



Scheme of work – Cambridge IGCSE[®] Physics (US) 0443

Unit: 3 Energy

Recommended prior knowledge

Although Cambridge IGCSE Physics itself can be used as an introduction to Physics, it is unlikely that many students will not have studied some Physics or General Science previously. The word *energy*, with a whole host of meanings and many subtle shades of emphasis, is likely to be part of a Cambridge IGCSE Physics student's vocabulary. When commencing the course, however, the student is unlikely to be especially exact in distinguishing words such as *force*, *energy*, *power* and *work*. Part of this course must be to help students use these terms appropriately and accurately when the context is purely scientific and to ensure that they realise that the terms are not simply interchangeable. It might well be argued that *energy* is the most basic idea in Physics and that every branch of Physics is the study of a corresponding energy. Again this idea is found by many students to be vague, intangible and inaccessible. In many ways, the ideas of this unit are going to be constantly revisited in every other unit of the course.

It is likely that most students will have encountered the concept of energy sources and will realise that the maintenance of many aspects of modern life relies on readily available energy sources. The ideas of renewable and non-renewable energy sources and of the benefits and problems associated with the use of fossil fuels are almost certain to be familiar to students at this stage. Likewise they will be aware of the concepts *heat* and *heating* but might well not think of it as a form of energy. The way in which *energy* relates to the other sciences, might also be understood to some extent. Students might have heard of units such as the *calorie* or *kilowatt-hour*, but are unlikely to have come across the *joule*.

Context

The concept of energy is hard to grasp, despite its being so crucial to the understanding of Physics. It is an idea that is best taught by using the term correctly and frequently throughout the course; examples of energy transfers could be included in almost any lesson. The section of this unit on renewable and non-renewable energy sources is an area where individual students can investigate the issues through project work and personal research either through the internet or by the use of periodicals, textbooks or television programmes. The topics on thermal energy transfer are much more easily taught in a conventional way with the usual experiments that show the distinction between transfer by conduction, convection and radiation.

Outline

This unit contains ideas that though superficially familiar to many students are unlikely to be properly understood. They are, however, ideas that are fundamental to this course and any proper understanding of the subject. They will need constant revisiting and the students will need to become familiar with them in a thoroughly convincing fashion.

(Please note: **(S)** in **bold** denotes material in the Supplement (Extended syllabus) only)

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
1.6 (a)	<p>Demonstrate an understanding that an object may have energy due to its motion or its position, and that energy may be transferred and stored</p> <p>Give examples of energy in different forms, including kinetic, gravitational, chemical, strain, nuclear, internal, electrical, light and sound</p> <p>Give examples of the conversion of energy from one form to another and, of its transfer from one place to another</p> <p>Apply the principle of energy conservation to simple examples</p>	<p>A number of devices which convert energy from one form to another e.g. loudspeaker, steam engine, solar-powered motor, candle etc. can be used. A circus of simple experiments can be set up for students to identify the energy conversions.</p>	<p>Some unusual and fun energy change experiments: www.littleshop.physics.colostate.edu/</p> <p>IGCSE Physics Coursebook CD-ROM Activity Sheet 6.1</p> <p>Unit 3: Past Paper Question Core 2</p>
1.6 (a) (S)	<p>Recall and use the expressions $k.e. = \frac{1}{2}mv^2$ and $p.e. = mgh$</p>		<p>IGCSE Physics Coursebook CD-ROM Activity Sheet 6.2</p> <p>Unit 3: Past Paper Question Extension 1</p>

