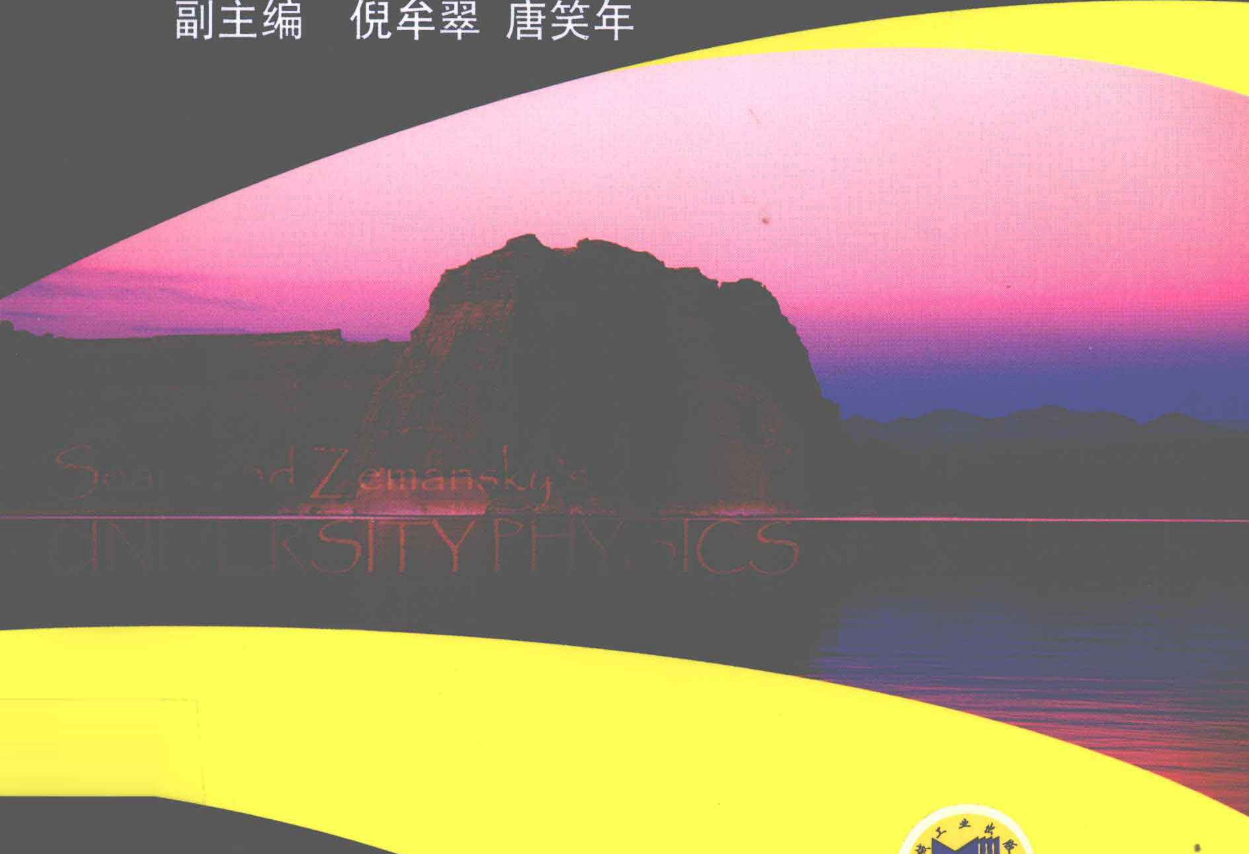
21世纪普通高等教育基础课规划教材

双语教学专用教材

西尔斯当代大学物理

词汇与习题选解

主　编　张成宝
副主编　倪牟翠　唐笑年



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主　编　张成宝
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本书是为主教材《西尔斯当代大学物理》（上下册）（英文改编版　原书第11版）配套的教材。每章内容包括从主教材同名章节中挑选出来的英文生词的汉语注释和部分习题选解，目的是为使用主教材的学生扫清阅读时的词汇障碍，并给出英文解题的范例。全书共有1800多个常见的有关物理概念和科学术语的词汇翻译和大约300道习题解答。另外，在每章的开头加有人生励志的英文格言，并在结尾附有英文幽默小故事。

