifth power of 4)

$(-2)(-2)(-2)(-2)=(-2)^4$ (the fourth power of -2)

$a\times a=a^2$ (the second power of a, called "a squared")

$$\left(\frac{1}{5}\right)\left(\frac{1}{5}\right)\left(\frac{1}{5}\right)=\left(\frac{1}{5}\right)^3 \quad \text{(the third power of } \frac{1}{5}\text{, called “}\frac{1}{5}\text{ cubed”)}$$

$$8\times8\times8\times8\times8\times8\times8\times8\times8=8^9 \quad \text{(the ninth power of 8)}$$

The basic operations with exponents will now be stated symbolically. We first state them for positive integers as exponents[57], and then show how zero and negative integers are used as exponents. Therefore, if m and n are positive integers, we have the following important operations for exponents.

$$a^m \cdot a^n = a^{m+n} \qquad (1-1)$$

$$\frac{a^m}{a^n} = a^{m-n} \quad (m > n,\ a \neq 0) \qquad \frac{a^m}{a^n} = \frac{1}{a^{n-m}} \quad (m < n,\ a \neq o) \qquad (1-2)$$

$$(a^m)^n = a^{mn} \qquad (1-3)$$

$$(ab)^n = a^n b^n, \quad \left(\frac{a}{b}\right)^n = \frac{a^n}{b^n} \quad (b \neq 0) \qquad (1-4)$$

In applying Eqs. (1 - 1) and (1 - 2), the base a must be the same for the exponents to be added or subtracted[58]. When a problem involves a product of different bases, *only exponents of the same base may be combined.* In the following three examples, Eqs. (1 - 1) to (1 - 4) are verified and illustrated.

I - 5 APPLICATIONS OF EQUATIONS

Equations and their solutions are of great importance in most fields of technology and science. They are used to attain, study, and confirm information of all kinds. One of the most important applications occurs in the use of formulas in mathematics, physics, engineering, and other fields. A formula is an algebraic statement that[59] two expressions stand for the same number. For example, the formula for the area of a circle is $A=\pi r^2$. The symbol A stands for the area, as does[60] the expression πr^2, but πr^2 expresses the area in terms of another quantity, the radius[61].

Often it is necessary to solve a formula for[62] a particular letter or symbol which appears in it. We so this in the same manner as[63] we solve any equation: we isolate the letter or symbol desired[64] by use of the basic algebraic operations.

EXAMPLE A

Solve $A=\pi r^2$ for π.

$\frac{A}{r^2}=\pi$ both sides divided by r^2

$\pi=\frac{A}{r^2}$ since each side equals the other, it makes no difference[65] which expression appears on the left

EXAMPLE B

A formula relating acceleration a, velocity v, initial velocity v_0, and time t, is $v=v_0+at$. Solve for t.

$$v - v_0 = at \qquad v_0 \text{ subtracted from both sides}$$

$$t = \frac{v - v_0}{a} \qquad \text{both sides divided by } a \text{ and then sides are switched}$$ [66]

As[67] we can see from Examples A and B, we can solve for the indicated literal number just as[68] we solved for the unknown in the previous section. That is, we perform the basic algebraic operations on the various literal numbers which appear in the same way[69] we perform them on explicit numbers[70]. Another illustration appears in the following example.

EXAMPLE C

The effect of temperature is important when accurate instrumentation is required. The volume V of a precision container at temperature T in terms of the volume V_0 at temperature T_0 is given by[71]

$$V = V_0[1 + b(T - T_0)]$$

where b depends on the material of which the container is made. Solve for T.

Since we are to solve for T[72], we must isolate the term containing T. This can be done by first removing the grouping symbols, and then isolating the term with T.

$$V=V_0[1+b(T-T_0)] \qquad \text{(original equation)}$$

$$V=V_0[1+bT-bT_0] \qquad \text{(remove parentheses)}$$

$$V=V_0+bTV_0-bT_0V_0 \qquad \text{(remove brackets)}$$

$$V-V_0+bT_0V_0=bTV_0 \qquad \text{(subtract } V_0 \text{ and add } bT_0V_0 \text{ to both sides)}$$

$$T=\frac{V-V_0+bT_0V_0}{bV_0} \qquad \text{(divide both sides by } bV_0 \text{ and switch sides)}$$

In practice it is often necessary to set up equations to be solved[73] by using known formulas and given conditions. The most difficult part in solving such a stated[74] problem is identifying the information[75] which leads to the equation. Often this is due to the fact that some of the information is inferred, but not explicitly stated, in the problem.

Since a careful reading and analysis are important to the solution of stated problems, it is possible only to give a general guideline to follow[76]. Thus, (1) *read the statement of the problem carefully*; (2) *clearly identify the unknown quantities, assign an appropriate letter to represent ont of them, and specify the others in terms of this unknown*; (3) *analyze the statement clearly to establish the necessary equation*; *and* (4) *solve the equation, checking the solution in the original statement of the problem.* Carefully read the following examples.

EXAMPLE D

Two machine parts together have a mass of 17 kg. If one has a mass of 3 kg more than the other, what is the mass of each?

Since the mass of each part is required, we write

let m = the mass of the lighter part

as a way of establishing the unknown for the equation. Any appropriate letter could be used, and we could have let[77] it represent the heavier part.

