物理专业英語文选

下　册

南京大学外文系普通英語教研組編

商务印书館

物理专业英語文选

下 册

南京大学外文系普通英語教研組編

商 务 印 書 館
1961年·北京

内容提要

物理专业英語文选是英語专业文选的一种，由南京大学外文系普通英語教研組根据不同的原文書刊編选注释而成。本書內容主要为有关力学、电学和光学方面的文章，材料足供一年使用。和上册一样，下册也分三十課，每課除正文外，还有詞汇和語法注释；書末附有总詞汇表，便于讀者查閱疑难单詞的释义。

本書可用作大学物理专业的讀本，也可供一般研究物理的英語讀者作为自修的参考書。

物理专业英語文选

下　册

南京大学外文系普通英語教研組編

商　务　印　書　館　出　版

北京复兴門外翠微路

（北京市書刊出版业营业許可証出字第107号）

新华書店北京发行所发行　各地新华書店經售

崇　文　印　刷　厂　印　装

統一書号　9017・277

1961年12月初版　　开本 850×1168 1/32

1961年12月北京第1次印刷　　字数 160千字

印张 6 1/16　　印数 1—8,100册

定价（10）0.95元

CONTENTS

本書所用語法术語略語

a.	adjective (形容詞)
adv.	adverb (副詞)
conj.	conjunction (連接詞)
n.	noun (名詞)
num.	numeral (数詞)
p.a.	participial adjective (分詞形容詞)
pl.	plural (复数)
prep.	preposition (前置詞)
pron.	pronoun (代詞)
sing.	singular (单数)
v.	verb (动詞)

1. FORCE AND COMPOSITION OF FORCES

Mechanics is the branch of physics and engineering which deals with the interrelations of force, matter, and motion. The term force, as used in mechanics,[1] refers to what is known in everyday language as a **push** or a **pull**.[2] We can exert a force on a body by muscular effort, a stretched spring exerts forces on the bodies to which its ends are attached; compressed air exerts a force on the walls of its container; a locomotive exerts a force on the train which it is drawing. In all of these instances the body exerting the force is in contact with the body on which the force is exerted, and forces of this sort are known as **contact** forces. There are also forces which act through empty space without contact, and are called **action-at-a-distance** forces. The force of gravitational attraction exerted on a body by the earth, and known as the weight of the body, is the most important of these for our present study. Electrical and magnetic forces are also action-at-a-distance forces, but we shall not be concerned with them for the present.

All forces fall into one or the other of these two classes, a fact[3] that will be found useful later when deciding just what forces are acting on a given body.[4] It is only necessary to observe what bodies are in contact with the one under consideration. The only forces on the body are then those exerted by the bodies in contact with it, together with the gravitational force or the weight of the body.

Those forces acting on a given body which are exerted by other bodies are referred to as **external** forces. Forces exerted on one part of a body by other parts of the same body are called **internal** forces.

When a number of forces are simultaneously applied at a point, it is found that the same effect can always be produced by a single force having the proper magnitude and direction. We wish to find this force, called the **resultant,** when the separate forces are known. The process is known as the **composition** of forces, and is evidently the converse problem to that[5] of resolving a given force into components. Let us begin by considering some simple cases.

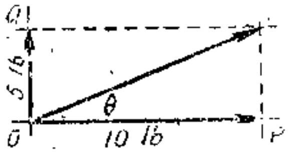

Fig. 1.

(1) Two forces at right angles. Suppose the two forces of 10 lbs and 5 lbs are applied simultaneously at the point O as in Fig. 1. To find the resultant force graphically, lay off the given forces OP and OQ to scale, and draw horizontal and vertical construction lines from P and Q, intersecting at S.[6] The arrow drawn from O to S represents the resultant of the given forces. Its length, to the same scale as that used for the original forces,[7] gives the magnitude of the resultant, and the angle θ gives its direction.

