国家级课题

“我国素质教育背景下的双语教学理论与实践研究”课题组

推荐用书

PHYSICS GCSE

高中物理英文课本

（中文注释）

[英]汤姆·邓肯　希瑟·肯尼特 著

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The Textbook Series of *Bilingual Pedagogy and Practice for Capacity Education in China* — a National Education Science Project for the Tenth Five-Year Plan

Foreword

The 21st century will be a special one for China. The past century witnessed a series of great changes in the country of a 5000-year civilization. China has changed from a closed, backward, despised monarchical nation into an open, dynamic and respectable socialist state with strong comprehensive strength. However, the 20th century left behind only a newly-decorated stage for the Chinese people, and their historical task is to stage a really splendid life drama in the 21st century.

China in the 21st century cannot develop without being closely linked with the international environment. In today's world there is a trend of integration of science, economy, and culture, which are promoting each other, learning from each other, and blending each other. China's entry into WTO, her hosting the 2008 Olympic Games and the 2010 World Expo, and her increasing use of the Internet all require that the whole nation, especially the adolescents, should enhance their foreign language ability. It will be of great significance to carry out bilingual teaching research and practice in some regions with advanced education system. *Bilingual Pedagogy and Practice for Capacity Education in China* —a National Education Science Project for the Tenth Five-Year Plan —is a comprehensive research project including the development of the textbook series.

Generally speaking, in the Chinese language context, bilingual teaching refers to the practice that all non-linguistic subjects are instructed totally or partly in a foreign language. This sort of teaching demands new textbooks and new approaches to learning. Thus, all teachers face great challenges in terms of their language ability, subject expertise, teaching skills and methodology. The aim of bilingual teaching is not merely language acquisition, for language is a tool of thinking, and the command of a new language means the command of a new way of thinking. And the change of thought pattern will lead to a better communication and a better understanding between different races, different nations and also different cultures. Strictly speaking, bilingual teaching should go for the multiple objectives of languages, disciplines and thought patterns.

The natural science textbooks by the British JOHN MURRY Press are quite novel, both in the content and in the style, and has a wide coverage with proper levels according to the educational reforming in China. The series of textbooks are also supervised by GCSE (General Certificate of Secondary Education of Britain). These are all characteristics beneficial to students' learning. Our compilers of the series have made careful adaptation and necessary explanation in line with the status quo of education in China. The layout of the series, with necessary notes of special terms at the end of each section, can not only meet the needs of different students, but also make easy reading. The series is a worthwhile model among bilingual textbooks. We hope the users of the textbooks will kindly give us their valuable comments and suggestions so as to contribute to the development of bilingual teaching.

Professor Qian Yuanwei
Head of *Bilingual Pedagogy and Practice for Capacity Education in China*
(A National Education Science Project for the Tenth Five-Year Plan)
Fundamental Educational Office
Shanghai Teachers' University
April 5, 2003

序　言

21世纪对于中国来说，将是一个不寻常的100年。过去的100年是我们这个具有5000年文明史的国家变化极为剧烈的时期。从一个闭关自守的、落后的、被世人看不起的君主国家演变为开放的、充满活力和具有不可忽视的综合国力的新型社会主义国家。然而，20世纪留给国人的还只是一个装饰一新的大舞台，在这一舞台上演出一台绚丽的生活秀是身处21世纪的人们不可推卸的历史重任。

21世纪中国的发展离不开国际大背景，当今世界正在涌动着一体化大潮，科学的、经济的、乃至文化的各个领域，正在互相推动，互相借鉴，互相交融。中国进入WTO，申奥成功，申博成功，国际互联网的广泛运用……都迫切需要全面提高国民，尤其是青少年一代的外语能力。在具备基本条件的若干教育发达地区，率先展开双语教学的实践研究具有前瞻性的重要意义。教育科学“十五”国家课题《我国素质教育背景下的双语教学理论与实践研究》是一项全面的行动研究，其中包括课程教材研发。

一般而言，在我国语言环境下，双语教学是指在非语言学科课程中使用部分或全部外国语的教学。这种教学，在学生的学习资料、学习方式等方面，提出了新的要求；而教师的语言与学科底蕴、教学技能、教学方法等也将面临全新的严峻挑战。双语教学目标并非单纯的是语言，语言是思维的工具，掌握一门新的语言也就是掌握了新的思维方式，而思维方式的改变必将导致不同民族、不同国家乃至不同文化之间的沟通和理解。规范地讲，双语教学应研究语言、学科知识、思维等多元目标。

英国JOHN MURRY出版公司出版的自然科学教材无论在内容上，还是在形式上都比较新颖，面广且深度适中，正符合我国教育改革的方向，特别有利于一般学生学习。这套教材是GCSE的审定教材，GCSE是英国General Certificate of Secondary Education （普通中学证书）的简称。本书整理者又根据我国的教学背景作了合理的编排调整和注释，这种编排顾及了不同层次学生的需求；又对专业知识、专业术语作了必要的注释，均列在每小节末，便于阅读。这是一套值得去试一试的双语教学范本。希望使用本书的师生提出宝贵意见，让我们共同为双语教学的健康发展而努力。