本书既适合以主教材为双语教学教材的师生使用，又可作为广大双语教学师生的参考书。

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前　言

2001年8月，教育部印发的《关于加强高等学校本科教学工作提高教学质量的若干意见》指出，为适应经济全球化的发展趋势和迎接科技革命的挑战，本科教育要创造条件使用英语等外语进行公共课与专业课教学。近年来，越来越多的高校把“大学物理”选作实施双语教学的公共课程。大学物理双语教学承载着培养学生学术能力以及提高学生英语水平的双重任务。如何在有限的课时内既完成教学大纲要求，又帮助学生熟悉物理专业词汇，掌握科技英语的句型结构，提高英语表达、阅读和写作能力，成为从事大学物理双语教学的教师们面临的一个关键问题。对于大学一、二年级的本科学生来说，大学物理课程所涉及的许多语言点在公共英语课程中均未专门学习过，例如物理专有名词、客体时空位置、状态及数量关系或方程式的表述方法等，甚至在常规的英汉辞典中也很难找到这些名词术语的准确解释。这无疑给学生阅读、理解英文教材造成了极大困难，使学生学习效率降低、甚至丧失学习双语物理的兴趣和信心。因此，一套针对性强、方便实用的词汇翻译及学习辅导材料对于双语物理的学习是至关重要的。

本书是专门以机械工业出版社出版的《西尔斯当代大学物理》（上下册）（英文改编版，原书第11版）为主教材编写的配套教材。每一章包括词汇翻译、习题选解两部分。所选词汇主要为主教材中的物理专有名词以及大学英语四级以上、对低年级本科生来说属于生词的词汇，并按其在章节中出现的顺序编排。为了便于帮助学生阅读理解主教材，词汇的解释一般只给出一种，即该词在主教材中的含义。习题选解部分是在每章中选择有代表性的10道习题给出示范解答。为帮助学生提高英文表达能力，每一题解除了力求物理内容表述完整、准确外，还采用了相对统一的格式，如已知（Known）、求（Find）、解（Solution）的基本结构以及其他表达因果关系的句型结构。这种结构便于学生学习模仿，在做习题的过程中锻炼英文表达能力及用英语进行逻辑思维、推理的能力，最终能够独立进行英文写作。需说明的是，书中的图按其所在章的顺序编排。对于引用的原书中的图仍给一图号，但图名用“OB + 原书图号”表示，以方便读者与原书对照。

我校从2002年开始进行大学物理双语教学，在2003 ~ 2010年期间使用英文版《西尔斯大学物理》（机械工业出版社、影印版、原书第10版）作为教材，并撰写了与教材配套的词汇及习题选解，以讲义的形式发给学生，得到了相当不

错的反响。学生感到这样的辅导材料起到了工具书的作用，对双语物理学习有切实的帮助。本书就是在校内讲义的基础上改写并完善的。

本书是由吉林大学物理教学中心双语物理教学组的教师合作完成的。具体分工如下：1～17 章由张成宝编写，18～24 章由倪牟翠编写，25～30 章由唐笑年编写。吉林大学物理学院研究生张鹏鹏参与进行了编辑和校对工作。另外，本书每章附有英文格言、幽默故事，由武汉大学张唯一同学编写。

在本书编写过程中，得到了吉林大学物理教学中心领导的关心和支持。机械工业出版社对本书的编写给予了热情关注并提供了大量宝贵意见，编者在此表示衷心感谢！

限于编写人员的水平，书中难免有缺点和错误，我们恳切地希望广大读者多提宝贵意见，以便继续修改完善。若这本词汇习题解在推进大学物理双语教学上能发挥一定作用，或对物理教学及相关专业的师生、科技工作者有所帮助，编者将不胜欣慰。

编　者

2011 年于长春南湖

CONTENTS

I PHYSICAL QUANTITIES AND VECTORS

Nothing in the world is more dangerous than sincere ignorance and conscientious stupidity.