Also, since "one has a mass of 3 kg more than the other," we can write

let $m+3=$the mass of the heavier part

Since the two parts together have a mass of 17 kg, we have the equation

$$m+(m+3)=17$$

This can now be solved.

$$2m+3=17$$
$$2m=14$$
$$m=7$$

Thus, the lighter part has a mass of 7 kg and the heavier part has a mass of 10 kg. This checks with[78] the original statement of the problem.

I - 6 APPLICATIONS OF THE INDEFINITE INTEGRAL

The applications of integration in engineering and technology are numerous. In this section we shall present two basic applications of the indefinite integral, with other applications being indicated in the exercises[79]. The sections which follow[80] deal with many of the basic applications of the definite integral.

The first of these applications deals with velocity and acceleration. The concepts of velocity as a first derivative[81] and acceleration as a second derivative were introduced in Chapters 22 and 23. Here we shall apply integration to the problem of finding the distance as a function of time, when we know the relationship between acceleration and time, as well as certain specific values of distance and velocity. These latter values[82] are necessary for determining the values of the constants of integration which are introduced[83]. Recalling[84] now that the acceleration a of an object is given by $a=\mathrm{d}v/\mathrm{d}t$, we can find the expression for the velocity in terms of a, t, and the constant of integration. We write

$$\mathrm{d}v = a\,\mathrm{d}t \quad \text{or}$$

$$v=\int a\,\mathrm{d}t \tag{25 - 1}$$

If the acceleration is constant, we have

$$v=at+C_1 \tag{25 - 2}$$

Of course, Eq. (25 - 1) can be used in general to find the velocity as a function of time so long as we know the acceleration as a function of time. However, since the case of constant acceleration is often encountered, Eq. (25 - 2) is often encountered. If the velocity is known for some specified time, the constant C_1 may be evaluated.

EXAMPLE A

Find the expression for the velocity if $a=12t$, given that[85] $v=8$ when $t=1$.

Using Eq. (25 - 1), we have

$$v=\int (12t)\ dt = 6t^2 + C_1$$

Substituting the known values, we obtain

$$8=6+C_1 \quad \text{or} \quad C_1=2$$

Thus, $v=6t^2+2$.

EXAMPLE B

For an object falling under the influence of gravity, the acceleration due to gravity[86] is essentially constant. Its value is $-9.8\ m/s^2$. (The minus sign is chosen so that all quantities directed up are positive, and all quantities directed down are negative.) Find the expression for the velocity of an object under the influence of gravity if $v=v_0$ when $t=0$.

We write

$$v=\int (-9.8)\ dt = -9.8t + C_1 \quad v_0 = 0 + C_1 \quad v = v_0 - 9.8t$$

The velocity v_0 is called the initial velocity. If the object is given an initial upward velocity[87] of 40 m/s, $v_0=40$ m/s[88]. If the object is dropped, $v_0=0$. If the object is given an initial downward velocity of 40 m/s, $v_0=-40$ m/s.

Once we obtain the expression for velocity, we can integrate to find the expression for displacement in terms of the time. Since $v=dt/dt$, we can write $ds=v\ dt$, or

$$s=\int v\ dt \tag{25 - 3}$$

EXAMPLE C

Find the expression for displacement in terms of time, if $a=6t^2$, $v=0$ when $t=2$, and $s=4$ when $t=0$.

$$v=\int 6t^2\ dt = 2t^3 + C_1; \quad 0 = 2(2^3) + C_1, \quad C_1 = -16$$

$$v = 2t^3 - 16$$

$$s=\int (2t^3 - 16)\ dt = \frac{1}{2}t^4 - 16t + C_2; \quad 4 = 0 - 0 + C_2, \quad C_2 = 4$$

$$s = \frac{1}{2}t^4 - 16t + 4$$

EXAMPLE D

Find the expression for the distance above the ground of an object, given a vertical velocity of v_0 from the ground[89].

From Example B, we know that $v=v_0-9.8t$. In this problem we know that $s=0$ when $t=0$ (given velocity v_0 *from the ground*) if distances are measured from ground level. Therefore,

$$s=\int(v_0-9.8t)\,dt=v_0t-4.9t^2+C_2;\quad 0=0-0+C_2,\quad C_2=0$$
$$s=v_0t-4.9t^2$$

EXAMPLE E

An object is thrown vertically from the top of a building 24.5 m high[90], and hits the ground 5 s later. What initial velocity[91] was the object given?

Measuring vertical distances from the ground, we know that $s=24.5$ m when $t=0$. Also, we know that $v=v_0-9.8t$. Thus,

$$s=\int(v_0-9.8t)\,dt=v_0t-4.9t^2+C$$
$$24.5=v_0(0)-4.9(0)+C,\quad C=24.5$$
$$s=v_0t-4.9t^2+24.5$$

We also know that $s=0$ when $t=5$ s. Thus,

$$0=v_0(5)-4.9(5^2)+24.5$$
$$5v_0=98.0$$
$$v_0=19.6\ \text{m/s}$$

This means that the initial velocity was 19.6 m/s upward.

The second basic application of the indefinite integral which we shall discuss comes from the field of electricity. By definition, *the current i in an electric circuit equals the time rate of change of the charge q (in coulombs) which passes a given point in the circuit*, or

$$i=\frac{dq}{dt} \tag{25-4}$$

Rewriting this expression in differential notation as[92] $dq=i\,dt$ and integrating both sides of the equation we have

$$q=\int i\,dt \tag{25-5}$$

Now, the voltage V_C across a capacitor C is given by $V_C=q/C$. By combining equations, the voltage V_C is given by

$$V_C=\frac{1}{C}\int i\,dt \tag{25-6}$$