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
1.6 (b)	<p>Distinguish between renewable and non-renewable sources of energy</p> <p>Describe how electricity or other useful forms of energy may be obtained from</p> <p>(i) chemical energy stored in fuel</p> <p>(ii) water, including the energy stored in waves, in tides and in water behind hydroelectric dams</p> <p>(iii) geothermal resources</p> <p>(iv) nuclear fission</p> <p>(v) heat and light from the Sun (solar cells and panels)</p> <p>Give advantages and disadvantages of each method in terms of cost, reliability, scale, and environmental impact</p> <p>Show a qualitative understanding of efficiency</p>	<p>Examples of both renewable and non-renewable sources of energy can be considered along with their advantages and disadvantages. Be careful with categorising wood; wood is a renewable resource, as is all biomass, although we sometimes use it in a non-sustainable way (deforestation).</p> <p>Important discussions here to consolidate the students' understanding of energy processes both in physical and environmental impact terms.</p>	<p>This website provides a useful investigation into alternative energy: www.altenergy.org/</p> <p>This website gives much interesting information about different types of power stations and includes a virtual tour of a power station: www.ergon.com.au/</p> <p>IGCSE Physics Coursebook CD-ROM Activity Sheet 7.1, 7.2</p>
1.6 (b) (S)	<p>Show an understanding that energy is released by nuclear fusion in the Sun</p> <p>Recall and use the equation:</p> $\text{efficiency} = \frac{\text{useful energy output}}{\text{energy input}} \times 100\%$		<p>Fusion in the Sun: www.youtube.com/watch?v=pusKIK1L5To</p>
2.3 (a)	<p>Describe experiments to demonstrate the properties of good and bad conductors of heat</p>	<p>Simple experiments to compare thermal conductivity e.g. using metal conductivity rods.</p>	<p>Conduction in copper and steel: www.youtube.com/watch?v=eMGqkOTJCN0:</p> <p>IGCSE Physics Coursebook CD-ROM Activity Sheet 11.1</p>

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
2.3 (a) (S)	Give a simple molecular account of the heat transfer in solids	Extend to a molecular account – a row of students can be used to model the idea of increased vibration of particles as the process of conduction.	How does heat travel? www.coolcosmos.ipac.caltech.edu/cosmic_classroom/light_lessons/thermal/transfer.html
2.3 (b)	Relate convection in fluids to density changes and describe experiments to illustrate convection	Use simple experiments to illustrate convection e.g. dissolving a crystal of potassium manganate VII at the bottom of a large beaker that is heated by a candle flame. Show convection in air using, for example, a mine ventilation model.	www.edumedia-sciences.com/en/a639-thermal-convection IGCSE Physics Coursebook CD-ROM Activity Sheet 11.2 Unit 3: Past Paper Question Core 3
2.3 (c)	Identify infra-red radiation as part of the electromagnetic spectrum		What is infra-red radiation? www.science.hq.nasa.gov/kids/imagers/ems/infrared.html www.youtube.com/watch?v=WP2XwBhmAk IGCSE Physics Coursebook CD-ROM Activity Sheet 11.3 Unit 3: Past Paper Question Core 1
2.3 (c) (S)	Describe experiments to show the properties of good and bad emitters and good and bad absorbers of infra-red radiation.	Leslie’s cube type experiments show the effect of the colour of a surface on the emission of radiation. A thick (3 – 5 mm) sheet of copper, covered with lamp-black (powdered carbon) on one side, if heated strongly with a Bunsen burner on the other side, will emit noticeably more heat from the blackened side when the Bunsen burner is removed. Absorption of infra-red can be easily shown by arranging two thermometers at equal distances from a working 12V headlamp bulb. One thermometer has a blackened bulb (use a felt-tipped pen or poster paint).	

Syllabus ref	Learning objectives	Suggested teaching activities	Learning resources
2.3 (d)	Identify and explain some of the everyday applications and consequences of conduction, convection and radiation.	A good opportunity to carry out some investigative experiments involving rate of cooling and insulation. Discussion of the vacuum flask is a useful way to revise conduction, convection and radiation as is discussion of the domestic refrigerator. Obtain two identical stainless steel vacuum flasks; drill a hole in the outside of one so that air enters the vacuum. Compare by data-logging the rates of fall of temperature.	Unit 3: Past Paper Question ATP 1