物理类专业系列教材

物理学专业英语简明教程

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内 容 简 介

本书是一本针对高等学校的物理学及其相关专业的专业英语教材。内容主要包括：专业英语的特点、词法、语法、翻译、阅读等专业英语知识的介绍；运动学、质点力学、刚体的定轴转动、振动与波动、电磁学、热学、光学、原子物理、量子力学、相对论等内容的选读，并附有文中出现的物理专业词汇的英汉对照词汇表，便于学生课前有针对性地查阅和掌握；对物理学专业英语中的一些常用表达，在每课中也以专题的形式进行了详尽汇总和举例说明，包括工具、仪器、设备、结构、原料、精度、性能、形状、方位、用途、状态、原因、结论等 24 个专题。最后在附录部分汇总了物理专业所开设课程名称的英文翻译、教务教学管理词汇、物理学一、二级学科名称英文词汇、数学符号及其英语表达、常用物理基本常数、常用汉英物理学专业词汇表、常用英汉物理学专业词汇表，供读者使用时查阅。

本教材适用于高等学校的物理及其相关专业的本科生、硕士生专业英语教学，也可用于理工科大学物理学的双语教学，也可作为科技工作者和物理学从业人员的参考书和工具书。

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前　言

在人类追求真理、探索未知世界的过程中，物理学展现了一系列科学的世界观和方法论，深刻影响着人类对物质世界的基本认识、人类的思维方式和社会生活，是人类文明发展的基石，在人才的科学素质培养中具有重要的地位。

随着科学的发展进入21世纪，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，专业英语早已经是国际上交流的主要语言。国家教育部也提出了高等学校各专业逐步使用英文教材，以培养和增强学生阅读英文专业文献的能力。具备良好的物理学专业英语水平和使用能力是每个物理学及其相关领域的学生和从业人员必备的素质。

本书编者在物理学专业英语教学、理工科大学物理学的双语教学和从事科研和国际交流活动的过程中发现：尽管物理学专业英语在教学和科研工作中经常使用，但是却没有一本合适而全面的参考教材和可供查阅的工具书。很多专业英语课程的学习方式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，而在使用专业英语交流时，则力不从心。

本书编写的目的就是希望能够通过这本教材的编写，总结一些专业英语和双语教学方面的经验，并将这方面的笔记、资料系统地汇编起来，以各个专题的形式总结出来，供广大物理学及其相关专业的本科生、硕士生、博士生作为教材使用，也适合物理学及其相关领域的科技工作者和从业人员在使用专业英语进行学习和交流时翻阅参考。

作者在教材编写的过程中突出了以下主要特色：①内容选择注重实用性，不仅可以作为教材使用，也可以作为工具书进行查阅参考；② 内容全面精练，例句的选择专业性强，并且恰当贴切；③ 以专题的形式进行介绍或进行汇总，便于独立学习和查询参考；④对于专业英语阅读内容中的专业词汇，在每篇后的词汇表中以中英文对照形式给出；⑤使学习者通过专业英语的学习培养和拓展实际应用英语的能力，进而掌握相应的方法和技巧。

本书共24课，分为6个单元，各单元之间既相互独立也有一定联系。每一课都包括三个部分：第一部分主要介绍有关物理学专业英语方面的知识，通过大量的例句、实例和范文介绍了包括专业英语的特点、词法、语法、句法、翻译、阅读等方面的内容；其中在专业英语的翻译部分，主要介绍了专业词汇、独立主格结构、名词化结构、分隔结构和长句的翻译；第二部分为专业英语的阅读内容，选择了关于运动学、质点力学、刚体的定轴转动、振动与波动、电磁学、热学、光学、原子物理、量子力学、相对论等专业文献的选读，为了读者查阅和节省查字典的时间，在每篇之后按照文中专业词汇出现的顺序编写了英汉对照词汇表。第三部分汇总了物理学专业英语中的一些常用表达，共24个实用的专题内容供参考查阅，包括工具、仪器、设备、结构、原料、精度、性能、形状、方位、用途、状态、原因、结论方面内容；尤其在每个单元的头一课中，汇总的都是在物理实验方面涉及的工具、仪器和设备等实用的内容。附录

部分共汇总了7个方面的内容：物理专业所开设课程名称的英文翻译、教务教学管理词汇、物理学一、二级学科名称英文词汇、数学符号及其英语表达、常用物理基本常数、常用汉英物理学专业词汇表、常用英汉物理学专业词汇表。

本书第一、第二单元由仲海洋、李磊、孙敏编写；第三、第四单元由王轶卓、车丽、陈季香编写；第五、第六单元由田莹、付姚、田一平编写。练习和附录部分由鹿学军、李燕、辛敏裕、张金苏、刘大军、董爱义编写。夏文文、杨帆参加了全书的校对工作，深表感谢。

我们还参考了国内外出版物（见本书后面的“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。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，选用时作了大量修改，在此不便一一注明，谨向有关人士深表谢意。

由于作者水平有限，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。

仲海洋

2022年9月

目　录

Unit One

LESSON 1

1.1 物理学专业英语的特点

1.1.1 物理学专业英语简介

从体裁上讲,英语主要有文学文体、政论文体、应用文体和科技文体四大类,物理学专业英语属于科技英语文体的一部分。

物理学专业英语把英语和物理学专业知识紧密结合起来,用专业语言来说明客观存在的事物或事实。专业英语的叙述要求客观、真实、明确、简洁,并大量使用科学术语和符号,也经常借用图表和插图来说明专业内容。这就决定了专业英语的文体风格:概念准确、表达正式、陈述客观、逻辑性强、专业性强、严谨周密、行文简练、重点突出、句式严整、少有变化、常用前置性陈述,即在句中将主要信息尽量前置,通过主语传递主要信息。

专业英语的语言特点表现在词汇、句法和修辞三个方面。

1.1.2 物理学专业英语的词汇特点

1. 纯科技词汇

所谓纯科技词汇是指那些只用于某个专业或学科的专门词汇或术语,如 hydroxide(氢氧化物)、diode(二极管)、isotope(同位素)等。随着物理学及其相关领域的发展,新学科、新分支的产生,这样的词汇层出不穷,其词义精确而狭窄,针对性极强。除少数术语是新造的词外,绝大多数术语都是在原有旧词的基础上,靠借用、加前后缀或合成等手段构成,其中尤以合成这种手段最为常见。专业英语中很多新术语都是用这几种手段组成的。阅读专业性强的文献,就要首先了解该领域的专门词汇和术语。

2. 通用科技词汇

通用科技词汇即不同专业都要经常使用的那些词汇,数量较大,如表示时间、空间、方位、方向、尺寸、形状、面积、体积等方面的词汇以及一批要求固定介词的形容词和动词。如 accumulate, accuracy, capital, cell, charge, current, load, intense, motion, operation, potential, pressure, react, reflection, resistance, revolution, tendency 等词汇均属于多门学科使用的半专业词汇。这类词的使用范围比纯科技词汇广、出现频率高,但在不同的专业里有较为稳定的词义。如 power 一词在物理学中的词义为“电”“电力”“动力”“电源”“功率”等,在数学中的词义为“乘方”“功效”“幂”等。

3．派生词汇

派生词指在已有的词汇上加前、后缀，或以词根生成，或以构词成分形成的新词。这种词汇在物理学专业文献中占有很大的比重。例如，由前缀 hydro-，hyper-，hypo-和 inter-构成的词条在物理学专业英语中就非常多；以表示学科的后缀-logy，-ics 和表示行为、性质、状态等的后缀-tion，-sion，-ance，-ence，-ment 构成的词汇在专业英语文献中俯拾皆是。

前缀的特点：加前缀构成的新词只改变词义，不改变词类。

intergalactic　　银河间的　　inter＋galactic

submicroscopic　　亚微观的　　sub＋microscopic

另外，前缀有固定的意义。如：

multi-表示“多”　　multimedia 多媒体

hyper-表示“超级”　　hyperelastic 超弹性的

后缀的特点：加后缀构成的新词可能改变也可能不改变词义，但一定改变词类。

infinity　无穷远（名词）＝infinite＋y（infinite 是形容词）

quantization　量子化（名词）＝quantize＋ation（quantize 是动词）

有些词加后缀后，语音或拼写可能发生变化。

electrification＝electrify＋cation

accelerator＝accelerate＋or

4．复合词汇

所谓复合词，就是指两个或两个以上的词组合在一起构建的新词。一般来说，复合词分为复合名词、复合动词、复合形容词和复合副词。有些词已经在词义上发生了变化，从意思上看不出复合的痕迹，但是从词形上仍然能够看出最初复合的痕迹。复合词常以连字符“-”连接两单词构成，或采用短语构成，但有的则去掉连字符形成一个单一的词。

以下是物理学中的一些加连字符复合词的例子：

by-pass 旁路，cathode-ray tube 阴极射线管，change-over switch 换向开关，current-carrying conductor 载流导体，digital-to-analogue conversion 数模转换，fine-adjustment 微调、细调，flat-bottomed flask 平底烧瓶，fly-back 回扫，full-wave rectifier 全波整流器，half-wave rectification 半波整流，infra-red ray 红外线，inverse-square law 平方反比定律，ion-pair 离子偶、离子对，push-button switch 按钮开关

值得一提的是，专业英语中-proof 使用的比较多，它是一个构词成分，意思是“防……的，能抗……的”“完全地或成功地抵制……的；不能穿透……的”。这个构词成分能构成许多有用的单词。例如：

a water-proof material	防水材料
a bullet-proof glass	防弹玻璃
a sound-proof room	隔音室
a bomb-proof shelter	防空洞
a fire-proof material	防火材料，耐火材料
a fail-proof method	万无一失的方法
a fool-proof instrument	操作十分简便的仪器

此外还有 acid-proof 抗酸的、耐酸的，corrosion-proof 抗腐蚀的、防腐蚀的，mar-proof 耐磨损的，ozone-proof 耐臭氧的等。

以下是一些无连字符复合词的例子：

joulemeter 焦耳计，kilowatt 千瓦特、千瓦，loudspeaker 扬声器，output 输出，ratemeter 率计、率表，supersaturation 过饱和

5. 混成词

混成词指由最少两个词语或词语的一部分结合而成的词语，该新词语的意义和读音集组成部分而成。一般而言，混成词是新词，诸如 motel 汽车旅馆（motor＋hotel），smog 烟雾（smoke＋fog），brunch 早午餐（breakfast＋lunch）和 cyborg 生化人（普遍代指 cybernetic organism 自动化生物）等混成词。

以下是一些物理学中混成词的例子：

potentiometer (potential＋meter)	分压器、电位器、电势差计、电位差计
radioisotope (radioactive＋isotope)	放射性同位素
radionuclide (radioactive＋nuclide)	放射性核素
radiotherapy (radioactive＋therapy)	放射疗法
sonometer (sonic＋meter)	弦音计
spectrometer (spectrum＋meter)	光谱仪、分光计
thermocouple (thermal＋couple)	温差电偶、热电偶
telesat(telecommunication＋satellite)	通信卫星

6. 缩略词

缩略词的构成有两种：将英语中较长的单词取其首部或者主干构成与原来单词同义的短单词，称为压缩或省略；将组成词汇的短语的各个单词的首字母拼接为一个字符串，称为缩写。

1）压缩或省略

一些单词比较长，难于记忆和拼写，通过压缩或省略的方法把它们压缩成一个短小的单词，或者仅仅取其头部，或仅取关键音节。

maths (mathematics)数学，lab (laboratory)实验室，plane (airplane)飞机，ft (foot/feet)英尺，cpd (compound)化合物

2）缩写

利用词的第一个字母代表一个词构成的缩略词，就叫作首字母缩略词。常见的有以下三类。

① 通常情况下以小写字母出现，并且已经作为常规词汇。

m (metre)公尺，cm (centimeter)厘米，g (gram)克，fm (frequency modulation)调频

scr (silicon-controlled rectifier)可控硅整流器，p. s. i. (pounds per square inch)磅每平方英寸，radar(radio detecting and ranging 无线电探测与定位)雷达，laser(light amplification by stimulated emission of radiation 受激发射光放大器)激光

② 以大写字母出现，有的具有主体发音音节，有的仅为字母缩写。

TV(television)电视，CD(compact disk)激光唱盘，CAD(computer-assisted design)计

算机辅助设计,IT(information technology)信息技术,IDD(international direct dial) 国际直拨电话,PVC(polyvinyl chloride)聚氯乙烯,FRP(fiber glass reinforced plastic)玻璃钢,DNA(deoxyribonucleic acid)脱氧核糖核酸,F(fluorine)氟,U(uranium)铀,CATV(cable television)有线电视,CD-ROM(compact disk-read-only memory)光盘只读存储器(也就是光驱),GHG(greenhouse gas)温室气体

③ 有的缩略词还可以和其他词连用,如:

E-mail (electric mail)电子邮件,H-bomb (hydrogen bomb) 氢弹,CO_2 (carbon dioxide)二氧化碳

7. 骈词

专业英语中有不少骈词,它们由同义词、近义词构成,两词前后顺序基本固定,中间由 and 连接,在语气、语调及语义方面有特殊的修辞效果。一般有以下三类:

1) 头韵类

如 effective and efficient, integral and indispensable, part and parcel, queries and questions 等。

It is clear that idealized model method provides an *effective and efficient* answer to a number of complex problems. 很明显,理想模型方法是解决许多复杂问题的一种快速高效的办法。

During the last twenty years, holography has become an *integral and indispensable* part of physics. 在最近二十年中,全息技术成为物理学不可或缺的部分。

Mechanics is *part and parcel* of physics. 力学是物理学的组成部分。

If there are *queries and questions* with laser, do not hesitate to contact us. 若对激光器有疑问,请立即和我们联系。

2) 尾韵类

如 first and most (foremost), wear and tear 等。

Calculus is the *first and most* common method of solving problems in physics. 微积分方法是最首要、最常用的解决物理问题的方法。

First and foremost, we should tackle the problem of energy sources. 首先,我们应该解决能源问题。

The *first and most* important step for learning university physics is to have a good command of calculus. 对大学物理学习来说,第一也是最重要的一步是学好微积分。

Regular maintenance of instruments reduces much needless *wear and tear*. 定期维护仪器可以大大减少不必要的磨损。

3) 无韵类

如 each and every, leaps and bounds, pure and simple, trial and error, ways and means 等。

This type of product manufacturing control ensures that consistent rare earth quality is achieved for *each and every* lot delivered to the labs. 这种产品制造控制方法,会保证发往实验室的每批稀土质量是稳定的。

Since the quantum was put forward, it has grown by *leaps and bounds* into a remarkably prosperous branch of physics. 自量子理论提出以来，它迅速发展为一个非常繁盛的物理学分支。

The operating error was due to carelessness *pure and simple*. 操作失误纯粹归因于粗心大意。

In general, the design procedure is not straightforward and will require *trial and error*. 一般来说，设计过程不是一帆风顺的，而是需要反复的试错。

The object of studying thermodynamic processes was to work out *ways and means* of improvements of the efficiency of heat engines. 研究热力学过程是为了找出改进热机效率的各种方法。

8. 专业词汇的隐喻

隐喻是把某种比喻意义从一个事物传给另一事物，即在两个本质不同的事物之间进行的暗含比较，是以相似和联想为基础的。

在物理领域，隐喻已经成为十分重要的形象思维手段和认知工具，词汇中充斥着大量的隐喻。原子结构理论的创立者丹麦物理学家 Henrik David Bohr（玻尔）把肉眼看不见的原子的内部结构想象成一个"太阳系"，称为 miniature solar system（微型太阳系），从大的宏观概念直至小的微观概念。与这种视微观世界为宏观世界的放大化隐喻相对应，专业词汇中也存在视宏观世界为微观世界的缩小化隐喻，如天文学家创造了 light-year（光年）这一术语作为计算星球之间距离的单位，用 crab nebula（蟹状云）来指称银河系中的某一强大射电源。当科学家发现了新的事物及其特点、规律时，他们在很多情况下不会任意杜撰或"发明"新的词汇来表示新概念，而是在原有词汇的基础上给新的概念和知识命名。这其中相当一部分是隐喻，即概念与概念之间的类比。

从已知到未知，从具体到抽象，由此及彼，相互类推，就会形成一条"隐喻链"。同一词语应用在不同学科中建构了一系列的科学概念名称，展现出隐喻思维的线索。例如从 wave（波）类推到 sound wave（声波），再到 light wave（光波）；到了电子时代，又有了 radio wave（无线电波），electromagnetic wave（电磁波），microwave（微波），ultrasonic wave（超声波）以及 long/medium/short wave（长/中/短波），及其到了量子时代的 matter wave（物质波）等。这些概念的建构一脉相承，都建立在同一喻体之上。

1.2 专业英语阅读

1.2.1 Introduction（引言）

We begin our study of the physical universe by examining objects in motion. The study of motion, whose measurement, more than 400 years ago gave birth to physics, is called kinematics.

Much of our understanding of nature comes from observing the motion of objects. In this chapter we will develop a description for the motion of a single point as it moves through space. Although a point is a geometrical concept quite different from everyday objects such as footballs and automobiles, we shall see that the actual motion of many objects is most easily described as the motion of a single point (the "center of mass"), plus the rotation of the object about that point. Postponing a discussion of rotation, let us begin here with a description of a single point as it moves through space.

1.2.2 Space and Time(时间与空间)

Kinematics is concerned with two basic questions, "Where?" and "When?". Though the questions are simple, the answers are potentially quite complicated if we inquire about phenomena outside our ordinary daily experiences. For example, the physics of very high speeds, or of events involving intergalactic distances or submicroscopic dimensions, is quite different from our common-sense ideas. We will discuss these interesting subjects in later chapters. For the present we shall adopt the space and time of Newton—those concepts we gradually developed as a result of our everyday experiences.

Space is assumed to be continuously uniform and isotropic. These two terms mean that space has no "graininess" and that whatever its properties may be, they are independent of any particular direction or location. In the words of Isaac Newton, "Absolute space, in its own nature, without relation to anything external, remains always similar and unmovable." Every object in the universe exists at a particular location in space, and an object may change its location by moving through space as time goes on. We specify the location of a particular point in space by its relation to a frame of reference.

Time, according to Newton, is also absolute in the sense that it "flows on" at a uniform rate . We cannot speed it up or slow it down in any way, in Newton's words, "Absolute, true, and mathematical time, of itself, and from its own nature, flows equably without relation to anything external, and by another name is called duration." Time is assumed to be continuous and ever advancing, as might be indicated by a clock.

Space and time are wholly independent of each other, though it is recognized that all physical objects must exist simultaneously in both space and time.

Remarkably, many of these traditional ideas turn out to be naive and inconsistent with experimental evidence. The world is just different from the picture we form from our common-sense, intuitive ideas. Space and time, by themselves, are concepts that are difficult (or perhaps impossible) to define in terms of anything simpler. However, we can measure space and time in unambiguous ways. We define certain operations by which we obtain numerical measurements of these quantities using rulers and clocks, based upon standard units of space and time.

For many years, our standard of time was based on astronomical observations of the earth's rotation. Because of the variations in the earth's rotation, in 1967 the 13th General Conference on Weights and Measures, attended by 38 nations, adopted an atomic standard for time.

Similarly, our former standard of length was the distance between two marks on platinum-iridium bar kept at Sevres, France. In 1960, the fundamental length standard was redefined in terms of the wavelength of light emitted during a transition between two atomic energy levels.

The standard units of time and length may be described as follows:

An interval of time. The fundamental unit is the **second** (s), which by international agreement is defined as the duration of 9 192 631 770 periods of radiation corresponding to the transition between the two lowest energy levels in the atomic isotope cesium 133.

An interval of length. The fundamental unit is the **meter** (m), which is defined independently of the time interval. Before 1983, by international agreement the meter was defined as exactly 1 650 763.73 wavelengths of the orange light emitted from the isotope krypton 86. In November 1983, the length standard was defined as the distance that light travels in a vacuum in 1/299 792 458 second.

Certain older units of length are still occasionally used.

$$1 \text{ angstrom}(\text{Å}) = 10^{-10} \text{ m} \quad 1 \text{ micron } (\mu \text{ or } \mu\text{m}) = 10^{-6} \text{ m}$$

Glossary

universe	宇宙	object	物体
measurement	测量	kinematics	运动学
motion of objects	物体的运动	center of mass	质心
space and time	时空	phenomena	现象
intergalactic	银河间的	submicroscopic	亚微观的
dimension	尺度	subject	研究的对象
uniform	均匀的	isotropic	各向同性的
continuously	连续地	graininess	颗粒性
direction	方向	location	位置
specify	规定	frame of reference	参考系
simultaneously	同时地	inconsistent with	与……不一致
define/definition	定义	meridian	子午线
general conference on weights and measures	国际计量大会	atomic standard	原子标准
former standard of length	长度原标准	platinum-iridium	铂铱合金
transition	跃迁	atomic energy level	原子能级
isotope cesium	铯同位素	krypton	氪
vacuum	真空	angstrom	埃

1.3 专业英语常用表达法-1 常用工具

toolbox 工具箱

handsaw 手锯

ball-pane hammer 球头锤

ball hammer 圆头锤

axe hammer 斧锤

nail hammer 羊角锤、拔钉锤

sledge hammer 大锤、双手锤

pick 镐

double-bladed axe 双刃斧

cutting nippers 剪钳、老虎钳

nipper pliers　尖嘴钳,剪丝钳
crowbar　铁锹、撬杠
nail　铁钉
coping saw　弓形锯
chisel　凿子
hand plane　刨子
screw　螺丝钉
screwdriver　螺丝刀
gimlet　手钻
scoop　铲子
triangle　三角板
protractor　量角器
curved ruler　曲尺
adjustable triangle　可调节三角板
T-square　丁字尺
angle square　角尺
drafting machine　平移角尺
dividers　两脚规
tape measure　卷尺
scissors　剪刀
wrench/spanner　扳手
adjustable spanner　活动扳手
double offset ring spanner　梅花扳手
inner hexagon spanner　内六角扳手
pipe spanner　管子扳手
connection cover cutting pliers　剥线钳
wire-cutting pliers　克丝钳
insulated pliers　绝缘钳
metal wire pliers　剪线钳
electric drill　电钻
hollow drill　空心钻
percussion drill　冲击钻
electric (soldering) iron　电烙铁
stopwatch　秒表、跑表、停表

LESSON 2

2.1　物理学专业英语的名词化结构

2.1.1　名词化

物理学专业英语的两个显著特点就是广泛使用名词化结构和大量使用被动语态。名词化是指词性作用的名词性转化,比如起名词作用的非谓语动词和与动词同根或同形的名词,也包括一些形容词来源的名词。这些词可以起到名词的作用,也可以表达谓语动词或形容词所表达的内容,常伴有修饰成分或附加成分,可构成短语。名词化结构指的是大量使用名词和名词词组,即在其他功能和题材的文章里用动词、形容词等词类充当某种语法成分,而在专业英语里往往会转化为由名词充当这种语法成分。

专业英语的"科学性"和"说理性"是名词化大量存在的理据。因为这种结构既可减少句子或分句的出现,又能包容大量的信息,并能反映科学内容的严肃性和客观性。下面就是一个名词化的例子:

(1) We can assume a freely falling body moves in one dimension under constant acceleration if we neglect air resistance.

在专业英语中则通常说成

(2) The motion of a freely falling body can be assumed to be motion in one dimension under constant acceleration by negligence of air resistance.

在这组例子中，名词化发生在两个地方。首先例(1)中的谓语动词转化为(2)中的名词主语，其次，例(1)中的状语从句的谓语动词 neglect 转化为名词结构介词短语来充当状语。经过名词化处理的例(2)由含有两个主谓结构的复合句变成了只含一个主谓结构的简单句，从而使句子的结构更加精练严谨，也由于使用抽象名词替代原来的人称代词做主语而使句子的语体更加正式。

2.1.2 名词化的分类

动词的名词化具有四种形式：

1）动作名词

在四种形式中，动作名词的名词性最强，而动词性最弱。动作名词用于一般性地叙述一个事实或概念，指出动作和技术的特点，而不强调动作本身的进行过程和时间。

Analysis of projectile motion is surprisingly simple if the following three assumptions are made.

2）动词性名词

动词性名词的名词性稍弱一些，而动词性略强。用于把概念和动作过程联系起来的描述，时间性也不强。

The *analyzing* of projectile motion is surprisingly simple if the following three assumptions are made.

3）动名词

动名词的动词性更强一些。在强调动作过程，概括地叙述一般行为，而不是特定行为，并且时间性也不强时，就可以使用动名词。

Analyzing projectile motion is surprisingly simple if the following three assumptions are made.

4）动词不定式

动词不定式的名词性最弱，动词性最强。通常用动词不定式表达某一次有时间性的特定动作或过程。

Projectile motion of the ball needs *to be analyzed* now if the following three assumptions are made.

2.1.3 名词化结构的构成

名词化结构的应用使得整个句子的结构便于写作修辞，也使得词句负载信息的容量增加。经常使用的名词化结构有：

1）名词(行为名词)＋介词＋名词

在此结构中，若“介词＋名词”构成的介词短语在逻辑上是行为名词的动作对象或动作的发出者，行为名词的含义在深层中转换或变异，使原来的名词变为动词，构成了动宾或主谓的关系。

The acceleration of the car is due to the force applied on it. 车的加速是由于外力的作用。

此句的 The acceleration of the car＝The car accelerates.

