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

初中物理英文课本

（中文注释）

[英]汤姆·邓肯　希瑟·肯尼特 著

世界图书出版公司

本书引进自英国经GCSE（普通中学证书）审定的教材，根据我国现行初中教学大纲整理汇编而成。本书形式新颖、程度适中、实例丰富、图片精美，符合我国教育改革的方向，特别有利于一般学生学习，是一本值得推荐的双语教学范本。

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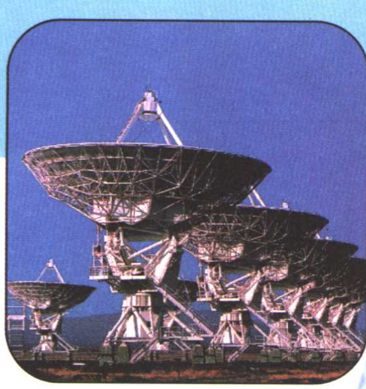

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The Textbook Series of *Bilingual Pedagogy and Practice for Capacity Education in China* — a National Education Science Project for the Tenth Five-Year Plan

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

Preface

Tom Duncan has been joined by Heather Kennett in the preparation of this new edition. A major revision has been undertaken to cover the core and extension content of the new GCSE courses and to meet the requirements of the revised National Curriculum. Material no longer in syllabuses has been removed and the following topics have been introduced, extended or brought up to date:

- **Ideas and evidence in science** – a section has been added with links to appropriate chapters.
- **Waves and sound** – details of a range of ultrasonic echo techniques such as medical ultrasound imaging have been included.
- **Motion and energy** – factors affecting stopping distances are analysed in greater detail and the sections on communication and monitoring satellites have been brought together and extended.
- **Heat and energy** – this section now includes a fuller comparison of different energy sources.
- **Electricity and electromagnetic effects** – the principle of inkjet printers has been included, potential divider circuits and applications are treated in more detail, and magnetic recording and metal detectors have been added.
- **Electrons and atoms** – extensions here include a review of sources of background radiation, radiation hazards, the uses of radioisotopes for dating and other applications, β^+ and β^- decay, nuclear stability, fundamental particles, optic fibre communications and digital signals.
- **Earth and space physics** – the method of location of earthquake epicentres has been introduced; the search for extra-terrestrial life is discussed and there is more on black holes and the big bang theory; material on the atmosphere and the weather, no longer required, has been removed.
- **Datalogging and computers** – investigations which are suitable for connection to a datalogger and computer have been identified throughout the text.
- **Questions** – older questions have been removed and many new questions from recent examination papers have been included. In the end-of-chapter questions, in the **Additional questions** (after each group of related topics, for homework) and in the **Revision questions** (at the end of the book, for quick, comprehensive revision before examinations), the more difficult 'higher' questions are marked with a stripe down the left-hand side.
- **Answers** – the answer section at the end of the book has been expanded to include all but long descriptive answers.

Many thanks are due to W.S. Tucker for his comprehensive analysis of the various GCSE syllabuses and for his detailed comments and helpful suggestions about where changes should be made to the text. Thanks again go to Keith Munnings, Neil Duncan and Brian and Malcolm Kennett for their helpful advice during the preparation of this or former editions. The authors are indebted to Jane Roth for her excellent editorial work in the preparation of this new edition.

T.D. and H.K.

Acknowledgement is made to the following examining boards (answers given being the sole responsibility of the authors):

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Physics and technology

Physicists explore the Universe. Their investigations range from particles that are smaller than atoms to stars that are millions and millions of kilometres away, Figures 1a, b.

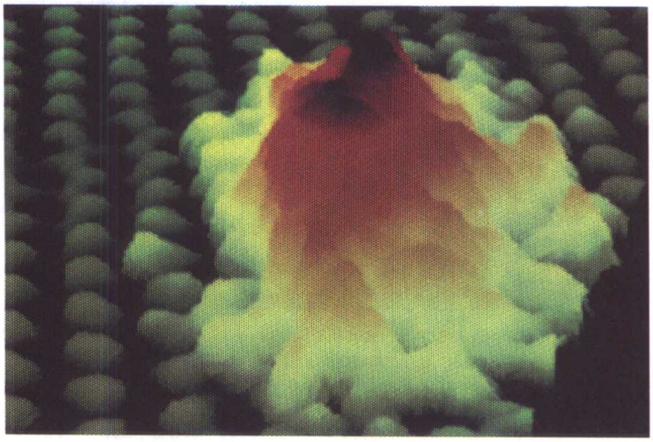


Figure 1a This image, produced by a scanning tunnelling microscope, shows an aggregate of gold just three atoms thick on a graphite substrate. Individual graphite (carbon) atoms are shown as green

