中小学
双语师资培养系列教材

总主编　刘春明

中学物理专业基础英语教程

A Fundamental English Course in Secondary School Physics

◎ 齐海燕 陈红君 贺小光 // 主编

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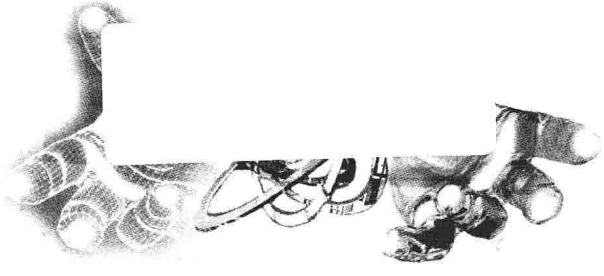

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前　言

20 世纪 90 年代以来，我国基础教育领域广泛开展了学科双语教学，急需大量中小学双语教师，高等师范院校理应承担起为中小学培养优秀双语教师的任务。迄今为止，我国高等师范院校中从未设立双语教学专业，现有的双语教师也基本上没有接受过专门的系统的双语教学培训，因此，编写双语师资培养的相关教材势在必行。

本书按照中学物理课程标准的要求，选取相应的英语文献资料进行统一编排，使学生掌握物理专业知识的英语表达方式，着重提高学生的物理专业英语的综合运用能力，为学生将来从事中学物理双语教学工作作好必要的准备。全书共分为 14 章，包括力学、热学、光学、电学、磁学等相关内容。

本书的编写力求适应中学物理双语师资培养的要求，为相关专业领域的师生服务。由于我们的编写水平有限，本书中一定有许多不妥之处，敬请各位同行和广大读者批评指正。

本书第 1，2，3，5，6，7，8，9，10 章由齐海燕编写，第 4，11，14 章由陈红君编写，第 12，13 章由贺小光编写，史俊杰负责全书的图片表格整理工作及校对工作，全书由齐海燕任主编。

CONTENTS

Unit 1 Physical Quantities and Measurement

Goals

After completing this unit, you will be able to:

* understand that all physical quantities consist of a numerical magnitude and a unit

* recall the seven base quantities and their units

* use prefixes and symbols to indicate very big or very small SI quantities

* describe how to measure a variety of lengths using the appropriate instruments

* describe how to measure periods of time using the pendulum, stopwatch and other appropriate instruments

New words and expressions

numerical 数字的，数值的

magnitude 大小

quantity 量，数量
thermodynamic 热力学的
luminous intensity 光照强度
amount of substance 物质的量
derived quantities 导出量
prefix 前缀
tape 胶带，卷尺
retractable 伸缩自如的
precision 精度
parallax 视差
caliper 卡尺，卡钳
vernier caliper 游标卡尺
micrometer screw gauge 螺旋测微器，螺旋千分尺
pendulum 钟摆，单摆
stopwatch 秒表，停表
oscillation 振荡，振动

Warming up

1. Why must physical quantities and units be clearly defined?

2. What is the SI unit for length? Write down some other units for length.

3. What is the SI unit for time? Write down some other units for time.

4. Can you tell me the width of your desk? How to measure the width?

Pre-reading

1. Write down some physical quantities and units in life.

2. Can you find the difference between physical quantities and numbers?

3. Provide some common measuring instruments of length and time.

4. Find some images of the vernier calipers and micrometer screw gauge on the Internet.

Reading

Physical Quantities and SI Units

➢ Physical quantities

A physical quantity is a quantity that can be measured. It consists of a numerical magnitude and a unit. They are found almost everywhere in our daily lives. For example, the sign found on an overhead bridge warns vehicles above the height of 4. 5m not pass underneath it.

There are altogether seven basic physical quantities, or **base quantities**. Length and time are two of them. Table 1. 1 shows the seven base quantities.

Table 1.1 The seven base quantities and their SI units

Base physical quantity	SI base unit	
	Name	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Amount of substance	mole	mol
Luminous intensity	candela	cd

The units of these seven base quantities are known as the SI units, from the French Le Système International d'Unités. Out of the seven basic quantities and their corresponding SI units, you will learn five of them in this course. They are length, mass, time, electric current and temperature.

All other common physical quantities such as area, volume and speed are derived from these seven quantities. They are called **derived quantities**. For example, speed is derived from length and time. Table 1.2 gives example of how some common physical quantities are derived from the base quantities.

Table 1.2 Some common derived quantities and units

Derived physical quantity	Defining equation	Symbol for unit
Speed	distance/time	$m \cdot s^{-1}$
Area	length× width	m^2
Volume	length× width× height	m^3

➢ **Why do we need SI units?**

In the past, people used parts of their bodies and things around them as units of measurement. That was how measuring terms like foot, yard and horsepower came about. Unfortunately, such methods of measurement created much confusion. It was not until 1968 that scientists agreed to adopt one universal set of units—the SI units.

➢ **Prefixes for SI units**

Using decimal notation, the distance between air molecules would be represented as 0.000 000 01 m. It would be cumbersome if we need to mention this quantity a number of times.