In the case of all freely falling bodies, gravity is essential in *the change of the velocity*. 所有作自由落体运动的物体,速度的改变都离不开重力。
其中 the change of the velocity＝the velocity changes.

2) 介词＋名词(行为名词)

在此结构中,行为名词的动作意义相对完整,与句中的其他部分之间存在着一定的逻辑关系,能起到时间状语、原因状语、条件状语和让步状语等作用。

A rigid body can change its position *by translation or rotation*. 刚体位置的改变可以通过平移或转动实现。

3) 谓语动词＋行为名词(＋介词短语)

此结构可以将宾语(介词宾语)转换成谓语。

Kepler's laws have *found application for* the exploration of the planets. 开普勒定律已经被用来探索行星。

此句可改变为 People have applied Kepler's laws to explore the planets.

此结构中谓语动词 find 含义空泛,只起语法作用,翻译时可以不译。类似的动词有:do, keep, have, make, take, pay, show, perform, offer 等。又如:

Friction *offers resistance to* the movement of the block. 摩擦力阻碍木块的运动。
句中 offer 几乎不表示什么意义,只起连接作用。此句可以改为:Friction resists the movement of the block.

4) 与动词构成固定搭配

名词化结构与动词构成固定搭配的常用形式为:动词＋动词名词化结构＋介词名词化结构。这种搭配大量地以一个动词短语的形式出现,约定俗成。例如:

make use of 利用, do research for 研究, lay emphasis on 强调, pay attention to 注意,等等。

5) 行为名词＋短语/从句

在此结构中行为名词可以译成动词,与后面的成分一起构成汉语的动宾结构。

I have a *doubt* whether the instrument works well. 我怀疑这仪器是否运行良好。

此句可以改换成 I doubt whether the instrument works well or not.

6) 名词＋名词(行为名词)

在此结构中,名词在表层结构上是前置定语,但在翻译过程中,其深层结构的内在含义可以译成动宾词组,行为名词转换成谓语。如:

heat conduction 导热, rust prevention 防锈, performance examination 性能检验

2.1.4 名词化的功能

名词化具有可以使语篇简洁、客观、量化、正式、严密等多种功能。

1) 简洁功能

简洁明了是物理学专业英语的重要特点之一,要求以精练的语言传达大量的信息,而名词化的使用可以使句子省去一些不必要的词语,使得结构紧凑,具有较强的可读性。例如:

Kepler's laws had been developed. For this reason, Newton could discover his laws of motion.

以上两句可用名词化结构分别表达为 the development of Kepler's laws 和 for Newton to discover his laws of motion。

若再把这两个名词化结构按句法要求组织起来，则是：

The development of Kepler's laws makes it possible for Newton to discover his laws of motion.

所以，利用名词化结构，不仅可把两个句子合二为一，使语言更简洁、更精练，而且可把更多的信息结构融合成逻辑关系明确的整体。

2）客观功能

英语中用动词体现过程，动词须有参与者，有时还须有补语。而名词化则使本来由动词体现的过程转而由名词体现，这个过程变成另一过程的参与者，与旧过程相关的参与者就可以省略掉，从而使表达显得客观、真实，避免主观因素和主观色彩。

If we substitute some rolling friction for sliding friction, we can considerably reduce the friction.

改用名词化结构后可以去掉句子的主语 we，提高了客观的程度。

The substitution of some rolling friction for sliding friction results in a very considerable reduction in friction.

3）量化功能

专业英语有时需要使用表示数量的词来表示某人做了多少事情或某物占有多少分量等，但是动词和形容词是不能被量化的，这时名词化就成了可采取的有效手段。例如：

Last year 17 major changes and improvements were made toward making the lab even more perfect.

这个句子使用了数字加动词 change 和 improve 的名词化形式，使表达准确、严谨。如果采用 Last year we changed 17 major things and improved the lab even more perfect. 则显得不够严谨，数量的概念不是很强。

4）正式功能

专业英语要求使用较为正式的语言，适当使用一些名词化结构，可以增加语篇的正式程度。

The engineers are confident about the motion of the "Shenzhou" spaceship from the very beginning.

这个句子中，使用动词 move 的名词化形式 motion，使整个句子显得很正式。如果改成 The engineers are confident about how the "Shenzhou" spaceship moves...则正式程度大为降低。

5）严密功能

由于名词化结构中大量使用抽象名词，因此可以借助于抽象思维的逻辑性和概念化使科技文章的表达更确切，更严密。此外，在使用上，句子信息结构最复杂、最重要的部分往往是名词化结构。

We begin our *study of* the physical universe by examining objects *in motion*. The *study of* motion, whose measurement, more than 400 years ago *gave birth to* physics, is called kinematics. Much of our *understanding of* nature comes from observing *the motion of* objects.

2.2 专业英语阅读

2.2.1 Vectors(矢量)

Many quantities in physics have magnitude and direction. **Vectors** are quantities with magnitude and direction. Examples include velocity, acceleration, momentum, and force. Quantities with magnitude but no associated direction—for example, distance and speed—are called **scalars**.

A vector is represented graphically by an arrow drawn in the same direction as that of the vector, and with a length that is proportional to the magnitude of the vector. When the magnitude of a vector is given, its unit must also be given.

Two vectors are defined to be equal if they have the same magnitude and the same direction. Graphically, this means that they have the same length and are parallel to each other. A consequence of the definition is that moving a vector so that it remains parallel to itself does not change it. Vectors do not depend on the coordinate system used to represent them (except for position vectors, which are introduced later).

2.2.2 Properties of Vectors(矢量的性质)

In comparing vectors and performing other mathematical operations such as addition and subtraction, we may translate vectors anywhere in the coordinate space for convenience. We must be careful, however, to preserve their magnitudes and directions with respect to the axes.

Vector Addition(矢量加法)

Two vectors are added graphically by placing the tail of one, $\boldsymbol{B}$, at the head of the other, $\boldsymbol{A}$ (Fig. 2-1). The resultant (or net) vector, $\boldsymbol{C}=\boldsymbol{A}+\boldsymbol{B}$, extends from the tail of $\boldsymbol{A}$ to the head of $\boldsymbol{B}$. This is the so-called **head-to-tail method.**

An equivalent way of adding vectors, called the **parallelogram method**, is to move $\boldsymbol{B}$ so that it is tail-to-tail with $\boldsymbol{A}$. The diagonal of the parallelogram formed by $\boldsymbol{A}$ and $\boldsymbol{B}$ then equals the resultant vector $\boldsymbol{C}$, as shown in Fig. 2-2.

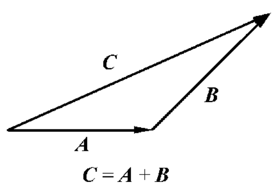


Fig. 2-1 Head-to-tail method of vector addition

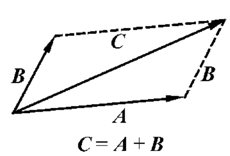


Fig. 2-2 Parallelogram method of vector addition

The vectors have the mathematical property of "obeying the **commutative law** in addition".

$$\boldsymbol{A}+\boldsymbol{B}=\boldsymbol{B}+\boldsymbol{A} \tag{2-1}$$

Vector Subtraction（矢量减法）

We subtract vector $\boldsymbol{B}$ from vector $\boldsymbol{A}$ by adding $-\boldsymbol{B}$ to $\boldsymbol{A}$. The result is shown in Fig. 2-3. Note that vector addition or subtraction can be done only when vectors are in the same unit.

Scalar Product (Dot Product)（标积/点积）

The scalar product of any two vectors is defined as a scalar quantity equal to the product of the magnitudes of the two vectors $\boldsymbol{A}$ and $\boldsymbol{B}$ and the cosine of the angle ϕ that is included between the directions of $\boldsymbol{A}$ and $\boldsymbol{B}$.

That is, the scalar product (or dot product) of $\boldsymbol{A}$ and $\boldsymbol{B}$ is defined by the relation

$$\boldsymbol{A} \cdot \boldsymbol{B} = AB\cos\phi \tag{2-2}$$

where ϕ is the angle between $\boldsymbol{A}$ and $\boldsymbol{B}$ as in Fig. 2-4. A is the magnitude of $\boldsymbol{A}$, and B is the magnitude of $\boldsymbol{B}$, Note that $\boldsymbol{A}$ and $\boldsymbol{B}$ need not have the same unit.

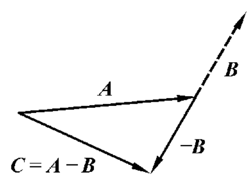


Fig. 2-3　Vector subtraction

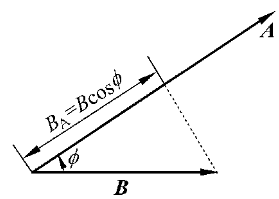
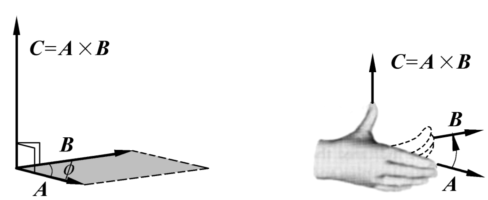


Fig. 2-4

Cross Product (Vector Product)（叉积/矢积）

The cross product of two vectors $\boldsymbol{A}$ and $\boldsymbol{B}$ is defined to be a vector $\boldsymbol{C}=\boldsymbol{A}\times\boldsymbol{B}$ whose magnitude equals the area of the parallelogram formed by the two vectors, as in Fig. 2-5(a). The vector $\boldsymbol{C}$ is perpendicular to the plane containing $\boldsymbol{A}$ and $\boldsymbol{B}$ in the direction given by the right-hand rule, that is, as your right-hand fingers curl from the direction of $\boldsymbol{A}$ toward the direction of $\boldsymbol{B}$, the direction of $\boldsymbol{A}\times\boldsymbol{B}$ is given by your thumb (Fig. 2-5(b)). If ϕ is the angle between the two vectors and $\boldsymbol{n}$ is the unit vector that is perpendicular to each in the direction of $\boldsymbol{C}$, the cross product of $\boldsymbol{A}$ and $\boldsymbol{B}$ is

$$\boldsymbol{C} = \boldsymbol{A} \times \boldsymbol{B} = (AB\sin\phi)\boldsymbol{n} \tag{2-3}$$



(a)　　(b)

Fig. 2-5

If $\boldsymbol{A}$ and $\boldsymbol{B}$ are parallel, $\boldsymbol{A}\times\boldsymbol{B}$ is a zero vector.

2.2.3 Unit Vectors(单位矢量)

A **unit vector** is a dimensionless vector with unit magnitude. Unit vectors that point in the positive x, y, and z directions are convenient for expressing vectors in terms of their rectangular components. They are usually written as $\boldsymbol{i}$, $\boldsymbol{j}$ and $\boldsymbol{k}$, respectively (Fig. 2-6). For example, the vector $A_x\boldsymbol{i}$ has a magnitude $|A_x|$ and points in the positive x direction if A_x is positive (or the negative x direction if A_x is negative). A general vector $\boldsymbol{A}$ can be written as the sum of three vectors, each of which is parallel to a coordinate axis

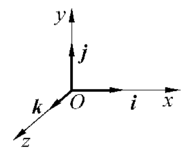


Fig. 2-6

$$\boldsymbol{A} = A_x\boldsymbol{i} + A_y\boldsymbol{j} + A_z\boldsymbol{k} \tag{2-4}$$

The addition of two vectors $\boldsymbol{A}$ and $\boldsymbol{B}$ can be written in terms of unit vectors as

$$\begin{aligned}\boldsymbol{A} + \boldsymbol{B} &= (A_x\boldsymbol{i} + A_y\boldsymbol{j} + A_z\boldsymbol{k}) + (B_x\boldsymbol{i} + B_y\boldsymbol{j} + B_z\boldsymbol{k}) \\ &= (A_x + B_x)\boldsymbol{i} + (A_y + B_y)\boldsymbol{j} + (A_z + B_z)\boldsymbol{k}\end{aligned} \tag{2-5}$$

The scalar products of the unit vectors are

$$\boldsymbol{i}\cdot\boldsymbol{i} = 1,\quad \boldsymbol{j}\cdot\boldsymbol{j} = 1,\quad \boldsymbol{k}\cdot\boldsymbol{k} = 1,\quad \boldsymbol{i}\cdot\boldsymbol{j} = 0,\quad \boldsymbol{j}\cdot\boldsymbol{k} = 0,\quad \boldsymbol{k}\cdot\boldsymbol{i} = 0 \tag{2-6}$$

The unit vectors $\boldsymbol{i}$, $\boldsymbol{j}$, and $\boldsymbol{k}$, which are mutually perpendicular, have cross products given by

$$\boldsymbol{i}\times\boldsymbol{j} = \boldsymbol{k},\quad \boldsymbol{j}\times\boldsymbol{k} = \boldsymbol{i},\quad \text{and}\quad \boldsymbol{k}\times\boldsymbol{i} = \boldsymbol{j} \tag{2-7}$$

$$\boldsymbol{i}\times\boldsymbol{i} = \boldsymbol{j}\times\boldsymbol{j} = \boldsymbol{k}\times\boldsymbol{k} = \boldsymbol{0} \tag{2-8}$$

Glossary

vector	矢量	magnitude	大小
velocity	速度	acceleration	加速度
momentum	动量	scalar	标量
proportional to	正比于	parallel	平行
position vector	位置矢量	coordinate system	坐标系
resultant/net vector	合矢量	addition	加法
subtraction	减法	equivalent	等价的
translate	平移	head-to-tail method	三角形法
parallelogram method	平行四边形法	diagonal	对角线
commutative law	交换律	scalar product	标积
dot product	点积	cross product	叉积
vector product	矢积	area	面积
right-hand rule	右手定则	parallel	平行
unit vector	单位矢量	unit magnitude	单位大小
dimensionless	无量纲的	respectively	分别地

2.3 专业英语常用表达法-2 仪器设备

apparatus 装置、设备、器械
appliance 器具、电器
device 装置
equipment 设备
facilities 设备、用具
gear 用具、装置
instrument 仪器、仪表
machine 机器、机械
machinery 机器设备、机械
mechanism 机械装置
plant 成套机械、装置
realia 教具、教学用品
set (成套)设备、仪器
tool 工具
unit 装置、组件、元件
a battery supply set 电池供电设备
a device for regulating temperature 控制温度的装置
a hand-operated tool 手动工具
a remote-control gear 遥控装置
acoustic analytical instrument 声分析仪
acoustical instrument 声学仪器
adiabatic apparatus 绝热装置
adjusting instrument 调节仪器、调节装置
all-purpose instrument 多用工具、万能仪表
altitude instrument 高度仪
an air-conditioning equipment for 供……用的空调设备
an instrument for measuring the spectra 测量光谱的仪器
arc-suppressing apparatus 灭弧装置
beat measuring apparatus 拍频测试仪
bolometer 辐射热测定器
bolometric instrument 辐射热量计
calorimeter 量热计
cathode ray apparatus 阴极射线仪器
chromatographic instrument/chromatograph 色谱仪
current-measuring instrument 测流仪器
depth-measuring instrument 测深仪
detecting instrument 检测仪器、探测仪器
dial instrument 指针式仪表、有刻度的仪表
digital measuring instrument 数字式测量仪
displaying instrument 指示仪器
double-scale instrument 双标度仪表
double-range instrument 双量程仪表
dynamometer 功率计、电力测功仪、测力计、动力计
echo-sounding instrument 回声探测仪

eddy current instrument　涡流仪器
educational instrument　教学仪器
electric instrument　电工测量仪表、电表
electrical appliance　电器用具
electroacoustical instrument　电声(测试)仪器
electromagnetic acoustical instrument　电磁声学仪器
electronic measuring instrument　电子测量仪器
electronic test instrument　电子试验(测试)仪器
electrostatic acoustical instrument　静电声学仪器
electrostatic instrument　静电式仪表
electrostatic measuring instrument　静电式电表、静电式测量仪
electrothermic instrument　热电式仪表
fine measuring instrument　精密测量仪器、精密量具
first-order instrument　一阶仪器
flow instrument　流量计
humidity-measuring instrument　湿度测量仪
instructional instruments　教学仪器
insulation test instrument　绝缘(电阻)测试仪器
laboratory apparatus　实验仪器(装置)
laboratory instrument　实验室仪器
laser distance-measuring instrument/laser range finder　激光测距仪
level instrument　位面计、水平仪
levelling instrument　水准器、水平尺、测平仪
measuring instrument　测量仪表、测量仪器
metrologic instrument　计量仪器
needle instrument　指针型仪器
optical instrument　光学仪器
photomicrographic apparatus　显微照相装置
portable instrument　便携式仪器
power plant/unit　动力装置/机组
precise instrument　精密仪器
radio instrument　无线电仪器
research instrument　试验设备、研究设备
resistance instrument　电阻式仪表
scientific apparatus/instrument　科学仪器/仪表
scientific experiment package　科学实验装置
sensing instrument　灵敏仪表、灵敏元件
spraying apparatus　喷雾器
supersonic thickness meter/gauge　超声测厚仪

surveying instrument　测量仪器、测绘仪器
test instrument　试验工具、测试设备
testing instrument　试验仪器
the latest research equipment　最新研究设备
visual instrument　目视仪器
X-ray diffraction instrument　X射线衍射仪

LESSON 3

3.1　物理学专业英语的语法特点

3.1.1　常用的动词时态

专业英语在时态运用上有限，尽管英语的动词有16种时态，但在专业英语中常见的只有四种：一般现在时、一般过去时、一般将来时和现在完成时。

1）一般现在时

在物理学英语文献资料中用得最多的时态是一般现在时，用以表述无时间性的科学定义、定理、公式、现象、过程等。究其原因可能是科学家和物理工作者都想表明他们所说的、所写的都是真理性的，都不受时间的限制。即使是叙述一个已完成的实验，或者是叙述一个将要做的实验，也大都使用一般现在时，意在表明其他人在任何时候都可以重复这样的实验而得到同样的结果。主要有以下三种用法。

（1）表示一般叙述过程。如：

As the electrons move, the surface charge density increases until the magnitude of the internal field equals that of the external field, giving a net field of zero inside the conductor.

If we now imagine the surface to shrink to zero like a collapsing balloon, until it essentially encloses a point, the charge at the point must be zero.

（2）叙述客观事实或科学定理。如：

A good electrical conductor contains charges (electrons) that are not bound to any atom and are free to move about within the material.

The electric field is zero everywhere inside the conductor.

Work done on a particle equals the change in its kinetic energy.

（3）表达通常或习惯发生的行为。如：

Much of our understanding of nature comes from observing the motion of objects.

The solutions of kinematic equations are usually obtained quite easily in a direct fashion using integral calculus.

2）一般过去时

在提到以前叙述过的事情、叙述物理学发展史时，经常使用过去时态。如：

The result is the same as Eq. (7-1), which was calculated directly from Coulomb's law.

The first capacitor was the Leyden jar, a glass container lined inside and out with gold foil. It was invented at the University of Leyden in the Netherlands by eighteenth-century experimenters who, while studying the effects of electric charges on people and animals, got the idea of trying to store a large amount of charge in a bottle of water. An experimenter held up a jar of water in one hand while charge was conducted to the water by a chain from a static electric generator. When he reached over to lift the chain out of the water with his other hand, he was knocked unconscious. Benjamin Franklin realized that the device for storing charge did not have to be jar-shaped and used foil-covered window glass, called Franklin panes.

3）一般将来时

在表示将来发生的行为或情况，或表达假设条件时，常用到将来时态。如：

In this chapter we shall use the energy concept in our study of electricity.

As we shall see in subsequent chapters, the concept of electric potential is of great practical value.

If the uncharged conductor is grounded, what will be the charge distribution and electric field near the slabs?

If a conductor is placed in an external field, the charges in the conductor will redistribute themselves, in the meantime, the external field will also be altered by the charge redistribution of the conductor.

4）现在完成时

表示已取得的成果或完成的工作。如：

We have stated that φ and $\boldsymbol{E}$ are equivalent descriptions of electric fields, and have determined how to calculate φ from $\boldsymbol{E}$.

This problem has already been solved graphically.

So far our use of Gauss's law has been confined to the situation in which no dielectric was present.

3.1.2 使用介词的侧重点

尽管介词为英语各种文体所共用，但侧重点有所不同。如在文学英语中 with 多表示“产生某种生理或心理状态的原因（pale with anger）”，而在科技英语中更为常见的是用以表示“工具、手段”。如：

The capacitor is sprayed with aluminum to prevent rust.

Nowadays labs are built with large cranes and modern equipment.

3.1.3 并列成分的使用

在专业英语中，并列成分得到了大量的使用，下面的例句中都使用了并列的成分：

The story of the quantum is the one of a confused and groping search for knowledge *conducted by* scientists of many lands on a front wider than the world of physics had ever seen before, *illumined by* flashes of insight, *aided by* accidents and guesses, and *enlivened by* coincidences such as one would expect to find only in fiction.

Since the beginning of the present century, an increasing degree of uncertainty about the wave theory of light has been developing *due to* the discovery of the photoelectric effect, the quantum theory, and a number of allied phenomena, and *due also to a* detailed investigation into the nature and physical properties of the ether. Also, during this period a great deal has been learned about the structures of the atom which is not altogether limited to a wave picture of light. Hence the photon, or a light corpuscle, has been postulated.

In announcing that "every particle of matter in the universe attracts every other particle with a force inversely proportional to the square of the distance between the two particles", *in showing that* the one universal and comparatively simple law governs not only the motion of the planets round the sun and of the satellites round their planets but, probably, also the relative motions of all the heavenly bodies, Newton gave to the world a truth the importance of which in all branches of human thought can hardly be overestimated. Of value to science, of course, from microphysics to macrophysics. But consider the effect on man's concept of nature and of his relations thereto of realizing, indeed, of having proven to him, for the first time that the physical universe is governed by law, not by caprice; and if the physical universe, why not the biological universe, even the moral universe.

3.1.4 经常使用的复合修饰语

复合修饰语的使用是为了使行文简洁,它可以由名词、形容词、副词、介词短语、从句等充当。在专业英语中,经常使用复合修饰语,通常包括以下三种情况:

1)一个以上的修饰语同时修饰同一个中心词。如:

sound and light waves 声波和光波,*particle and wave* duality 波粒二象性

"*Absolute*, *true*, *and mathematical* time, of itself, and from its own nature, flows equably without relation to anything external." 绝对的、真实的、数学的时间,就其本身而言,就其本性而言,均匀流逝,与外界任何事情都无关。

2)一个修饰语同时修饰一个以上的中心词。如:

analyze the *efficiency and performance* of machinery 分析机械的运行情况及其效率

3)一个以上的修饰词同时修饰一个以上的中心词。如:

Scientists always check statements and make experiments *carefully and objectively* to verify them. 科学家总是谨慎而客观地核对各种说法,并以同样的态度通过实验来加以验证。

3.1.5 广泛使用被动语态

专业英语中的谓语约三分之一是被动语态。这是因为物理文献侧重叙事推理,强调客观准确。第一、二人称使用过多时,会造成主观臆断的印象,因此尽量使用第三人称叙述,采用被动语态,例如:

Attention must be paid to the working temperature of the machine. 应当注意机器的工作温度。

而很少说：You must pay attention to the working temperature of the machine. 你们必须注意机器的工作温度。

此外，如前所述，专业文章将主要信息前置，放在主语部分。这也是广泛使用被动态的主要原因。观察并比较下列两段短文的主语：

We can store electrical energy in two metal plates separated by an insulating medium. We call such a device a capacitor, or a condenser, and its ability to store electrical energy capacitance. It is measured in farads. 电能可储存在由一绝缘介质隔开的两块金属极板内。这样的装置称为电容器，其储存电能的能力称为电容。电容的测量单位是法(拉)。

变为如下被动语态句：

Electrical energy can be stored in two metal plates separated by an insulating medium. Such a device is called a capacitor, or a condenser, and its ability to store electrical energy capacitance. It is measured in farads.

这一段短文中各句的主语分别为：electrical energy, such a device, its ability to store electrical energy 和 it(capacitance)。它们都包含了较多的信息，并且处于句首的位置，非常醒目。四个主语完全不同，避免了单调重复，前后连贯，自然流畅，充分表明被动结构可取得简洁客观的效果。

3.1.6 大量使用从句

专业英语对客观事物的描述要求准确、完整，因而各种从句用得较多，但层次清楚。以下是一些从句的例子：

1) 状语从句

The body possesses a definite store of potential energy *while it is in the elevated position*.

2) 定语从句

Switching circuits are the ones *that perform logical functions*.

3) That 引导的从句

在句子中可以起主语、宾语、补语等作用。如：

For example, in electric circuits it is often assumed *that the relations between voltages and currents are linear*.

Stated in words, Ohm's law says *that the steady current through any portion of an electric circuit equals the potential difference across that portion of the circuit divided by the resistance of that portion of the circuit*.

4) 疑问词从句

由疑问词 what, where, how, which, who, whose, whether 等引导的从句，在句子中可以起主语、宾语、补语、同位语等作用。如：

In order to determine *whether a system is performing properly and ultimately* to control the system performance, the engineer must know *what the system is doing* at any instant of time.

The question *whether the atom can or cannot be split up* is known to have interested scientists from ancient times.