WORDS

1. physics	物理
2. discipline	学科
3. paleontologist	古生物学者
4. interplanetary	行星间的
5. adventure	探险
6. foundation	基础
7. preliminary	准备
8. system of units	单位制
9. vector	矢量
10. analyze	分析
11. principle	原理
12. discard	抛弃
13. ultimate	根本的
14. revise	修正
15. be inconsistent with	与……不一致
16. validity	适用性
17. rigid	刚性的
18. seam	缝合处
19. spin	旋转
20. neglect	忽略
21. concentrate	集中，专心
22. assumption	假定，设想
23. physical quantity	物理量
24. operational definition	操作性定义

25. unit	单位
26. International System of units	国际单位制
27. meter	米
28. second	秒
29. cumbersome	麻烦的
30. mass	质量
31. kilogram	千克
32. macroscopic	宏观的
33. unit prefix	单位前缀
34. dimensionally consistent	量纲一致
35. uncertainty	不确定
36. error	误差
37. accuracy	准确率
38. significant figure	有效数字
39. scientific notation	科学计数法
40. powers-of-10 notation	科学计数法
41. scalar quantity	标量
42. vector quantity	矢量
43. magnitude	大小
44. direction	方向
45. distinction	差别
46. vector addition	矢量加法
47. commutative law	交换律
48. associate law	结合律
49. vector subtraction	矢量减法
50. vector multiplication	矢量乘法
51. scalar product	标量积
52. dot product	点积
53. vector product	矢量积
54. cross product	叉积
55. unit vector	单位矢量
56. component	分量

SOLUTIONS

1.1 Find the angle between the two vectors $\vec{A}=2\hat{i}+3\hat{j}+\hat{k}$ and $\vec{B}=-4\hat{i}+2\hat{j}-\hat{k}$.

Solution: From $\vec{A}\cdot\vec{B}=|\vec{A}||\vec{B}|\cos\varphi$, we have $\cos\varphi=\dfrac{\vec{A}\cdot\vec{B}}{|\vec{A}||\vec{B}|}=-\dfrac{\sqrt{6}}{14}$. So $\varphi\approx$ $100°$.

1.2 If $\vec{a}=3\hat{i}-4\hat{j}$ and $\vec{b}=-2\hat{i}+3\hat{k}$, what is $\vec{c}=\vec{a}\times\vec{b}$?

Solution: $\vec{c}=\vec{a}\times\vec{b}=\begin{vmatrix}\vec{i} & \vec{j} & \vec{k}\\ 3 & 4 & 0\\ 2 & 0 & 3\end{vmatrix}=12\vec{i}+9\vec{j}+8\vec{k}$

1.4 In the product $\vec{F}=q\vec{v}\times\vec{B}$, take $q=2$, $\vec{v}=2.0\hat{i}+4.0\hat{j}+6.0\hat{k}$ and $\vec{F}=4.0\hat{i}-20\hat{j}+12\hat{k}$. What then is $\vec{B}$ in unit-vector notation if $B_x=B_y$?

Known: $\vec{F}=q\vec{v}\times\vec{B}$, $q=2$, $\vec{v}=2.0\hat{i}+4.0\hat{j}+6.0\hat{k}$, $\vec{F}=4.0\hat{i}-20\hat{j}+12\hat{k}$, $B_x=B_y$

Find: $\vec{B}$

Solution: Assume that $\vec{B}=B_x\hat{i}+B_y\hat{j}+B_z\hat{k}$.

$$\vec{v}\times\vec{B}=2.0\hat{i}-10\hat{j}+6\hat{k}=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 2.0 & 4.0 & 6.0\\ B_x & B_y & B_z\end{vmatrix}$$

$$=(4.0B_z-6.0B_y)\hat{i}+(6.0B_x-2.0B_z)\hat{j}+(2.0B_y-4.0B_x)\hat{k}$$

At the same time, $B_x=B_y$. So $B_x=B_y=-3$, $B_z=-4$ and $\vec{B}=-3\hat{i}-3\hat{j}-4\hat{k}$

1.6 The density of a material is equal to its mass divided by its volume. What is the density (in kg/m^3) of a rock of mass 1.80kg and volume $1.60\times10^{-4}m^3$? Make sure your answer has the correct number of significant figures.

Known: $m=1.80kg$, $V=6.0\times10^{-4}m^3$

Find: ρ

Solution: $\rho=\dfrac{m}{V}=3.0\times10^3kg/m^3$

1.8 For the two vectors $\vec{A}=3\hat{i}+2\hat{j}$ and $\vec{B}=4\hat{i}+5\hat{k}$, find the scalar product $\vec{A}\cdot\vec{B}$ and the vector product $\vec{A}\times\vec{B}$ in terms of unit vectors.

