高等师范院校规划教材

物理
专业科技英语

SCIENCE AND TECHNOLOGY ENGLISH IN PHYSICS

主编 李 锦 谢康宁

陕西师范大学出版总社有限公司
SHAANXI NORMAL UNIVERSITY GENERAL PUBLISHING HOUSE CO.,LTD.

DJ 高等师范院校规划教材

陕西师范大学教材建设基金资助出版

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图书代号　JC13N1188

图书在版编目(CIP)数据

物理专业科技英语／李锦，谢康宁主编．—西安：陕西师范大学出版总社有限公司，2014.1
ISBN 978－7－5613－7237－1

Ⅰ.①物…　Ⅱ.①李…　②谢…　Ⅲ.①物理学—英语—高等学校—教材　Ⅳ.①H31

中国版本图书馆CIP数据核字(2013)第190872号

物理专业科技英语

主　　编／李　锦　谢康宁
责任编辑／王红凯
责任校对／贾　莉
封面设计／鼎新设计
出版发行／陕西师范大学出版总社有限公司
(西安市长安南路199号　邮编710062)
网　　址／http://www.snupg.com
经　　销／新华书店
印　　刷／兴平市博闻印务有限公司
开　　本／787mm×1092mm　1/16
印　　张／15
字　　数／311千
版　　次／2014年1月第1版
印　　次／2014年1月第1次印刷
书　　号／ISBN 978－7－5613－7237－1
定　　价／42.00元

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电　话：(029)85303622(传真)　85307864

前 言

随着物理学科的不断发展和新技术的广泛应用,以及物理学及其相关领域的国际教育与研究合作交流更加频繁,科技英语早已经是国际上专业交流的主要语言。对物理学专业学生来说,学习物理专业科技英语是必不可少的,也是吸取国外先进知识,进行国内外学术交流的基础。然而,很多高校的物理学专业英语课程并没有得到应有的重视,也没有形成系统的课程体系,在本科生一、二年级上完大学外语以后,即使开设了专业英语,很多专业英语课程的学习方式也仅仅停留在复印一些英文材料进行阅读、解释和翻译的阶段。学生学习后只是提高了一些专业词汇量和阅读翻译水平,而在使用专业英语进行写作和口头交流时,仍力不从心。基于此,作者认为,系统的专业英语的教学,对学生素质的影响举足轻重,不可忽视。

基于这样的想法,作者从自身近几年从事物理学专业科技英语教学、专业课程双语教学以及从事科学研究、国际学术交流的经验出发,编写了这本面向物理学专业的《物理学专业科技英语基础及应用》。

本书是一本针对高等学校物理学及其相关专业的专业英语教材,主要按照两大模块、七章内容、七个部分对物理学专业英语知识进行全方位的阐述。各部分内容既构成统一的整体,同时又自成体系,具体包括:物理学专业英语基础和物理学专业英语应用两大模块;力学、热学、光学、电学、近代物理学、科技英语写作以及科技英语交流七章内容;课文、生词表、课文注释、扩展阅读、常用用法、同义词辨析以及练习题七个部分。其中课文是从西尔斯大学物理英文原版教材中所选取的经典内容,然后通过生词表解释课文中部分难度较大的词汇。课文注释对课文中的语法、词汇表达等内容进行了详尽的解释。扩展阅读选用物理学相应领域的一些前沿和热点话题,用来拓宽学生的知识面。常用用法对物理学专业中用到的一些工具、仪器、设备、数学符号、物理量及其英语表达等做了列举,可供学生有针对性地查阅和掌握。在每节课的最后配备了一些形式多样的练习题,供学生课外练习使用。

全书分为物理学专业英语基础和物理学专业英语应用两个部分,第一、三、七章由谢康宁编写;第二、四、五、六章由李锦编写。雷涛、刘大钊、李瑜、徐文敏、赵筱等都参与查找资料、校对工作之中,在此深表感谢。在本书的编写过程中,屈世显、刘渊声等人为我们提出了宝贵的意见,给予了很大的帮助,在此谨表示衷心的感谢。

书中所有课文和部分扩展阅读的内容都选自《西尔斯物理学》(英文版·原书第10版),在此,向该书的所有作者表示感谢。我们还参考了国内外出版物(见某些章节后面以及本书后面的"参考文献")中的部分观点和内容,在此谨向这些编著者致以真诚的谢意,并对未能够事先征得同意表示歉意。此外,我们还选用了互联网上的部分资料,由于这些资料涉及面广,选用时做了大量修改,在此不便一一注明,谨向有关人士深表感谢。