It would be more convenient if we use prefixes to represent the above quantity. In this case, it can be expressed as 0.01 μm where μ represents the submultiple 10^{-6}. The prefixes listed in Table 1.3 are very big or very small.

Another convenient and acceptable way of expressing the same quantity is to use the standard form. In this case, it will be expressed as 1×10^{-8} m.

Table 1.3 Some common SI prefixes

Prefix	Symbol	Factor
pico-	p	10^{-12}
nano-	n	10^{-9}
micro-	μ	10^{-6}
milli-	m	10^{-3}
centi-	c	10^{-2}
deci-	d	10^{-1}
kilo-	k	10^{3}
mega-	M	10^{6}
giga-	G	10^{9}
tera-	T	10^{12}

In Physics, length is an important quantity that is measured almost all the time. For example, we measure length to know how far an object has moved, how much space an object occupies or how far apart two objects are.

The SI unit for length is the metre. There is a wide range of lengths in this world. It is necessary to use the appropriate instruments and methods to measure different types of length. The metre rule and tape measure are just two examples of instruments that can be used. In following pages, you will learn more about measuring instruments and how to use them.

Measurement of Length

➢ The metre rule and the tape measure

The metre rule and tape measure are common instruments used to measure length.

A measure rule can measure lengths of up to one metre. A retractable steel tape is suitable for distances longer than a metre. Suppose we want to measure the width of a pond that is about 10 m. Which measuring instrument should we use?

We should use a retractable steel tape. The retractable steel tape should be long enough to measure the distance. How about measuring how deep the pond is? A metre rule may be used.

1. Precision of an instrument

What is the smallest unit on the metre rule? It is 0.1 cm or 1 mm. The smallest unit an instrument can measure is known as its "precision". For example, the metre rule cannot accurately measure the thickness of a piece of paper, which is obviously thinner than 1mm. You will have to estimate its thickness. In this

case, the uncertainty, known as the instrument error, is due to the limitations of the metre rule.

2. Avoiding reading errors

When you sue a metre rule, position your eye directly above the markings to avoid **parallax errors.** By taking several readings and taking the average, your will minimize reading errors.

Do take note that for metre rules, the zero mark is often at the very end of the rule. Wear and tear of the metre rule may make this mark unsuitable for measuring purposes. This worn end may introduce errors to the readings. Hence, it is better to measure from some randomly chosen point and subtracts it from the final reading.

➢ The calipers

An instrument for measuring the diameters of cylinders or circular objects are the calipers. The jaws of the calipers are used to grip the widest part of the object. When the object is removed, the distance between the jaws can be measured using a metre rule. (Figure 1. 1)

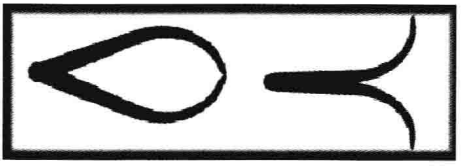


Figure 1. 1 External calipers and internal calipers

➢ The vernier calipers

The vernier calipers (Figure 1. 2) consist of a main scale and a sliding vernier scale. It is a useful tool that is used to measure both the internal and external diameters of an object. The vernier

calipers are able to measure to a precision of 0. 01 cm. Figure 1. 2 on the following page shows how to use the vernier calipers.

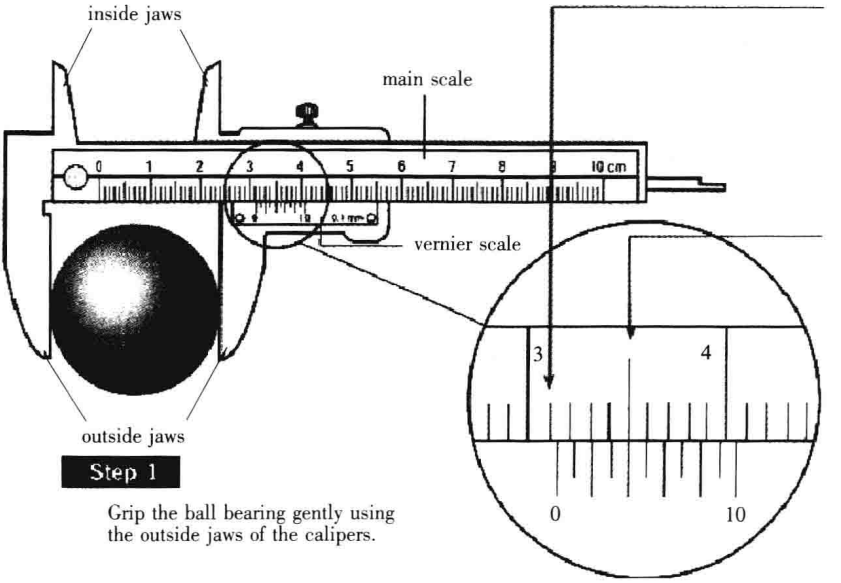
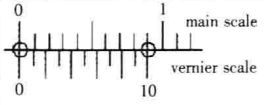
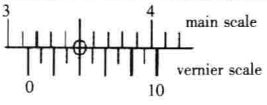
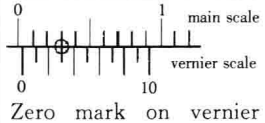
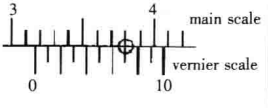
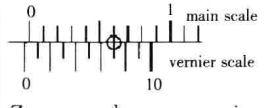
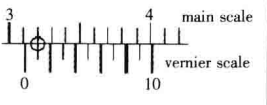


Figure 1. 2 Using vernier calipers to measure the diameter

1. Avoiding reading errors when using the vernier calipers

Before using the vernier calipers, we need to examine the instrument for zero error. This is to check that the zero mark on the main scale coincides with the zero mark on the sliding vernier scale when we are not measuring anything between the jaws. Table 1. 4 on the following page shows how we should deal with zero errors on the vernier calipers.