3.1.7 大量使用后置定语

大量使用后置定语也是科技文章的特点之一。常见的结构有以下五种：

1）介词短语

The forces *due to friction* are called frictional forces. 由于摩擦而产生的力称为摩擦力。

2）形容词及形容词短语

In radiation, thermal energy is transformed into radiant energy, *similar in nature to light*. 热能在辐射时，转换成性质与光相似的辐射能。

3）副词

The force *upward* equals the force *downward* so that the balloon stays at the level. 向上的力与向下的力相等，所以气球就保持在这一高度。

4）单个分词，但仍保持较强的动词意义

The heat *produced* is equal to the electrical energy *wasted*. 产生的热量等于浪费了的电能。

5）定语从句

The molecules exert forces upon each other, *which depend upon the distance between them*. 分子相互间都存在着力的作用，这些力的大小取决于它们之间的距离。

关于定语从句，会在以后的章节中进一步讨论，在此不再详述。

3.1.8 大量使用非限定动词结构

专业英语文章要求行文简练，结构紧凑。为此，往往使用分词短语代替定语从句或状语从句；使用分词独立结构代替状语从句或并列分句；使用不定式短语代替各种从句；使用介词＋动名词短语代替定语从句或状语从句。这样既可将句子缩短，又比较醒目。试比较下列各组句子。

A direct current is a current which flows always in the same direction.

A direct current is a current flowing always in the same direction.

直流电是一种总是沿同一方向流动的电流。

When heat radiates from the earth, it causes air currents to rise.

Radiating from the earth, heat causes air currents to rise.

热量由地球辐射出来时，使得气流上升。

A body can move uniformly and in a straight line if there is no cause to change that motion.

A body can move uniformly and in a straight line, there being no cause to change that motion.

如果没有改变物体运动的原因，那么物体将作匀速直线运动。

Vibrating objects produce sound waves, and each vibration produces one sound wave.

Vibrating objects produce sound waves, each vibration producing one sound wave.

振动的物体产生声波，每一次振动产生一个声波。

There are different ways which change energy from one form into another.

There are different ways of changing energy from one form into another.

将能量从一种形式转变成另一种形式有各种不同的方法。

When the radio waves are made to correspond to each sound in turn, messages are carried from a broadcasting station to a receiving set.

By making the radio waves correspond to each sound in turn, messages are carried from a broadcasting station to a receiving set.

使无线电波依次对每一个声音作出相应变化时，消息就由广播电台传递到接收机。

3.2 专业英语阅读

3.2.1 Linear Motion with Constant Acceleration（匀加速直线运动）

A very common and simple type of one-dimensional motion occurs when the acceleration is constant, or uniform. Consequently, the velocity increases or decreases at the same rate throughout the motion.

For motion along a straight line, we choose a rectangular coordinate system that is oriented so that one of the axes (for example, the x-axis) is along the line. Then, components of position vector, velocity, and acceleration lie along this direction, and the y and z components are zero. The vector equations then become scalar equations. If the velocity is v_0 at time $t=0$, and v at some later time t, the corresponding acceleration is

$$a=\frac{\Delta v}{\Delta t}=\frac{v-v_0}{t-0}=\frac{v-v_0}{t} \tag{3-1}$$

A Case in Point—Freely Falling Bodies

It is well-known that all objects, when dropped, will fall toward the earth with nearly constant acceleration. In the idealized case, where air resistance is neglected, such motion is referred to as **free fall.**

We shall denote the acceleration due to gravity by the symbol $\boldsymbol{g}$. The magnitude of $\boldsymbol{g}$ decreases with increasing altitude. Furthermore, there are slight variations in g with altitude. The vector $\boldsymbol{g}$ is directed downward toward the center of the earth. At the earth's surface, the magnitude of $\boldsymbol{g}$ is approximately 9.80 m/s^2.

If we neglect air resistance and assume that the gravitational acceleration does not vary with altitude, then the motion of a freely falling body is equivalent to motion in one dimension under constant acceleration. Therefore our kinematic equations for constant acceleration can be applied. We shall take the vertical direction to be the y axis and call y positive upward. With this choice of coordinates, we have $a=-g$. The negative sign simply indicates that the acceleration is downward. We get the following expressions:

$$v = v_0 - gt \tag{3-2}$$

$$y - y_0 = v_0 t - \frac{1}{2}gt^2 \tag{3-3}$$

$$v^2 - v_0^2 = -2g(y - y_0) \tag{3-4}$$

You should note that the negative sign for the acceleration is already included in these expressions. Therefore, when using these equations in any free-fall problem, you should simply substitute $g = 9.80\ \text{m/s}^2$.

3.2.2 Projectile Motion(抛体运动)

Anyone who has observed a football in motion (or, for that matter, any object thrown in the air) has observed projectile motion. This very common form of motion is surprisingly simple to analyze if the following three assumptions are made: (1) the acceleration due to gravity, $\boldsymbol{g}$, is constant over the range of motion and is directed downward, (2)the effect of air resistance is negligible, and (3) the rotation of the earth does not affect the motion. With these assumptions, we shall find that the path of a projectile, which we call it trajectory, is always a parabola.

If we choose our reference frame such that the y direction is vertical and positive upward, then $a_y = -g$ (as in one-dimensional free fall) and $a_x = 0$ (since air friction is neglected). Furthermore, let us assume that at $t = 0$, the projectile leaves the origin ($x_0 = y_0 = 0$) with a velocity v_0, as in Fig. 3-1.

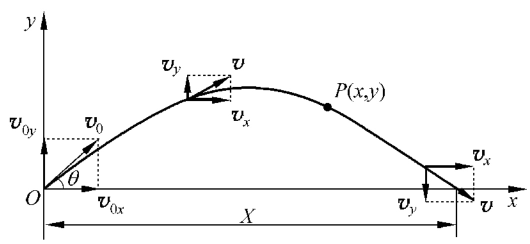


Fig. 3-1 The parabolic trajectory of a projectile that leaves the origin with a velocity v_0

If the vector makes an angle with the horizontal, then the initial velocity and acceleration have components

$$v_{0x} = v_0 \cos\theta \tag{3-5a}$$

$$v_{0y} = v_0 \sin\theta \tag{3-5b}$$

$$a_x = 0, \quad a_y = -g \tag{3-6}$$

Notice that v_x does not depend on v_y and vice versa: The horizontal and vertical components of projectile motion are independent. The velocity components and coordinates for the projectile at any time t are

$$v_x = v_{x0} = v_0 \cos\theta = \text{constant} \tag{3-7}$$

$$v_y = v_{y0} - gt = v_0 \sin\theta - gt \tag{3-8}$$

$$x = v_{x0}t = (v_0 \cos\theta)t \tag{3-9}$$

$$y = v_{y0}t - \frac{1}{2}gt^2 = (v_0 \sin\theta)t - \frac{1}{2}gt^2 \tag{3-10}$$

From Eqs. (3-9) and (3-10), we conclude that projectile motion is the superposition of two motions: (1) the motion of a freely falling body in the vertical direction with constant acceleration and (2) uniform motion in the horizontal direction with constant velocity.

The Total Flight Time(总飞行时间)

The total flight time T is obtained by setting $y=0$ in Eq. (3-10)

$$y = (v_0 \sin\theta)T - \frac{1}{2}gT^2 = 0, \quad T > 0$$

The flight time of the projectile is thus

$$T = \frac{2v_0 \sin\theta}{g} \tag{3-11}$$

Horizontal Range and Maximum Height(射程与最大高度)

There are two special points that are interesting to analyze: the peak with Cartesian coordinates labeled ($X/2$, Y) and the point with coordinates (X, 0). The distance X is called the **horizontal range** of the projectile, and Y is its **maximum height**.

We can determine the maximum height, Y, reached by the projectile by noting that at the peak, $v_y=0$. Therefore, Eq. (3-8) can be used to determine time t it takes to reach the peak

$$t = \frac{v_0 \sin\theta}{g}$$

Substituting this expression for t into Eq. (3-10) gives Y in terms of v_0 and θ

$$Y = \frac{v_0^2 \sin^2\theta}{2g} \tag{3-12}$$

The range, X, is the horizontal distance traveled in the total flight time T. Using Eq. (3-9) and noting that $x=X$ at $t=T$, we find that

$$X = v_0 \cos\theta \cdot \frac{2v_0 \sin\theta}{g} = \frac{2v_0^2 \sin\theta\cos\theta}{g}$$

Since $\sin 2\theta = 2\sin\theta\cos\theta$, X can be written in the form

$$X = \frac{v_0^2 \sin 2\theta}{g} \tag{3-13}$$

The maximum value of $\sin 2\theta$ is unity, which occurs when $2\theta = 90°$. Therefore, we see that X is maximum when $\theta = 45°$, as you would expect if air friction is neglected.

Glossary

one-dimensional	一维的	corresponding	对应的
freely falling body	自由落体	air resistance	空气阻力

acceleration due to gravity	重力加速度	altitude	高度
vertical direction	竖直方向	negative sign	负号
projectile	抛体	trajectory	轨迹
assumption	假设	negligible	可忽略的
rotation	转动	air friction	空气摩擦
parabola	抛物线	parabolic trajectory	抛物线轨迹
initial	初始的	horizontal	水平的
superposition	叠加	flight time	飞行时间
horizontal range	射程	maximum height	最大高度

3.3 专业英语常用表达法-3 状态 状况 技术设备的更新

1. 表示“状态、状况”等的词汇

at a complete standstill 处于完全停顿状态
at high temperature 在高温下
at/in/on/under... 处于……状态
at low concentration 在低密度(浓度)下
at rest 处于静止状态
at room temperature 在室温下
at the same electric potential 在相同电势下
at work 正在工作(运行)
bring/put...into/to... 使处于……状态
have a high density 具有高密度
in a good state of repair 维修良好、状态良好
in a stable state 处于稳定状态
in a state of disorder 处于杂乱(无序)状态
in a state of unstable equilibrium 处于非稳定平衡状态
in a suspended state 处于悬挂/暂停状态
in danger 处于危险状态、受到危险
in equilibrium 处于平衡状态
in motion 处于运动状态
in operation 正在运行、在运行(工作)中
in progress 正在进行、在进行中
in suspension 吊着、悬浮着、悬着
in vacuum 在真空状态下
on fire 着火、在燃烧
on test 正在经受试验/测试
on the decrease 正在减少
on the increase 正在增长
under construction 正在建造中

under control　处于受控状态
under development　正在研制之中
under discussion　正在讨论中
under heat treatment　在热处理中
under investigation　在调查中
under study　在研究中
under way　正在进行

2. 表示“过时、陈旧、淘汰”等的词汇

obsolete　荒废的、陈旧的
old　陈旧的、古老的
old-fashioned　老式的、过时的
out-of-date　老式的、过时的
timeworn　陈旧的、老化的
behind the times　过时、落伍
fall into disuse　淘汰
out of repair　失修
in disrepair　年久失修
in poor condition　状况不佳

3. 表示“更新、换代”等的词汇

remove　更换、升级
renew (renewal)　更新
renovate (renovation)　革新、改造
replace　取代、替换
introduce (introduction)　引进、纳入
install (installation)　安装、安置
update　使现代化、更新
upgrade　使升级、改良
in one's place　代替
in place of　代替
take the place of　代替

以下是一些具体的例子：

An object *at rest* will remain *at rest* and an object *in motion* will continue *in motion* with a constant velocity unless it experiences a net external force. 任何物体都保持静止的或沿一条直线作匀速运动的状态，除非作用在它上面的力迫使它改变这种状态。

Both Fermi-Dirac and Bose-Einstein become Maxwell-Boltzmann statistics *at high temperature* or *at low concentration*. 费米-狄拉克统计和玻色-爱因斯坦统计在高温或者低密度的情况下都会变为麦克斯韦-玻尔兹曼统计。

When no motion of charge occurs within the conductor, the conductor is *in electrostatic equilibrium*. 当导体内的电荷没有运动时，导体就处于静电平衡状态。

If an object is instantaneously *at rest*, is the force on it necessarily zero? 如果一个物体在某一瞬间是静止的，那么它所受到的外力是否必然为零呢？

Because the two spheres are connected by a conducting wire, the entire system is a single conductor and all points must be *at the same electric potential*. 由于这两导体球被导线连接，所以整个系统构成一个导体，因而所有各点处于电势相同的状态。

If a body is acted on by a number of forces and still remains stationary, the body is said to be *in equilibrium*. 如果一个物体受到数个力的作用而仍保持静止状态，我们说该物体处于平衡状态。

If the electric field were not zero, free charges in the conductor would accelerate *under the action of the electric force*. 如果电场不为零,导体内的自由电荷在电场力的作用下会加速运动。

The pig-iron comes out of the blast-furnace *in a molten state*. 生铁呈熔化状态流出高炉。

Metal which is hardened by cold-working may *be brought back to its original state/condition* by annealing. 通过冷加工而变硬的金属可通过退火恢复到它原来的状态。

The engine should be *under normal working conditions* during the test. 在试验时发动机应处于正常运行状态。

The surface of the liquid is *under a tension*. 液体的表面处在张力作用下。

Thus *renewal* of equipment began. 就这样设备开始更新了。

These were *obsolete* and had to be replaced with digital technology. 这些(设备)已经陈旧不堪,将被淘汰而改用数字技术(设备)。

Many old facilities have been *updated* since 2005. 自 2005 年以来许多陈旧的设施已被更新换代。

When we arrived here we found a very congested *old* system which needed total *renovation*. 当我们到这里时,我们发现系统陈旧又拥挤不堪,需要进行彻底改造。

They had to *remove* many lines and exchanges which were over 20 years old and completely *out-of-date*. 他们必须把已经用了 20 多年的、完全过时的线路和电话交换台予以更换。

This system will most probably be *upgraded* in the long run to a completely fiber-optic cable route. 这套系统最终将会全部升级,改用光纤线路。

LESSON 4

4.1 物理学专业英语的修辞特点

物理学专业英语的主要作用是提供事实、数据、假设、理论、实验等信息,运用概念、判断、推理,系统论述自然科学。其内容往往是一种客观的叙述,用于描述事实、记录实验,阐明规律或探讨理论,比如经常对环境、仪器设备进行描写,对实验过程和工艺流程进行描写,对工作原理、实验结果、性能、用途、条件等进行说明。不论是科学文章、科普文章、原版专业书籍,还是技术文本,都需要把科学道理说清楚。专业英语具有平铺直叙、简洁、确切的特点,注重的是科学事实和逻辑概念等,因而其文体十分严谨,修辞比较单调。为了具有科学性、准确性、客观性和抽象性等风格特点,专业英语经常运用如下几种修辞方式。

4.1.1 多使用逻辑语法词表示各种关系

表示原因的逻辑语法词如 because, due to, owing to, as a result of, for...

表示语气转折 but, however, nevertheless, yet, otherwise...

表示限制 only, if only, except, besides, unless...

表示逻辑顺序 so, thus, therefore, furthermore...

表示假设 suppose, assuming, provided, providing...

4.1.2 使用一些词语表示过程或顺序

表示先后顺序、承上启下的词语，常用的有：first，first of all，second，secondly，third，thirdly，next，then，before，prior to，after，after that，last，lastly，finally 等，还可用 for one thing，for another，also，in addition，on top of that，more than that，furthermore 等。此外，还有如 when，where，which，and，by the time 等起连接作用的词语也经常被采用。

One must judge a model by how well it meets two standards. *First*, is the model based upon the best experimental evidence that we have? *Second*, is it good enough to allow us to predict what would happen in a new situation that has not been investigated before? 评判一个模型必须根据它在多大程度上符合下面两个标准：①该模型是不是以我们所获得的最佳实验证据为其依据？②它是不是足以使我们能预测在至今尚未研究过的新条件下将会发生什么情况？

We have decided not to import the complete plant. *For one thing*, it is expensive; *for another* its reliability is open to question. 我们已决定不进口这套成套设备了。首先，它价格昂贵；其次，它的可靠性也有问题。

Following are a set of procedures in making a scientific discovery. A problem must *first of all* be recognized. *Secondly*, existing knowledge and theories about the problem must be studied. On this basis, *the third step* is to collect factual data relevant to the problem. *Next* comes the most important step of all: the formation of a hypothesis. *After* developing a hypothesis, *the next step* is testing it. *The last step* is reporting the discovery. 科学发现的步骤是这样的：首先是确认课题，接着是研究与该课题有关的、现有的学说。在此基础上，第三步就是收集与该课题相关的资料。第四步最重要，就是形成假设。紧接着就是对该假设加以验证。最后就是把这一科学发现公之于众。

4.1.3 下定义

下定义是为了对某一科学概念或事物的本质和特征有清晰的介绍而采用的一种描述方法。一般说来定义语言都遵循一定的格式，即：被定义的事物＝被定义事物的种属、类别＋被定义事物的特殊属性（如果被定义的事物是可数名词，要用单数形式，并冠以不定冠词 a 或 an）。常用 be，be called，be known as，be defined as，be referred to as…等结构。如：

A vernier caliper	is	a measuring instrument	consisting of an L-shaped frame with…
被定义事物		被定义事物的种属	被定义事物的特殊属性

定义通常采用关系从句（限制性或非限制性关系从句，多使用关系代词 who，which，whom，that，whose 等）或非限定动词结构，也可以采用括号或者破折号对所定义的对象进行解释，如：

The particles making up atoms are often referred to as elementary particles or fundamental particles. 构成原子的粒子通常称为基本粒子。

A force is an effect of attraction or repulsion between two bodies or particles. 力是物体或粒子之间的吸引或排斥效应。

另外，我们还会见到一句话定义后，又补充有例证、对比、说明等较长的定义形式。如：

Latent heat is the heat needed to change the state of matter of a material. While the latent heat is given to the material, its temperature remains constant. 潜热是改变物质的物态所需的热量。当物质吸收潜热时，其温度保持不变(恒定)。

4.1.4 分类

物理学中的事物错综复杂、多种多样，为研究、分析、讨论的方便，往往要对事物进行分类，找出它们之间的共同点，说明它们之间的区别。

对事物进行分类，需要三个方面的信息：①被分类的一组事物；②被分成的不同类型；③分类的标准或依据。

专业英语文本中常见的分类叙述有以下几种。

1) 完整的分类叙述：有关文字叙述直接提供上述三方面的信息。如：

Waves may be divided into two types based on the direction of the particles' oscillations relative to the wave velocity: transverse waves and longitudinal waves.

从本句可以看到：①被分类的事物为 waves；②被分成的类型为两种，即 transverse waves and longitudinal waves；③分类依据为 the direction of the particles' oscillations。

2) 不完整的分类说明：略去上述三条信息中的有关分类的标准或依据。如：

Quantities in physics can be classified as vectors or scalars.

3) 完全分类：根据某一标准把分类事物的全部归到一定数目的类型之中，加以分析讨论。如：

All the different forces observed in nature can be classified as members of one of four fundamental forces. These four fundamental forces are the gravitational force, the electromagnetic force, the strong nuclear force and the weak nuclear force. For example, the weight of the body is the gravitational force.

4) 不完全分类：在分类时，只提及有讨论价值的几种类型，而略去其余无关紧要的，或没有代表性的事物。如：

According to their shapes, capacitors can be classified into several categories: parallel-plate capacitors(平行板电容器), cylindrical capacitors(圆柱形电容器), spherical capacitors(球形电容器), etc.

在此例句中，没有说明电容器到底可以分成几种类型，只举了三种常见类型，所以我们称为“不完全分类”。

5) 多级分类：根据某一分类原则把一大类事物分成若干“子类”，然后再根据另一个分类原则把某一“子类”再分成若干更小的类别，更小的类别还可以继续分类，以此类推。我们把这种逐层分类法称为多级分类。如：

Synthesis techniques for nanomaterials, in general, can be divided into two broad categories as chemical methods and physical methods. Under chemical methods different routes, viz., colloidal, capping, cluster formation, sol-gel, electrochemical, etc., are being followed. Physical methods mostly used are molecular beam epitaxy, ionised cluster beam, liquid metal ion source, consolidation, sputtering and gas aggregation of monomers.

6）隐含分类：在上述五种分类中，我们可以直接使用分类词，如 divide，classify 等。但有时文章中不出现这种直接提供分类信息的词语，这种情况我们称为隐含分类。如：

In physics sometimes we are concerned with the properties of substances, which may be either physical properties or chemical properties. Physical properties of a substance are those which can be observed or measured without changing it into another substance; for example, its color, form, hardness and its melting and boiling points. Chemical properties of a substance are those which describe its behavior when it changes into other substances, e. g. when it burns or is destroyed by acids.

虽然在此作者没有使用分类词语，但同样为我们提供了有关分类的三方面的信息：①被分类的事物，properties of substance；②被分成的类型，physical properties 及 chemical properties；③分类依据，whether the properties involve any change from one substance to another substance，or more substances.

4.2 专业英语阅读

4.2.1 Circular Motion（圆周运动）

Motion along a circular path, or a segment of a circular path, is called **circular motion.**

If a particle moves along a circular arc, the direction from the particle toward the center of the circle is called the centripetal direction.

Angular Velocity and Angular Acceleration（角速度与角加速度）

Fig. 4-1 illustrates a particle undergoes circular motion about O. As the particle moves along the circle from point A to the point B in a time interval Δt, it moves through an arc length Δs and the radius vector sweeps out an angle $\Delta\theta$, which equals the angular displacement. We define the average angular velocity as the ratio of this angular displacement to the time interval Δt:

$$\omega = \frac{\Delta\theta}{\Delta t} \tag{4-1}$$

The **instantaneous angular velocity**, ω, is defined as the limit of the ratio in Eq. (4-1) as Δt approaches zero:

$$\omega = \lim_{\Delta t\to 0}\frac{\Delta\theta}{\Delta t} = \frac{d\theta}{dt} \tag{4-2}$$

Angular velocity has units of rad/s, or s^{-1}, since radians are not dimensional. We shall take ω to be positive when θ is increasing (counterclockwise motion) and negative when θ is decreasing (clockwise motion).

Note that angular velocity is a vector. Its direction follows the **right-hand rule**, perpendicular to the plane the particle moves in. That is, the four fingers of the right hand are wrapped in the direction of the moving particle, and the extended right thumb points in the direction of ω (Fig. 4-2). Angular velocities, when they add vectorially, follow parallelogram rule for vectors.

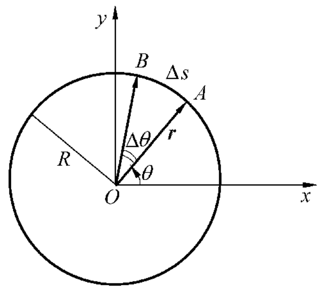


Fig. 4-1

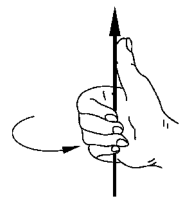


Fig. 4-2

If the instantaneous angular velocity changes, the particle has an angular acceleration. In analogy to linear acceleration, the **angular acceleration $\boldsymbol{\alpha}$** is defined as

$$\boldsymbol{\alpha} = \lim_{\Delta t \to 0} \frac{\boldsymbol{\omega}_{t+\Delta t} - \boldsymbol{\omega}_t}{\Delta t} = \lim_{\Delta t \to 0} \frac{\Delta \boldsymbol{\omega}}{\Delta t} = \frac{\mathrm{d}\boldsymbol{\omega}}{\mathrm{d}t} \tag{4-3}$$

Angular acceleration has units of rad/s^2, or s^{-2}. Note that α is positive when ω is increasing in time and negative when ω is decreasing in time.

Circular Motion with Varying Speed（变速圆周运动）

Let us consider the motion of a particle along a circular path where the velocity changes both in direction and in magnitude. In this situation, the velocity of the particle is always tangent to the path; however, the acceleration vector $\boldsymbol{a}$ is now at some angle to the path. As the particle moves along the curved path, the direction and magnitude of the acceleration vector, $\boldsymbol{a}$, may change from point to point. This vector can be resolved into two component vectors: a radial component vector, $\boldsymbol{a}_n$, and a tangential component vector, $\boldsymbol{a}_t$. That is, the total acceleration vector, $\boldsymbol{a}$, can be written as the vector sum of these component vectors:

$$\boldsymbol{a} = \boldsymbol{a}_n + \boldsymbol{a}_t \tag{4-4}$$

The **tangential acceleration** arises from the change in the speed of the particle, and its magnitude is given by

$$a_t = \frac{\mathrm{d}v}{\mathrm{d}t} \tag{4-5}$$

The **radial or normal acceleration** is due to the time rate of change in direction of the velocity vector and has a magnitude given by

$$a_n = \frac{v^2}{R} \tag{4-6}$$

Since $\boldsymbol{a}_n$ and $\boldsymbol{a}_t$ are perpendicular component vectors of $\boldsymbol{a}$, it follows that $a = \sqrt{a_n^2 + a_t^2}$. As in the case of uniform circular motion, $\boldsymbol{a}_n$ always points toward the center of the circle. The direction of $\boldsymbol{a}_t$ is either in the same direction as $\boldsymbol{v}$ (if the speed v is increasing) or opposite $\boldsymbol{v}$ (if the speed v is decreasing).

Note that in the case of uniform circular motion, where v is constant, $a_t = 0$ and the acceleration is always radial. Furthermore, if the direction of $\boldsymbol{a}$ does not change, then there is no radial acceleration and the motion is one-dimensional ($a_n=0$, $a_t\neq 0$).

4.2.2 Relative Motion(相对运动)

In this section, we describe how observations made by different observers in different frames of reference are related to each other. We shall find that observers in different frames of reference may measure different displacements, velocities, and accelerations for a particle in motion. That is, two observers moving with respect to each other will generally not agree on the outcome of a measurement.