As well as having to find the **facts** by observation and experiment, physicists also must try to discover the **laws** that summarize (often as mathematical equations) these facts. Sense has then to be made of the laws by thinking up and testing **theories** (thought-models) to explain the laws. The reward, apart from a satisfied curiosity, is a better understanding of the physical world. Engineers and technologists use physics to solve **practical problems** for the benefit of people, though in solving them social, environmental and other problems may arise.

In this book we will study the behaviour of **matter** (the stuff things are made of) and the different kinds of **energy** (such as light, sound, heat, electricity). We will also consider the applications of physics in the home, in transport, medicine, research, industry, energy production, meteorology, communications and electronics. Figures 2a, b, c and d show some examples.

Mathematics is an essential tool of physics and a 'reference section' of some of the basic mathematics is given at the end of the book along with a suggested procedure for solving physics problems.

Figure 1b The many millions of stars in the Universe, of which the Sun is just one, are grouped in huge galaxies. This photograph of two interacting spiral galaxies was taken with the Hubble Space Telescope (see Figure 9.6). This orbiting telescope is enabling astronomers to tackle one of the most fundamental questions in science, i.e. the age and scale of the Universe, by giving much more detailed information about individual stars than is possible with ground-based telescopes

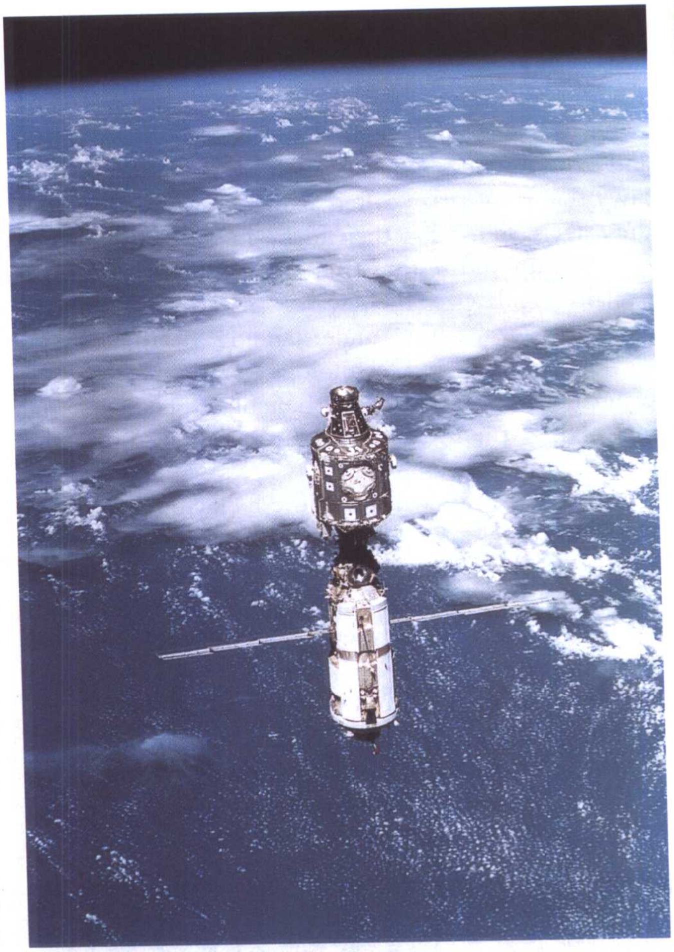


Figure 2a The manned exploration of space is such an expensive operation that international co-operation is seen as the way forward. This is the International Space Station, being built module-by-module in orbit around the Earth. It is operated as a joint venture by the USA and Russia

Figure 2b In the search for alternative energy sources, 'wind farms' of 20 to 100 wind turbines have been set up in suitable locations, such as this in North Wales, to generate at least enough electricity for the local community