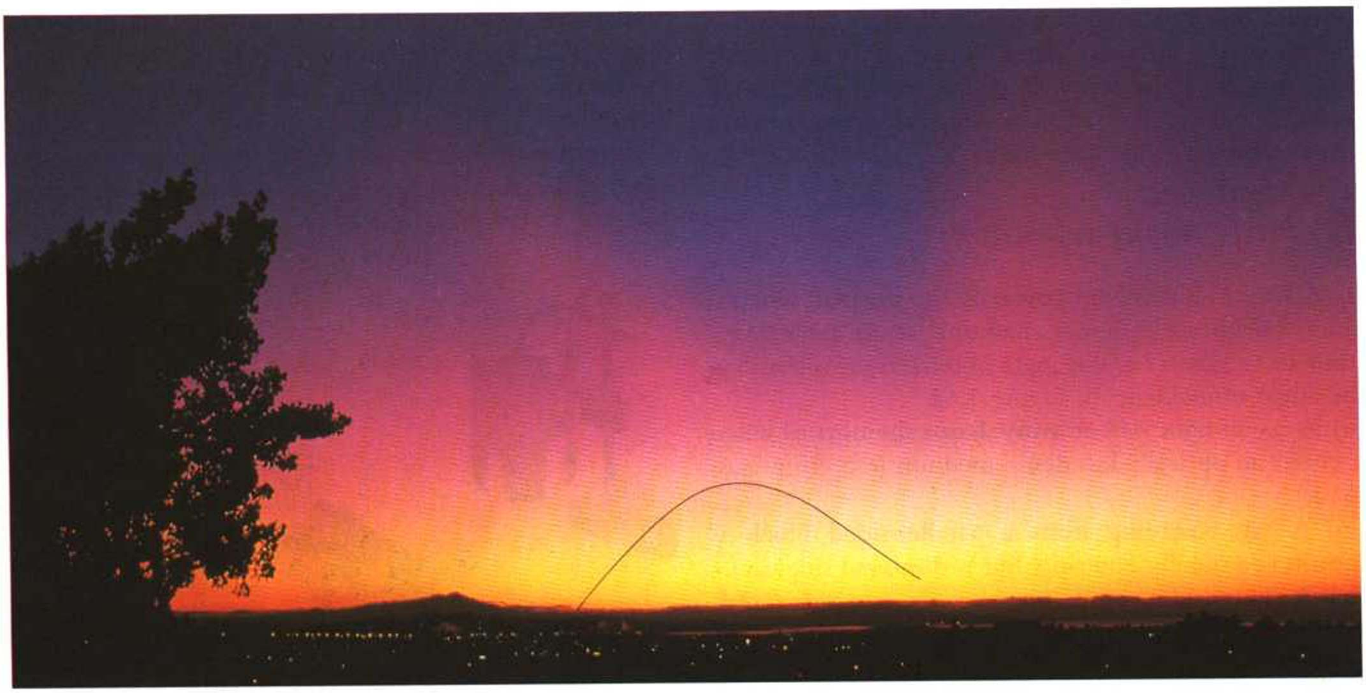
“十五”国家课题《我国素质教育背景下的双语教学理论与实践研究》课题负责人钱源伟

2003年4月5日　于上海师范大学基础教育处

Contents

Earth and space physics

Light and sight



1 Refraction of light

Facts about refraction
Real and apparent depth
Refractive index[1]
Refraction by a prism
Practical work
Refraction in glass.

If you place a coin in an empty mug and move back until you *just* cannot see it, the result is surprising if someone *gently* pours in water. Try it.

Although light travels in straight lines in one transparent material, such as air, if it passes into a different material, such as water, it changes direction at the boundary between the two, i.e. it is bent. The **bending of light** when it passes from one material (called a medium) to another is called **refraction**[2]. It causes effects like the coin trick.

Facts about refraction

(i) A ray of light is bent **towards** the normal[3] when it enters an optically denser medium[4] at an angle (e.g.[5] from air to glass), i.e. the angle of refraction *r* is less than the angle of incidence[6] *i*, Figure 1.1a.
(ii) A ray of light is bent **away from** the normal when it enters an optically less dense medium (e.g. from glass to air).
(iii) A ray emerging from a parallel-sided block is **parallel** to the ray entering, but is displaced sideways.[7]
(iv) A ray travelling along the normal is **not refracted**, Figure 1.1b.

Note 'Optically denser' means having a greater refraction effect; the actual density may or may not be greater.

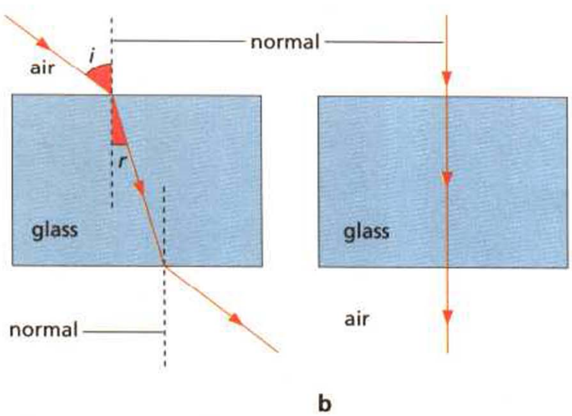


Figure 1.1 Refraction of light in glass

Practical work

Refraction in glass

Shine a ray of light at an angle on to a glass block (which has its lower face painted white or frosted)[8], Figure 1.2. Draw the outline ABCD of the block on the sheet of paper under it. Mark the positions of the various rays in air and in glass.