本书可以作为物理学及其相关专业本科生、硕士生的教材使用,也适合物理学及其相关领域的科技工作者在使用专业英语进行学习和交流时翻阅参考。

由于水平有限,并且是第一次进行物理学专业科技英语教材的编写,错误和不足是难免的,请读者和同行多指教,以利于再版时修正和改进。

本书由国家自然科学基金项目(基金号:61102094)和陕西师范大学教材出版项目资助出版。

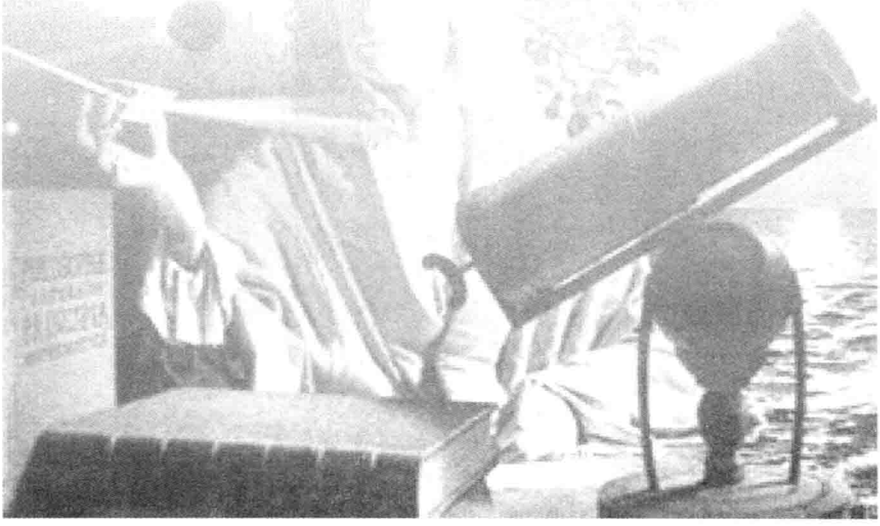
李　锦
2013 年 7 月

目 录

Part One 物理学专业英语基础

Part One

物理学专业英语基础



第一章 力 学

Lesson 1

内容 1.1 牛顿第一定律 Newton's First Law
1.2 生词表 New Words
1.3 课文注释 Text Annotation
1.4 扩展阅读 Extended Reading: Newton's Second Law
1.5 常用用法 Usages and Expressions
Ⅰ. 数学表达式 Mathematical Expressions
Ⅱ. 力学常用实验仪器 Usual Experimental Mechanics Instruments
1.6 同义词辨析 Synonyms
1.7 练习题 Exercise

1.1 牛顿第一定律 Newton's First Law

[1] **To begin with, let's consider what happens when the net force on a body is zero.** You would almost certainly agree that[2] **if a body is at rest, and if no net force acts on it (that is, no net push or pull), that body will remain at rest.** [3] **But what if there is zero net force acting on a body in motion?**

Suppose you slide a hockey puck along a horizontal table top, applying a horizontal force to it with your hand (Fig. 1 – 1a). After you stop pushing, the puck does not continue to move indefinitely; it slows down and stops. To keep it moving, you have to keep pushing (that is, applying a force). You might come to the "common sense" conclusions that bodies in motion naturally come to rest and that a force is required to sustain motion.

But now imagine pushing the puck across a smooth surface of ice (Fig. 1 – 1b). After you quit pushing, the puck will slide a lot farther before it stops. Put it on an air-hockey table, where it floats on a thin cushion of air, and it moves still farther (Fig. 1 – 1c). In each case, what slows the puck down is friction, an interaction between the lower surface of the puck and the surface on which it slides. Each surface exerts a frictional force on the puck that resists the puck's motion; the difference in the three cases is the magnitude of the frictional force.

The tendency of a body to keep moving once it is set in motion results from a property called inertia. You use inertia when you try to get ketchup out of a bottle by shaking it. First you start the bottle (and the ketchup inside) moving forward; [4] **when you jerk the bottle back, the ketchup tends to keep moving forward and, you hope, ends up on your burger.** The tendency of a body at rest to remain at rest is also due to inertia. You may have seen a tablecloth yanked out from under the china without breaking anything. The force on the china isn't great enough to make it move appreciably during the short time it takes to pull the tablecloth away.