Figure 2c Communications satellites like the INTELSAT IX shown above are in geostationary orbit 36 000 km above the equator where they circle the Earth in 24 hours and so appear to be at rest. Microwave signals are sent to the satellite and received from it by Earth stations with large dish aerials (like those in Physics 2, Figure 29.19), enabling digital voice, data, internet and video transmissions across the globe

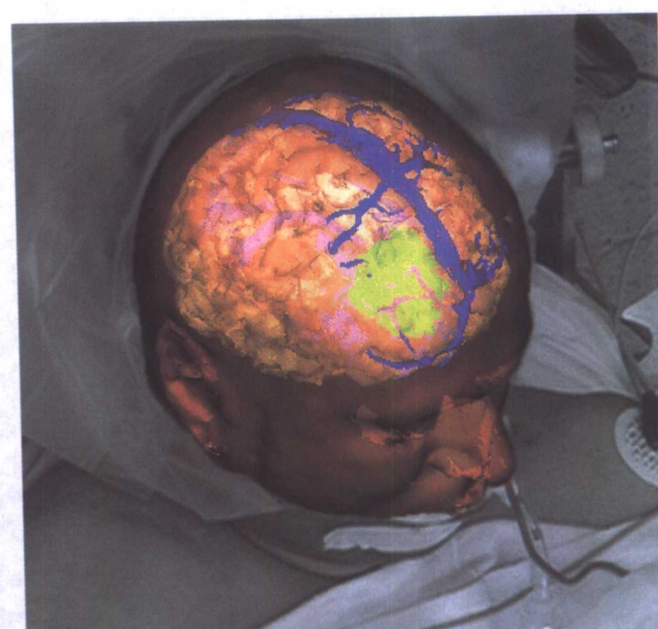


Figure 2d An effect called 'virtual reality' can be produced using computer graphics. In this photograph a virtual reality image of a patient's brain, with tumour and blood vessels, is superimposed on to the patient's head. This enables the surgeon to locate the tumour before an incision is made, resulting in minimally invasive surgery avoiding the vital blood vessels

Scientific enquiry

During your course you will have to carry out a few scientific investigations aimed at encouraging you to develop some of the **skills** and **abilities** that scientists use to solve real-life problems.

Investigations may arise from the topic you are currently studying in class, or your teacher may provide you with suggestions to choose from, or you may have your own ideas. However an investigation arises, it will probably require at least one hour of laboratory time, but often longer and will involve you in the following four aspects.

1 **Planning** how you are going to set about finding answers to the questions the problem poses. Making predictions and hypotheses (informed guesses) may help you to focus on what is required at this stage.
2 **Obtaining** the necessary experimental data safely. You will have to decide on the equipment needed, what observations and measurements have to be made and what variable quantities need to be manipulated.
3 **Presenting** and **interpreting** the evidence in a way that enables any relationships between quantities to be established.
4 **Considering** and **evaluating** the evidence by drawing conclusions, assessing the reliability of data gathered and making comparisons with what was expected.

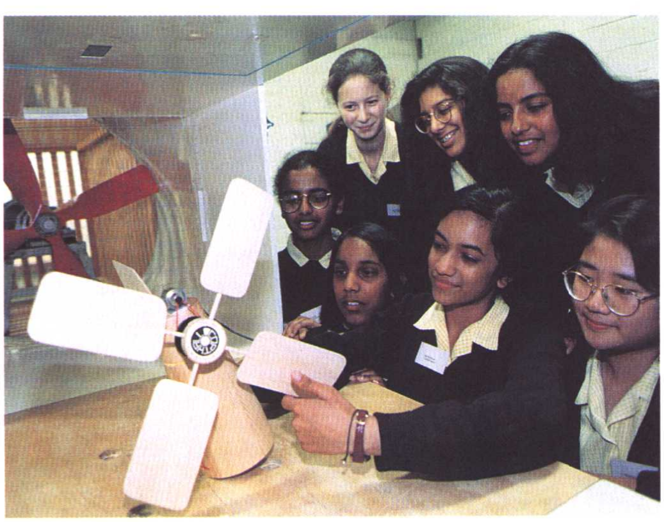


Figure 3 Girls from Copthall School, Mill Hill, London, with their winning entry for a contest to investigate, design and build the most efficient, elegant and cost-effective windmill

A **written report** of the investigation would normally be made, indicating the aim of the work, giving records of procedures, observations and measurements, and stating and evaluating the conclusions based on the evidence gathered.