Remove the block and draw the normals on the paper at the points where the ray enters AB (see Figure 1.2) and where it leaves CD.

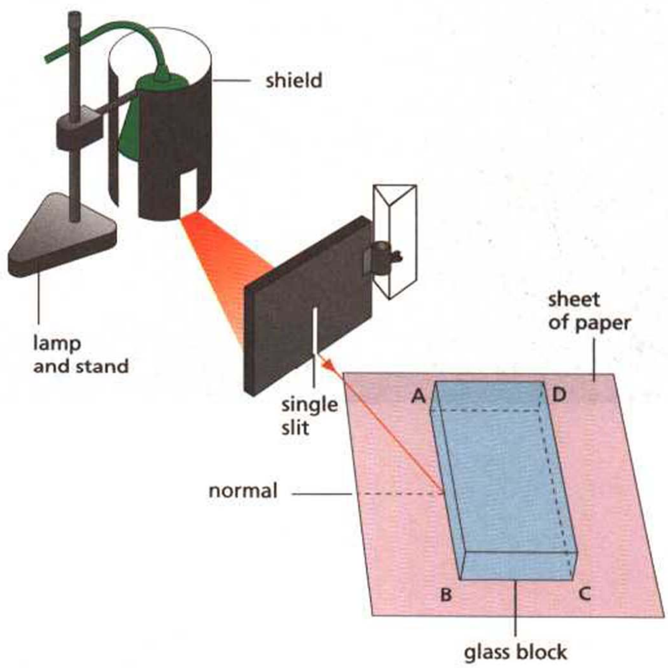


Figure 1.2

What *two* things happen to the light falling on AB? When the ray enters the glass at AB is it bent towards or away from the part of the normal in the block? How is it bent at CD? What can you say about the direction of the ray falling on AB and the direction of the ray leaving CD?

What happens if the ray hits AB at right angles?

Real and apparent depth

Rays of light from a point O on the bottom of a pool are refracted away from the normal at the water surface since they are passing into an optically less dense medium, i.e. air, Figure 1.3. On entering the eye they appear to come from a point I *above* O; I is the virtual image of O formed by refraction. The apparent depth of the pool is less than its real depth.

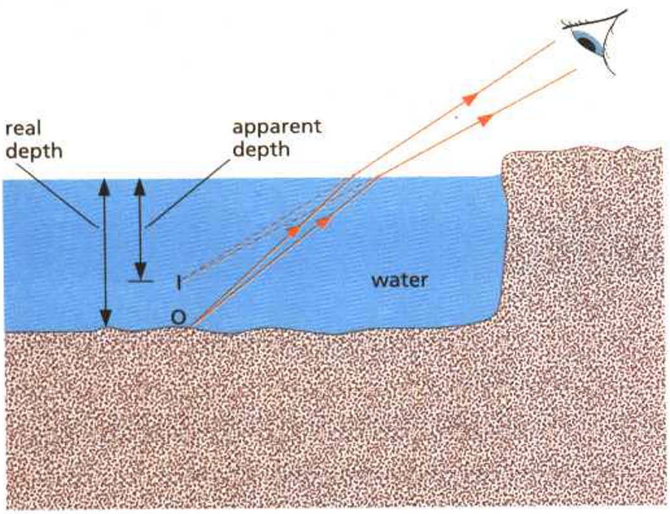


Figure 1.3 A pool of water appears shallower than it is

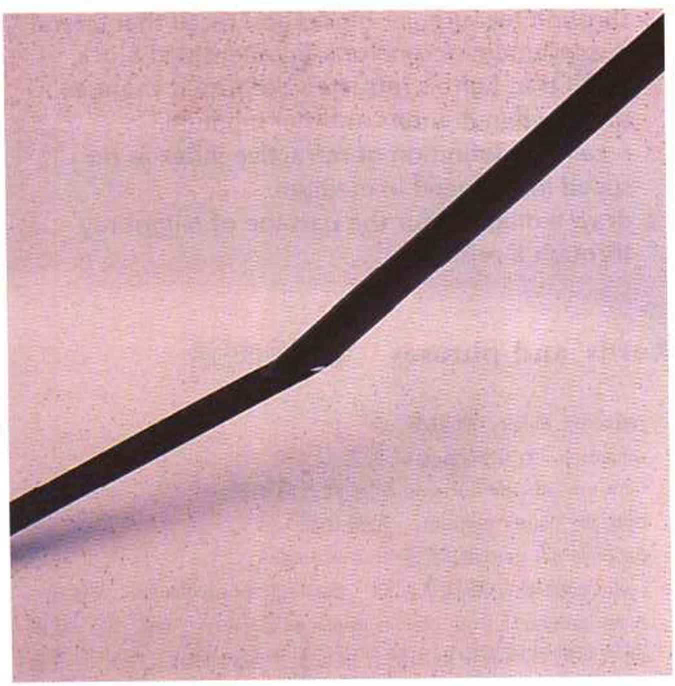


Figure 1.4 A straight stick seems bent in water. Why?