Suppose a person on a moving vehicle (observer A) throws a ball straight up in the air according to his frame of reference, as in Fig. 4-3(a). According to observer A, the ball will move in a vertical path. On the other hand, a stationary observer B, standing on the ground, will see the path of the ball as a parabola, as illustrated in Fig. 4-3(b).

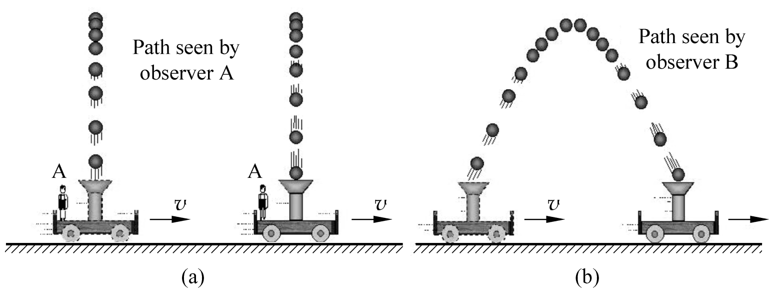


Fig. 4-3

(a) Observer A in a moving vehicle throws a ball upward and sees a straight-line path for the ball;

(b) A stationary observer B sees a parabolic path for the same ball

In a more general situation, consider a particle located at the point P in Fig. 4-4. Imagine that the motion of the particle is being described by two observers, one in reference frame S, fixed with respect to the earth, and the other in reference frame S', moving to the right relative to S with a constant velocity $\boldsymbol{u}$. (Relative to an observer in S', S moves to the left with a velocity $-\boldsymbol{u}$.)

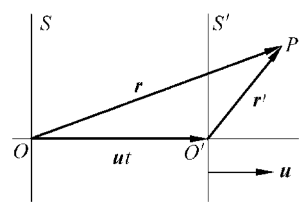


Fig. 4-4

We label the position of the particle with respect to the S frame with the position vector $\boldsymbol{r}$ and label its position relative to the frame S' with the vector $\boldsymbol{r}'$, at some time t. If the origins of the two reference frames coincide at $t=0$, then the vectors $\boldsymbol{r}$ and $\boldsymbol{r}'$ are related to each other through the expression

$$\boldsymbol{r}=\boldsymbol{r}'+\boldsymbol{u}t \tag{4-7}$$

If we differentiate Eq. (4-7) with respect to time and note that $\boldsymbol{u}$ is constant, we get

$$\frac{\mathrm{d}\boldsymbol{r}}{\mathrm{d}t}=\boldsymbol{u}+\frac{\mathrm{d}\boldsymbol{r}'}{\mathrm{d}t} \tag{4-8}$$

$$v = u + v' \quad (4\text{-}9)$$

where v' is the velocity of the particle observed in the frame S' and v is the velocity observer in the S frame. Eqs. (4-7) and (4-9) are known as **Galilean transformation equations.** They relate the coordinates and velocity of a particle in the earth's reference frame to those measured in a frame of reference in uniform motion with respect to the earth.

Glossary

circular motion	圆周运动	centripetal	向心的
arc length	弧长	angular displacement	角位移
instantaneous angular velocity	(瞬时)角速度	radian(s)	弧度
dimensional	有量纲的	counterclockwise	逆时针
clockwise	顺时针	circle	圆
center of a circle	圆心	vectorially	矢量地
angular acceleration	角加速度	tangential acceleration	切向加速度
resolve	(矢量)分解	uniform circular motion	匀速圆周运动
radial	径向的	radial/normal acceleration	法向加速度
perpendicular	垂直的	observer	观察者
outcome	结果	measurement	测量
stationary	静止的	differentiate	微分
Galilean transformation	伽利略变换		

4.3 专业英语常用表达法-4 组成 构成 成分 质量 标准

1. 表达“组成、构成、成分”的常用名词

component 成分、组分、零件

constitution 构造、组成

content 内容、含量

ingredient 成分、配料

composition 合成、组成、成分

constituent 成分、要素

formation 形成、构成

make-up 组成、构造

2. 表达“组成、构成、成分”的常用词组

component assembly 零件装配

component part 成分、组分、零件

component wire (电缆)芯线

bath composition 电解液成分

composition of forces 力的合成

alloying ingredient 合金的组分

crystal formation 结晶、晶体生成

formation of n-p-n junction N-P-N 结结构

shock wave formation 激波系

microscopic constitution 显微组织

structural constitution 结构成分

component (of) velocity 分速度

component sine waves 正弦波分量

pressure component 分压力

composition metal 合金

composition of radiance 辐射谱

moisture content 湿度、含水量

formation of image　成像
chemical constitution　化学成分(结构)
isotopic constitution　同位素成分
pulse formation　脉冲的形成
molecular constitution　分子结构(构成)

以下是一些具体的例子：

The factory produces *components* for aircraft. 这个工厂生产飞机构件(部件)。

The *composition* of cast-iron is different for different purposes. 铸铁的成分随用途的不同而有所不同。

The carbon *content* of wrought-iron is very low. 熟铁的碳含量很低。

Ferrite and carbon are the *constituents* of mild steel. 铁氧体和碳是软钢的成分。

The moisture *content* of the cylinder increased. 汽缸的水分含量增加了。

The chemical *composition* of water remains constant whether it is in solid, liquid or gaseous state. 无论处于固态、液态或气态，水的化学成分都保持不变。

3. 表达"组成、构成、成分"的常用动词和短语

be combined into...　组成、构成
compose　组成、构成
constitute　组成、构成
form　组成、构成
make up　组成、构成
be composed of...　由……组成
be made up of...　由……组成
be sprayed with...　用……喷镀
consist of...　由……组成
comprise　由……组成
contain　包含、包括

以下是一些具体的例子：

be sprayed with a metal coating　喷镀一层金属

be sprayed with a coating of paint　喷镀一层涂料

A hydrogen atom *consists of* a single electron moving round a single proton. 一个氢原子是由一个电子绕着一个质子旋转构成的。

All substances on the earth, whether gaseous, liquid or solid, *are made up of* atoms. 地球上所有的物质无论它们是气态的、液态的或是固态的，都是由原子组成的。

This physical instrument *is composed of* several different parts. 这台物理仪器由几个不同的部件组装而成。

Steel *is composed of* iron and a number of other elements. 钢是由铁和若干种其他元素构成的。

Fermi-Dirac statistic is a part of the science of physics that describes the energies of single particles in a system *comprised of* many particles that obey the Pauli Exclusion Principle. 费米-狄拉克统计是物理学的一部分，它用来描述由遵守泡利不相容原理的多粒子所构成系统的单个粒子的能量。

The technician *made up* a bottle of dilute sulfuric acid. 技术人员配置了一瓶稀硫酸。

Brass *consists of* copper and zinc. 黄铜由铜和锌构成。

The atmosphere *comprises* a number of gases. 大气由许多种气体构成。

The electro-magnet *comprises* a soft iron core shaped like a horseshoe. 电磁铁包括一块马蹄形的软铁芯。

Cast-iron *is made up of* about six different substances. 铸铁大约由六种不同的物质构成。

Sometimes two different types of machines *are combined into* a complex one. 有时两台不同的机器组成一台复杂的机器。

Ferrite and carbon *make up* mild steel. 铁氧体和碳构成软钢。

The alloy *contains* 10% nickel and 8% iron. 这合金含有10%的镍和8%的铁。

The rare earths *comprise* the series of elements in the sixth row of the periodic table stretching from lanthanum to ytterbium. 稀土(元素)包括元素周期表第六行中的从镧到镱的一系列元素。

4. "质量高，优质"的常用表达

常用 fine, high, good, better, best, top, first-class, first-rate 等词，也可说

standard quality　符合标准的质量

choice quality　精选的质量

a fine quality of...　优质的……

a good quality stop watch　一块高质量的停表

products of quality　优质产品

quality concrete　高级/优质混凝土

be superior in quality　质量好

have quality　质量好

of good quality　上等的、优质的

5. "符合质量要求"的常用表达

reach the (official) standard　达到(官方)标准

maintain the quality　保持合格质量

meet the (minimum) standard　达到(最低)标准

be up to the standard (grade, category)　达标

come up to the standard　达标

make the grade　达到(理想)标准、合乎(质量)要求

6. "质量一般"的常用表达

fair quality　质量还行

acceptable quality　可接受的质量

above the average quality　高于平均质量水平

7. "基本够格，稍有问题"的常用表达

be borderline　基本够格

have a borderline result　结果勉强够格

8. "质量次、差"的常用表达

除 bad, poor, inferior 等词外，还可说

off quality　品质差

below standard　低于标准
not up to standard　未达标
below the average quality　低于平均质量水平
out of grade　未达标
of poor quality　劣等的、劣质的

Unit Two

LESSON 5

5.1 物理学专业英语中的比较

在物理学中，经常需要对所研究的事物或采用的方法进行比较说明。比较是人们认识客观事实的一个重要途径，它利用事物之间的相似或不同之处，通过类比使人们理解或接受那些不易理解或接受的东西。英语中的比较结构内容丰富，形式多样，并有其独特的表现形式，所以正确理解和表达比较结构及其相应翻译在专业英语学习中很有必要。通过比较可以发现被描述物之间的相同点和不同点，能对抽象的概念，如事物的性质、特点、功能、形状、尺寸等，有较为具体的了解。下面列举几种常见的比较和对比。

5.1.1 同等比较

表示两对象在性质、特征等方面相似或相同。其结构形式有：

1）as...as （和……一样）

The lightning rod is as good as any other. 这避雷针与其他任何一种避雷针一样好。

2）be identical with，be the same as，be equal to （和……相同）

The TV set uses the same capacitor as that one does. 这台电视机用的电容器和那台一样。

The rating of this engine is equal to that of Toyota motor. 这台发动机的额定值与那台丰田发动机的额定值等同。

3）no more(less)...than... （和……一样不……，不亚于……）

Rubber is no more conductor than glass. 橡胶和玻璃一样都不是导体。

类似的表达结构还有：

As (Just as)...，so... （和……一样，……也……）

The same thing is true of... （同样……也……）

Like (Similarly，Likewise，In the same way)...（同样……）

A and B have/share several things in common. A 和 B 有几个共同点。

A and B are alike/identical/similar/the same (in design/in every respect/in most respects). A 和 B(在设计上/在每一方面/在大多数方面)相像/一致/类似/一样。

A like/as B has/have/is/are C. A 和 B 一样，都是 C。

A bears some close resemblance(s) to B. A 和 B 有一些相似之处。

There is little resemblance between A and B. A 和 B 没有相似之处。

A do/does/be…, so do/does/be B. （A……,B 也……）

A do/does/be not…, nor do/does/be B. （A……，B 也不……）

（As ＋从句/短语）＋主句＋as 从句/短语 （和……一样……）

这些句型还可以与一些副词连用来表示程度，例如 exactly，just，precisely，more or less，almost，approximately，about，practically 等。

5.1.2 差等比较

差等比较包括两方面："优等比较"和"劣等比较"。前者表示"A 优于 B"，后者表示"A 劣于 B"。其结构形式有：

1）…than… （比更……一些）

The carbon content of cast steel is greater than that of mild steel. 铸铁的碳含量比软钢高。

2）…not as/so …as （和……不一样，不如……）

Water doesn't have a boiling point as low as alcohol. 水的沸点不如酒精低。

3）be superior to /be inferior to （优于……/劣于……）

The power of the new engine is superior to that of the old one. 这台新发动机的功率优于旧的。

5.1.3 有额比较

表示具体比较结果，即"额"是多少。其结构形式有：

1）额＋比较级＋than （比……多，是……）

Sound travels nearly three times faster in copper than in lead. 声音在铜中的传播速度几乎是铅中的 3 倍。

2）额＋as＋原级＋as，额＋the size/weight/price/number/age/that… （是多少……）

Jupiter is 1500 times as large as/the size of the Earth. 木星是地球的 1500 倍大。

The effort is two thirds as great as the resistance. 作用力是阻力的 2/3。

3）表示减少或增加意义的动词（decrease，increase，rise，exceed，grow，raise，expand，go up 等）＋额（增加/减少了……）

The production of various picture tubes has increased three times as against 2003. 各种显像管的产量比 2003 年增加了 3 倍。

The new invention makes it possible that small amounts of electricity can increase hydrogen production from waste water 4 times. 这项新发明使得低耗电废水提取氢的产量提高 4 倍成为可能。

The technicians tried hard to make the balloon expand its size 6 times. 技师们尽最大努力使得气球的体积膨胀了 6 倍。

4）表示倍数意义的动词（double，treble，quadruple）＋宾语/表语 （增加了……倍）

Production quadruples this year. 今年产量增加了 3 倍。

5.1.4 递进比较

这种比较表示一种不断递进的语义关系。其结构形式有：

1）the＋比较级＋句子/句子＋比较级，the＋比较级＋句子 （越……，越……）

The thicker the wire is，the more freely it can carry current. 导线越粗，导电就越容易。

A subject weighs less，the farther it gets from the surface of the earth. 物体离地球表面越远重量越轻。

2）比较级＋and＋比较级 （越来越……）

More and more new knowledge is discovered in physics. 越来越多的物理学新知识被发现。

More and more scientists today work for government sponsored bodies. 今天越来越多的科学家为政府支持的机构工作。

3）never…enough，never too…，can't…over/too （越……越……，怎么也不为过）

You can never be careful enough when operating this instrument. 操作这台仪器越小心越好。

The significance of the invention can't be overestimated. 这个发明的意义不管怎样估计都不会过高。

5.1.5 终极比较

表示某物在特定范围内显得最突出，或某一动作在一定情况下达到最高程度。其结构主要用形容词和副词的最高级。

The kilometer is the largest metric unit of measurement. 千米是最大的米制衡量单位。

注意：终级比较和差等比较也可表示完全相同的意思，只是说话者看问题的角度不同而已。这时候的差等比较结构中往往带有 other 或 else。如：

Strontium titanate is far better as a dielectric than any other ones in the group. 作为电介质，钛酸锶比其他电介质强得多。

5.1.6 选择性比较

1）more…than，less…than，better…than，not so much…as （与其……不如……，不是……倒是……，不但没有……反而……）

His explanation about the Hall effect was more confusing than clarifying. 他对于霍尔效应的解释不但没使人明白，反而使人更糊涂了。

This material is not so much a conductor as a semiconductor. 与其说这种材料是导体不如说是半导体。

2）prefer…to…，prefer to…，rather than… （喜欢……不喜欢……）

Physicists usually prefer idealized models to real objects when dealing with problems. 在处理问题时，物理学者通常喜欢采用理想模型取代实际物体。

He prefers to carry out experiments rather than theoretical induction. 他喜欢动手做实

验，不喜欢理论推理。

5.1.7 表示 A≠B

即 A 与 B 不相同，有差异，其常用句式为：

A is not as/so＋形容词 as B.

A is (totally/completely/entirely/quite) different from B (in every way/in every respect/in its shape/that 从句).

A (totally/completely/entirely/quite) differs from B (in every way/in every respect/in its shape/that 从句).

A can be distinguished from B (by its shape).

A unlike/as distinct from/as against B has/have C/ is/are C.

例句：

Heat waves are different/differ from light waves only in their wavelengths. 热波与光波的差异只是波长不同。

Iron, unlike glass, is a good conductor of electric current. 铁不同于玻璃，它是电流的良导体。

5.2 专业英语阅读

5.2.1 Newton's Laws of Motion（牛顿运动定律）

The purpose of classical mechanics is to provide a connection between the acceleration of a body and the forces acting on it. Keep in mind that classical mechanics deals with objects that are large compared with that dimensions of atoms ($\approx 10^{-10}$ m) and move at speeds that are much less than the speed of light (3×10^{8} m/s).

In this chapter, we describe Newton's three laws of motion and begin using them to solve problems involving objects in motion and at rest.

5.2.2 Newton's First Law（牛顿第一定律）

A modern wording of **Newton's first law of motion** is:

An object at rest will remain at rest and an object in motion will continue in motion with a constant velocity (that is, constant speed in a straight line) unless it experiences a net external force (or resultant force).

In simpler terms, we can say that when the resultant force on a body is zero, its acceleration is zero. From the first law, we conclude that an isolated body (a body that does not interact with its environment) is either at rest or moving with constant velocity.

Inertial Frames（惯性系）

Newton's first law is sometimes called **law of inertia**, and it applies to objects in an inertial frame of reference.

An **inertial frame of reference** is one in which an object, subject to no force, moves with constant velocity. That is, a reference frame in which Newton's first law is valid is called an **inertial frame**.

In effect, Newton's first law defines an inertial frame of reference. A reference frame that moves with constant velocity relative to the distant stars is the best approximation of an inertial frame. The earth is not an inertial frame because of its orbital motion about the sun and rotational motion about its own axis. However, in most situations we shall assume that the earth is an inertial frame.

Thus, if an object is in uniform motion ($\boldsymbol{v}$ = constant), an observer in one inertial frame (say, one at rest with respect to the object) will claim that the acceleration and the resultant force on the object are zero. An observer in any other inertial frame will also find that $\boldsymbol{a}=0$ and $\boldsymbol{F}=0$ for the object. According to the first law, a body at rest and one moving with constant velocity are equivalent. Unless stated otherwise, we shall unusually write the laws of motion with respect to an observer "at rest" in an inertial frame.

5.2.3 Newton's Second Law(牛顿第二定律)

Newton's second law answers the question of what happens to an object that has a nonzero resultant force acting on it.

Newton's second law of motion is:

The time rate of change of momentum of an object is equal to the resultant external force acting on the object.

$$\sum \boldsymbol{F}=\frac{\mathrm{d}\boldsymbol{p}}{\mathrm{d}t}=\frac{\mathrm{d}(m\boldsymbol{v})}{\mathrm{d}t} \tag{5-1}$$

where $\boldsymbol{p}$ is the momentum of the object as the product of the mass, m, and the velocity, $\boldsymbol{v}$

$$\boldsymbol{p}=m\boldsymbol{v} \tag{5-2}$$

Eq. (5-1) is the most general form of Newton's second law, which is valid in any inertial frame of reference.

If m is treated as a constant, then Eq. (5-1) can be expressed

$$\sum \boldsymbol{F}=\frac{\mathrm{d}\boldsymbol{p}}{\mathrm{d}t}=\frac{\mathrm{d}(m\boldsymbol{v})}{\mathrm{d}t}=m\frac{\mathrm{d}\boldsymbol{v}}{\mathrm{d}t}=m\boldsymbol{a} \tag{5-3}$$

which can be stated as the acceleration of an object is directly proportional to the resultant force acting on it and inversely proportional to its mass.

5.2.4 Newton's Third Law(牛顿第三定律)

Newton's third law states that *if two bodies interact, the force exerted on body* 1 *by body* 2 *is equal to and opposite the force exerted on body* 2 *by body* 1. That is,

$$\boldsymbol{F}_{12}=-\boldsymbol{F}_{21}$$

This law is equivalent to stating that forces always occur in pairs, or that a single isolated force cannot exist. The force that body 1 exerts on body 2 is sometimes called the **action force**, while the force of body 2 on body 1 is called the **reaction force**. Either force can be labeled the action or reaction force. The action force is equal in magnitude to the reaction force and opposite in direction. In all cases the action and reaction forces act on different objects.

5.2.5 The Four Fundamental Forces(四种基本力)

All the different forces observed in nature can be explained in terms of four basic interactions that occur between elementary particles.

The Gravitational Force(引力)—the force of mutual attraction between objects

Newton's law of universal gravitation states that *every particle in the universe attracts every other particle with a force that is directly proportional to the product of the masses of the particles and inversely proportional to the square of the distance between them.*

$$F = \frac{Gm_1 m_2}{r^2} \qquad (5\text{-}4)$$

where $G = 6.67 \times 10^{-11}\ \mathrm{N \cdot m^2/kg^2}$ is the **universal gravitational constant.**

The Electromagnetic Force(电磁力)—the force between electric charges

This class of forces includes electric and magnetic forces. The electric force binds atoms and molecules in compounds to form ordinary matter. It is much stronger than the gravitational force. Coulomb's law states that the magnitude of the electrostatic force between two charged particles is

$$F_e = \frac{kq_1 q_2}{r^2}$$

where $k = 9 \times 10^9\ \mathrm{N \cdot m^2/C^2}$ is the **Coulomb constant.**

The Strong Nuclear Force(强核力)—the force between subatomic particles

This force holds the nucleus of an atom together. All nuclei except those of hydrogen contain electrically neutral neutrons and positively charged protons. The charged protons repel each other. It is the strong nuclear force that counteracts the repulsive electrical interactions. Note that the nuclear force is extremely short range and its strength decreases very rapidly outside the nucleus.

The Weak Nuclear Force(弱力)—the force between subatomic particles during certain radioactive decay processes

The weak nuclear force is a **short-range force** that is responsible for a common form of radioactivity called beta decay, in which a neutron in a radioactive nucleus is transformed into a proton while ejecting an electron and an essentially massless particle. The weak force play no direct role in the behavior of ordinary matter, but it is very important in interactions among fundamental particles.

Glossary

at rest	静止	approximation	近似
net external force/resultant force	合外力	inertial frame of reference	惯性参考系
inertia	惯性	act on＝exert	(力)作用于
unless stated otherwise	除非另有说明	nonzero	非零的
rate of change	变化率	mass	质量
directly proportional to	正比于	momentum	动量
inversely proportional to	反比于	interact	相互作用
action force	作用力	opposite	相反、相对
reaction force	反作用力	isolated	孤立的
gravitational force	引力	universal gravitational constant	万有引力常数
electromagnetic force	电磁力	electric charge	电荷
atom	原子	molecule	分子
compound	混合物、化合物	bind	约束
Coulomb's law	库仑定律	electrostatic force	静电力
charged particle	带电粒子	strong nuclear force	强力
subatomic	亚原子的	hydrogen	氢
nucleus (*pl.* nuclei or nucleuses)	原子核	neutron	中子
proton	质子	repel	排斥
repulsive	排斥的	counteract	抵抗
strength	强度	weak nuclear force	弱力
short-range force	短程力	radioactivity	放射性
radioactive decay	放射性衰变	beta decay	β衰变
electron	电子	massless	无质量的
fundamental particles	基本粒子		

5.3 专业英语常用表达法-5 力学常用实验仪器

pendulum wire	摆线	stopwatch	秒表
surface tension tester	表面张力测定仪	torsion pendulum	扭摆
dynamic meter	测力计	viscometer	黏度计
ballistic pendulum	冲击摆	gas density balance	气体密度秤
simple pendulum	单摆	balance/scale	天平
poise/weight	砝码	standard line meter	线纹米尺
(running)time meter/timer	计时器	pressure vacuum meter	压力真空表
Jolly balance	焦利秤	vernier caliper	游标卡尺
micrometer	螺旋测微仪、千分尺	pendulum weight/bob	摆锤

standard meter 标准米尺
gear 齿轮
ticker-tape timer 纸带打点计时器
spring balance 弹簧秤
analytical balance 分析天平
psychrometer 干湿计
measuring cup/graduate 量杯
densimeter 密度计、比重计
tweezers 镊子
torsion balance 扭力天平、扭秤
air track 气垫导轨
barometer 气压计
balance reading glass 天平读镜
pressure meter/gauge 压力计
Young's modulus tester 杨氏模量测定仪
balance spring/hair spring 游丝
centrifugal pendulum/centrifugal governor/centrifugal speed regulator 离心调速器
graduate, graduated/measuring volumetric cylinder 量筒
physical/compound pendulum 复摆、物理摆
target collision experiment facility 碰撞打靶实验仪
moment of inertia detector 转动惯量测定仪
new type of simple pendulum experiment facility 新型单摆实验仪
coefficient of liquid surface tension detector 液体表面张力系数测定仪
shear modulus and moment of inertia experiment facility 切变模量与转动惯量实验仪
general experimental sound velocity measurement instrument 声速测量综合实验仪
viscosity of liquid drop-ball tester 落球法液体黏滞系数测定仪
simple harmonic motion and spring stiffness coefficient experiment facility 简谐振动与弹簧劲度系数实验仪

LESSON 6

6.1 物理学专业英语中的举例和列举

6.1.1 举例

举例是专业英语中常见的表达方式。举例是作者为了更形象、更生动地揭示所表达的内容,帮助读者理解而采取的一种方法,起到进一步解释说明的作用。举例可以使抽象的内容更加具体、形象、生动,便于理解、记忆和运用。

在专业英语中,举例一般用于作者下完定义或写明某一观点之后。有时作者使用浅显的信息进一步解释抽象的概念、观点,使文章通俗易懂,表达清晰。

举例时常用到如下句型:

For example... 例如……

For example 既可以放在句首,也可以放在句中。放在句首时,要大写,后面有逗号;放在句中时,前后都有逗号,形似插入语;也可以放在破折号后面,因为破折号本身表示解释说明的意思。For example 没有连接词的作用,不能连接两个分句。

e. g. ... 例如……

e. g. 是拉丁语 exempli gratia 的缩写，意为 for example，但不如 for example 正式，使用时一般放在括号内。

take... as an example　以……为例

take... for example　以……为例

For instance...　例如……

与 for example 用法一样，但 for instance 比 for example 举例更具体些。

common/typical examples are...　常见的/典型的例子是……

an even more dramatic example is...　一个更生动的例子是……

examples of which are...　属于此种类型的例子有……

use an example to show...　用一个例子表明……

an example of...　一个……的例子

furnishes a good example of...　提供了一个……的好例子

like...　像……

afford an illustration of...　提供了一个……的例子

a case in point　恰当的例子

as an example　例如、举例来说

as an illustration　作为实例

as demonstrated by...　例如

by way of example　例如、举例来说

illustrated with...　用……举例说明

including　包含、包括

involving　包括

like　类似

range over　涉及、包括

say　比如说

something like...　有点像……

specifically　具体地

such　诸如此类的

such as　例如、诸如

take the case of...　以……为例

to illustrate by an example 举例说明

以下是一些具体的例子：

Waves transport energy and momentum through space without transporting matter. As a water wave moves across a pond, *for example*, the molecules of water oscillate up and down, but do not cross the pond with the wave. 波动只传播能量和动量而不传播媒质。例如，当水波穿过水池时，水分子上下振动，但是不随波穿过水池。