Suggestions for investigations

1 Vibrating of a long steel strip clamped at one end (Physics 2, Chapter 7).
2 Resonance of an air column (Physics 2, Chapter 7).
3 Pitch of note from a vibrating wire (Physics 2, Chapter 7).
4 Stretching of rubber bands (Physics 1, Chapter 12).
5 Stretching of copper wires – **wear safety glasses** (Physics 1, Chapter 12).
6 Bending of 'beams' (strips or sheets) of different materials (Physics 1, Chapter 14).
7 Friction – factors affecting (Physics 2, Chapter 9).
8 Energy values from burning fuel, e.g. firelighter (Physics 1, Chapter 15).
9 Fall of ball-bearings in a liquid (Physics 2, Chapter 10).
10 Flow of liquid through tubes (Physics 2, Chapter 10).
11 Viscosity of different liquids (Physics 2, Chapter 10).
12 Speed of a bicycle and its stopping distance (Physics 2, Chapter 16).
13 Circular motion using a bung on a string (Physics 2, Chapter 17).
14 Heat loss using different insulating materials (Physics 1, Chapter 22).
15 Model wind turbine design (Physics 1, Chapter 24).
16 Resistance of a thermistor and temperature (Physics 1, Chapter 28).
17 Heating effect of an electric current (Physics 1, Chapter 29).
18 Strength of an electromagnet (Physics 1, Chapter 32).
19 Efficiency of an electric motor (Physics 2, Chapter 21).

Ideas and evidence in science

You may find that in some of the investigations you perform in the school laboratory you do not interpret your data in the same way as your friends do; perhaps you will argue with them as to the best way to explain your results and try to convince them that your interpretation is right. Scientific controversy frequently arises through people interpreting evidence differently.

Observations of the heavens led the ancient Greek philosophers to believe that the Earth was at the centre of the planetary system, but a complex system of rotation was needed to match observations of the apparent movement of the planets across the sky. In 1543 Nicolaus Copernicus made the radical suggestion that all the planets revolved not around the Earth but around the Sun. (His book '*On the Revolutions of the Celestial Spheres*' gave us the modern usage of the word 'revolution'.) It took time for his ideas to gain acceptance. The careful astronomical observations of planetary motion documented by Tycho Brahe were studied by Johannes Kepler, who realised that the data could be explained if the planets moved in elliptical paths (not circular) with the Sun at one focus. Galileo's observations of the moons of Jupiter with the newly invented telescope led him to support this 'Copernican view' and to be imprisoned by the Catholic Church in 1633 for disseminating heretical views. About 50 years later, Isaac Newton introduced the idea of gravity and was able to explain the motion of all bodies, whether on Earth or in the heavens (Physics 2, Chapter 14), which led to full acceptance of the Copernican model. Newton's mechanics were refined further at the beginning of the 20th century when Einstein developed his theories of relativity; even today, data from the Hubble Space Telescope is providing new evidence which confirms Einstein's ideas.

Many other scientific theories have had to wait for new data, technological inventions, or time and the right social and intellectual climate for them to become accepted. In the field of health and medicine, for example, because cancer takes a long time to develop it took several years before people recognised that X-rays and radioactive materials could be dangerous (Physics 2, Chapter 26).