Refractive index

Light is refracted because its speed changes when it enters another medium. An analogy helps to explain why.

Suppose three people A, B, C are marching in line, with hands linked, on a good road surface. If they approach marshy ground at an angle, Figure 1.5a, A is slowed down first, followed by B and then C. This causes the whole line to swing round and change its direction of motion.

In air (and a vacuum) light travels at 300 000 km/s (3×10^8 m/s), in glass its speed falls to 200 000 km/s (2×10^8 m/s), Figure 1.5b. The **refractive index** n of the medium, i.e. glass, is defined by the equation

$$\text{refractive index } n = \frac{\text{speed of light in air (or a vacuum)}}{\text{speed of light in medium}}$$

$$\therefore \quad n = \frac{300\,000\text{ km/s}}{200\,000\text{ km/s}} = \frac{3}{2}$$

Experiments also show that

$$n = \frac{\text{sine of angle of incidence}}{\text{sine of angle of refraction}}$$

$$= \frac{\sin i}{\sin r} \quad \text{(see Figure 1.1a)}$$

The more light is slowed down when it enters a medium from air, the greater is the refractive index of the medium and the more it is bent.

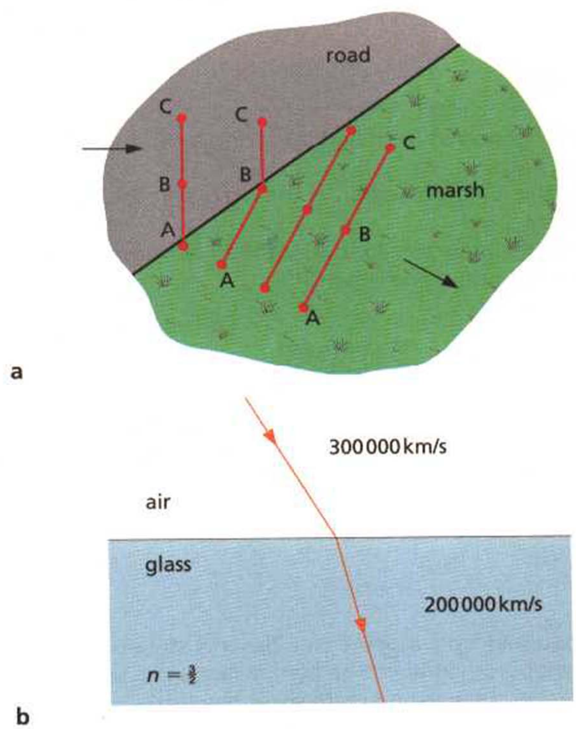
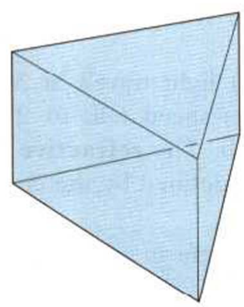


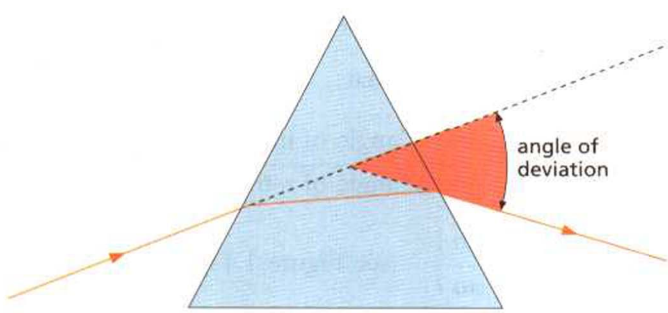
Figure 1.5

Refraction by a prism

In a triangular glass prism[9], Figure 1.6a, the deviation (bending) of a ray[10] due to[11] refraction at the first surface is added to the deviation at the second surface, Figure 1.6b. The deviations do not cancel out as in a parallel-sided block where the emergent ray, although displaced, is parallel to the incident ray.



a



b

Figure 1.6

Questions

1 Figure 1.7 shows a ray of light entering a rectangular block of glass.
 a Copy the diagram and draw the normal at the point of entry.
 b Sketch the approximate path of the ray through the block and out of the other side.

Figure 1.7

2 Draw two rays from a point on a fish in a stream to show where someone on the bank will see the fish. Where must the person aim to spear the fish?

3 What is the speed of light in a medium of refractive index 6/5 if its speed in air is 300 000 km/s?

4 Figure 1.8 shows a ray of light OP striking a glass prism and then passing through it. Which of the rays **A** to **D** is the correct representation of the emerging ray?

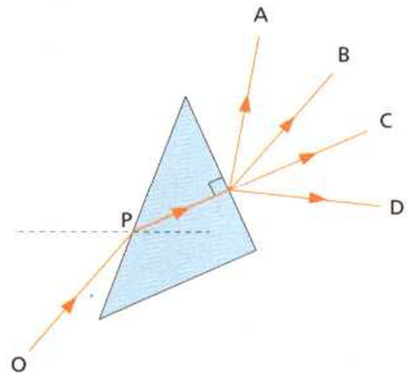


Figure 1.8

Checklist

After studying this chapter you should be able to

- state what the term **refraction** means,
- give examples of effects that show light can be refracted,
- describe an experiment to study refraction,
- draw diagrams of the passage of light rays through rectangular blocks and recall that lateral displacement occurs for a parallel-sided block,
- recall that light is refracted because it changes speed when it enters another medium,
- recall the definition of refractive index as n = speed in air/speed in medium,
- draw a diagram for the passage of a light ray through a prism.