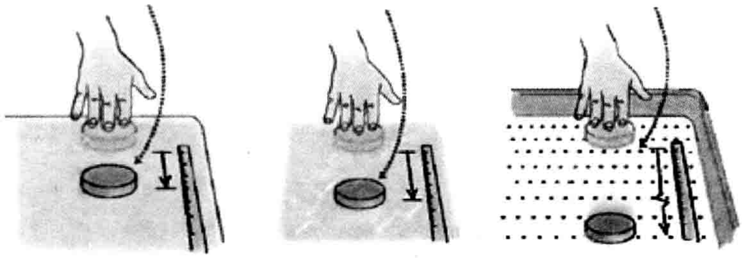


Fig. 1 – 1 (a) Table: puck stops short. (b) Ice: puck slides further. (c) Air-hockey table: puck slides even further.

When no net force acts on a body, the body either remains at rest or moves with constant velocity in a straight line. Once a body has been set in motion, no net force is needed to keep it moving. We now call this observation Newton's first law of motion.

Newton's first law of motion: A body acted on by no net force moves with constant velocity (which may be zero) and zero acceleration.

It's important to note that the net force is what matters in Newton's first law. For example, a physics book at rest on a horizontal table top has two forces acting on it: an upward supporting force, or normal force, exerted by the table top and the downward force of the earth's gravitational attraction (a long-range force that acts even if the table top is elevated above the ground). The upward push of the surface is just as great as the downward pull of gravity, so the net force acting on the book (that is, the vector sum of the two forces) is zero. In agreement with Newton's first law, if the book is at rest on the table top, it remains at rest. The same principle applies to a hockey puck sliding on a horizontal, frictionless surface: The vector sum of the upward push of the surface and the downward pull of gravity is zero. Once the puck is in motion, it continues to move with constant velocity because the net force acting on it is zero.

Inertial Frames of Reference

The concept of frame of reference is central to Newton's laws of motion. Suppose you are in a bus that is traveling on a straight road and speeding up. If you could stand in the aisle on roller skates, you would start moving backward relative to the bus as the bus gains speed. If instead the bus was slowing to a stop, you would start moving forward down the aisle. In either case, it looks as though Newton's first law is not obeyed; there is no net force acting on you, yet your velocity changes. What's wrong?

The point is that the bus is accelerating with respect to the earth and is not a suitable frame of reference for Newton's first law. This law is valid in some frames of reference and is not valid in others. A frame of reference in which Newton's first law is valid is called an inertial frame of reference. The earth is at least approximately an inertial frame of reference, but the bus is not. (The earth is not a completely inertial frame, owing to the acceleration associated with its rotation and its motion around the sun. These effects are quite small, however.) Because Newton's first law is used to define what we mean by an inertial frame of reference, it is sometimes called the law of inertia.

There is no single inertial frame of reference that is preferred over all others for formulating Newton's laws. If one frame is inertial, then every other frame moving relative to it with constant velocity is also inertial. [5] **Viewed in this light, the state of rest and the state of motion with constant velocity are not very different**; both occur when the vector sum of forces acting on the body is zero.

1.2 生词表 New Words

hockey puck 冰球
friction *n.* 摩擦力
inertia *n.* 惯性
ketchup *n.* 番茄酱
jerk *v.* 猛拉
yank *v.* 猛拉
velocity *n.* 速度
acceleration *n.* 加速度
exert *v.* 施以影响
gravitational *adj.* 重力的,引力的
elevate *v.* 提升;举起
gravity *n.* 重力
vector *n.* 向量
frame of reference 参照系
aisle *n.* 过道
roller skate 轮式溜冰鞋
obey *v.* 遵守
owing to 由于

1.3 课文注释 Text Annotation

【1】To begin with, let's consider what happens when the net force on a body is zero.

首先,让我们考虑当作用在物体上的合力为零时,会发生什么。

net 这个单词有两个语源,一是"网",可以作名词或动词;二是"净(neat)",一般作形容词,表示去掉外围剩下的核心部分,与此相对的是 gross,表总数。

▶1. "网"

e. g. :a fishing net 捕鱼网(名词)

If the ball touches the net during a service in a game of tennis, you have to serve again.

在网球比赛中如果发球触网,必须重新发球。(名词)

How many fish did you net this afternoon?

今天下午你网了多少鱼?(动词)

▶2. “净(neat)”

e. g. : I earn £ 5,000 gross, but my net income (= income that is left after tax has been paid) is about £ 2,000.

我总收入 5 000 英镑,但我的净收入(税后收入)大约是 2 000 英镑。

【2】if a body is at rest, and if no net force acts on it (that is, no net push or pull), that body will remain at rest.

如果一个物体处于静止状态,并且没有合力作用于其上(即没有推力或拉力)时,该物体将会保持静止。

at rest 静止;休息;安眠。这里的意思是“静止”。

◆1. 静止,不运动

e. g. :My heartbeat is only 50 at rest.