Since the length PS or OQ represents 5 lbs. and the length OP represents 10 lbs, the magnitude of the resultant may be computed from the right triangle OPS. Thus

$$OS = \sqrt{OP^2 + PS^2} = \sqrt{10^2 + 5^2} = 11.2 \text{ lbs.}$$

The **angle** θ may also be computed from either its sine, cosine, or tangent. Thus

$$\sin\theta = \frac{5}{11.2} = 0.447$$

$$\cos\theta = \frac{10}{11.2} = 0.893$$

$$\tan\theta = \frac{5}{10} = 0.500$$

Using any one of these values we find from tables of natural functions

$$\theta = 26.5^\circ$$

We conclude, then, that a single force of 11.2 lbs; at an angle of 26.5° above the horizontal, will produce the

same effect as the two forces of 10 lbs horizontally and 5 lbs vertically. Notice that the resultant is not the arithmetic sum of 5 lbs and 10 lbs. That is, the two forces are not equivalent to a single force of 15 lbs.

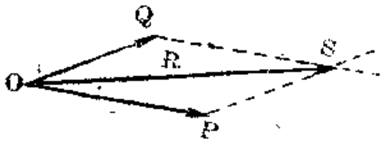

Fig. 2. Parallelogram method for finding the resultant of two vectors.

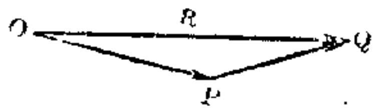

Fig. 3. Triangle method for finding the resultant of two vectors.

(2) Two forces not at right angles. (a) Parallelogram method. Let *OP* and *OQ* in Fig. 2 represent the forces whose resultant is desired. Draw construction lines from *P* parallel to *OQ*, and from *Q* parallel to *OP*, intersecting at *S*. The arrow *OS* represents the resultant *R* in magnitude and direction. Since *OPSQ* is a parallelogram, this method is called the parallelogram method. The magnitude and direction of the resultant may be found by measurement or may be computed from the triangle *OPS* with the help of the sine and cosine laws.

NOTE. The diagonal *QP* is not the resultant of the given forces.

(b) Triangle method. Draw one force vector with its tail at the head of the other as in Fig. 3 (the construction may be started with either vector), and complete the triangle. The closing side of the triangle, *OQ*, represents the resultant. A comparison of Figs. 3 and 2 will show that the same resultant is obtained by either method.

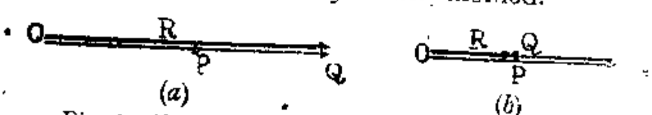

Fig. 4. Vector *R* is the resultant of vectors *P* & Q.

(3) Special case. Both forces in the same line. When both

forces lie in the same straight line the triangle of Fig. 3 flattens out into a line also. To be able to see all of the force vectors, it is customary to displace them slightly as in Fig. 4. We then have Fig. 4 (*a*) or Fig. 4 (*b*), depending upon whether the two forces are in the same or opposite directions.[9] Only in this case is the magnitude of the resultant equal to the sum (or difference) of the magnitude of the components.[10]

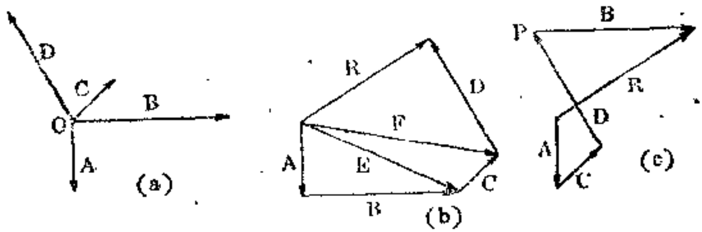

Fig. 5. Polygon method.

(4) More than two forces. Polygon method. When more than two forces are to be combined, one may first find the resultant of any two, then combine this resultant with a third, and so on.[11] The process is illustrated in Fig. 5, which shows the four forces *A*, *B*, *C*, and *D* acting simultaneously at the point *O*. In Fig. 5 (*b*), forces *A* and *B* are first combined by the triangle method giving a resultant *E*; force *E* is then combined by the same process with *C* giving a resultant *F*; finally *F* and *D* are combined to obtain the resultant *R*. Evidently the vectors *E* and *F* need not have been drawn—one need only draw the given vectors in succession with the tail of each at the head of the one preceding it, and complete the polygon by a vector *R* from the tail of the first to the head of the last vector. The order in which the vectors are drawn makes no difference as shown in Fig. 5 (*c*).