Words and phrases 单词和短语

1 refractive index 折射率
2 refraction / rɪ'frækʃən / n. 折射
3 bent towards the normal 朝法线方向偏转
4 optically denser medium 光密介质
5 e.g.(exempli gratia的缩写)=for example
6 i.e.(id est的缩写)那就是，即 the angle of incidence 入射角
7 A ray emerging from...but is displaced sideways. 译：从一块两面平行的玻璃板中射出的光线平行于射入时的光线，但是有了侧移。
8 "which has its lower face painted white or frosted" 补充说明 "a glass block"，意为：玻璃的底部涂成白色或使其成为毛面
9 triangular / traɪ'æŋgjʊlə / a. 三角形的 ~glass prism 三角形的玻璃棱镜
10 the deviation (bending) of a ray 光线的偏离
11 due to 由……引起

2 Total internal reflection

Critical angle

When light passes at small angles of incidence from an optically denser to a less dense medium, e.g. from glass to air, there is a strong refracted ray and a weak ray reflected back into the denser medium, Figure 2.1a. Increasing the angle of incidence increases the angle of refraction.[2]

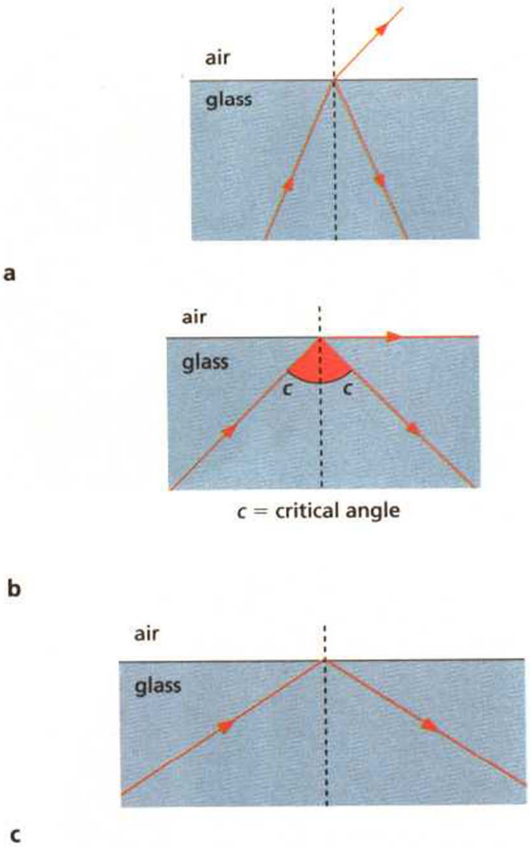


Figure 2.1

At a certain angle of incidence, called the **critical angle** *c*, the angle of refraction is 90°, Figure 2.1b. For angles of incidence greater than *c*, the refracted ray disappears and *all* the incident light is reflected inside the denser medium, Figure 2.1c. The light does not cross the boundary and is said to undergo **total internal reflection**[3].

Practical work

Critical angle of glass

Place a semicircular glass block on a sheet of paper, Figure 2.2, and draw the outline LOMN where O is the centre and ON the normal at O to LOM. Direct a narrow ray (at an angle of about 30°) *along a radius towards* O. The ray is not refracted at the curved surface. Why? Note the refracted ray in the air beyond LOM[4] and also the weak internally reflected ray in the glass.

Slowly rotate the paper so that the angle of incidence increases until total internal reflection *just* occurs. Mark the incident ray. Measure the angle of incidence; it equals the critical angle.

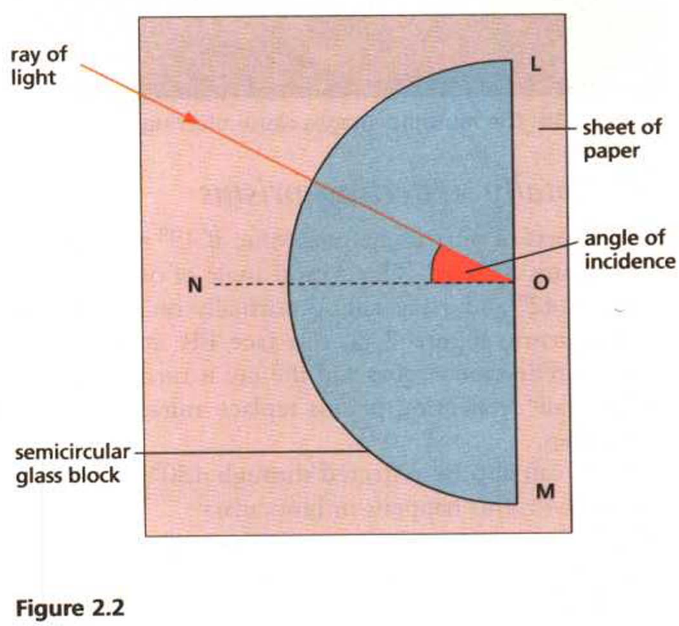


Figure 2.2

Multiple images in a mirror

An ordinary mirror silvered at the back[5] forms several images of one object, due to[6] multiple reflection inside the glass, Figures 2.3a, b. These blur the main image I (which is formed by one reflection at the silvering), especially if the glass is thick. The trouble is absent in front-silvered mirrors but they are easily damaged.