Solution: $\vec{A}\cdot\vec{B}=(3,2,0)\cdot(4,0,5)=12$, $\vec{A}\times\vec{B}=\begin{vmatrix}\hat{i} & \hat{j} & \hat{k}\\ 3 & 2 & 0\\ 4 & 0 & 5\end{vmatrix}=10\hat{i}-15\hat{j}-8\hat{k}$

1.9 You are given vectors $\vec{A}=5.0\hat{i}-6.5\hat{j}$ and $\vec{B}=-3.5\hat{i}+7.0\hat{j}$. A third vector $\vec{C}$ lies in the xy-plane. If $\vec{C}\perp\vec{A}$ and $\vec{C}\cdot\vec{B}=15.0$, from this information, find the components of vector $\vec{C}$.

Known: $\vec{A}=5.0\hat{i}-6.5\hat{j}$, $\vec{B}=-3.5\hat{i}+7.0\hat{j}$, $\vec{C}\perp\vec{A}$, $\vec{C}\cdot\vec{B}=15.0$

Find: $\vec{C}$

Solution: Assume that $\vec{C}=C_x\hat{i}+C_y\hat{j}$

From the hint, we have $-3.5C_x+7.0C_y=15.0$ and $5.0C_x-6.5C_y=0$

So $C_x=8.0$, $C_y=6.1$ and $\vec{C}=8.0\hat{i}+6.1\hat{j}$

1.13 Is the vector $(\hat{i}+\hat{j}+\hat{k})$ a unit vector? Justify your answer.

Solution: $|\hat{i}+\hat{j}+\hat{k}|=\sqrt{1^2+1^2+1^2}=\sqrt{3}\neq 1$, so it's not a unit vector.

1.14 Later in your study of physics we will encounter quantities represented by $(\vec{A}\times\vec{B})\cdot\vec{C}$. Prove that for any three vectors, $\vec{A}\cdot(\vec{B}\times\vec{C})=(\vec{A}\times\vec{B})\cdot\vec{C}$.

Solution: $\vec{A}\cdot(\vec{B}\times\vec{C})=A_x(B_yC_z-B_zC_y)+A_y(B_zC_x-B_xC_z)+A_z(B_xC_y-B_yC_x)$

$(\vec{A}\times\vec{B})\cdot\vec{C}=C_x(A_yB_z-A_zB_y)+C_y(A_zB_x-A_xB_z)+C_z(A_xB_y-A_yB_x)$

$=A_x(B_yC_z-B_zC_y)+A_y(B_zC_x-B_xC_z)+A_z(B_xC_y-B_yC_x)$

Obviously, $\vec{A}\cdot(\vec{B}\times\vec{C})=(\vec{A}\times\vec{B})\cdot\vec{C}$

1.15 How many correct experiments do we need to disprove a theory? How many to prove a theory? Explain.

Solution: One. Every.

1.16 If $\vec{A}$ and $\vec{B}$ are nonzero vectors, is it possible for $\vec{A}\cdot\vec{B}$ and $\vec{A}\times\vec{B}$ both to be zero? Explain.

Solution: From $\vec{A}\cdot\vec{B}=A_xB_x+A_yB_y=0$, we have $A_x=-\dfrac{A_yB_y}{B_x}$

And $\vec{A}\times\vec{B}=(A_xB_y-B_xA_y)\hat{k}=-\dfrac{A_y(B_x^2+B_y^2)}{B_x}$

For $\vec{A}$ and $\vec{B}$ are nonzero vectors, $-\dfrac{A_y(B_x^2+B_y^2)}{B_x}\neq 0$

So it is impossible for $\vec{A}\cdot\vec{B}$ and $\vec{A}\times\vec{B}$ both to be zero.