詞 汇

composition [kɔmpə'ziʃən] **of forces** 力的合成
branch [brɑːntʃ] *n.* 部門
engineering [endʒi'niəriŋ] *n.* 工程学
deal with 处理，研究
interrelation [intəri'leiʃən] *n.* 相互关系
stretch [stretʃ] *v.* 伸长
container [kən'teinə] *n.* 容器
in contact with 与…接触
sort [sɔːt] *n.* 种类
contact ['kɔntækt] **force** 接触力
empty ['empti] *a.* 空的
action-at-a-distance force 超距力
electrical [i'lektrikəl] *a.* 电的
magnetic [mæg'netik] *a.* 磁的
fall into 分成，归(类)
class [klɑːs] *n.* 种类
together with 和…一起
internal [in'təːnl] **force** 内力
single ['siŋgl] *a.* 单一的
proper ['prɔpə] *a.* 适当的
evidently ['evidəntli] *adv.* 显然地
at right angles 成直角
suppose [sə'pouz] *v.* 假定
lay off 划分
vertical ['vəːtikəl] *a.* 垂直的
intersect [intə'sekt] *v.* 相交
right triangle ['traiæŋgl] 直角三角形
sine [sain] *n.* 正弦
cosine ['kousain] *n.* 余弦
tangent ['tændʒənt] *n.* 正切
table ['teibl] *n.* 表
natural function ['fʌŋkʃən] 自然函数
conclude [kən'kluːd] *v.* 得出結論
notice ['noutis] *v.* 注意
arithmetic [æriθ'metik] **sum** 算术和
equivalent [i'kwivələnt] **to** 等于
parallelogram method [ˌpærə'leləgræm 'meθəd] 平行四边形法
triangle method 三角形法
tail [teil] *n.* 尾部
comparison [kəm'pærisən] *n.* 比較
flatten ['flætən] *v.* 使扁平
customary ['kʌstəməri] *a.* 习惯的
polygon ['pɔligən] **method** 多边形法
in succession [sʌk'seʃən] 相繼
order ['ɔːdə] *n.* 次序

課文注释

1. ... as used in mechanics, 是用 as 引出的状語从句，一般可以簡略，此处 as后省去 it is.
2. what is known in everyday language as a push or a pull 是名詞子句，作前置詞 to 的宾語从句.
3. 此处 a fact 指其前整个句子，因此可說是前面整个句子的同位語.
4. what forces are acting on a given body 是分詞 deciding 的宾語从句.
5. 此处 that 指 the problem.
6. To find the resultant force graphically 是不定式短語，作目的状語；謂語动詞 lay, draw 前的主語省略；to scale 是前置詞短語，作状語，修飾 lay，意即按比例尺.
7. to the same scale as that used for the original forces 是前置詞短語，用作程度状語，修飾 gives.
8. using any one of these values 是分詞短語，用作时間－条件状語，修飾 find.

9. ..., depending upon whether the two forces are in the same or opposite directions. 連接詞 whether 引出的从句，用作现在分詞短語 depending upon 的宾語.

10. Only in this case is the magnitude of the resultant equal to the sum (or difference) of the magnitude of the components. only 表示强調，本句中主語和謂語动詞必須倒装.

11. and so on 这是一連接詞短語，可譯作"等等，以此类推".