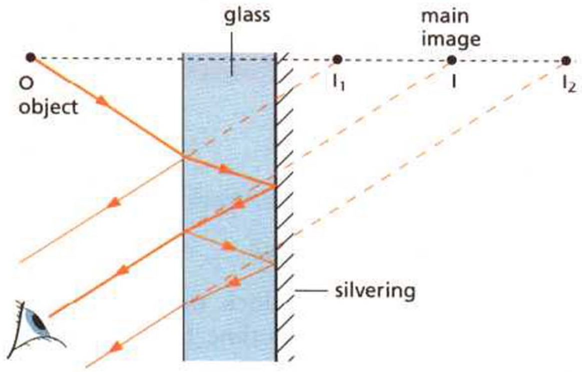


Figure 2.3a Multiple reflections in a mirror

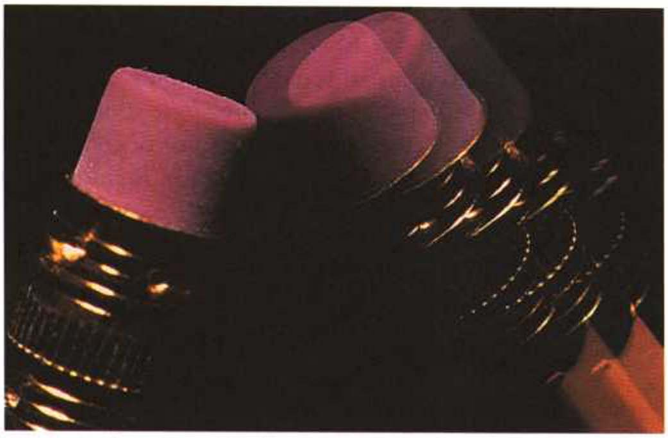
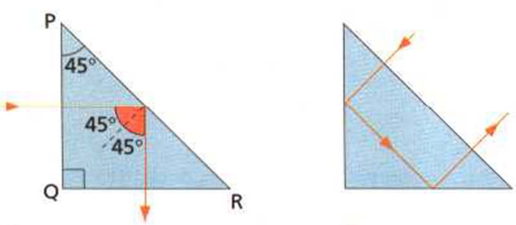


Figure 2.3b The multiple images cause blurring

Totally reflecting prisms

The defects of mirrors are overcome if 45° right-angled glass prisms are used. The critical angle of ordinary glass is about 42° and a ray falling normally on face PQ of such a prism, Figure 2.4a, hits face PR at 45°. Total internal reflection occurs and the ray is turned through 90°. Totally reflecting prisms replace mirrors in good periscopes.

Light can also be reflected through 180° by a prism, Figure 2.4b; this happens in binoculars[7].



a b

Figure 2.4 Reflection of light by a prism

Light pipes and optical fibres

Light can be trapped by total internal reflection inside a bent glass rod and 'piped' along a curved path, Figure 2.5.[8] A single, very thin glass fibre behaves in the same way. If several thousand such fibres are taped together a flexible light pipe is obtained that can be used, for example, by doctors as an 'endoscope', Figure 2.6a, to obtain an image of an internal organ in the body, Figure 2.6b, or by engineers to light up some awkward spot for inspection. The latest telephone 'cables' are optical (very pure glass) fibres carrying information as pulses of laser light.

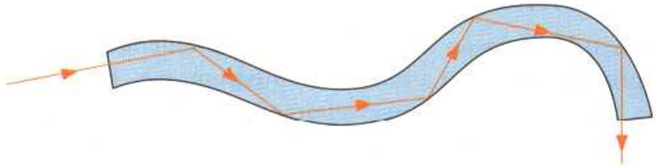


Figure 2.5 Light travels through a curved glass rod or fibre by total internal reflection