Take the spring system *as an example*. A block attached to a spring on a frictionless track moves in simple harmonic motion. 以弹簧系统为例，一个与弹簧相连、放在光滑轨道上的木块的运动就是简谐运动。

Mechanical waves are waves that disturb and propagate through a medium; the ripple in the water due to the pebble and a sound wave, for which air is the medium, are *examples of* mechanical waves. 机械波是扰动在媒质中传播形成的波,石头落入水中形成的波纹、以空气作媒质的声波都是机械波的例子。

To illustrate this, we *take* temperature *for example*. 为了阐明此理,我们以温度为例说明。

Another method that can be used to obtain the potential due to a finite continuous charge distribution is to start with the definition of the potential difference given by Eq. (8-7). If $\boldsymbol{E}$ is known or can be obtained easily (*e.g.* from Gauss's law), then the line integral of $\boldsymbol{E}\cdot d\boldsymbol{r}$ can be evaluated. 还有另外一种方法可以用来求有限连续分布电荷产生的电势,那就是利用方程(8-7)定义的电势差。如果电场 $\boldsymbol{E}$ 已知或者可以容易求得(例如利用高斯定律求得),那么 $\boldsymbol{E}\cdot d\boldsymbol{r}$ 的线积分就可以计算出来了。

When, *for instance*, we hit a nail with a hammer, we expect the nail to move. 比如,当我们用锤子敲打钉子时,我们可预知钉子要移动。

The mutual inductance depends on the geometrical arrangement of the two circuits. *For instance*, if the circuits are far apart, the flux through circuit 2 due to the current I_1 will be small and the mutual inductance will be small. 互感与两个回路的几何形状位置有关。例如,如果两个回路相距较远,电流 I_1 在回路 2 产生的通量就会小,从而互感就会小。

Electromagnetic waves are a special class of waves that do not require a medium in order to propagate; it is the varying electromagnetic field that propagates through space, *examples of which are* light waves and radio waves. 电磁波是一种特殊种类的波,它的传播不需要媒质;它是变化的电磁场在空间的传播,例如光波和无线电波。

An even more dramatic example of longitudinal waves is sound waves in air. 空气中的声波是纵波的一个更生动的例子。

Many machines vibrate because they have rotating parts that are not in perfect balance (observe a washing machine in the spin cycle *for an example*). 许多机器都会振动,那是因为它们的转动部分未在精确的平衡位置,作为一个例子,你可以观察一下内部旋转时的洗衣机。

A common example of the conversion of work into heat is movement with friction. 功转化为热的一个常见的例子就是摩擦运动。

Some common examples of adiabatic processes include the expansion of hot gases in an internal combustion engine, the liquefaction of gases in a cooling system, and the compression stroke in a diesel engine. 绝热过程的一些常见的例子包括:内燃机内热气的膨胀、冷却系统内的气体液化、还有柴油机内的压缩冲程。

We'll *use an example to* show that if the heat-engine statement is false, then the refrigerator statement is false. 我们可以用一个实例来说明,如果关于热机的说法是错误的,那么关于冰箱的说法也是错误的。

Another example of such a forbidden process would be if all of the air in your room spontaneously moved to one half of the room, leaving a vacuum in the other half. 另外一

个不可能发生的过程的例子是：你房间内的空气自动聚集到房间的一半里边，而另一半成了真空状态。

The result shows that the capacitance is proportional to the length of the cylinders and also depends on the radii of the two cylindrical conductors. *As an example*, a coaxial cable consists of two concentric cylindrical conductors of radii a and b separated by an insulator. 结果表明，电容正比于两个圆柱形导体的半径和长度。半径分别为 a 和 b 的两个同轴导体，中间用绝缘体隔开形成的同轴电缆就可以作为一个例子。

A nonconducting material, *such as* air, glass, paper, or wood, is called a dielectric. 不导电的物质，比如空气、玻璃、纸、木头，叫作电介质。

A water wheel, turned by water flowing over a weir, *furnishes a good example of* potential energy being turned into useful mechanical energy. 由流水过坝转动的水轮提供一个说明位能正在转变成有用的机械能的例子。

A city electric-power plant *affords an illustration of* complicated transformations of energy. 城市发电厂为能量转换复杂关系的说明提供了例子。

6.1.2 列举

物理学专业英语中经常会用到多项内容的列举，例如同一对象呈现出的多种特性、变化，支持同一结论的各种依据、原因、理论、方法等。各项内容之间的关系也不尽相同，可以是并列、递进或对比等。这些内容之间的关系可以通过使用过渡词语来更为准确、清楚地表达，同时增加了内容的条理性，不会使某些方面被忽略。这些过渡词语让我们把两个观点更好地衔接在一起，使行文或口语表达紧凑、流畅、条理清晰。

以下就是一些专业英语中常见的表示列举的过渡词语。

(1) 表示并列、顺序与附加关系的

additionally　另外、加之
afterward　后来、以后
again　再次
alike　相似地、同样地
all the same　同样
also　也、而且、此外
analogous to　类似地
and　而且、亦、另外
another　另外的、另一
as well as　也、以及
aside from(this)　除……以外
at first　首先、最初
at the same time　同时
besides (that)　此外
by the same token　同样地
concurrently　同时
conjointly　相连地
coupled with　连同
equally important　同样重要
first of all　首先
following this　之后
for a start　首先
for one thing　首先、一则
in addition (to)　除此之外
in like manner　同样地
in similar fashion　相似地
in the first place　起初、首先
in the same way　同样地
later on　后来
likewise　同样地
meanwhile　同时
next　其次

on top of that　最后
once again　再次
once more　再一次
or　或者
over again　再一次
plus　并且
similarly　类似地
simultaneously　同时
so forth　等等
so on　等等
subsequently　随后、后来
then　然后
to begin with　首先
together with　连同
what is more　而且
Basically... Similarly... As well...
Both... and...
Either... or...
First... Second... Third... Next...
For one thing..., for another...
In the first place... Also... Lastly...
In the first place... Just in the same way... Finally...
Neither... nor...
Not only... but also...
To be sure... Additionally... Lastly...

例如：

Whether a physical model is good or not should be judged by how well it meets three standards. *First*, is the model similar with the original object in some specific aspects? *Second*, is it rational to neglect the difference between the model and the original object? *Finally*, is the model good enough to allow us to predict what would happen in a new situation that has not been investigated before? 一个物理模型是否完善应该通过其是否满足三个标准来判定。首先，这个模型是否与原物在某些具体方面相似？其次，对原物与模型间的差异进行忽略是否合理可行？最后，这个模型是否完善到可以使我们在尚未研究过的新环境下对未来将要发生的情况进行预测？

(2) 表示递进关系的

even more　更
further　此外、进一步
furthermore　而且、此外
more important　更重要的是
moreover　此外、加之
still　更
Clearly... Then...
Generally... Furthermore... Finally...
In the first place... In the second place... Lastly...
In the first place... Pursuing this further... Finally...
On the one hand..., on the other hand...

(3) 表示转折、让步与对照关系的

alternatively　作为选择、可选择的
although　尽管、虽然
as opposed to　与……相对比
but　但是

by comparison　比较起来
by way of contrast　两相对比
compared to　与……相比
contrarily　反之、相反地
conversely　相反地
despite　不管、尽管
even so　虽然如此
even though　即使
however　然而
in contrast　与此相反
in spite of　尽管
in turn　反之、反过来
instead　代替、也可以
Not... but...　不是……，而是……
Not only... but also...　不但……，而且……
Sometimes... But not always...　有时……，但不总是……
nevertheless　仍然、不过
nonetheless　尽管如此（仍然）
notwithstanding　虽然、尽管
on the contrary　正相反
otherwise　否则、要不然
rather than　不是……而是……
rather　恰恰相反
still　仍然
whereas　然而、反之、却
yet　然而

6.2　专业英语阅读

6.2.1　Work and Energy（功和能）

Work and **energy** are important concepts in physics as well as in our everyday lives. In physics, a force does work if its point of application moves through a distance and there is a component of the force in the direction of the velocity of the force's point of application. For a constant force in one dimension, the work done equals the force component in the direction of the displacement times the displacement.

Energy is closely associated with work. When work is done by one system on another, energy is transferred between the two systems. For example, when you do work pushing a swing, chemical energy of your body is transferred to the swing and appears as kinetic energy of motion or as gravitational potential energy of the earth-swing system.

6.2.2　Work（功）

In dot-product notation, the element work $\mathrm{d}A$ done by a constant force $\boldsymbol{F}$ on a particle over a displacement $\mathrm{d}\boldsymbol{r}$ is

$$\mathrm{d}A = \boldsymbol{F} \cdot \mathrm{d}\boldsymbol{r} \tag{6-1}$$

The work done on the particle as it moves from point 1 to point 2 is

$$A = \int_1^2 \boldsymbol{F} \cdot \mathrm{d}\boldsymbol{r} \tag{6-2}$$

Work is a scalar quantity that is positive if $\mathrm{d}\boldsymbol{r}$ and $\boldsymbol{F}$ have the same signs and negative if they have opposite signs. The SI unit of work and energy is the **joule** (J), which equals the product of a newton and a meter:

$$1\ \mathrm{J} = 1\ \mathrm{N \cdot m}$$

A convenient unit of work and energy in atomic and nuclear physics is the electron volt (eV):

$$1\ \mathrm{eV} = 1.6 \times 10^{-19}\ \mathrm{J}$$

Commonly used multiples are keV (10^3 eV) and MeV (10^6 eV). The work required to remove an electron from an atom is of the order of a few eV, whereas the work needed to remove a proton or a neutron from an atomic nucleus is of the order of several MeV.

Work Done by a Variable Force（变力的功）

In Fig. 6-1 we plot a constant force F_x as a function of position x. The work done on a particle whose displacement is Δx is represented by the area under the force versus-position curve, indicated by the shading in Fig. 6-1.

Many forces vary with position. For example, a stretched spring exerts a force proportional to the distance it is stretched. And the gravitational force the earth exerts on a spaceship varies inversely with the square of the distance between the two bodies. We can approximate a variable force by a series of constant forces (Fig. 6-2). The work done by a variable force is then

$$A = \lim_{\Delta x_i \to 0} \sum_i F_x \Delta x = \text{area under the } F_x\text{-versus-}x \text{ curve} \qquad (6\text{-}3)$$

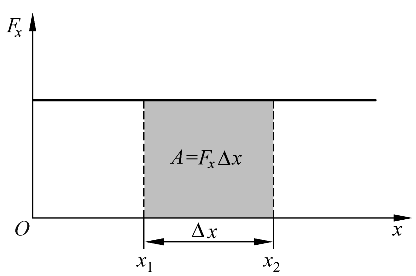


Fig. 6-1

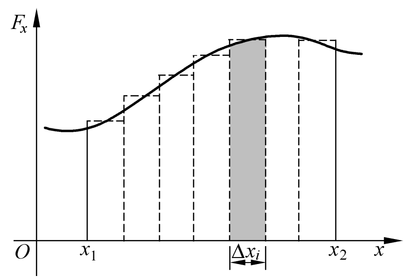


Fig. 6-2

This limit is the integral of F_x over x. So the work done by a variable force F_x acting on a particle as it moves from x_1 to x_2 is

$$A = \int_{x_1}^{x_2} F_x \, dx = \text{area under the } F_x\text{-versus-}x \text{ curve} \qquad (6\text{-}4)$$

For each displacement interval Δx_i, the force is essentially constant. Therefore the work done equals the area of the rectangle of height F_{xi} and width Δx_i. As was shown earlier, this work equals the change in kinetic energy for this displacement interval (if the force is the net force). The total work done is the sum of the areas over all displacement intervals. It follows that the total work equals the change in kinetic energy for the entire displacement. Thus, $A_{\text{total}} = \Delta E_k$ holds for variable forces as well as for constant forces.

6.2.3 Conservative Force and Potential Energy（保守力和势能）

The total work done on a particle equals the change in its kinetic energy. But we are often interested in the work done on a system consisting of two or more particles. Often, the work done by external forces on a system does not increase the total kinetic energy of the system, but instead is stored as **potential energy**—energy associated with the configuration of the system.

Potential Energy(势能)

Consider lifting a barbell of mass m to a height h. The work done by the gravitational force on the barbell starts at rest and ends at rest. Because the kinetic energy of the barbell does not change, we know the total work done on the barbell is zero. That means the work done by the force of your hands on the barbell is $+mgh$. Now consider the barbell and the earth to be a system of two particles (You are not the part of this system). The external forces on the earth-barbell system are the gravitational attraction you exert on the earth, the force your feet exert on the earth, and the force mg exerted by your hands on the barbell (Fig. 6-3). The barbell moves, but the motion of the earth is negligible, so only the force exerted on the barbell by your hands does work on the system. The total work done on the earth-barbell system by all forces external to the system is mgh. This work is stored as potential energy, which is energy associated with the position of the barbell relative to the earth. That is energy associated with the configuration of the earth-barbell system. This kind of energy is called **gravitational potential energy.**

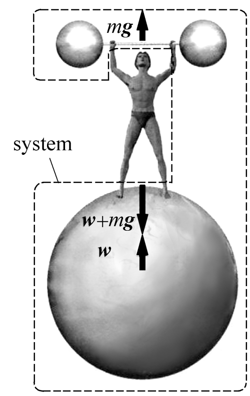


Fig. 6-3

Another system that stores energy associated with its configuration is a spring. If you stretch or compress a spring, energy associated with the length of the spring is stored as potential energy. Consider the spring shown in Fig. 6-4 as the system. You compress the spring, pushing it with equal and opposite forces $\boldsymbol{F}_1$ and $\boldsymbol{F}_2$. These forces sum to zero, so the net force on the spring remains zero. Thus, there is no change in the kinetic energy of the spring. The work you do on this system is stored not as kinetic energy, but as **elastic potential energy.** The configuration of this system has been changed, as evidenced by the change in the length of the spring. The total work done on the spring is positive because both $\boldsymbol{F}_1$ and $\boldsymbol{F}_2$ do positive work.

Conservative Force (保守力)

When you ride ski lift to the top of a hill of height h, the work done by gravity on you is $-mgh$ and the work done by the lift on you is $+mgh$ independent of the shape of the hill. The total work done by gravity on you during the round trip up and down the hill is zero, independent of the path you take. The force of gravity, exerted by the earth on you is a **conservative force.**

A force is conservative if the total work it does on a particle is zero when the particle moves around any closed path, returning to its initial position. From Fig. 6-5 we see that this definition implies that: The work done by a conservation force on a particle is independent of the path taken as the particle moves from one point to another.

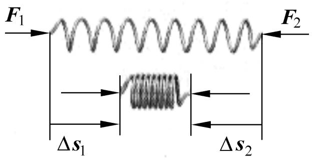


Fig. 6-4

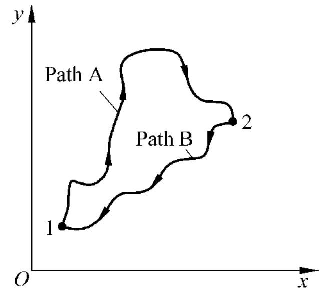


Fig. 6-5

Now consider yourself and the earth to be a two-particle system. (The ski lift is not part of this system.) When a ski lift raises you to the top of the hill, it does work mgh on the you-earth system. This work is stored as the gravitational potential energy of the system. When you ski down the hill, this potential energy is converted to the kinetic energy of your motion.

Glossary

work	功	point of application	作用点
joule	焦耳	notation	符号
eV	电子伏特	conservative force	保守力
potential energy	势能	positional function	位置函数
gravitational force	重力	elastic potential energy	弹性势能
independent of	与……无关		

6.3 专业英语常用表达法-6 原料 用途 功能 性能和特点

1. 表示原料

除用 have,(be) made of,with 外,主要用“名词(或形容词)+名词”这种结构:

a brick structure 砖结构	cut-off glass screen 玻璃隔热屏障
a concrete core 混凝土芯	a steel mast 钢柱
cast glass 压铸玻璃	a stone wall 石墙
rough-cast glass 毛玻璃	a wooden frame 木框
a glass screen 玻璃屏	tools made of iron 铁制工具

以下是一些具体例子:

The new greenhouse *has a mild steel structure*, with glass beneath it. 这座新暖房(用的)是低碳钢结构,结构下面是玻璃。

A curved screen *is made of* steel and glass. 弧形隔热屏障是用钢和玻璃制的。

Up in the roof here, we have a 6mm thick *cast glass*. 在这里屋顶上用的是 6 mm 厚的压铸玻璃。

Nearly 4500 square meters of space, under one low, *glass roof*. 近 4500 m^2 的面积的都是在一个低矮的玻璃屋顶之下。

Locomotives *are built of* steel, and airplanes *of* aluminum. 火车头由钢制成，而飞机由铝制成。

We want *such materials as can bear high temperature and pressure*. 我们需要能耐高温高压的材料。

2. 表示用途、功能

(1) 用 for 或动词不定式

for reference　供参考

a manual *for* technician　技工手册

solve the equation *for* x　解方程求 x

use the symbol Pb *for* lead　用符号 Pb 表示铅

What is the tool *for*? 这工具是做什么用的？

This is the very instrument *for* the experiment. 这是最适合做这个实验的仪器。

The institute is an international centre *for* physics research. 该机构是物理学研究的国际中心。

The key lab is primarily a research establishment but also it is there *to welcome the public*. 这个重点实验室主要是一个科研机构，但同时也面向公众。

(2) 用 the function (或 purpose) is＋动词不定式

The rough-cast glass has several functions, and probably the main one *is to hide the internal structure*. 毛玻璃有好几个作用，主要的可能是为了把内部结构遮盖起来。

At the end we have a clear glass, and *its function* there *is* to give you a view out of the lab. 在末端用的是透明玻璃，它的作用是使你看得见实验室外边的情景。

(3) 用下列词语

be designed＋动词不定式(或 for 短语)

help＋动词不定式

have the function of

serve the purpose of

例如：

The building *is designed primarily for* experiment facilities rather than people. 这座建筑是供实验仪器而不是供人们使用的。

The cast glass *helps to express* the internal configuration of the lab. 压铸玻璃有助于显露出实验室的内部结构。

It also *serves the purpose of* giving access over the roof for maintenance and for cleaning the glass. 它还起到这样的作用，使(工人)能走上屋顶，进行维修保养、清洗玻璃。

3. 表示性能和特点

介绍仪器、设备等的性能特点是专业英语的重要功能之一，这在说明书、操作指南、产品

鉴定会、学术会议等场合是常用的。其中有一些属通用词汇，对各行各业都适用，如 feature，characteristic，performance 等名词，major，main，leading，striking，unique 等形容词，以及 feature，characterize 等动词。作为口头表达，常用 The idea is...。例如：

The instrument *has several features of*... 该仪器有如下特点……

This system *features* simplicity of operation as its major design objectives. 操作简便是在设计本系统时考虑到的主要特点之一。

Operational flexibility and durable service life *feature* the equipment. 操作灵便，经久耐用是本设备的两大特色。

Micrometer *are characterized by* extreme accuracy, high reliability as well as simplicity and ease of control. 螺旋测微仪不仅操作简易，而且精密度高，性能可靠。

The rare earths *are characterized by* a partially filled $4f$ shell that is shielded from external fields by $5s^2$ and $5p^6$ electrons. 稀土(元素)的特征为：由于被 $5s^2$ 和 $5p^6$ 壳层的电子屏蔽了外场，$4f$ 壳层仅被部分填充。

Every *character* is of practical value and is based on long experience in building this type of lidar. (本产品的)每一个特点都有其实用价值，这是(本公司)在制造这类激光雷达中长期经验积累的结果。

The idea of the device is to allow the operator to perform handling and loading with the greatest convenience. (设计)这个装置的想法是使操作者能十分方便地进行装卸。

The whole idea is that ever greater attention must be paid to a better working environment. 总的想法是，必须更加重视创制一个更为良好的工作环境。

LESSON 7

7.1 物理学专业英语中的结果和结论

7.1.1 结果

在专业英语中，表示过程或计算的结果时，时态可采用一般过去时，语态可采用主动语态或被动语态。但是，被动语态的使用频率高于主动语态的使用频率。如果采用主动语态进行表达，那么，可以采用这一句型：主语＋宾语或由 that 引导的宾语从句。如：

Our final equation revealed an important general property of simple harmonic motion: the total mechanical energy in simple harmonic motion is proportional to the square of the amplitude. 最后的方程揭示了简谐运动的一个重要特点：简谐运动的总机械能与振幅的平方成正比。

展示研究结果，常用词汇有：show，result，present 等。

常见的表达方式有：...was(were)...；We found...；There was...等。

常见的用 that 从句表示结果的有：

The results indicated that ... 结果表明……

The results showed that ... 结果显示……

The results demonstrated that ... 结果证明了……

The results revealed that ... 结果揭示了……

常见的由 It 引导的 that 从句有：

It was shown that ... 结果显示……

It can be seen that ... 可以看出……

It was found that ... 结果发现……

It was discovered that ... 发现……

It was concluded that ... 结论为……

It has been demonstrated that ... 结果已经证明……

It was clarified that ... 结果明确为……

It was revealed that ... 说明/阐明……(结果)，揭示了……

It is considered that ... 考虑到……

It was confirmed that ... 可以确信……

It is suggested that ... 提出(……结果)

It was supposed that ... 推测(……结果)，假定(……结果)

It has become apparent that ... 已经明显表明……

也可以用 to be 后面的表语成分表示测定、计算等的结果。例如

When the measured value of ε_0 and defined value of μ_0 are put into Eq. (15-1), the speed of electromagnetic waves is found *to be* about 3×10^8 m/s, the same as the measured speed of light. 当把 ε_0 的测定值和 μ_0 的定义值代入方程(15-1)时，得到的电磁波的速度结果约为 3×10^8 m/s，这与测量所得到的光速相同。

For paramagnetic and diamagnetic materials, the magnetization is found *to be* proportional to the applied magnetic field that produces the alignment of the magnetic dipoles in the material. 对于顺磁质和抗磁质，磁化的程度正比于使磁介质产生磁偶极取向排列的外加磁场的强度。

The theoretical equation was proved *to be* correct by the experimental results. 实验的结果证实了理论方程的正确。

7.1.2 结论

结论句一般置于正文的最后，通常用于总结主要的研究成果、提出的独到见解或建议、表明作者的观点和看法、陈述主要结论等。专业文章的结论语句简洁、突出重点。专业英文通常用完整的句子来表达结论，动词时态用一般现在时或现在完成时。在写作时通常直接写结论，也可用一些句型引出结论。介绍结论常用的词汇有：summary, sum up, introduce, conclude, as a result，in short，in a word，in brief，therefore 等。常用的英文表达方式有：

...is probably... ……或许是……

...is... ……是……

Our conclusion is that... 我们的结论是……

This study shows that... 研究表明……

This study suggests that... 研究提出……

This study confirms that... 研究确信……

These observations support... 这些观察支持(……结论)

The findings indicate that... 结果表明……

The results indicate/show that... 结果表明……

This paper concludes that... 这篇文章的结论……

This study/investigation/research leads the author(s) to conclusion that... 通过本研究作者得到的结论为……

The research enables us to conclude that... 通过研究我们得到的结论为……

It is concluded that... 结论为……

Thus, it can be concluded that... 所以,可以得出结论……

Draw the following conclusion... 得到如下结论……

The results agree with ... 这些结果与……一致

The experiment shows that... 实验表明……

It is suggested that... 可以推想(……结论),可以料想(……结论)

These results will/can be significant for... 这些结果对……来说会/可能有意义

In conclusion, ... 最后/总之,……

In general, ... 总体来说,……

To conclude, ... 总之,……

In brief, ... 简而言之,……

In a word, ... 总之,……

In short, ... 简而言之,……

In summary, ... 概括来说,……

By and large, ... 大体上/基本上……

All in all, ... 总而言之,……

Generally speaking, ... 总体来说,……

On the whole, ... 大体上……基本上……

For the above-mentioned reasons, ... 基于上述原因,……

As we have seen, ... 正如我们所知,……

As already mentioned, ... 正如已提及的一样,……

To sum up, ... 总之/总而言之,……

To summarize, ... 概括而言,……

We can easily come to the conclusion that... 我们很容易就可以得到这样的结论,……

What we can be sure of is that... 可以肯定的是……

Now it is believed that... 由此我们相信……

It is almost certainly true to say that... 几乎可以准确地说……

Clearly, ... 显然……

It may be possible to (do something)... 可能(发生……情况)

Therefore，we can find that… 因此，我们发现……

It is quite clear that… 很明显……，很清楚……

It is well-known that… 众所周知……

Now it comes to conclusion that… 可以得出结论……

There is no doubt that… 无疑……

以上句型中，措辞不同，表明对结论的肯定程度不同。以下为具体例子：

We can *draw the following general conclusion*：For any system the most probable macroscopic state is the one with the greatest number of corresponding microscopic states，which is also the macroscopic state with greatest disorder and the greatest entropy. 我们可以得到如下一般结论：任何系统的最概然宏观态就是具有最大数目对应微观态的状态，也就是具有最大无序和最大熵的宏观态。

To illustrate this further，*we can make the conclusion of* boundary conditions for Half-wave Loss… 为了进一步说明，我们可以把半波损失的边界条件的结论归纳为……

Comparing Eq.（20-23）and Eq.（20-24），we can *conclude* that when simple harmonic waves propagate，for each element of the medium，kinetic energy equals potential energy at any time. 把方程（20-23）和方程（20-24）相比较，我们得到的结论为：当简谐波传播时，媒质中的每一质元的动能和势能在任何时刻都相等。

Clearly，this inelastic collision is an irreversible process. 显然，这种非弹性碰撞是不可逆过程。

Now I would like *to sum up* what I said in a few sentences. 现在我想用几个句子来总结一下我讲过的内容。

The long and short of it is that the experimental results coincide with the theoretical speculations to a certain extent. 总之，实验结果与理论推测在一定程度上相吻合。

Thus the conclusion we can draw is that the kind of materials is not suitable to be used under high temperature. 因此我们可以得出结论，这种材料不适合用在高温环境中。

In general，all the characteristics of the ferromagnetic material come from the special internal structure of it. 总之，铁磁材料的特性都源自其内部的特殊结构。

7.2 专业英语阅读

7.2.1 Rigid Body（刚体）

In order to study some problems easily，we used to imagine some bodies as **rigid bodies**，which are idealized models of particles system. If the body is nondeformable or the separations between all pairs of particles in the body remain constant，we may look it as a rigid body，which consists of a large number of particles，each with its own velocity and acceleration.