2. WEIGHT AND MASS

Every body in the universe exerts a force of gravitational attraction on every other body. The earth attracts the book and pencil lying on your desk; each of these attracts the other; the earth attracts the moon; the sun attracts the earth and the other **planets** of the solar system as well as the **most** distant stars; and each of these bodies pulls back on each of the others which attract it, with an equal and opposite force. This **phenomenon** of universal gravitational attraction will be considered in more detail later. At present we are concerned with one aspect of it only, namely, the force of gravitational attraction between the earth and bodies on or near its surface. **The force of gravitational attraction which the earth exerts on a body is called the weight of the body.** Thus the statement that a man weighs 160 lbs is equivalent to stating that he is attracted by the earth with a force of 160 lbs.[1] Since the weight of a body is a force, it must be expressed in force units, that is, in **pounds**, in the English system, and in **newtons** or **dynes** in the mks or cgs system.

The mass of a body, although it is not the same thing as the body's weight, is directly proportional to the weight as will be shown shortly. Hence the weight of any body of **known** mass can be found by direct proportion if one measures **once and for all**[2] the weight of each unit of mass.

That is, one must measure the force of the earth's attraction, in pounds, for a mass of one slug; the force of attraction, in newtons, for a mass of one kilogram; and the force of attraction, in dynes, for a mass of one gram. The experimental method consists simply of allowing a unit mass to fall freely.[3] While it is falling, the only force acting on it is its weight, which we wish to know, and its acceleration is that of a freely falling body.[4]

Consider a one-slug mass falling freely. Its acceleration is the acceleration of gravity, g, at the point where the experiment is performed. In round numbers, this is 32 ft/sec^2. By definition, a unit force (one pound) imparts to a one-slug mass an acceleration of only 1 ft/sec^2.[5] Since the freely falling slug has an acceleration of g ft/sec^2, the force accelerating it must be g times as great as the unit force, or g pounds. In other words, **one slug weighs g pounds** where g is the local acceleration of gravity expressed in ft/sec^2. In round numbers, **one slug weighs about 32 lbs.**

If the body is one kilogram, falling with an acceleration of g m/sec^2, or about 9.8 m/sec^2, the accelerating force must be g newtons, since by definition a force of one newton imparts to a mass of one kilogram an acceleration of only 1 m/sec^2. Hence **one kilogram weighs g newtons,** where g is the local acceleration of gravity expressed in m/sec^2. In round numbers, **one kilogram weighs about 9.8 newtons.**

Similar reasoning shows that **one gram weighs g dynes,** where g is the local acceleration of gravity expressed in cm/sec^2. In round numbers, **one gram weighs about 980 dynes.**

All bodies, whatever their mass, fall with the same acceleration at the same point on the earth's surface.[6] It follows that the accelerating force or the weight of a body is directly proportional to its mass.[7] If this were not the case[8]—if, for example, the weight of a 2-slug mass were slightly more or less than twice the weight of a 1-slug mass —then the acceleration of a 2-slug mass in free fall would not equal that of a 1-slug mass. Since weight and mass are proportional, and since the weight of each mass unit is known, the weight of any body of known mass can be found, and vice versa.

The preceding analyses can be carried out more briefly by simply applying Newton's second law to any freely falling body of mass m. The resultant force on the body is its weight W, its acceleration is g, and the equation $F=ma$ becomes $W=mg$. In other words, the weight of a body, when expressed in terms of the force unit of any system, is numerically equal to the mass of the body, in the mass unit of that system, multiplied by the corresponding value of the acceleration of gravity.

$$W=mg, \quad m=\frac{W}{g} \tag{1}$$

The reader undoubtedly knows that the force of gravitational attraction between two bodies decreases as the distance between them increases. Therefore, the weight of a body, or the force of gravitational attraction between the body and the earth, is not an invariant property of the body but diminishes as the elevation of the body is increased, because of the increased distance to the earth's center.[9] Since the mass of a body is an invariant property of the body, entirely independent of its position, it follows from Eq. (1) that the acceleration of gravity varies in direct proportion to the variation in a body's weight. That is, the reason that g is smaller at high altitudes than at low is because a body weighs less at high altitudes and therefore accelerates more slowly in free fall.