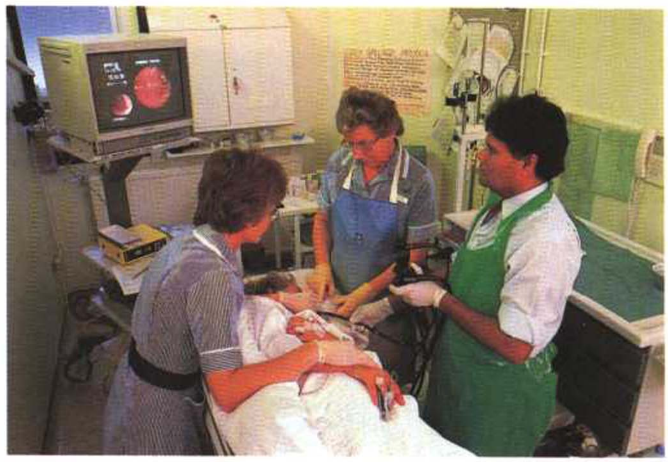


Figure 2.6a Endoscope in use

Figure 2.6b Trachea (windpipe) viewed by an endoscope

Questions

1 Figure 2.7 shows rays of light in a semicircular glass block.

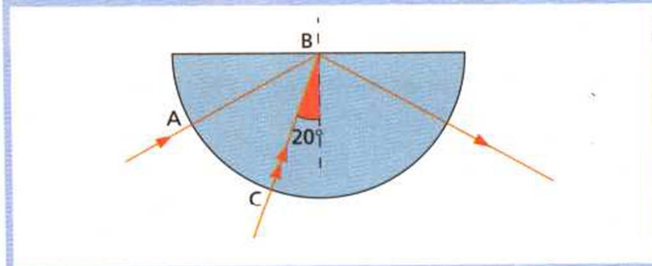


Figure 2.7

a Explain why the ray entering the glass at A is not bent.
b Explain why the ray AB is reflected at B and not refracted.
c Ray CB does not stop at B. Copy the diagram and draw its approximate path after it leaves B.

2 Copy Figures 2.8a and b and complete the paths of the rays through the glass prisms.

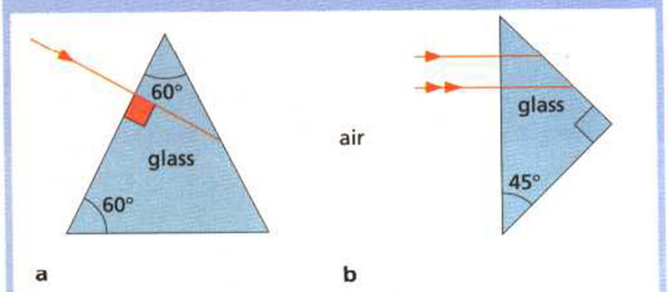


Figure 2.8

3 Name two instruments which use prisms to reflect light.

Checklist

After studying this chapter you should be able to

- explain with the aid of diagrams what is meant by **critical angle** and **total internal reflection,**
- describe an experiment to find the critical angle of glass or Perspex,
- draw diagrams to show the action of totally reflecting prisms in periscopes and binoculars,
- explain the action and state some uses of optical fibres.

Words and phrases 单词和短语

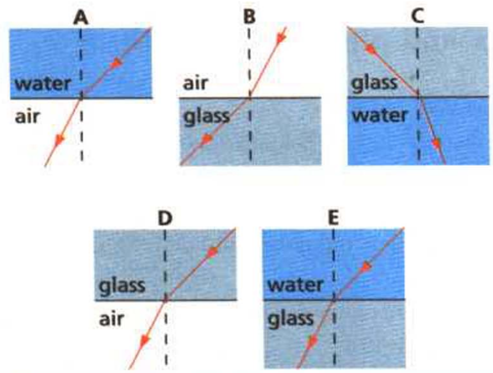
1 critical angle 临界角
2 Increasing the angle of...of refraction. 译：随着入射角的增大，折射角也增大。
3 total internal reflection 全内反射
4 the refracted ray in the air beyond LOM 穿过LOM进入空气中的折射光线
5 an ordinary mirror silvered at the back 一块背后镀银的普通镜子
6 due to 因为，由于
7 binocular / bɪ'nɒkjʊlə / n. 双目望远镜
8 Light can be trapped...Figure2.5a. 译：光由于全内反射而被限制在弯曲的玻璃管内，并沿着弯曲的轨道传送，如图2.5a。

Light and sight

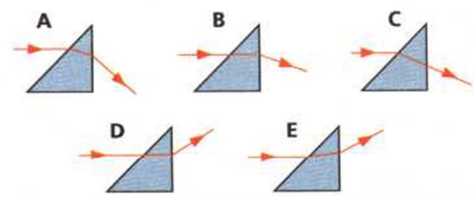
Additional questions

1 Light travels up through a pond of water of critical angle 49°. What happens at the surface if the angle of incidence is **a** 30°, **b** 60°?