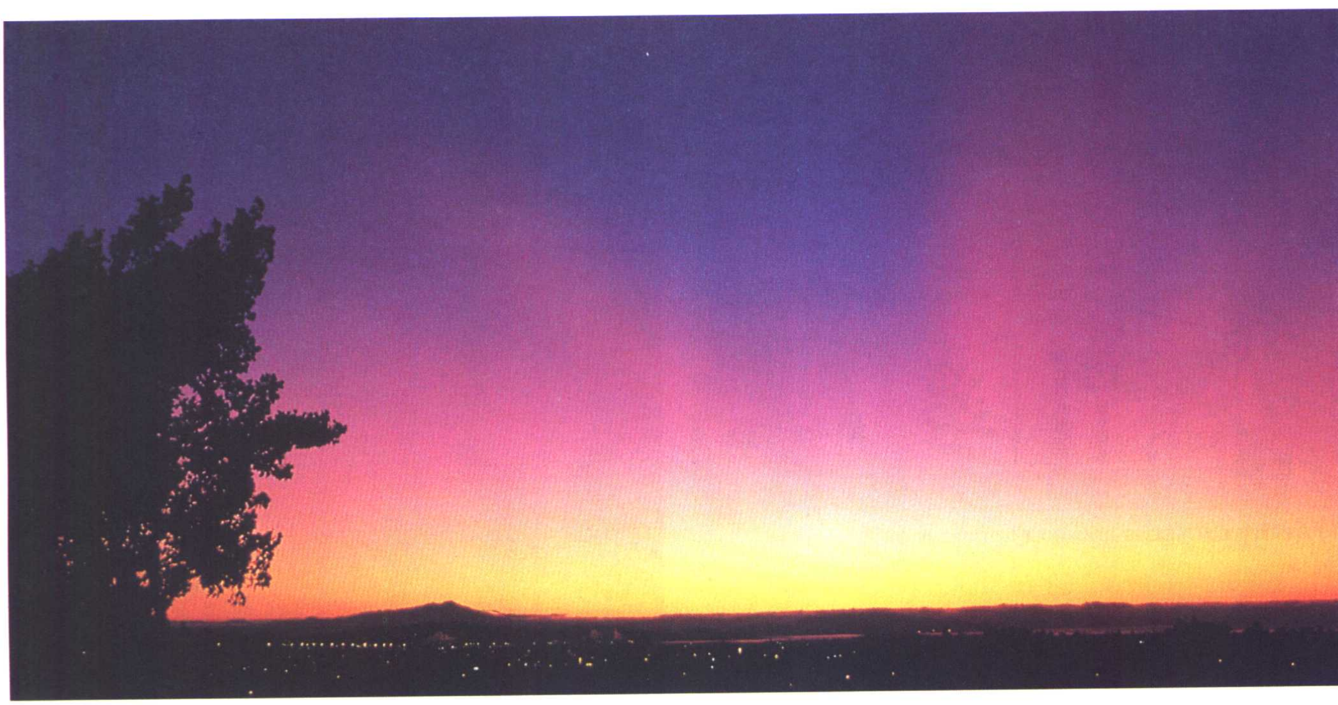
Wegener's theory of continental drift in the 1920s explained a wide range of different geological information, but a suitable mechanism for the movement of the continents had not been proposed. The ideas of plate tectonics (Physics 2, Chapter 30) developed in the 1960s. Studies of the magnetism of ancient rocks supported the idea that Europe and North America had once been joined and indicated that the magnetic field of the Earth reversed from time to time. The discovery of patterns of magnetic stripes on both sides of mid-ocean ridges could be explained by the creation of new rock which acquired magnetism based on the Earth's field at the time the material solidified. Continents could thus move by introducing new material between them.

At the beginning of the 20th century scientists were trying to reconcile the wave theory and the particle theory of light (Physics 2, Chapter 25) by means of the new ideas of quantum mechanics.

Today we are collecting evidence on possible health risks from microwaves used in mobile phone networks. The cheapness and popularity of mobile phones may make the public and the manufacturers reluctant to accept adverse findings, even if risks are made widely known in the press and on television. Although scientists can provide evidence and evaluation of that evidence, there may still be room for controversy and a reluctance to accept scientific findings, particularly if there are vested social or economic interests to contend with. This is most clearly shown today in the issue of global warming.

Contents

Light and sight



1 Light rays

Sources of light	***Shadows***	***Practical work***
Rays and beams	***Speed of light***	The pinhole camera.

Sources of light

You can see an object only if light from it enters your eyes. Some objects such as the Sun, electric lamps and candles make their own light. We call these **luminous** sources.

Most things you see do not make their own light but reflect it from a luminous source. They are **non-luminous** objects. This page, you and the Moon are examples. Figure 1.1 shows some others.

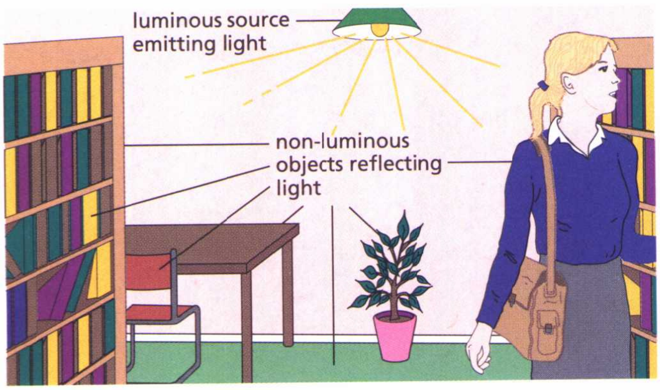


Figure 1.1 Luminous and non-luminous objects

Luminous sources radiate light when their atoms become 'excited' as a result of receiving energy. In a light bulb, for example, the energy comes from electricity. The 'excited' atoms give off their light haphazardly in most luminous sources.