Much[10] of the confusion which exists between the concepts of weight and mass arises from the fact that the terms pound, gram, and kilogram are often used with other meanings than they have in the English gravitational, the mks and the cgs systems. In the English absolute system of units the unit of mass is the mass of the standard pound, the same body whose weight is the force unit in the English gravitational system. The name "pound" is given to this unit of mass, so we have the same name for a unit of force in one system and a unit of mass in another. The force unit in the English absolute system is the **poundal**, defined as the force which imparts to a "one-pound mass" an acceleration of one ft/sec^2. Since the "pound mass" is 1/32 as large as the slug,[11] the poundal is 1/32 as large as a one-pound force, or about one half an ounce. The English absolute system is not used at all in our country and we shall make no use of it. When the word pound is used, it will refer to a force only.

There are also two other (incomplete) systems of units in which as in the English gravitation system, the unit of force rather than mass is arbitrarily defined. These systems take as their units of force the weight of the standard kilogram, and the weight of a gram. The former force is called "one kilogram of force" and the latter "one gram of force." One "kilogram of force" is about 2.2 lbs of force or about 9.8 newtons; one "gram of force" is about 0.0022 lbs or 980 dynes. The "gram of force" is commonly used as a force unit in elementary physics texts, where the reader has probably met it. The "kilogram force" is used as a force unit in engineering work in those countries which use the metric system exclusively. We shall use either of these units in this book, and the words gram and kilogram will refer to mass only.

词 汇

sun [sʌn] *n.* 太阳
planet ['plænit] *n.* 行星
solar ['soulə] **system** 太阳系
distant ['distənt] *a.* 远方的

star [stɑː] *n.* 星

in more detail [ˈdiːteil] 更加詳細地

later [ˈleitə] *adv.* 以后，后来

aspect [ˈæspekt] *n.* 方面

namely [ˈneimli] *adv.* 即

statement [ˈsteitmənt] *n.* 叙述，講法

equivalent [iˈkwivələnt] *a.* 同等的

shortly [ˈʃɔːtli] *adv.* 馬上，即刻

proportion [prəˈpɔːʃən] *n.* 比，比例

once and for all 一次做成，一劳永逸

experimental [ɪksperiˈmentl] **method** 实驗法

round [raund] **number** 整数

impart [imˈpɑːt] *v.* 分給，产生

reasoning [ˈriːzniŋ] *n.* 推理

local [ˈloukəl] *a.* 局部的

whatever [hwɔtˈevə] *pron.* 任何，无論什么

vice versa [ˈvaisi ˈvəːsə] 反过来說也是这样

analyses [əˈnæləsiːz] *n.pl.* 分析

carry [ˈkæri] **out** 貫彻，实行

freely falling body 自由落体

reader [ˈriːdə] *n.* 讀者

undoubtedly [ʌnˈdautidli] *adv.* 无疑地

elevation [eliˈveiʃən] *n.* 高度

because of 因为，由于

entirely [inˈtaiəli] *adv.* 完全地

altitude [ˈæltitjuːd] *n.* 高度

confusion [kənˈfjuːʒən] *n.* 混乱

arise [əˈraiz] *v.* 发生，出起

absolute [ˈæbsəluːt] *a.* 絕对的

poundal [ˈpaundl] *n.* 磅达（力的单位）

not...at all 完全不，一点也不

make no use of 不利用

incomplete [inkəmˈpliːt] *a.* 不完备的

rather [ˈrɑːðə] **than** 而不是

elementary physics text 初級物理課本

engineering [endʒiˈniəriŋ] *n.* 工程

the metric system [ˈmetrik] 公制

exclusively [iksˈkluːsivli] *adv.* 专門地，单独地

課 文 注 释

1. Thus the statement that a man weighs 160 lbs is equivalent to stating that he is attracted by the earth with a force of 160 lbs (因此，我們說一个人重 160 磅，就等于說他被地球以 160 磅的力所吸引)。本句中第一个 that 引出的从句是主語 statement 的同位定語，第二个 that 引出的从句是动名詞 stating 的宾語从句，而 stating 又是前置詞 to 的宾語。
2. once and for all 是状語短語，修飾 measures，意即一次做成，一劳永逸。
3. The experimental method consists simply of allowing a unit mass to fall freely. allowing a unit mass to fall freely 是动名詞短語，用作 of 的宾語，而其中的动詞不定式短語 to fall freely 又是 allowing 的宾語 a unit mass 的补足語。
4. While **it** is falling, the only force acting on it is its weight, which we wish to know, and its acceleration is that of a freely falling body. 本句是主从复合句，主句本身是并列复合句，即 the only force acting on it is its weight 和 its acceleration is that of a freely falling body; while it is falling 是这两个并列复合句的共同的时間状語从句; which we wish to