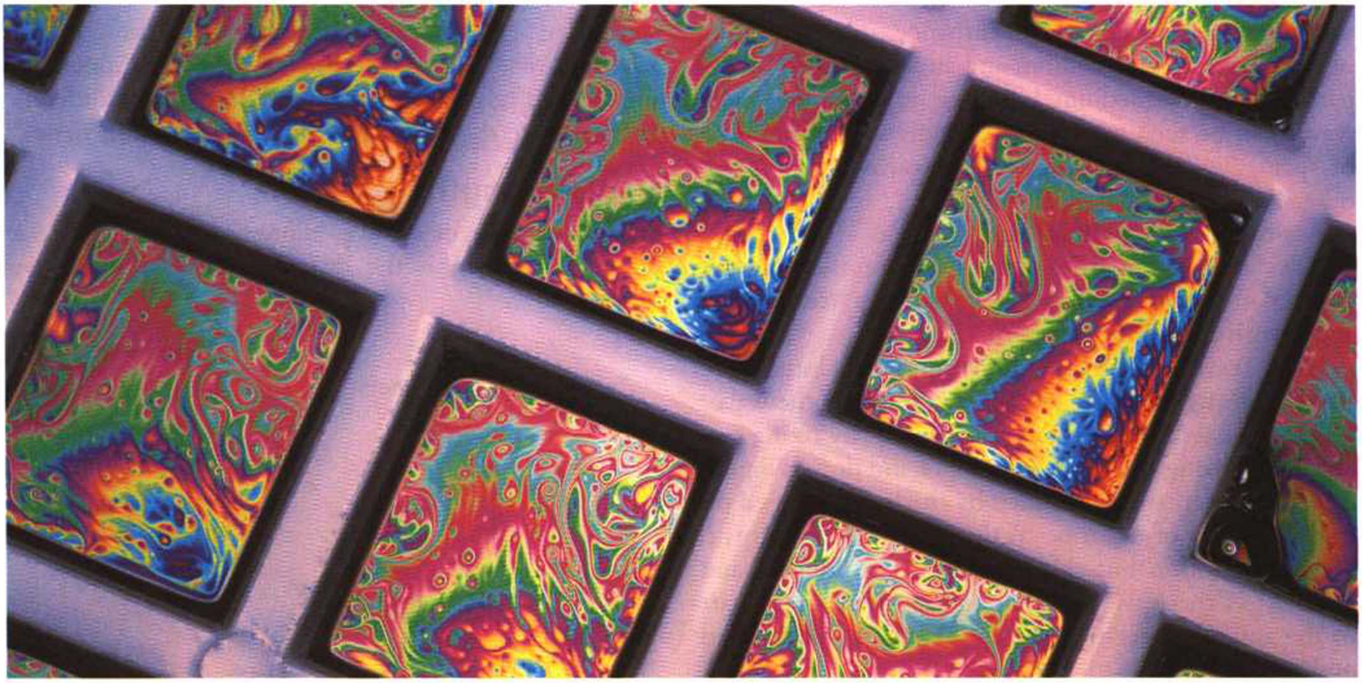
2 Which diagram shows the ray of light refracted correctly?



3 Which diagram shows the correct path of the ray through the prism?



Waves and sound



3 Mechanical waves

Types of wave
Describing waves
The wave equation
Reflection
Refraction
Diffraction
Interference
Polarization
Practical work
The ripple tank.

Types of wave

Several kinds of wave occur in physics. **Mechanical waves**[1] are produced by a disturbance, e.g. a vibrating object, in a material medium and are transmitted by the particles of the medium vibrating to and fro[2]. Such waves can be seen or felt and include waves on a rope or spring, water waves and sound waves in air or in other materials.

A **progressive** or travelling wave[3] is a disturbance which carries energy from one place to another without transferring matter. There are two types, **transverse**[4] and **longitudinal**[5] (Chapter 6).

In a transverse wave, the direction of the disturbance is at **right angles** to the direction of travel of the wave. One can be sent along a rope (or a spring) by fixing one end and moving the other rapidly up and down, Figure 3.1. The disturbance generated by the hand is passed on from one part of the rope to the next which performs the same motion but slightly later[6]. The humps[7] and hollows[8] of the wave travel along the rope as each part of the rope vibrates transversely about its undisturbed position.

Water waves are transverse waves.

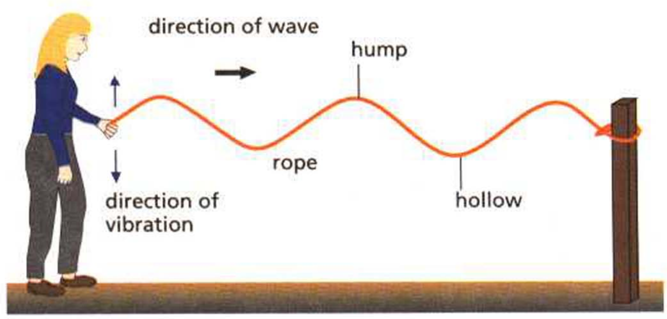


Figure 3.1 A transverse wave

Describing waves

Terms used to describe waves can be explained with the aid of a **displacement–distance** graph[9], Figure 3.2. It shows the distance moved sideways from their undisturbed positions, of the parts vibrating at different distances from the cause of the wave, at a **certain time**.[10]

a) Wavelength

The wavelength of a wave, represented by the Greek letter λ (lambda), is the distance between successive crests[11].

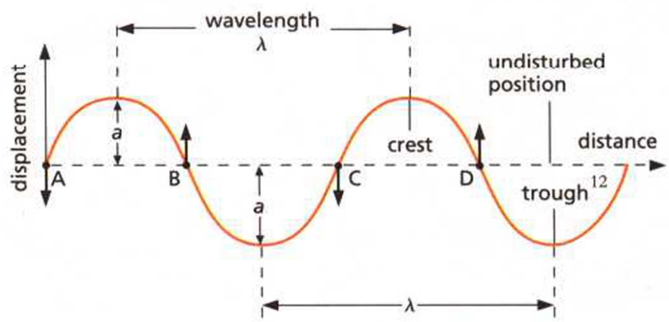


Figure 3.2 Displacement–distance graph for a wave at a particular instant

b) Frequency

The frequency f is the number of complete waves generated per second. If the end of a rope is jerked up and down[13] twice in a second, two waves are produced in this time. The frequency of the wave is 2 vibrations per second or 2 **hertz** (2 Hz; the hertz being the unit of frequency) which is the same as the frequency of jerking of the end of the rope. That is, the frequencies of the wave and its source are equal.

The frequency of a wave is also the number of crests passing a chosen point per second.