Happy moment! (*^__^*)

***Keys*? *Kiss*?**

A friend of mine was giving an English lesson to a class of adult who had recently come to live in the United States. After placing quite a number of everyday objects on a table, he asked various members of the class to give him the ruler, the book, the pen and so on. The class went very smoothly and the students seemed interested and serious about the work that they were engaged in until when my friend turned to an Italian student and said, "Give me the keys." The man looked surprised and somewhat at a loss. Seeing this, my friend thought that the student hadn't heard him clearly, so he repeated "Give me the keys." The Italian shrugged his shoulders. Then, he threw his arms around the teacher's neck and kissed him on both cheeks.

2 KINEMATICS

Originality and the feeling of one's own dignity are achieved only through work and struggle.

WORDS

1. space-shuttle	航天飞机
2. orbiter	轨道飞行物
3. parachute	降落伞
4. brake	制动
5. kinematics	运动学
6. dynamics	动力学
7. coordinate frame	坐标系
8. position vector	位置矢量
9. origin	原点
10. function	函数
11. eliminate	消除
12. the path equation	路径方程
13. displacement	位移
14. simplicity	简单
15. average velocity	平均速度
16. instantaneous velocity	瞬时速度
17. acceleration	加速度
18. confusion	混淆
19. rectilinear motion	直线运动
20. combination	组合
21. formula	公式
22. valid	正确的
23. differential	微分的
24. derivation	求导
25. constant	常量

26. centripetal 向心的
27. integral 积分的
28. integration 积分
29. explicit function 显函数
30. drag 阻力
31. terminal speed 极限速度
32. integral variable 积分变量
33. calculation 计算
34. derivative 导数
35. with respect to 相对于
36. inertial frame 惯性系
37. rocket 火箭
38. positive 正的
39. lamp 灯
40. suspend 悬挂
41. height 高度
42. shadow 影子
43. plane 平面
44. particle 粒子
45. initial 初始的
46. force 力
47. act 作用
48. Earth satellite 地球卫星
49. circular orbit 圆形轨道
50. period 周期
51. radius 半径
52. coefficient 系数

SOLUTIONS

2.1 A space rocket travels along a straight line. The motion function is $x = ut + u\left(\frac{1}{b} - t\right)\ln(1 - bt)$, in which u and b are known constants. Find the velocity and acceleration expressions of the rocket.

Solution: $v = \frac{dx}{dt} = -u\ln(1 - bt)$, $a = \frac{dv}{dt} = \frac{ub}{1 - bt}$

2.2 The Relation between the acceleration and velocity of rectilinear moving particle is $a = -kv^2$. Find the velocity expression $v = v(x)$ with the coordinate x as variable. Assume the initial value of x_0, $v(x_0) = v_0$ is given.

Solution: From $a = \frac{dv}{dx}\frac{dx}{dt} = \frac{dv}{dx}v = -kv^2$, we have $\frac{dv}{dx} = -kv$

That is $\int_{v_0}^{v_x} \frac{dv}{v} = -k\int_{x_0}^{x} dx$. We get $v(x) = v_0 e^{-k(x-x_0)}$

2.3 The acceleration of rectilinear moving particle is $a = A\cos\omega t$, in which A and ω are positive constants. If $x|_{t=0} = 0$, $v|_{t=0} = 0$, find the motion function of the particle.

Solution: $v = v_{(0)} + \int_0^t A\cos\omega t dt = \frac{A}{\omega}\sin\omega t$, $x = x_{(0)} + \int_0^t \frac{A}{\omega}\sin\omega t dt = \frac{A}{\omega^2}(1 - \cos\omega t)$

2.4 A boy walks along x axis in positive direction with a constant speed v_0. A lamp suspended above the origin at the height h_1. Find the speed expression $v = v(x)$ of the shadow casted by the boy's head if his height is $h_2 (h_2 < h_1)$.

Solution: $\frac{h_2}{h_1} = \frac{vt - v_0 t}{vt}$, so $v = \frac{h_1}{h_1 - h_2}v_0$

2.5 A particle moves so that its position (in meters) as a function of time (in seconds) is $\vec{r} = \hat{i} + 4t^2\hat{j} + t\hat{k}$. Write expressions for (a) its velocity and (b) its acceleration as functions of time.