我安静时的心跳只有 50 次/分钟。

◆2. 对死亡的敬语

e. g. : Tom was a very troubled man, but he's at rest now.

汤姆是个多灾多难的人,但现在他安息了。

◆3. set/put sb. 's mind at rest/ease 令某人不再担心

e. g. : Mary phoned to say she had gone home safely, and that really put her mother's mind at rest.

玛丽打电话说她已经安全回家了,她的妈妈不再担心了。

【3】But what if there is zero net force acting on a body in motion?

但是如果作用于运动中的物体的合外力为零的话,结果会是怎样?

zero 是“零”,复数形式为 zeros 或 zeroes,可以是可数名词或不可数名词。zero 也可以作形容词,意思为“没有”。在英国还经常用 nought 表示“零”。

◆1. 作名词

e. g. : The number one thousand is written with a one and 3 zeros/noughts.

数字 1 000 写为 1 个 1 和 3 个 0。

◆2. 作形容词

e. g. : My chances of getting the job were zero (= I had no chance).

我得到那个工作的机会是零。

【4】when you jerk the bottle back, the ketchup tends to keep moving forward and, you hope, ends up on your burger.

当你迅速拉回瓶子时,番茄酱趋向于继续向前运动,并且,你希望它最终会落在你的汉堡包上。

end up 是动词短语,意为“最终处于某个位置或情况”,通常带有偶然和意外的意味。

e. g. : She fled with her children, moving from neighbour to neighbour and ending up in a friend's basement.

她和她的孩子们逃走了,从一家邻居转到另一家,最终来到一个朋友家的地下室。

If you don't know what you want, you might end up getting something you don't want.

如果你不知道自己想要什么,你可能会到头来得到自己不想要的东西。

【5】Viewed in this light, the state of rest and the state of motion with constant velocity are not very different.

从这个观点考虑,处于静止状态和匀速直线运动状态是相同的。

in this light 短语,意为“就这个方面(情况、观点)而言”。light 的意思很多,最基本的意思是名词“光”和形容词“轻的”,在此处的意思是 a particular perspective or aspect of a situation。

▶1. 情况;观点

e. g. :Although he saw it in a different light, he still did not understand.

虽然他换了一种角度看这个(事物),但是他仍然无法理解。

▶2. the light of your life

e. g. : the person you love most 你最爱的那个人

▶3. come to light 显示

e. g. : Fresh evidence has recently come to light which suggests that he didn't in fact commit the murder.

最新的证据表明,他实际上并没有参与谋杀。

▶4. cast/shed/throw light on sth. 解释

e. g. :As an economist, he was able to shed some light on the problem.

作为一名经济学家,他能对这个问题做出解释。

▶5. show someone in a bad light 使某人看起来像个坏人

注意区别另一个类似的短语 in (the) light of,该短语意思为 because of。

▶6. in(the) light of = because of

e. g. :In the light of recent incidents, we are asking our customers to take particular care of their personal belongings.

由于近来的事件,我们正督促用户特别注意个人物品安全。

1.4 扩展阅读 Extended Reading

Newton's Second Law

Newton's first law tells us that when a body is acted on by zero net force, it moves with constant velocity and zero acceleration. Suppose a hockey puck is sliding to the right on wet ice. There is negligible friction, so there are no horizontal forces acting on the puck; the downward force of gravity and the upward normal force exerted by the ice surface sum to zero. So the net force acting on the puck is zero, the puck has zero acceleration, and its velocity is constant.

But what happens when the net force is not zero? We apply a constant horizontal force to a sliding puck in the same direction that the puck is moving. Then net force is constant and in the same horizontal direction as velocity. We find that during the time the force is acting, the velocity of the puck changes at a constant rate; that is, the puck moves with constant acceleration. The speed of the *puck increases, so the acceleration is in the same direction as velocity and net force.*

Newton's second law of motion: If a net external force acts on a body, the body accelerates. The direction of acceleration is the same as the direction of the net force. The mass of the body times the acceleration of the body equals the net force vector.

In symbols,

$$\sum \vec{F} = m\vec{a} \tag{1-1}$$

The above equation has many practical applications. You've actually been using it all your life to measure your body's acceleration. In your inner ear, microscopic hair cells sense the magnitude and direction of the force that they must exert to cause small membranes to accelerate along with the rest of your body. By Newton's second law, the acceleration of the membranes—and hence that of your body as a whole—is proportional to this force and has the same direction. In this way, you can sense the magnitude and direction of your acceleration even with your eyes closed!