7.2.2 Law of Rotation of a Rigid Body about a Fixed Axis(刚体定轴转动定律)

To set a top spinning, you twist it. In Fig. 7-1, a disk is set spinning by the forces $\boldsymbol{F}_1$ and $\boldsymbol{F}_2$ exerted at the edges of the disk in the tangential direction. The directions of these forces are important. If the same forces are applied in the radial direction (Fig. 7-2), the disk will not start to spin.

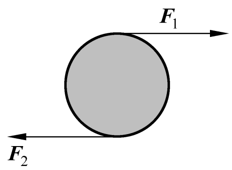


Fig. 7-1

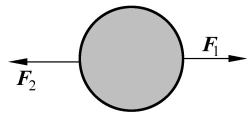


Fig. 7-2

Fig. 7-3 shows a particle of mass m attached to one end of a massless rigid rod of length r. There is an axis perpendicular to the rod and passing through its other end, and the rod is free to rotate about this axis. Consequently, the particle is constrained to move in a circle of radius r. A single force $\boldsymbol{F}$ is applied to the particle as shown. Applying Newton's second law to the particle and taking components in the tangential direction gives $F_t = ma_t$. We wish to obtain an equation involving angular quantities. Substituting $r\alpha$ for a_t and multiplying both sides by r gives

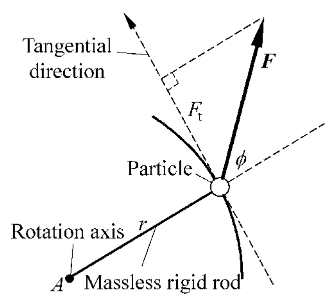


Fig. 7-3

$$rF_t = mr^2\alpha \tag{7-1}$$

The product rF_t is the **torque** M associated with the force. That is,

$$M = F_t r \tag{7-2}$$

Substituting into Eq. (7-1) gives

$$M = mr^2\alpha \tag{7-3}$$

A rigid object that rotates about a fixed axis is just a collection of individual particles, each of which is constrained to move in a circular path with the same angular velocity ω and acceleration α.

$$M_{i\text{-net}} = m_i r_i^2 \alpha$$

Applying a rigid object that rotates about a fixed axis is just a collection of individual particles, each of which is constrained to move in a circular path with the same angular velocity ω and acceleration α. Applying Eq. (7-1) to the ith of these particles gives

$$M_{i\text{-net}} = m_i r_i^2 \alpha$$

where $M_{i\text{-net}}$ is the torque due to the net force on the i th particle. Summing both sides over all particles gives

$$\sum M_{i\text{-net}} = \sum m_i r_i^2 \alpha = \left(\sum m_i r_i^2\right)\alpha = J\alpha \tag{7-4}$$

The sum in the term on the right is the object's **moment of inertia** J for the axis of rotation.

$$J = \sum_i m_i r_i^2 \tag{7-5}$$

In the past we saw that the net force acting on a system of particles is equal to the net force acting on the system because the internal forces (those exerted by the particles within the system on one another) cancel in pairs. The treatment of internal torques exerted by the particles within a system on one another leads to a similar result, that is, the net torque acting on a system equals the net external torque acting on the system. We can thus write Eq. (7-4) as

$$M_{\text{net,ext}} = \sum M_{\text{ext}} = J\alpha \tag{7-6}$$

So *torque acting on a rigid body is proportional to its angular acceleration, and the proportionality constant is the moment of inertia*. This is **law of rotation of a rigid body about a fixed axis**, which is analog of Newton's second law for linear motion, $\sum \boldsymbol{F} = m\boldsymbol{a}$.

7.2.3 Torque and Angular Momentum(力矩和角动量)

Torque is expressed mathematically as the cross product (or vector product) of $\boldsymbol{r}$ and $\boldsymbol{F}$

$$\boldsymbol{M} = \boldsymbol{r} \times \boldsymbol{F} \tag{7-7}$$

Fig. 7-4 shows a particle of mass m moving with a velocity $\boldsymbol{v}$ at a position $\boldsymbol{r}$ relative to the origin O. The linear momentum of the particle is $\boldsymbol{p} = m\boldsymbol{v}$. The **angular momentum $\boldsymbol{L}$** of the particle relative to the origin O is defined to be the cross product of $\boldsymbol{r}$ and $\boldsymbol{p}$

$$\boldsymbol{L} = \boldsymbol{r} \times \boldsymbol{p} \tag{7-8}$$

If $\boldsymbol{r}$ and $\boldsymbol{p}$ are in the xy plane, as in Fig. 7-4, $\boldsymbol{L}$ is parallel with the z axis and is given by $\boldsymbol{L} = \boldsymbol{r} \times \boldsymbol{p} = mvr\sin\phi\boldsymbol{k}$. Like torque, angular momentum is defined relative to a point in space.

Fig. 7-5 shows a particle of mass m attached to a circular disk of negligible mass in the xy plane with its center at the origin. The disk is spinning about its axis with angular speed ω. The speed v of the particle and its angular speed are related by $v = r\omega$. The angular momentum of the particle relative to the center of the disk is

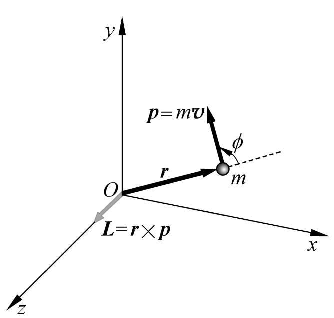


Fig. 7-4

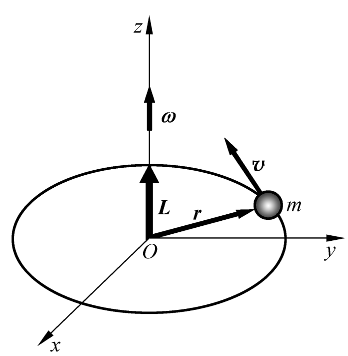


Fig. 7-5

$$\boldsymbol{L} = \boldsymbol{r} \times \boldsymbol{p} = \boldsymbol{r} \times m\,\boldsymbol{v} = rmv\sin 90^{\circ}\boldsymbol{k}$$
$$= rmv\boldsymbol{k} = mr^2\omega\boldsymbol{k} = mr^2\boldsymbol{\omega}$$

The angular momentum vector is in the same direction as the angular velocity vector. Since mr^2 is the moment of inertia for a single particle about the z axis, we have

$$\boldsymbol{L} = mr^2\boldsymbol{\omega} = J_z\boldsymbol{\omega}$$

This result does not hold for the angular momentum about a general point on the z axis. Fig. 7-6 shows the angular momentum vector $\boldsymbol{L}$ for the same particle attached to the same disk but with $\boldsymbol{L}'$ computed about a point on z axis that is not at the center of the circle. In this case, the angular momentum is not parallel to the angular velocity vector $\boldsymbol{\omega}$, which is parallel with z axis.

In Fig. 7-7, we attach a second particle of equal mass to the spinning disk. The angular momentum vector $\boldsymbol{L}'_1$ and $\boldsymbol{L}'_2$ are shown relative to the same point O'. The total angular momentum $\boldsymbol{L}'_1 + \boldsymbol{L}'_2$ of the two-particle system is again parallel to the angular velocity $\boldsymbol{\omega}$. In this case, the axis of rotation, the z axis, passes through the center of mass of the two-particle system, and the mass distribution is symmetric about this axis. Such an axis is called a **symmetry axis.** For any system of particles that rotates about a symmetry axis, the total angular momentum (which is the sum of the angular momenta of the individual particles) is parallel to the angular velocity and is given by

$$\boldsymbol{L} = J\,\boldsymbol{\omega} \tag{7-9}$$

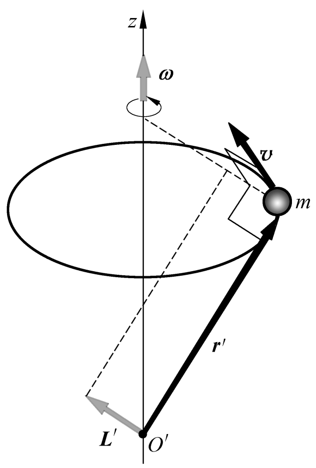


Fig. 7-6

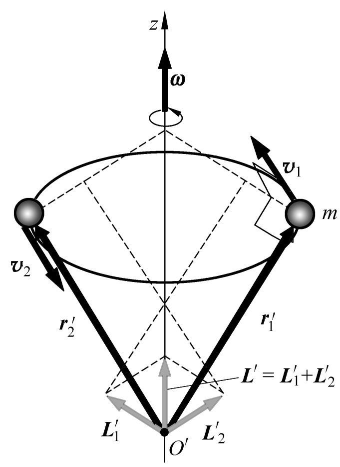


Fig. 7-7

There are several additional results concerning torque and angular momentum for a system of particles. The first of these is

$$\boldsymbol{M}_{\text{net,ext}} = \frac{\mathrm{d}\boldsymbol{L}_{\text{sys}}}{\mathrm{d}t} \tag{7-10}$$

The net external torque acting on a system equals the rate of change of the angular momentum of the system. This is called **theorem of angular momentum.**

Glossary

torque	力矩	axis of rotation	旋转轴
moment of inertia	转动惯量	proportionality constant	比例常数
analog	类似、相似	is proportional to	与……成正比
mass distribution	质量分布	symmetry axis	对称轴
angular momentum	角动量	theorem of angular momentum	角动量定理

7.3 专业英语常用表达法-7 形状 面积 体积 容量

1. 基本形状

triangle 三角形
right triangle 直角三角形
isosceles triangle 等腰三角形
equilateral triangle 等边三角形
obtuse angle 钝角
acute angle 锐角
right angle 直角
square 正方形
rectangle 矩形
parallelogram 平行四边形
trapezoid 梯形
rhombus 菱形
polygon 多边形
quadrilateral 四边形
pentagon 五边形
hexagon 六边形
octagon 八边形
circle 圆形
semicircle 半圆
ellipse 椭圆
cylinder 圆柱
cone 圆锥
cube 正方体/立方形
cuboid 长方体
sector 扇形
cone 锥形
curve 曲线
cylinder 圆柱(筒)形
sphere 球形
hemisphere 半球形
ellipsoid 椭面、椭圆形
oblong 长方形
pyramid 棱锥形

2. 描述形状常用形容词

circular 圆形的、环状的
conical 锥形的
(criss-)cross 十字形的
cubical 立方形的
curved 曲线的、弯曲的
cylindrical 圆柱形的
depressed 凹陷的
ellipsoidal 椭圆的
flat (扁)平的
half-round 半圆的
half-moon-shaped 半月形的
heart-shaped 心形的
hemispherical 半球形的
hollow 空心的
hyperbolic 双曲线的
I-shaped 工字形
oblong 长方形的
pointed/sharp 尖的

pyramidal　棱锥形的、金字塔形的
round/rounded　圆的
spherical　球形的
square　正方形的
straight　直(线)的
triangular　三角形的
rectangular　矩形的
semicircular　半圆形的
spindle-shaped　纺锤形的
solid　实心的
star-shaped　星形的
U-shaped　U 形的

3. 表示形状常用词组

a curved surface　曲面
a pointed roof　尖形屋顶
a round box　圆盒
triangular compasses　三角规
T-socket　T 形套管
I-steel　工字钢
herring bone pattern　人字形
Y-connection　Y 形连接
U-pipe　U 形管
A-frame　A 形架
O-ring　O 形环
T-track　锤形径迹
V-belt　三角皮带
clamp　弓形夹具
Y-pipe　叉形管
a flat cable　扁平电缆
rectangular timber　方木
a spherical mirror　球面镜
T-plate　T 字板
I-bar　工字铁
cross-wire　十字线
herring bone gear　人字齿轮
X-tube　X 形管
Z-beam　Z 字梁
C-washer　C 形垫圈
S-wrench　S 形扳手
U-bolt　马蹄螺栓
set square　三角板
U-steel　槽钢
X-type　交叉形

4. 表示形状常用词语结构

be＋adj.(＋in shape/form)　(形状)是……的，是……形的
be shaped like...　形状像……
have the shape of...　具有……形状
(be) in the shape of...　呈……的形状，以……的形式
take the shape of...　呈……的形状

以下是一些具体例子：

This plate is *curved/flat*. 这块板是弯的/平的。
This rod is *pointed/rounded* at one end. 这根棒一头是尖/圆的。
This line is *straight/curved*. 这条线是直的/弯的。
What *shape* is the top of the rocket? 火箭顶部是什么形状？
The lab building is built *in the shape of* a letter “L”。这座实验室造成字母 L 形。
The top of the planetarium *is like a snail in shape*. 天文馆的顶部形状像一只蜗牛。
The coil *is rectangular in shape*. 这线圈是矩形的。
The flask *resembles a pear in shape*. 这烧瓶的外形像只梨。
The curves *are hyperbolic in form*. 这些曲线是双曲线。

A wheel *has the same shape as* the letter "O"。车轮的形状与字母 O 相同。

The curve of normal distribution *is shaped like* a bell. 正态分布曲线的形状像一口钟。

A safety-pin *is so shaped that* it cannot easily prick you. 安全别针做成不易伤人的形状。

The simplest wave form *is a sinusoidal* curve. 最简单的波形是正弦曲线。

In weightlessness, a drop of liquid *takes a spherical shape/takes the shape of a sphere*. 在失重状态,一滴液体呈球形。

5. 面积的表示法

(1) 通常用 by 表示乘、除及度量关系

The room is 6 meters *by* four. 这个房间长 6 m,宽 4 m。

Multiply the base *by* the height and you have the area of a rectangle. 底乘以高,就可得出长方形的面积。

This is a room 20 *by* 30 feet. = This is a room 20 feet *by* 30. = This is a room 20×30 ft. 这是一个 20 英尺宽 30 英尺长的房间。

(2) 其他表示方法

The room has an area of ten square meters. = The area of the room is ten square meters. =The room is ten square meters in area. =The room covers an area of ten square meters. 这个房间的面积为 10 m^2。

Tianjin is about 11 760.26 square kilometers in the area. 天津面积约为11 760.26 km^2。

China's land area is 9 600 000 sq km. 我国国土面积是 960 万 km^2。

6. 体积、容量的表示法

(1) 常用"基数词+长度名词+ by +基数词+宽度名词+ by +基数词+高度名词"表示立方体尺寸,若长、宽、高的单位一致,则通常省略后两个单位名词。如:

The box is eight inches *by* six *by* five. 这个盒子长、宽、高分别为 8 英寸、6 英寸、5 英寸。

The box measures three feet *by* four *by* two. 这箱子的尺寸是(3×4×2)英尺。

(2) 用 capacity, volume 以及 cube(立方), cubed(自乘二次的), to the third power (……的三次方), liter, cubic meter, cumec, cubic centimeter 等。其结构有:The volume/capacity is...; has a capacity of...; be with a capacity of...等。例如:

The pretreatment works will *have a capacity of* 45 *cumecs*, or 45 cubic meters per second. 这个预处理厂将会有 45 m^3/s 的处理能力。

The *capacity* of the treatment works *is approximately* 45 cumecs. 这个处理厂的处理能力约为 45 m^3/s。

Before the waste joins the sea, it will pass through a large new pretreatment works *with a capacity of* 45 cumecs, or 45 cubic meters per second. 污水在流入海之前,要先通过一个容量为 45 m^3/s 新建的大型预处理厂。

The formula for *the volume of* a cube with edge l is $V=l^3$. (V equals l cubed, or V equals l to the third power) 求边长为 l 的立方体的体积，其公式为 $V=l^3$.

The *volume* measuring accuracy of this system is ±0.25%. 系统容积的测量精度为±0.25%。

LESSON 8

8.1 物理学专业英语在口语体上的特点

专业英语口语体兼有专业英语及一般英语口语体的某些特点。

1) 使用大量的术语以及书面词语

例如常见的用语有 be concerned with, be subjected to, be exposed to, the order of 等。

It is well known that, different from physics, chemistry *is concerned with* the composition, properties and structure of substances and *with* the changes they undergo. 众所周知，与物理学不同，化学是研究物质的成分、(化学)性质及其结构的，还研究这些物质(在化学反应中)的变化。

The sample temperature was controlled by a thermocouple with a precision on *the order of* 0.1℃. 样品温度用热电偶控制，其精度在0.1℃左右。

2) 重在客观的叙述，较少使用人称代词

为了使内容的叙述更加客观，句子中通常不出现人称代词，如果使用也常用 one 或 we。例如：

There is a steady loss of energy in the cycle. 在循环中能量持续损失。

In the real case *there is* a need for energy compensation. 在实际情况中需要补充能量。

As *one* shakes the end of a stretched rope, the disturbance transfers energy from the hand to the rope and a wave pulse travels down the rope. 摇动绳子的一端，扰动就会把能量从手传递给绳子，一个波脉冲就会在绳子上传播。

If *we* look into the experiment we can see the secret of what is happening. 如果我们审视一下实验，就会明白事情发生的原因。

3) 用名词短语替代从句

口语使用名词短语的目的在于可以使整个句子的结构简化，易于理解。例如：

They enjoy *the newness of the building*. 相当于 They like the building *because it is new*.

These experiments demonstrated *the truth of the theory*. 相当于 These experiments demonstrated *that the theory is true*.

4) 用"主语＋谓语动词的被动态＋动词不定式"替代名词从句。

例如：

An atom *is found to consist of* electrons and some other very small particles. (相当于 *It is found that* an atom consists of electrons...). (据认为)原子是由电子及其他微粒子所

组成。

这就是说,“主语+谓语动词的被动态+动词不定式”这种结构由于能使语言简练,在专业口语体中是常见的,能用于这种结构的谓语动词有 know,think,believe,say 等。

Alloy steel *is said to be* a carefully made steel.(相当于 *It is said that* alloy steel *is* a carefully made steel.)合金钢可以说是一种精细冶炼的钢。

5)对量度表达没有书面语那么确切并具体

专业英语口语在表达量度时通常不像书面语那么具体,有时只是笼统地说“高、矮、大、小、长、短”等。

The tidal range is *of the order of* 10 *meters*. 浪高在 10 m 的数量级。(书面体)

The tide is *as high as* 10 *meters*/10 *meters high*.(口语体)

Some waves have been *of heights of up to* 7 *or* 9 *meters*. 有的浪高达到 7 m 或 9 m。(书面体)

Some waves have been 7 *or* 9 *meters high*.(口语体)

6)经常使用主动语态

在专业英语书面体中常用被动语态,但在口语体中,会经常用 we 作主语的主动语态。

If the end of a stretched rope *is given* a quick shake, the disturbance transfers energy from the hand to the rope。(书面体)

If *we* give the end of a stretched rope a quick shake, the disturbance transfers energy from the hand to the rope.(口语体)

7)其他特点

一般地说,专业英语口语体还有不简练、冗余度大、用词不推敲、语法不规范、结构和层次不严密,边说边自我纠正等特点。例如:

The fact that the lab *is designing* primarily for experiment facilities rather than people, *that* makes it particularly special. 实验室的设计主要是供实验设备而不是供人使用的,这就使得它有其独特之处。

这句话是口语体,在语法和用词上不很严格。如果严格规范要求,is designing 要改为 is designed;第二个 that 要去掉。

Internally the structure is very much played down and the various instruments are beginning to dominate and it's very important, I feel, right from the outset, that the instruments should be allowed to dominate internally, especially as the spaces are relatively small and the roof is relatively low. 在实验室内,钢架结构已不占主要地位,突出的是各种仪器。我认为从一开始就要重视使各种仪器在室内居主导地位,这尤其是因为要考虑到室内的空间相对来说是少了些,屋顶也较低了些。

这是一个包含有 6 个子句的长句。因为属于口语体,有几层意思是反复说的,显得不够简练。其中,I feel 是一个表示态度的插入句;right 用以强调 from the outset,意思是:从一开始就……;it is important that... 是一句型,表示愿望、建议等,that 从句中的谓语用 should +*v*.(这是口语体),如果是书面语体,可用动词原形,即 It is important that the instruments be allowed...。

Any glassware which has a... a delicate shape, an interesting shape, is seen very clearly against a cast glass background, it's seen in silhouette.

在口语体中,因为是即席讲话,往往不可能做到字斟句酌,于是当讲话人发现用字不当时,可随时加以修正。如这里先用了 has a... a delicate shape(有一个细小的、优美的形状),说后感到 delicate 并不达意,于是又加上了 an interesting shape,这个短语可以说是对前一个短语的修正。

8.2 专业英语阅读

8.2.1 Oscillation(振动)

Oscillation occurs when a system is disturbed from a position of stable equilibrium. There are many familiar examples: boats bob up and down, clock pendulums swing back and forth, and the strings and reeds of musical instruments vibrate. Others, less familiar examples are the oscillations of air molecules in a sound wave and the oscillations of electric currents in radios and television sets.

In this section, we deal mostly with simple harmonic motion, the most basic type of oscillatory motion. Applying the kinetics and dynamics of simple harmonic motion provides the analysis of the oscillatory motion of a variety of interesting systems. In some situations dissipative forces dampen the oscillatory motion, but in other situations driving forces sustain the motion by compensating for the damping.

8.2.2 Description of Simple Harmonic Motion(简谐运动的描述)

A common, very important and very basic kind of oscillatory motion is **simple harmonic motion(SHM)** such as the motion of an object attached to a spring (Fig. 8-1).

The **kinetic equation** for a simple harmonic motion is

$$x(t) = A\cos(\omega t + \varphi) \tag{8-1}$$

where A, ω, and φ are constants. It is a mathematical representation of the position of the particle as a function of the time. For the spring system, x is the displacement of the object from its equilibrium position. In general, x can be any oscillatory quantities.

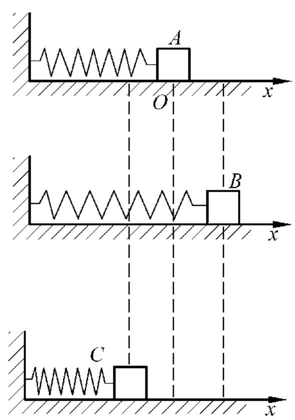


Fig. 8-1 A spring system

There are three property quantities for a simple harmonic motion:

The maximum displacement $x_{\max}$ from equilibrium position is called the **amplitude** A. The value of the amplitude depends on initial position and the energy of the system. The constant ω is called the **angular frequency**. It has units of radians per second and dimensions of inverse time, the same as angular speed, which is also designated by ω. *The time it takes for a displaced object to execute a complete cycle of oscillatory motion*—from one extreme to the other extreme and back—is called the **period** T. The unit of the period is second. The reciprocal of the period is the **frequency** ν, which is *the number of cycle per second*

$$\nu = \frac{1}{T} \tag{8-2}$$

The unit of the frequency is the cycle per second (cy/s), which is called a hertz (Hz).

The period T is the shortest time satisfying the relation

$$x(t) = x(t+T)$$

for all t. Substituting into this relation using Eq. (8-1) gives

$$\begin{aligned} A\cos(\omega t + \varphi) &= A\cos[\omega(t+T) + \varphi] \\ &= A\cos(\omega t + \varphi + \omega T) \end{aligned}$$

The cosine (and sine) function repeats in value when the angle increases by 2π, so

$$\omega T = 2\pi \quad \left(\text{or } \omega = \frac{2\pi}{T}\right) \tag{8-3}$$

The frequency is the reciprocal of the period

$$\nu = \frac{1}{T} = \frac{\omega}{2\pi} \tag{8-4}$$

The argument of the cosine function in Eq. (8-1), $\omega t + \varphi$, is called the **phase** of the motion, and the constant φ is called the **phase constant**, which is the phase at $t=0$. If we have just one oscillating systems, we can always choose $t=0$ at which $\varphi=0$. If we have two systems oscillating with the same amplitude and frequency but different phase, we can choose $\varphi=0$ for one of them. The equations for the two systems are then

$$x_1 = A\cos(\omega t)$$

and

$$x_2 = A\cos(\omega t + \varphi)$$

We can see by inspection that each time t increases by T, the phase increases by 2π and one cycle of the motion is completed.