A light source that works differently is the **laser**, invented in 1960. In it the 'excited' atoms[1] act together and emit a narrow, very bright beam of light. The laser has a host of applications. It is used in industry to cut through plate metal, in scanners to read the bar code at shop and library check-outs, in CD players, in optical fibre telecommunication systems, in delicate medical operations on the eye or inner ear, for example, Figure 1.2, in printing, and in surveying and range-finding.[2]

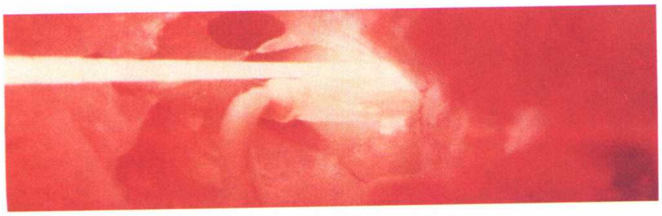


Figure 1.2 Laser surgery in the inner ear

Rays and beams

Sunbeams streaming through trees, Figure 1.3, and light from a cinema projector on its way to the screen both suggest that **light travels in straight lines**. The beams are visible because dust particles in the air reflect light into our eyes.

The direction of the path in which light is travelling[3] is called a **ray** and is represented in diagrams by a straight line with an arrow on it. A **beam** is a stream of light and is shown by a number of rays; it may be parallel[4], diverging[5] (spreading out) or converging[6] (getting narrower), Figure 1.4.

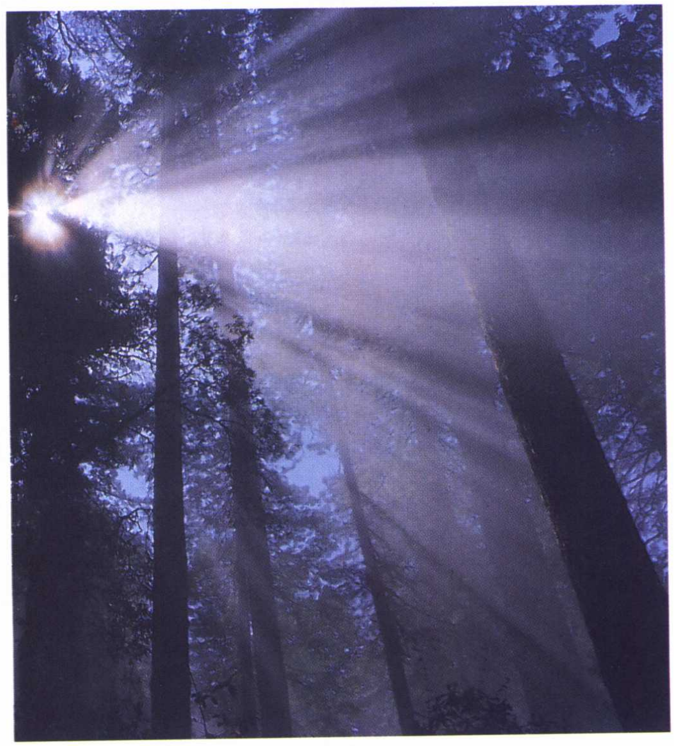


Figure 1.3 Light travels in straight lines

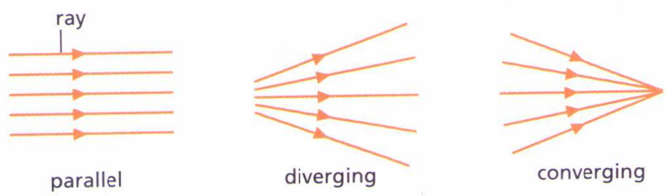


Figure 1.4 Beams of light

Practical work

The pinhole[7] camera

A simple pinhole camera is shown in Figure 1.5a. Make a small pinhole in the centre of the black paper. Half-darken the room. Hold the box at arm's length so that the pinhole end is nearest to and about 1 metre from a luminous object, e.g. a carbon filament lamp or a candle[8]. Look at the **image** on the screen (an image is a likeness of an object and need not be an exact copy).