Using Newton's Second Law

First, the equation is a vector equation. Usually we will use it in component form, with a separate equation for each component of force and the corresponding acceleration:

$$\sum F_x = ma_x, \quad \sum F_y = ma_y, \quad \sum F_z = ma_z \tag{1-2}$$

This set of component equations is equivalent to the single vector equation. Each component of the net force equals the mass times the corresponding component of acceleration.

Second, the statement of Newton's second law refers to external forces. By this we mean forces exerted on the body by other bodies in its environment. It's impossible for a body to affect its own motion by exerting a force on itself; if it were possible, you could lift yourself to the ceiling by pulling up on your belt!

Third, Eqs. (1-1) *and* (1-2) *are valid only when the mass m is constant. It's easy to think of systems whose masses change, such as a leaking tank truck, a rocket ship, or a moving railroad car being loaded with coal. But such systems are better handled by using the concept of momentum.*

Finally, Newton's second law is valid only in inertial frames of reference, just like the first law. Thus it is not valid in the reference frame of any accelerating vehicles; relative to any of these frames, the passenger accelerates even though the net force on the passenger is zero. We will usually assume that the earth is an adequate approximation to an inertial frame, although because of its rotation and orbital motion it is not precisely inertial.

"Force of Acceleration" Does Not Exist

You must keep in mind that even though the vector $m\vec{a}$ *is equal to the vector sum* $\sum \vec{F}$ *of all the forces acting on the body, the vector is not a force. Acceleration is a result of a nonzero net force; it is not a force itself. It's "common sense" to think that there is a "force of acceleration" that pushes you back into your seat when your car accelerates forward from rest. But there is no such force; instead, your inertia causes you to tend to stay at rest relative to the earth, and the car accelerates* *around you. The "common sense" confusion arises from trying to apply Newton's second law where it isn't valid, in the non-inertial reference frame of an accelerating car. We will always examine motion relative to inertial frames of reference only.*

Mass and Weight

One of the most familiar forces is the weight of a body, which is the gravitational force that the earth exerts on the body. (If you are on another planet, your weight is the gravitational force that planet exerts on you.) Unfortunately, the terms mass and weight are often misused and interchanged in everyday conversation. It is absolutely essential for you to understand clearly the distinctions between these two physical quantities. Mass characterizes the inertial properties of a body. Mass is what keeps the china on the table when you yank the tablecloth out from under it. The greater the mass, the greater the force needed to cause a given acceleration; this is reflected in Newton's second law.

Weight, on the other hand, is a force exerted on a body by the pull of the earth. Mass and weight are related: Bodies having large mass also have large weight. A large stone is hard to throw because of its large mass, and hard to lift off the ground because of its large weight.

To understand the relationship between mass and weight, note that a freely falling body has an acceleration of magnitude g. Newton's second law tells us that a force must act to produce this acceleration. If a 1kg *body falls with an acceleration of* 9.8 m/s^2, *the required force has magnitude*

$$F = ma = (1\ \text{kg})(9.8\ \text{m/s}^2) = 9.8\ \text{kg}\cdot\text{m/s}^2 = 9.8\ \text{N}.$$

We will use $g = 9.80\ \text{m/s}^2$ *for problems on the earth (or, if the other data in the problem are given to only two significant figures,* $g = 9.8\ \text{m/s}^2$*). In fact, the value of g varies somewhat from point to point on the earth's surface, from about* 9.78 *to* 9.82 m/s^2, *because the earth is not perfectly spherical and because of effects due to its rotation and orbital motion. At a point where* $g = 9.80\ \text{m/s}^2$, *the weight of a standard kilogram is* $G = 9.80$ N. *At a different point, where* $g = 9.78\ \text{m/s}^2$, *the weight is* $G = 9.78$ N *but the mass is still* 1 kg. *The weight of a body varies from one location to another; the mass does not.*

The concept of mass plays two rather different roles in mechanics. The weight of a body (the gravitational force acting on it) is proportional to its mass; we call the property related to gravitational interactions gravitational mass. On the other hand, we call the inertial property that appears in Newton's second law the inertial mass. If these two quantities were different, the acceleration due to gravity might well be different for different bodies. However, extraordinarily precise experiments have established that in fact the two are the same to a precision of better than one part in 10^{12}.

1.5 常用用法 Usages and Expressions

Ⅰ. 数学表达式 Mathematical Expressions

表达式	发 音
$a+b$	*a* plus *b*
$a-b$	*a* minus *b*