8.2.3 Damped Oscillations(阻尼振动)

Left to itself, a spring or a pendulum eventually stops oscillating because the mechanical energy is dissipated by frictional forces. Such motion is said to be **damped.** If the damping is large enough, as, for example, a pendulum submerged in molasses, the oscillator fails to complete even one cycle of oscillation. Instead it just moves toward the equilibrium position with a speed that approaches zero as the object approaches the equilibrium position. This type of motion is referred to as **overdamped.** If the damping is small enough that the system oscillates with an amplitude that decreases slowly with time—like a child on a playground swing when Mum stops providing a push each cycle—the motion is said to be **underdamped.** Motion with the minimum damping for nonoscillatory motion is said to be **critically damped.**

8.2.4 Driven Oscillations and Resonance(受迫振动和共振)

To keep a damped system going, mechanical energy must be put into the system. When this is done, the oscillator is said to be **driven** or **forced**. When you keep a swing going by "pumping", that is, by moving your body and legs, you are driving an oscillator. If you put mechanical energy into the system faster than it is dissipated, the mechanical energy increases with time, and the amplitude increases. If you put mechanical energy in at the same rate it is being dissipated, the amplitude remains constant over time. The motion of the oscillation is then said to be in **steady state.**

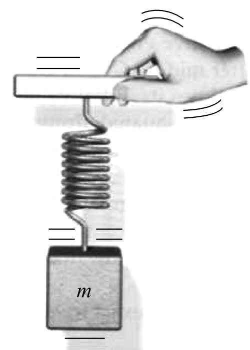


Fig. 8-2

Fig. 8-2 shows a system consisting of an object on a spring that is being driven by moving the point of support up and down with simple harmonic motion of frequency ω. At first the motion is complicated, but eventually steady state motion is reached in which the system oscillates with the same frequency as that of the driver and with a constant amplitude and, therefore, at constant energy. In the steady state, the energy put into the system per cycle by the driving force equals the energy dissipated per cycle due to the damping.

The amplitude, and therefore the energy, of a system in the steady state depends not only on the amplitude of the driving force, but also on its frequency. The **natural frequency** of a oscillator, ω_0, is its frequency when no driving or damping force are present (In the case of a spring, for example, $\omega_0 = \sqrt{k/m}$). If the driving frequency is approximately equal to the natural frequency of the system, the system will oscillate with a relatively large amplitude. For example, if the support in Fig. 8-2 oscillates at a frequency close to the natural frequency of the mass-spring system, the mass will oscillate with a much greater amplitude than it would if the support oscillates at higher or lower frequencies. This phenomenon is called **resonance.** When the driving frequency equals the natural frequency of the oscillator, the energy per cycle transferred to the oscillator is maximum. The natural frequency of the system is thus called the **resonance frequency.**

There are many familiar examples of resonance. When you sit on a swing, you learn intuitively to pump with the same frequency as the natural frequency of the swing. Many machines vibrate because they have rotating parts that are not in perfect balance (observe a washing machine in the spin cycle for an example). If such a machine is attached to a structure that can vibrate, the structure becomes a driven oscillatory system that is set in motion by the machine. Engineers pay great attention to balancing the rotary parts of such machines, damping their vibrations, and isolating them from building supports.

Glossary

oscillation/vibration	振动	oscillatory motion	振动
simple harmonic motion (SHM)	简谐运动	dissipative force	耗散力
		spring	弹簧
damping	阻尼	angular frequency	角频率、圆频率
equilibrium position	平衡位置	period	周期
radian	弧度	reciprocal	倒数
hertz(Hz)	赫兹	argument	辐角
amplitude	振幅	phase angle/(phase constant)	初相、初位相
phase	相、位相、周相		
average value	平均值	dissipate	消耗
damped oscillations	阻尼振动	submerge	浸入
molasses	糖蜜	oscillator	振子
overdamping	过阻尼	critically damped	临界阻尼的
overdamped	过阻尼的	driven oscillation	受迫振动
steady state	稳态	underdamped	欠阻尼的
resonance	共振	critical damped	临界阻尼
natural frequency	固有频率	resonance frequency	共振频率
nonoscillatory	不摆动的、不振动的		

8.3 专业英语常用表达法-8 一致 符合

1. 常用动词

accord	符合、一致	agree	符合、一致
coincide	一致、相符	answer	符合
fit	符合	meet	符合、适合

2. 常用名词

accord	一致、符合	agreement	符合、一致
coincidence	符合、一致	consistence/consistency	一致(性)
correspondence	符合、一致	conformity	符合、一致
congruence/congruency	一致、符合		

3. 常用形容词

consistent	一致的、符合的	accordant	一致的
congruous	一致的、全等的	conformable	一致的、符合的
corresponding	一致的、符合的		

4. 常用词组

answer to　适应、符合

be in agreement with... 与……相一致
be in accord with... 与……相一致
be in conformity with/to... 与……相一致
be/as consistent with... 与……相一致(协调)、符合……
bring...into accord with... 使……与……一致(相调和)
bring...into correspondence with... 使……与……一致起来
conform to... (使)一致、(使)符合
conform M to N 使 M 与 N 一致
conform with 与……一致、与……符合
correspondence between M and N M 与 N 相符
correspond to/with... 符合于……
fit in with 符合、适应
fit...into... 使……符合……
fit...like a glove 完全符合……
tally with... 与……相符合、与……一致

例如：

answer a description 与描述相符
observations that *fit* the theory nicely 与理论完全相符的观测
consistence of composition 成分的一致性
consistency check 一致性检验
curve *fit* 曲线拟合
meet a criterion 符合标准
meet the specification 符合规格/规范

The lab *answers to* his description. 这实验室与他的描述相符。

The experimental results *agree/accord with* the theoretical calculations. 实验结果与理论计算相符合。

The actual experimental figures are *in agreement with/in accord with/in conformity with/consistent with* the estimated figures. 实验中的数字与估计数字相符合。

A contact lens *conforms to/is consistent with* the curvature of the eyeball. 接触透镜与眼球的曲率相符。

The theory does not *correspond to* the experimental facts. 这一理论与事实情况不符。

Our results *coincide with* those obtained by other professors. 我们的结果与其他一些教授所取得的结果相一致。

It is shown that the QCT (quasi-classical trajectory) calculated results *agree well with/show a good agreement with* the experimental data for the reaction. 结果表明，对于这种反应，利用准经典轨线法计算的结果与实验获得的数据吻合得很好。

Unit Three

LESSON 9

9.1　物理学专业英语中的长句分析(一)

总的来说,专业英语文献中的句子长度呈现两种趋向:长难句多,短的简单句也多。一个句子长达一百来个单词,构成一个完整段落的现象屡见不鲜。

物理学专业英语用于表达科学理论、原理、规律、概述,以及各事物之间错综复杂的关系,而复杂的科学思维是无法使用简单句来表达的。为了表示严谨、精确的含义,语法结构复杂的长句有较多的应用,而这种严谨周密、层次分明、重点突出的语言手段也就成了专业英语文体又一重要特征。长句由基本句型扩展而成,其方式有增加修饰成分如定语、状语的,有用各种短语如介词、分词、动名词或不定式短语充当句子成分的,也可能是通过关联词将两个或两个以上的句子组合成复合句。从句子结构来看,英语中句子可分简单句,并列复合句和主从复合句。

英语利用形态变化、词序和虚词三大语法手段可构成包孕许多修饰成分或从句的长句,句中各部分顺序灵活多样。通常英语句中的表态部分(如判断和结论)在先,而叙事部分(如事实和描写)在后,汉语则正好相反;英语句中先短后长,"头轻脚重",而汉语也正好相反;英语借助形态变化和连接手段而将句中成分灵活排列,汉语则常按时间和逻辑顺序由先到后、由因到果、由假设到推论、由事实到结论这样排列。

在专业英语的学习中,长句的分析是一个非常重要的基础,无论是专业文献阅读、翻译还是严谨精确地写作,都要从长句分析开始。长句分析既重要也有些难度。然而,无论多长的句子、多么复杂的结构,它们都是由一些基本的成分组成的。只要弄清英语原文的句法结构,找出整个句子的中心内容,理解各层意思,然后分析各层意思之间的逻辑关系,再按汉语的特点和方式表达就可以理解或译出原文了。

9.1.1　长句结构的分析

抓住主干,添枝加叶。所谓抓住主干,就是在理解长句时首先要找到主语、谓语这两个主要成分。添枝加叶,就是在主语、谓语这两个主要成分的基础上,逐个加上各种修饰语,包括定语、状语、补语、非谓语动词结构、各种从句等。比如:

In the engine, the heat required to change the water into steam is produced by the combination of the oxygen gas in the air with the fuel. 在蒸汽机中,把水变成蒸汽所需要的热是由空气中的氧气与燃料结合而产生的。

该句主语 heat 容易确定,它后面紧跟一个动词过去分词 required,这个 required 很容易被误解为谓语,其实真正的谓语是 is produced。

Laser, its creation being thought to be one of today's wonders, is nothing more than a light①*that differs from ordinary lights only in* ②*that it is many times more powerful* and so be applied in fields ③ *that no ordinary light or other substance has ever been able to get in*.

此例是带有两个定语从句和一个宾语从句的主从复合句。主句为"Laser...is nothing more than a light."。定语从句①修饰主句中的名词 light,宾语从句②为介词 in 的宾语,定语从句③修饰名词 fields。另外,主句中又有一个独立主格结构"its creation... today's wonder"作状语。

The property the air has of taking up a great amount of water when heated and giving it out when cooled, is the cause of our clouds and rain. 空气所具有的这种热时吸收、冷时放出大量水汽的性能,是云和雨生成的原因。

该句主语 property 后面省略了一个 that 或 which,用来引导定语从句 the air has,修饰主语的介词短语 of taking... and giving...中又套两个用 when 引导的状语从句,显得句子结构复杂。借助 is 前面这个逗号,使我们找到了这个谓语联系动词。

在进行长句分析时,首先要理解透原文,分析句子结构,弄清语法关系。而对一个句子做结构分析,通常可采取下列步骤:通读全句,确定句子的种类——简单句或复合句,然后对句子的各种成分进行层次分析。

9.1.2 简单句的分析

对于简单句,进行句子分析时,要先找出句子的主要成分——主语、谓语,并进一步判明句中其余部分的语法成分——宾语、定语、状语、补足语、同位语、插入语等。一个简单句中只有一个主语和谓语,主谓结构是句子的骨干(主干);其他的句子成分,如定语、状语、补语等,则是生长在这个骨干上的次要(枝叶)成分。因此,在分析简单句时,应首先找出主语和谓语,再确定其他成分跟主语和谓语之间的关系以及各次要成分之间的关系。在把原文的意思彻底弄清楚之后,再来考虑如何用中文进行表达。例如:

In order to understand the operation of a transistor, it is first necessary to be familiar with the mechanism of charge transfer across a junction formed between a piece of n-type semi-conductor and a piece of p-type semi-conductor.

分析:在这个句子中。It 是句子的形式主语,真正的主语是 to be familiar with the mechanism; is necessary 是谓语。of charge transfer across a junction 是个介词短语,作 mechanism 的定语;formed 是过去分词,作 junction 的定语;between a piece of n-type semi-conductor 是介词短语,作 formed 的状语。In order to...transistor 是个目的状语,修饰全句。这个句子有三层意思:①为了理解晶体管的工作原理;②首先必须熟悉电荷越过结的机理;③结是在一块 N 型半导体材料和一块 P 型半导体材料之间形成的。

9.1.3 复合句的分析

所谓复合句就是由两个或两个以上完整的子句组合而成的句子。一般来说,英语中一

个句子只能有一个谓语,如果出现两个谓语,那么其中一个谓语只能是以从句、并列句或非谓语动词的形式出现。

把两个子句结合在一个句子中,英语需要加上连接词或加上标点符号。而由连接词and,or,but...或标点符号结合的子句,在全句内处于并列的地位,这样的复合句称为并列复合句。这种复合句不过是简单地将两句写成一句而已,所以分析起来并不困难。

另一类复合句中的子句地位不平等,一个子句是主句,其他是从句,这样的复合句称为主从复合句。主从复合句是由"主句+从句"构成,它是专业英语学习中比较复杂的句子结构。所谓从句是指从属于主句的句子,由从属连词连接。从句的种类有很多,但根据其性质和作用可以分为:名词性从句、形容词性从句(即定语从句)、副词性从句(即状语从句)三大类。

在进行句子分析时,如遇到的长句为复合句,按照我们刚才介绍的方法"抓住主干,添枝加叶",应先找出主句,然后确定各个从句的性质及其作用,判明各从句之间的关系——并列关系或从属关系,并对各成分进行层次分析。

对于结构复杂,层次纷纭的主从复合句要抓住引导各种从句的连词,弄清各种从句的性质,这样就能掌握全局结构,分清主次。

在复合句中,包含从句较多的长句又可以分为以下几种:

1)以状语从句或含有从句的状语短语开头的长主从复合句

由于状语可以位于句首,因而很多长句是以状语从句或含有从句的状语短语开头的。在从句末尾往往有一逗号,逗号之后就是主句。这样的长句,在结构上与汉语的句子类似。例如:

①Although there exists much experimental knowledge in regard to the behaviour of bodies ②which are not in the conditions ③to which the mathematical theory is applicable, yet it appears ④that the appropriate extensions of the theory ⑤which would be needed in order to incorporate such knowledge within it cannot be made ⑥ until much fuller experimental knowledge has been obtained.

这是一个以 although 引导的让步状语从句开头的复合句。它的从句多达六个:①although 引导的修饰主句谓语的让步状语从句;②which 引导的修饰 bodies 的定语从句;③to which 引导的修饰 conditions 的定语从句;④that 引导的主语从句;⑤which 引导的修饰 extensions 的定语从句;⑥until 引导的修饰 cannot be made 的时间状语从句。

2)以主句开头的长主从复合句

主句位于句首,后面可以接以引导词引导的各种从句,如主语从句、定语从句、状语从句等。例如:

Viscosity is a general term for all those properties of matter ①by virtue of which the resistance ②which a body offers to any change, depends upon the rate ③at which the change is effected.

这是一个以主句开头的复合句。其中包含三个从句:①以 by virtue of which 引导的定语从句;②以 which 引导的修饰 resistance 的定语从句;③以 at which 引导的修饰 rate 的定语从句。

3)并列成分多或长的长复合句

正确判断并列成分是能否对长句进行正确分析的重要因素。这些并列的成分,既可以

是并列的分句,也可以是并列的主语、谓语、宾语、定语和状语等。而且,并列成分一般多由 and 等连词连接。在大多数情况下,根据该连词后面那个词或短语的性质到前面去找与之性质相同的词或短语,即可对并列成分做出正确判断。例如:

Such activities as investigating the strength and uses of materials, extending the findings of pure mathematics to improve the sampling procedures used in agriculture or social sciences, and developing the potentialities of atomic energy, are all examples of the work of the applied scientist.

该句中 and 后面是动名词短语 developing the potentialities of atomic energy,and 前面也有两个动名词短语 investigating...和 extending...,可以肯定这三个动名词短语并列,用作 as 引导的定语从句的主语。

4) 从句中含有从句的长复合句

在有的长句中,某个从句本身有可能也是含有一个或一个以上从句的复合句;甚至这种从句本身又含有从句。遇到这种比较复杂的现象,必须要对每个从句的性质做出正确的分析,找出与它发生关系的词。例如:

A further inference was drawn by Pascal, who reasoned that if this "sea of air" existed, its pressure at the bottom (i. e. sea-level) would be greater than its pressure further up, and that therefore the height of mercury column would decrease in proportion to the height above the sea-level.

此句中,who 引导的定语从句为一复合句,含有一个以 that 引导的宾语从句。而这个 that 引导的宾语从句又是一个复合句,其中含有一个以 if 引导的条件状语从句,and 连接的两个并列的宾语从句。

为了能够做好长句结构的分析,掌握好专业英语中关于复合句、非谓语动词的知识是非常必要的。在接下来的几课中,将介绍一下关于复合句、非谓语动词的知识。然后我们再结合实例来介绍长句结构分析的方法(见 Lesson 17,物理学专业英语中的长句分析(二))。

9.2 专业英语阅读

9.2.1 Thermal Equilibrium and Temperature(热平衡及温度)

Temperature is familiar to us as the measure of the hotness or coldness of objects or of our surroundings.

Our sense of touch can usually tell us if an object is hot or cold. Early in childhood we learn that to make a cold object warmer, we place it in contact with a hot object and to make a hot object cooler, we place it in contact with a cold object.

When an object is heated or cooled, some of its physical properties change. Most solids and liquids expand when they are heated. A gas, if its pressure is kept constant, will also expand when it is heated, or, if its volume is kept constant, its pressure will rise. If an electrical conductor is heated, its electrical resistance changes. A physical property that changes with temperature is called a **thermometric property.** A change in a thermometric property indicates a change in the temperature of the object.

Suppose that we place a warm copper bar in close contact with a cold iron bar so that the copper bar cools and the iron bar warms. We say that the two bars are in **thermal contact**. The copper bar contracts slightly as it cools, and the iron bar expands slightly as it warms. Eventually this process stops and the lengths of the bars remain constant. The two bars are then in **thermal equilibrium** with each other.

Suppose instead that we place the warm copper bar in a cool running stream. The bar cools until it stops contracting, at the point at which the bar and the water are in thermal equilibrium. Next we place a cold iron bar in the stream on the side opposite the copper bar. The iron bar will warm until it and the water are also in thermal equilibrium. If we remove the bars and place them in thermal contact with each other, we find that their lengths do not change. They are in thermal equilibrium with each other. Though it is common sense, there is no logical way to deduce this fact, which is called the **zeroth law of thermodynamics** (Fig. 9-1):

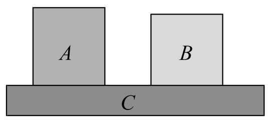


Fig. 9-1 If objects A and B are separately in thermal equilibrium with a third object, C, then A and B are in thermal equilibrium with each other

If two objects are in thermal equilibrium with a third, then they are in thermal equilibrium with each other.

Two objects are defined to have the same temperature if they are in thermal equilibrium with each other.

9.2.2 The Ideal-Gas Law(理想气体定律)

The properties of gases at low densities allow the definition of the ideal-gas temperature scale. If we compress such a gas while keeping its temperature constant, the pressure increases. Similarly, if a gas expands at constant temperature, its pressure decreases. To a good approximation, the product of the pressure and volume of a low-density gas is constant at a constant temperature. This result was discovered experimentally by Robert Boyle (1627—1691), and is known as **Boyle's law**:

$$PV = \text{constant} \quad (\textbf{constant temperature})$$

A more general law exists that reproduces Boyle's law as a special case. As we know, the absolute temperature of a low-density gas is proportional to its pressure at constant volume. In addition—a result discovered experimentally by Jacques Charles (1746—1823) and Joseph Gay-Lussac (1778—1850)—the absolute temperature of a low-density gas is proportional to its volume at constant pressure. We can combine these two results by stating

$$PV = CT \qquad (9\text{-}1)$$

where C is a constant of proportionality. We can see that this constant is proportional to the amount of gas by considering the following. Suppose that we have two containers with identical volumes, each holding the same amount of the same kind of gas at the same temperature and pressure. If we consider the two containers as one system, we have twice the amount of gas at twice the volume, but at the same temperature and pressure. We have thus doubled the quantity $PV/T = C$ by doubling the amount of gas. We can therefore write C as a constant k times the number of molecules in the gas N

$$C = kN$$

Eq. (9-1) then becomes

$$PV = NkT \tag{9-2}$$

The constant k is called **Boltzmann's constant.** It is found experimentally to have the same value for any kind of gas

$$k = 1.381 \times 10^{-23}\ \text{J/K} = 8.617 \times 10^{-5}\ \text{eV/K} \tag{9-3}$$

An amount of gas is often expressed in moles. A **mole** (mol) of any substance is the amount of that substance that contains Avogadro's number N_A of atoms or molecules, defined as the number of carbon atoms in 12 g of C^{12}

$$N_A = 6.022 \times 10^{23} \tag{9-4}$$

If we have ν moles of a substance, then the number of molecules is

$$N = \nu N_A \tag{9-5}$$

Eq. (9-2) is then

$$PV = \nu N_A kT = \nu RT \tag{9-6}$$

where $R = N_A k$ is called the **universal gas constant.** Its value, which is the same for all gases, is

$$R = N_A k = 8.314\ \text{J/(mol} \cdot \text{K)} = 0.082\,06\ \text{L} \cdot \text{atm/(mol} \cdot \text{K)} \tag{9-7}$$

An **ideal gas** is defined as one for which $PV/(\nu T)$ is constant for all pressures. The pressure, volume, and temperature of an ideal gas are related by

$$PV = \nu RT \tag{9-8}$$

Eq. (9-8), which relates the variables P, V, and T, is known as the **ideal-gas law**, and is an example of an **equation of state.** It describes the properties of real gases with low densities (and therefore low pressures). At higher densities, corrections must be made to this equation. For any gas at any density, there is an equation of state relating P, V, and T for a given amount of gas. Thus the state of a given amount of gas is determined by any two of the three state variables P, V, and T.

The temperature 0℃ and the pressure of 1 atm are often referred to as **standard conditions.** Under standard conditions, a mol of an ideal gas occupies a volume of 22.4 L.