Solution: $\vec{v} = \frac{d\vec{r}}{dt} = (8t\hat{j} + \hat{k})$ m/s, $\vec{a} = \frac{d\vec{v}}{dt} = 8\hat{j}$ m/s^2

2.6 A bird flies in the xy-plane with a velocity vector given by $\vec{v} = (\alpha - \beta t^2)\hat{i} + \gamma t\hat{j}$, with $\alpha = 2.4$ m/s, $\beta = 1.6$ m/s^3, and $\gamma = 4.0$ m/s^2. At $t = 0$, the bird is at the origin. Calculate the position and acceleration vectors as functions of time.

Solution: $\vec{v} = (2.4 - 1.6t^2)\hat{i} + 4.0t\hat{j}$, $\vec{a} = \frac{d\vec{v}}{dt} = -3.2t\hat{i} + 4.0\hat{j}$

$$\vec{r} = \int_0^t \vec{v}dt + \vec{r}_{(0)} = (2.4t - 0.53t^3)\hat{i} + 2.0t^2\hat{j}$$

2.9 A particle moves along x axis and starts from the origin with initial speed $v(0) = v_0$. Find the speed function $v = v(x)$ swith x as variable if the force acted on it can be expressed as $F = -kx$. Assume the mass of the particle is m.

Solution: From $a = \frac{dx}{dt}\frac{dv}{dx} = -\frac{kx}{m}$, we get $vdv = -\frac{kx}{m}dx$

So $\int_{v_0}^{v(x)} vdv = -\frac{k}{m}\int_0^x xdx$, $v(x) = \pm\sqrt{v_0^2 - \frac{k}{m}x^2}$

2.10 An Earth satellite moves in a circular orbit 640km above the Earth's surface with a period of 98.0min. What are (a) the speed and (b) the magnitude of the centripetal acceleration of the satellite? (The radius of the Earth is $R = 6.37 \times 10^6$m.)

Known: $T = 98.0$min, $r_1 = 640$km, $R = 6.37 \times 10^6$m

Find: v、a

Solution: From $F = m\frac{4\pi^2}{T^2}r = m\frac{v^2}{r} = ma$

we have $v = \frac{2\pi r}{T} = \frac{2\pi(r_1 + R)}{T} = 7.49 \times 10^3$m/s, $a = \frac{v^2}{r} = 8.00$m/s^2

2.14 A particle leaves the origin with an initial velocity $\vec{v} = (3.00\hat{i})$m/s and a constant acceleration $\vec{a} = (-1.00\hat{i} - 0.500\hat{j})$m/s^2. When the particle reaches its maximum x coordinate, what are (a) its velocity and (b) its position vector?

Solution: (a) $\vec{v} = \vec{v}_0 + \int_0^t \vec{a}\mathrm{d}t = [(3.00 - 1.00t)\hat{i} - 0.500t\hat{j}]$ m/s

(b) $\vec{x} = 0 + \int_0^t \vec{v}\mathrm{d}t = [(3.00t - 0.500t^2)\hat{i} - 0.250t^2\hat{j}]$ m

From the hint, $\frac{\mathrm{d}x}{\mathrm{d}t} = 0$, that is $3.00 - 1.00t = 0$. So t = 3s when the particle reaches its maximum x coordinate and $\vec{v}_3 = -1.50\hat{j}$, $\vec{x}_3 = 4.50\hat{i} - 2.25\hat{j}$.

2.16 The acceleration of a particle is given by $a_x = -2.00 + 3.00t$ (in SI). (a) Find the initial speed v_{x0} such that the particle will have the same x coordinate at $t = 4.00$s as it had at $t = 0$. (b) What will be the velocity at $t = 4.00$s?

Solution: We know $a_x = -2.00 + 3.00t$

So $v = v_{(x0)} + \int_0^t a\mathrm{d}t = [v_{(x0)} + (-2.00t + 1.5t^2)]$m/s, $x = (x_{(0)} + v_{(x0)}t - t^2 + 0.5t^3)$ m

From $x_{(4.00)} = x_{(0)}$, $v_{(x0)} = -4$m/s and $v = (-4 - 2t + 1.5t^2)$m/s. We will also get that the velocity equals 12m/s when $t = 4.00$s.

Happy moment! (*^__^*)

A Married Man Is Preferable

"Just why do you want a married man to work for you, rather than a bachelor?" Asked the curious chap.

"Well," sighed the boss, "the married men don't get so upset if I yell at them."