know 是并列复合句第一个独立子句的表語 weight 的定語从句；第二个独立子句中的 that 代替 the acceleration.

5. By definition, a unit force (one pound) imparts to a one-slug mass an acceleration of only 1 ft/sec^2. acceleration 是 imparts 的宾語.
6. All bodies, whatever their mass, fall with the same acceleration at the same point on the earth's surface. whatever their mass 是 whatever their mass may be 的省略形式，因此是省略的讓步状語从句，意即不管它們的質量是多少.
7. It follows that the accelerating force or the weight of a body is directly proportional to its mass. It 是先行代詞，指代后面 that 引出的主語从句，意即从此可以推得…；这种句型在科技英語中極为普通.
8. If this were not the case — if, for example, the weight of a 2-slug mass were slightly more or less than twice the weight of a 1-slug mass — then the acceleration of a 2-slug mass in free fall would not equal that of a 1-slug mass. If this were not the case 是連接詞 if 引出的条件状語从句，它表示虛拟語气，与事实相反，因此謂語动詞必須用 were，而主要子句的謂語动詞前必須用 would；意即假如不是这样.
9. … because of the increased distance to the earth's center. because of 是复合前置詞，和其宾語构成原因状語.
10. 此处 much 是名詞，等于 a good deal，意即許多，大量；在句中作主語.
11. Since the "pound mass" is 1/32 as large as the slug. as the slug 是比較状語从句，是 as the slug is large 的省略形式，但必須省略.

3. NEWTON'S FIRST LAW AND THIRD LAW

Newton's first law states that **when a body is at rest or moving with constant speed in a straight line, the resultant of all of the forces exerted on the body is zero.** The various girders, beams, columns, etc., which form the structure of a building or bridge, are bodies at rest. The forces exerted on them are their own weights, those exerted by other parts of the structure, and whatever loads the structure must carry. Since the resultant of all of the forces must be zero, if some of the forces are known the others may be computed. By successive application of Newton's first law to the various elements of a structure the engineer can compute how much force each part must withstand and therefore how strong each girder, beam, or column must be.

In most instances the forces on a structural element are so distributed that the turning effect, or the moment of each force, must also be taken into account. We shall postpone this complication, and consider for the present only structures in which all of the forces intersect at a common point. We shall also limit the discussion to co-planar forces.

Notice particularly that three words are emphasized in the preceding statement of Newton's first law—"the resultant of all of the forces exerted on the body." Most[2] of the difficulties encountered in the application of this law to specific problems are due to a failure to use the resultant force, or to include all of the forces, or to use the forces exerted on the body.[3] Furthermore, since Newton's second law also involves the resultant of all of the forces exerted on a body, it is extremely important that one should learn as early as possible how to recognize just what forces are exerted on a particular body.

When the resultant of all of the forces on a body is zero the body is said to be in **equilibrium.** This[4] will be the case if it is at rest or moving with constant speed in a straight line. Both of these cases are grouped under the common heading of problems in statics. The forces on a body in equilibrium must satisfy the following conditions:

$$\Sigma X = 0, \qquad \Sigma Y = 0 \tag{1}$$

These equations are sometimes called the "first condition of equilibrium."

A carefully drawn diagram, in which each force exerted on a body is represented by an arrow, is essential in the solution of problems of this sort. The standard procedure is as follows: First, make a neat sketch of the apparatus or structure. Second, choose some one body which is in equilibrium and in a separate sketch show all of the forces exerted on it. This is called "isolating" the chosen body. Write on the diagram, which should be sufficiently large to