For a fixed amount of gas, we can see from Eq. (9-8) that the quantity PV/T is constant. Using the subscripts 1 for the initial values and 2 for the final values, we have

$$\frac{P_2 V_2}{T_2} = \frac{P_1 V_1}{T_1} \tag{9-9}$$

Glossary

temperature	温度	thermal equilibrium	热平衡
hotness	热	electrical conductor	电导体
coldness	冷	thermometric property	热力学特性
the zeroth law of thermodynamics	热力学第零定律	thermal contact	热接触
ideal-gas temperature scale	理想气体温标	Boyle's law	波意耳定律
universal gas constant	普适气体常量	constant volume	等体
Boltzmann's constant	玻尔兹曼常量	equation of state	状态方程
mole	摩尔	state variable	状态参量
Avogadro's number	阿伏伽德罗常量	standard condition	标准条件
carbon atom	碳原子	subscript	下标

9.3 专业英语常用表达法-9 热学和波动常用实验仪器

refrigerator 电冰箱
digital thermometer 数字温度计
heater 加热器
heat converter 热交换器
hot-water bag 热水袋
thermometer 温度计
thermal converter 热转换器
thermostat 恒温箱、温控器
thermionic tube 热离子管
calorimeter 热量表、量热器、热量计
sonometer 弦音计、振动频率计
refrigerating box 冷藏箱
refrigerating fluid 冷冻液、制冷剂
thermopile 温差电堆、热电堆
heat exchanger 热交换器
thermos, thermos bottle, vacuum bottle 热水瓶
wet and dry thermometer 干湿温度计
empty box barometer 空盒气压计
magnetic barrel calorimeter 磁桶量热器
thermomotor 热力机、热气机、热发动机
boron thermopile 硼温差电堆
tuning fork 音叉
resonance tuning forks 共振音叉
specific heat capacity converter 比热容转换器
varying-temperature viscosity coefficient tester 变温黏滞系数实验仪
single-junction vacuum thermopile 单接头真空温差电堆
sublimation and condensation of iodine demonstrator 碘的升华与凝华演示器
solid shrink force demonstrator 固体缩力演示器
interconversion of mechanical energy and heat energy demonstrator 机械能热能互变演示器
metal linear expansion demonstrator 金属线膨胀演示器
refrigerated centrifuge 冷冻离心分离机
solidification and melt of naphthalene experiment device 萘的熔解凝固实验器
experimental device for gas law 气体定律实验器

gas law demonstrator　气体定律演示器
heat conduction demonstrator　热传导演示器
thermoelectric couple，thermocouple，thermoelectric pair　热电偶、温差电偶
heat flux density converter　热流密度转换器
thermistor thermometer　热敏温度计、热敏电阻温度计
demonstrator of sound propagation　声传播演示器
quick freezing refrigeration device　速冻制冷装置
standing waves on a string instrument　弦线上驻波实验仪
harmonic wave analysis experimental instrument　谐波分析实验仪
liquid specific heat detector　液体比热测定仪
vacuum flask/dewar flask　真空瓶/杜瓦瓶
vacuum thermopile　真空热电堆、真空温差电堆
refrigeration compressor　制冷压缩机、冷冻机
thermal coefficient meters　导热系数测定仪
meter of metal specific heat capacity　金属比热容测定仪
meter of specific heat ratio of gas　气体比热容比测定仪
thermotics experiment facility　热学实验仪
multi-function constant-temperature controller　多功能恒温控制仪

LESSON 10

10.1　物理学专业英语中的主语从句

前面已经提到过，英语的主从复合句一般分为三大类型：名词性从句、形容词性从句和副词性从句。

名词性从句在整个复合句中起名词作用。主语、宾语、表语和同位语等各种从句统称为名词性从句，在句中起名词作用，充当主语、宾语、表语和同位语。

引导名词性从句的连接词可分为三类：

连接词：that，whether，if（不充当从句的任何成分）

连接代词：what，whatever，who，whoever，whom，whose，which

连接副词：when，where，how，why

主语从句是在复合句中充当主语的从句。

10.1.1　主语从句的引导词

主语从句通常由连词 that 和 whether，连接代词或连接副词，以及关系代词 what 引导。

1）that 引导

That each atom has a tiny but massive nucleus that contains protons and neutrons is a general phenomenon. 每个原子都有一个包含质子和中子的小而重的原子核，是个普遍现象。

That two objects carrying the same type of charge repel each other is certain. 带有同

种电荷的两个物体互相排斥，这是确定无疑的。

That she became a physicist may have been due to her father's influence. 她成为物理学家可能是受她父亲的影响。

There seems little doubt *that radar technology is a permanent and important aspect of research and development in electronics*.（That 引导的从句作实际主语）似乎没有疑问，在电子学的研究和发展中，雷达技术是一个永久并且重要的方面。

2）whether 引导

Whether the experiment of dropping bodies of different weight from the leaning tower of Pisa was performed before a multitude, as some accounts have it, was not known. 我们不知道比萨斜塔落体实验是否像某些资料记载那样在很多人目睹下进行。

Whether the plan of carrying out the experiment is feasible remains to be proved. 这一实验计划是否可行还有待证实。

Whether the discharge will do us harm remains to be seen. 放电是否有害还要看一看。

Whether the experimental result would support the theory was a problem. 实验结果是否会支持这个理论还是一个问题。

Whether a length is exactly a meter is a question no experiment can decide. 一段长度是否精确地是 1 m，没有实验能够决定。

3）连接代词引导

Whoever discovered the phenomena did not make any difference. 到底是谁发现这个现象的，没有什么分别。

Whichever of the particles gets out first does not matter. 无论哪个粒子先出来都没有关系。

Who should be responsible for the environmental degradation is still unknown. 谁对环境恶化负责还不清楚。

4）连接副词引导

When magnetism was recognized is not quite clear. 磁现象是什么时候被发现的，不是十分清楚。

How the experiment was done was a mystery. 这个实验怎样做的是一个谜。

How this happened is not clear to anyone. 这件事怎样发生的，谁也不清楚。

Where Coulomb confirmed the inverse-square law for the electrostatic force remains to be proved. 库仑到底是在哪里确定静电力的平方反比定律还有待证实。

5）关系代词 what 引导

What we need is a precision tool. 我们需要的是精密工具。

What the physicists were waiting for at that time was a solar eclipse. 那时，物理学家们等待的就是一次日食。

What make the lab more impressive are the modern instruments. 为实验室增色的是现代化的仪器设备。

10.1.2 主语从句与形式主语 it

有时为了考虑句子平衡，通常在主语从句的位置使用形式主语 it，而将真正的主语从句移至句末。用 it 作形式主语的 that 从句有以下四种不同的搭配关系：

"It＋be＋形容词＋that 从句"，如：

It is necessary that... 有必要……

It is natural that... 很自然……

It is strange that... 奇怪的是……

"It＋be＋过去分词＋that 从句"，如：

It is known to all that... 众所周知……

It is reported that... 据报道……

It is said that... 据说……

It has been proved that... 已证实……

"It＋be＋名词＋that 从句"，如：

It is a fact that... 事实是……

It is an honor that... 非常荣幸……

It is common knowledge that... ……是常识

"It＋不及物动词＋that 从句"，如：

It appears that... 似乎……

It seems that... 似乎……

It happened that... 碰巧……

It occurs that... 碰巧……

用 it 作形式主语时分以下三种情况：

1）对于以连词 that 引导的主语从句，通常用形式主语代替主语从句：

For example, in electric circuits it is often assumed *that the relations between voltages and currents are linear*. 例如，在电路中通常假设电压和电流的关系是线性的。

It has been found repeatedly in science *that the discovery that two branches are related leads to each branch helping in the development of the other*. 在科学中经常发现，与两个分支相关的发现会导致两方相互促进发展。

It is quite clear *that the whole project is doomed to failure*. 很清楚，整个计划注定要失败。

It's a pity *that he didn't find any useful results in the experiment*. 很遗憾他在实验中没找到什么有用的结果。

It is important that *the experiment should be carried out in vacuum*. 实验必须在真空内进行。

2）对于以连接代词(副词)引导的主语从句，可以使用形式主语代替主语从句，也可直接在句首使用主语从句：

Whether they would support us was a problem. 他们是否会支持我们还是一个问题。

It was a problem *whether they would support us*. 他们是否会支持我们还是一个

问题。

It remains to be seen *whether the material will do us harm or good*. 这材料对我们是利是害，还得看看再说。

3）对关系代词型 what 引导的主语从句，通常直接将主语从句放在句首。如：

What we need is an inertial frame of reference. 我们需要的是惯性参考系。

What I want to know is how we apply Newton's laws to solve problems. 我想知道的就是如何运用牛顿定律解决问题。

有时也可借用形式主语。如：

It is clear enough what the results meant. 结果是什么意思很清楚。

4）如果句子是疑问句，则必须用带形式主语 it 的结构：

Is it true *that the electric field of the source particles is present* whether or not we introduce a test particle into the field? 不论检验电荷是否放入，场源电荷产生的电场都是存在的，是真的吗？

How is it *that the two particles attract each other*？两个粒子怎么会互相吸引呢？

10.1.3 连词 that 的省略问题

引导主语从句的连词 that 有时可省，有时不能省，其原则是：若 that 引导的主语从句直接位于句首，则 that 不能省略；若 that 引导的主语从句位于句末，而在句首使用了形式主语 it，则 that 可以省略。

That you failed to use Ampere Circuital Theorem correctly was a pity. 很遗憾你未能正确使用安培环路定理。（that 不可省）

It was a pity (that) *you failed to use Ampere Circuital Theorem correctly*。很遗憾你未能正确使用安培环路定理。（that 可省）

10.1.4 主语从句不可位于句首的五种情况

（1）if 引导的主语从句不可居于复合句的句首。

（2）It is said (reported)… 结构中的主语从句不可提前。

（3）It happens…，It occurs… 结构中的主语从句不可提前。

（4）It doesn't matter how/whether… 结构中的主语从句不可提前。

（5）含主语从句的复合句是疑问句时，主语从句不可提前。

10.1.5 What 与 that 在引导主语从句时的区别

What 引导主语从句时在从句中充当句子成分，如主语、宾语、表语，不能省略。That 不作任何成分，而只在语法上起连接作用，并且在句首使用了形式主语 it 时 that 可以省略。

10.2 专业英语阅读

10.2.1 Heat and the First Law of Thermodynamics（热及热力学第一定律）

Heat is energy that is being transferred from one system to another because of a difference in temperature. In the seventeenth century, Galileo, Newton, and other scientists generally supported the theory of the ancient Greek atomists who considered thermal energy to be a manifestation of molecular motion. In the next century, methods were developed for making quantitative measurements of the amount of heat that leaves or enters an object, and it was found that if objects are in thermal contact, the amount of heat that leaves one object equals the amount that enters the other. This discovery led to the caloric theory of heat as a conserved material substance. In this theory, an invisible fluid called "caloric" flowed out of one object and into another and this "caloric" could be neither created nor destroyed.

The caloric theory reigned until the nineteenth century, when it was found that friction between objects could generate an unlimited amount of thermal energy, deposing of the idea that caloric was a substance present in a fixed amount. The modern theory of heat did not emerge until the 1840s, when James Joule (1818—1889) demonstrated that the increase or decrease of a given amount of thermal energy was always accompanied by the decrease or increase of an equivalent quantity of mechanical energy. Thermal energy, therefore, is not itself conserved. Instead, thermal energy is a form of internal energy, and it is energy that is conserved.

We will always talk about energy transfer to or from some specific *system*. The system might be a mechanical device, a biological organism, or a specified quantity of material such as the refrigerant in an air conditioner. A **thermodynamic system** is a system which can interact (and exchange energy) with it surroundings, or environment. A process in which there are changes in the state of thermodynamic system is called a **thermodynamic process**.

In this part, we define heat capacity, and examine how heating a system can cause either a change in its temperature or a change in its phase. We then examine the relationship between heat conduction, work, and internal energy of a system and express the law of conservation of energy for the thermal systems as the first law of thermodynamics. Finally, we shall see how the heat capacity of a system is related to its molecular structure.

We describe the energy relations in any thermodynamic process in terms of the quantity of heat Q added to the system and the work W done by the system. Both Q and W may be positive, negative, or zero. A positive value of Q represents heat flow into the system, with a corresponding input of energy to it; negative Q represents heat flow out of the system. A positive value of W represents work done by the system against it surroundings, such as work done by an expanding gas, and hence corresponds to energy leaving the system. Negative W, such as work done during compression of a gas in which work is done on the gas by its surroundings, represents energy entering the system.

When the law of conservation of energy was first introduced in previous chapter, it was stated that the mechanical energy of a system is conserved in the absence of nonconservative forces, such as friction. That is, the changes in the internal energy of the system were not included in this mechanical model.

The first law of thermodynamics is a generalization of the law of conservation of energy that includes possible changes in internal energy.

It is a universally valid law that can be applied to all kinds of processes. Furthermore, it provides us with a connection between the microscopic and macroscopic worlds.

We have seen that energy can be transferred between a system and its surroundings in two ways. One is work done by (or on) the system. This mode of energy exchange results in measurable changes in the macroscopic variables of the system, such as the pressure, temperature, and volume of gas. The other is heat transfer, which takes place at the microscopic level.

To put these ideas on a more quantitative basis, suppose a thermodynamics system undergoes a change from an initial state to a final state in which Q units of heat are absorbed (or removed) and W is the work done by (or on) the system. For example, the system may be a gas whose pressure and volume change from P_i, V_i to P_f, V_f. If the quantity $Q-W$ is measured for various paths connecting the initial and final equilibrium states (that is, for various process), one finds that $Q-W$ is the same for all paths connecting the initial and final states. We conclude that the quantity $Q-W$ is determined completely by the initial and final states of the system, and we call the quantity $Q-W$ *the change in the internal energy of the system*. Although Q and W both depend on the path, the quantity $Q-W$, that is, *the change in internal energy is independent of the path*. If we represent the internal energy function by the letter E, then the change in internal energy, $\Delta E=E_f-E_i$, can be expressed as

$$\Delta E=E_f-E_i=Q-W \qquad (10\text{-}1)$$

where all quantities must have the same energy units. Eq. (10-1) is known as the **first law of thermodynamics**. When it is used in this form, we must note that Q is positive when heat enters the system and W is positive when work is done by the system.

10.2.2 Kinds of Thermodynamic Processes(热力学过程的种类)

In this section we describe four specific kinds of thermodynamic processes that occur often in practical situations. These can be summarized briefly as “no heat transfer” or adiabatic, “constant volume” or isochoric, “constant pressure” or isobaric, and “constant temperature” or isothermal. For some of these we can use a simplified form of the first law of thermodynamics.

Adiabatic Process(绝热过程)

An adiabatic process is defined as one with no heat transfer into or out of a system, $Q=0$. We can prevent heat flow either by surrounding the system with thermally insulating material or by carrying out the process so quickly that there is not enough time for appreciable heat flow. From the first law we find that for every adiabatic process

$$E_2 - E_1 = \Delta E = -W \quad \text{(adiabatic process)} \qquad (10\text{-}2)$$

When a system expands adiabatically, W is positive (the system does work on its surrounding), so ΔE is negative and the internal energy decreases. When a system is compressed adiabatically, W is negative (work is done on the system by its surroundings) and E increases. In many (but not all) systems an increase of internal energy is accompanied by a rise in temperature.

The compression stroke in an internal-combustion engine is an approximately adiabatic process. The temperature rises as the air-fuel mixture in the cylinder is compressed. The expansion of the burned fuel during the power stroke is also an approximately adiabatic expansion with a drop in temperature.

Isochoric Process(等体过程)

An isochoric process is a constant-volume process. When the volume of a thermodynamic system is constant, it does no work on its surroundings. Then $W=0$, and

$$E_2 - E_1 = \Delta E = Q \quad \text{(isochoric process)} \qquad (10\text{-}3)$$

In an isochoric process, all the energy added as heat remains in the system as an increase in internal energy. Heating a gas in a closed constant-volume container is an example of an isochoric process. (Note that there are types of work that do not involve a volume change. For example, we can do work on a fluid by stirring it.)

Isobaric Process(等压过程)

An isobaric process is a constant-pressure process. In general, none of the three quantities ΔE, Q, and W is zero in an isobaric process, but calculating W is easy nonetheless.

$$W = P(V_2 - V_1) \quad \text{(isobaric process)} \qquad (10\text{-}4)$$

Isothermal process(等温过程)

An isothermal process is a constant-temperature process. For a process to be isothermal, any heat flow into or out of the system must occur slowly enough that thermal equilibrium is maintained. In general, none of the quantities ΔE, Q, or W is zero in an isothermal process.

In some special cases the internal energy of a system depends only on its temperature, not on its pressure or volume. The most familiar system having this special property is an ideal gas. For such system, if the temperature is constant, the internal energy is also constant; $\Delta E=0$, and $Q=W$, that is, any energy entering the system as heat Q must leave it again as work W done by the system. For most systems other than ideal gases the internal energy depends on pressure as well as temperature, so E may vary even when T is constant.

Glossary

atomist	原子学家	thermal energy	热能
manifestation	表现形式	molecular motion	分子运动
thermal contact	热接触	internal energy	内能
thermodynamic system	热力学系统	thermodynamic process	热力学过程
caloric	*a*.热的;*n*.热(质)	heat capacity	热容量
phase	相	heat conduction	热传导
initial state	初态	final state	末态
adiabatic	绝热的	isochoric	等体积的
isobaric	等压强的	isothermal	等温的
thermally insulating material	绝热材料	adiabatically	绝热地
compression stroke	压缩冲程	internal-combustion engine	内燃机
power stroke	做功冲程		

10.3　专业英语常用表达法-10　精度

1. 精度的表达方法

accuracy control　精确控制
accuracy grade　准确度等级
accuracy index　准确度(精确度)指数
accuracy requirements　准确度要求
high accuracy　高精度
percentage of accuracy　准确度百分数
order of accuracy　准确度
overall accuracy　总精度、总准确度
standard of accuracy　准确度标准
to an accuracy of...　精度达……、准确到……
with accuracy　正确地、准确地
within accuracy of...　精度达……、准确到……
with an accuracy of...　精度达……、以……的精度
within the accuracy of...　在……的精度范围内
the accuracy with/to which...　……的精度
accurate to...　精度达……、精确到……
accurate (to) within...　精度在……的范围之内
be accurate to dimension　符合加工尺寸
be accurate to/within plus or minus five per cent　精确到(精度在)±5%以内
例如：
With care a micrometer will give *an accuracy of* better than 1 part in thousand. 使用

得法时，测微计能给出高于 0.1%的准确度。

It is impossible to say *with any accuracy* how many are affected. 无论如何也说不准受影响的有多少。

The volume measuring *accuracy* of this system is ±0.25%. 系统容积的测量精度为±0.25%。

Readings can be obtained to *an accuracy of* one micron. 获得的读数精度可达 1 μm。

The discrepancy is *within the accuracy of* the analysis. 误差在分析精度范围之内。

The *accuracy with which* scientists can use laser can also be of help in making different kinds of measurements. 科学家使用激光所能达到的精度对进行其他各种测量也可能有所帮助。

It depends on *the degree of accuracy to which* the parts must be made. 这取决于制造零件所应达到的精度。

All input data are *accurate to* three significant figures. 所有输入的数据精确到 3 位有效数字。

This apparatus is *accurate within* microseconds. 这台装置的精确度在数微秒之内。

These parameters are known with *an accuracy of* 5%. 这些参数的已知精确度为 5%。

The components can be positioned *with an accuracy* better than 0.010 in. 这些部件固定的精确度可高于 0.010 in。

2. 用 The function（或 purpose） is ＋ 动词不定式来表达功能

It has several functions and probably *the main one is to hide the structure of the instrument*. 它有好几个作用，主要的可能是为了把这台仪器的内部结构遮盖起来。

At the end we have a clear glass, *its function there is to give you a view of the circuit inside*. 在末端用的是透明玻璃，它的作用是使你看得见里边的电路。

3. 其他表达用途、目的和功能的词语

be designed ＋ 动词不定式（或 for 短语）

help ＋ 动词不定式

have the function of

serve the purpose of

The building *is designed* primarily *for students* rather than teachers. 这座建筑是供学生而不是供教师使用的。

The cast glass *helps to express* the structure of the lab. 压铸玻璃有助于显露出实验室的结构。

It also *serves the purpose of* giving access over the roof for maintenance and for cleaning the glass. 还可以利用它到实验室顶部去进行维修和清洁玻璃。

LESSON 11

11.1 物理学专业英语中的宾语从句

宾语从句就是在复合句中作宾语的名词性从句，通常放在主句谓语动词（及物动词）或介词之后。例如：

For a situation like this, in which the current is discontinuous in space, Ampere's law is not valid. In following, we will see *how Maxwell was able to modify Ampere's law so that it holds for all currents*. 对于像空间中电流不连续的情况，安培定律就不成立了。下面我们将看到麦克斯韦是如何修正安培定律从而使其对所有电流都适用。

This law describes *how electric field lines diverge from a positive charge and converge on a negative charge*. Its experimental basis is Coulomb's law. 这个定律说明了电场线如何发散于正电荷、聚集于负电荷，其实验基础是库仑定律。

11.1.1 宾语从句的引导词

宾语从句通常由连词 that 和 whether/if，连接代词或连接副词，以及关系代词 what 引导。

1）that 引导

It is a common fallacy to suppose *that mathematics is important for physics only because it is a useful tool for making computations*. 人们通常错误地认为数学对物理很重要仅仅因为它是一种有用的计算工具。

Stated in words, Ohm's law says *that the steady current through any portion of an electric circuit equals the potential difference across that portion of the circuit divided by the resistance of that portion of the circuit*. 欧姆定律用语言表述为：电路中任一部分的电流强度等于这部分的电势差除以这部分的电阻。

Archimedes principle states *that a body wholly or partially immersed in a fluid is buoyed up by a force equal to the weight of the fluid displaced by it*. 阿基米德原理表述为：部分或全部浸在水中的物体受到的浮力等于物体排开液体的重量。

That 引导的从句常跟在下列形容词后作宾语：afraid, anxious, aware, certain, confident, convinced, determined, glad, proud, surprised, worried, sorry, thankful, ashamed, disappointed, annoyed, pleased, hurt, satisfied, content 等。例如：

I am afraid *that the shock waves will be very strong in this case*. 在这种情况下，恐怕冲击波会很强。

2）whether/if 引导

Before making this case a general rule, test it by experiment two or three times and see *if the experiment produces the same effect*. 在把这一情况定为常规之前，先做两三次实验看看是否产生同一效果。

In order to determine *whether a system is performing properly and ultimately to* *control the system performance*, the engineer must know what the system is doing at any instant of time. 为了确定系统是否准确运行以及全面控制系统性能，工程人员必须随时了解系统在做什么。

I wonder *if the voltage is high enough*. 我不知道电压是否够高。

3）连接代词引导

Put them together and see *which is larger*. 把它们加起来看看哪个更大。

We'll do *whatever we can* to measure the magnetic force between the two parallel current-carrying wires. 我们将尽我们所能来测量这两个平行电流间的相互作用磁力。

I don't know *who/whom you mean*. 我不知道你指谁。

You can take *whichever you like*. 你爱拿哪个就拿哪个吧。

Few people knew *what the relativity meant at that time*. 那时很少有人明白相对论。

4）连接副词引导

We often fail to realize *how little we know about a thing* until we attempt to simulate it on a computer. 在我们试图用计算机模拟一件事之前，我们通常意识不到我们对它的了解是多么少。

Our success depends upon *how well we can cooperate with one another*. 我们的成功取决于彼此间的良好合作。

The sum, difference and product of continuous functions are also continuous. The quotient of continuous functions is continuous except *where the denominator vanishes*. 连续函数的和、差、积仍然连续，连续函数的商在分母不为零时也连续。

This essay aims to explore *why quantum was put forward at that time*. 本文将探讨为什么量子的概念会在那个时候提出。

I'd like to know *when the electrification will be finished*. 我很想知道充电什么时候会结束。

5）关系代词 what 引导

In order to determine whether a system is performing properly and ultimately to control the system performance, the experimenter must know *what the system is doing at any instant of time*. 为了确定系统在运行中是否准确全面地控制系统性能，实验人员必须随时了解系统在做什么。

First let's introduce *what the Atwood's machine is like*. 首先让我们介绍一下阿特伍德机。

【注意】 有时介词后可接一个宾语从句(但介词后通常不接 that 和 if 引导的宾语从句)：

From *what Maxwell stated*, the displacement current was reasonable. 根据麦克斯韦所说，位移电流是合理的。

有极个别介词(如 but, except)可接 that 引导的宾语从句：

The experimenters need do nothing about it except *that they should turn the power on*. 实验人员只需要通上电源，其他的什么都不需要做。

11.1.2 宾语从句与形式宾语 it

当宾语从句后跟有宾语补足语时，特别是在带复合宾语的句子中，通常在宾语从句处使

用形式宾语 it,而将真正的宾语从句移至句末。

I think *it* best *that you should explain the Guass's law in detail now*. 我认为你最好现在把这个高斯定理仔细解释一下。

He hasn't made *it* known *when he is going to get started with thermodynamics*. 他还没宣布他何时开始讲热力学。

She found *it* difficult *how she could answer the question about Maxwell's Equations*. 她发现回答这个关于麦克斯韦方程组的问题很困难。

The director made *it* a rule *that every graduate student should make at least one presentation in the discussion*. 导师规定每个研究生在讨论时至少发一次言。

11.1.3 连词 that 的省略问题

引导宾语从句的连词 that 通常可以省略。

Einstein thought (*that*) *the quantum theory was unreasonable*. 爱因斯坦认为量子理论难以置信。

She said (*that*) *the equivalent capacitance of a series combination of capacitors would be less than any individual capacitance in the combination*. 她说过串联电容器的总电容会小于其中任何一个电容器的电容。

I promise you (*that*) *I will be there when they maintain the equipment*. 我答应你在他们维护仪器时我会去照看的。

I hoped (*that*) *I would/should succeed in the experiment*. 我曾希望我会在实验中成功。

He thinks (*that*) *they will fix the equipment on time*. 他想他们会按时安装好设备的。

He thought (*that*) *they would set up the equipment in time*. 他本想他们会按时安装好设备的。

I expect (*that*) *the experiment's result will turn out perfect*. 我料想实验的结果将会很完美。

I suggested (*that*) *they should handle the device carefully*. 我建议他们小心操纵设备。

【注意】 有时为了强调,that 引导的宾语从句可位于句首,此时 that 不可省略。

That the electric appliance should be grounded I know. 这电器应该接地,我是知道的。

11.1.4 宾语从句与否定转移

当动词 think, believe, suppose, expect, imagine 后接一个表示否定意义的宾语从句时,其否定通常转移到主语。

I *don't* suppose *that the data they presented is true*. 我认为他们提供的数据不是真的(而不是 I suppose *that the data they presented is not true*.)。

I *don't* think *we need waste much time on the maintenance*. 我想我们不必在仪器维护上面花太多时间(而不是 I think we need not waste much time on the maintenance.)。

11.1.5 不能省略 that 的宾语从句

引导宾语从句的 that 在下列情况下一般不省略。

1）宾语从句前有插入语。如：

We hope，*on the contrary*，*that* he can find the kinetic equation for the simple harmonic motion. 恰恰相反，我们希望他能够找到简谐运动的运动学方程。

2）有间接宾语时。如：

He told *me that* he would apply Huygens Principle to describe the propagation of waves. 他告诉我他要用惠更斯原理来描述波的传播。

3）that 在与之并列的另一个宾语从句之后。如：

The book states (that) the standing waves are very interesting and *that*（不省略）*a standing wave does not transfer energy*. 那本书说驻波很有趣，驻波也不传播能量。

4）在"it(形式宾语)＋补语"之后时。如：

Teachers think *it* necessary *that* physics is taught with multimedia. 教师们认为利用多媒体教授物理学是必要的。

5）that 从句单独回答问题时。如：

—What did he hear? 他听说了什么事？

—*That* Kate had found a new way to prove the theory.（他听说）凯特发现了一个证明这个理论的新方法。

6）在 except 等介词后。如：

The experimenters need do nothing about it except *that* they should turn the power on. 实验人员只需要通上电源，其他的什么都不需要做。

7）位于句首时。如：

That the wave like this is nothing but a standing wave，I believe. 我相信像这样的波就是驻波。

8）在较为正式或不常用的动词(如 reply，object)后。如：

The editor replied *that the paper was accepted*. 编辑回复说文章被接受了。

11.1.6 后边不能直接跟 that 从句的动词

这类动词有 allow，refuse，let，like，cause，force，admire，condemn，celebrate，dislike，love，help，take，forgive 等。这类词后可以用不定式或动名词作宾语，但不可以用 that 引导的宾语从句。

11.1.7 不可用 that 从句作直接宾语的动词

有些动词不可用于"动词＋间接宾语＋that 从句"结构中，常见的有 envy，order，accuse，refuse，impress，forgive，blame，denounce，advise，congratulate 等。例如：

He impressed the expert as an excellent experimenter.（right）

He impressed the expert that he was an excellent experimenter.（wrong）