Table 1.4 Checking and correcting zero errors when using the vernier calipers

Checking for zero error	Observed reading	Corrected reading
 The two zero marks coincide—**no zero error.**	 Reading = 3.14 cm	3.14 cm (No zero error correction required)
 Zero mark on vernier slightly to the right — **positive zero error** of +0.03 cm.	 Reading = 3.17 cm	3.17 cm − (+0.03) = 3.14 cm (The positive zero error is subtracted from the reading)
 Zero mark on vernier slightly to the left — **negative zero error** of −0.03 cm (count from 10).	 Reading = 3.11 cm	3.11 cm − (−0.03) = 3.14 cm (The negative zero error is added to the reading)

2. How to use the vernier calipers?

Step 1: Grip the ball bearing gently using the outside jaws of the calipers.

Step 2: Read the main scale directly opposite the zero mark on the vernier scale. In this case, the reading on the main scale is 31 mm or 3.1 cm.

Step 3: The 4th vernier mark coincides with a marking on the main scale. This gives a reading of +0.4 mm or +0.04 cm to be added to the main scale reading.

Step 4: The diameter is found by adding the main scale reading to the vernier scale reading:

31 mm+0.4 mm=31.4 mm (Figure 1.2)

➢ The micrometer screw gauge

The micrometer screw gauge is used to measure lengths to a precision of 0.01 mm or 10 micrometers (Figure 1.3). It can measure the external diameter of wires and ball bearings. We use it mainly to measure anything less than 1 cm—too small for the vernier calipers to measure. How to use the micrometer screw gauge?

Step 1: Turn the thimble until the anvil and the spindle gently grip the object. Then turn the ratchet until it starts to click.

Step 2: Read the main scale reading at the edge of the thimble. In this case, it is 8.5 mm.

Step 3: The thimble scale has 50 divisions, each of which is 0.01 mm. Take the thimble reading opposite the datum line of the main scale. In this case, it is 40 divisions, which gives a value of 40×0.01 mm=0.40 mm.

Step 4: Diameter is found by adding the main scale reading to the thimble reading: 8.5 mm+0.40 mm=8.90 mm.

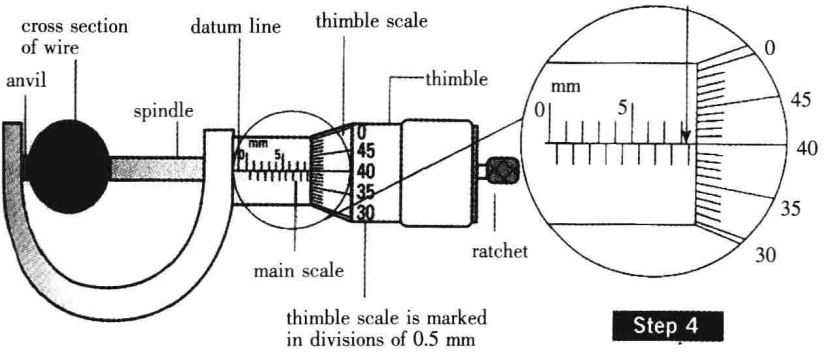


Figure1.3 Using the micrometer screw gauge to measure the diameter

Measurement of Time

➢ **How do we measure time?**

Imagine that you are stranded on an island. You do not have a watch or mobile phone. How can you tell the time?

One obvious way is to keep track of the position of the Sun. At noon, the Sun is high in the sky. During the evening, it is low in the western sky. After the Sun sets, we know that it is night. By counting the number of sunsets, we can determine the number of days.

What property of the Sun are we using to measure time? We are making use of the fact that the Sun rises and sets each day—an event that repeats at a regular interval. We measure time by observing events that repeat at regular intervals or periods.

Many natural events repeat themselves at regular intervals. The Sun sets daily. The shape of the Moon changes from a full Moon to a crescent and back to a full Moon again, showing that a month has passed by. In temperate countries, spring comes once a year. These are examples of time intervals: day, month and year. They are relatively long time intervals.

➢ **Using a pendulum to tell time**

A simple pendulum can be used to measure time more accurately. It consists of a heavy object called a bob, like a metal ball, attached to a string. The string is fixed at one end. If we swing the pendulum, it will move back and forth at regular intervals. Each completer to and fro motion is one oscillation. The period of the simple pendulum is the time taken for one complete oscillation.

On Earth, it is known that the period of a pendulum depends