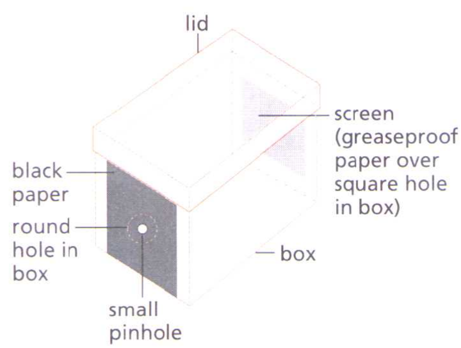
Can you see *three* ways in which the image differs from the object? What is the effect of moving the camera closer to the object?

Make the pinhole larger. What happens to the

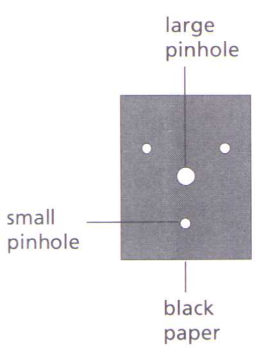
(i) brightness,
(ii) sharpness,
(iii) size of the image?

Make several small pinholes round the large hole, Figure 1.5b, and view the image again.

The forming of an image is shown in Figure 1.6.



a A pinhole camera



b

Figure 1.5

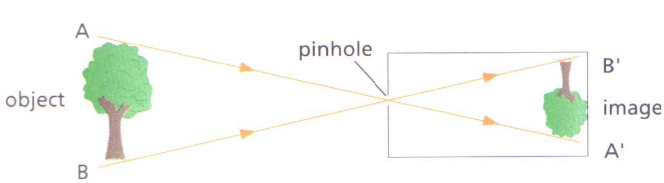
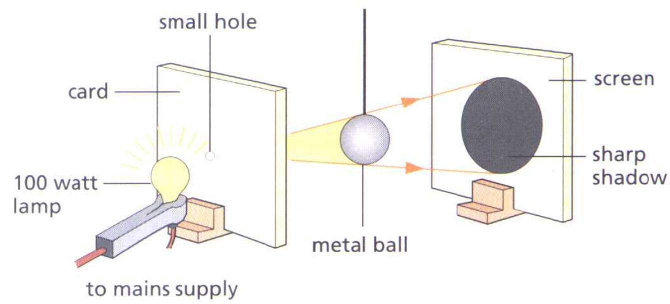


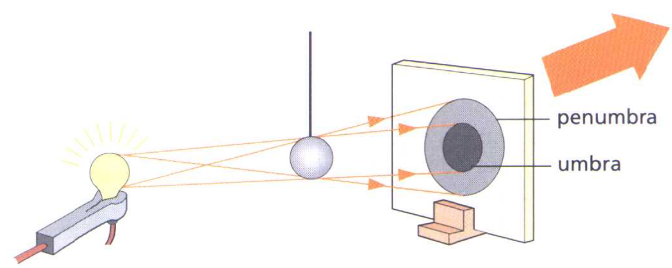
Figure 1.6 Forming an image in a pinhole camera

Shadows

Shadows are formed for two reasons. First, because some objects, which are said to be **opaque**[9], do not allow light to pass through them. Second, because light travels in straight lines. The sharpness of the shadow depends on the size of the light source. A very small source of light, called a **point** source[10], gives a sharp shadow which is equally dark all over. This may be shown as in Figure 1.7a where the small hole in the card acts as[11] a point source.



a With a point source



b With an extended source

Figure 1.7 Forming a shadow

If the card is removed the lamp acts as a large or **extended** source, Figure 1.7b. The shadow is then larger and has a central dark region, the **umbra**, surrounded by a ring of partial shadow, the **penumbra**[12]. You can see by the rays that some light reaches the penumbra but none reaches the umbra.

Speed of light

Proof that light travels very much faster than sound is provided by a thunderstorm. The flash of lightning is seen before the thunder is heard. The length of the time lapse is greater the further the observer is from the storm.

The speed of light has a definite value; light does not travel instantaneously from one point to another but takes a certain, very small time[13]. Its speed is about 1 million times greater than that of sound.