

IGCSE Co-ordinated Sciences 0654

Unit 19: Energy transfer

Recommended Prior Knowledge

Pupils should be able to handle simple formulae and rearrange them.

Context

This Unit covers Topics P5 and P6. It links with B7, Respiration and with C14 Fuels.

Outline

This Unit looks at various ways in which energy is transferred and transformed. The concepts of energy, power and efficiency are developed. The relationship between heating things, energy transfers and temperature rise is dealt with, leading to an understanding of the concept of conservation of energy.

| Topic | Learning outcomes | Suggested Teaching activities | Learning resources |
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| P5 | appreciate that when change takes place, energy is transferred | A circus could be used to investigate a number of devices which convert energy from one form to another, e.g. loudspeaker, steam engine, solar-powered motor, candle and son. Students can be asked to identify the energy transfers or transformations. | Some unusual and fun energy change experiments. http://littleshop.physics.colostate.edu/ Click on Ideas for teachers, then Changes in energy. IGCSE Physics, Hodder, Duncan T and Kennet H, page 83 |
| | know that work, measured as force x distance moved, is a measure of energy transfer | Students can get the 'feel' of a joule by lifting an apple through a distance of one metre. They can walk up steps, and then calculate the work done by measuring their mass and the vertical distance moved. | IGCSE Physics, Hodder, Duncan T and Kennet H, page 85 |
| | know that pressure is related to the size of the force and the area over which the force acts | A flat piece of plasticine can be used to provide a qualitative estimate of pressure; place objects of the same mass but different surface area onto the plasticine and then press down by placing a heavy | IGCSE Physics, Hodder, Duncan T and Kennet H, page 88 |

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| | be able to use the relationship $pressure = force / area$ | mass on top; compare the depth of the dent produced. | |
| | understand that liquids can be used to send forces where they are required | | IGCSE Physics, Hodder, Duncan T and Kennet H, pages 88–90 |
| | know that hydraulic systems are force multipliers and describe everyday applications of hydraulic systems (car braking systems and hydraulic jacks) | | |
| | understand that power is the rate at which energy is transferred | Extend the 'walking upstairs' exercise by measuring the time it takes for different students to reach the top (CARE: do not endanger any student's health and safety); calculate the power produced by each student. | IGCSE Physics, Hodder, Duncan T and Kennet H, page 85 and 198 |
| | appreciate that there is an energy cost in making things happen | | IGCSE Physics, Hodder, Duncan T and Kennet H, page 83 |
| | appreciate that machines are devices enabling the transfer of energy, but that the energy cost of doing a job is still at least the same as if the job were to be done without the help of a machine (and will certainly | | |

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| | <p>be greater than that)</p> <p>understand that engines are devices for transferring energy from fuels to enable force-using jobs to be done</p> <p>appreciate that the use of machines and engines always means some wastage of energy</p> <p>appreciate that heat engines cannot function without transferring substantial amounts of energy to the surroundings</p> | | |
| P6 | <p>understand that 'heating' is a mode of energy transfer</p> <p>know the meaning of the terms <i>conduction</i>, <i>convection</i> and <i>radiation</i></p> | <p>Students should see or carry out simple experiments involving these methods of energy transfer (see suggested text resource).</p> <p>A row of students can be used to model the idea of increased vibration of particles as the process of conduction.</p> <p>For convection, place a crystal of potassium manganate VI at the bottom of a large beaker of water, and heat with a candle.</p> <p>For radiation, place a thermometer at some distance</p> | IGCSE Physics, Hodder, Duncan T and Kennet H, pages 155–162 |

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| | | from a working 12V headlamp bulb. You could extend this by investigating the radiating properties of silver and black objects. | |
| | appreciate that, unlike work, heating as a mode of energy transfer is not measured directly, but in terms of the rise in temperature it can produce | Discuss the difference between 'heat' and 'temperature'. Demonstrate the effect of heating two different volumes of water using identical burners providing the same quantity of heat, to illustrate the fact that the same quantity of heat does not provide the same rise in temperature. | IGCSE Physics, Hodder, Duncan T and Kennet H, page 135 |
| | appreciate that energy may be transferred to a substance in changing it from solid to liquid or liquid to gas without raising its temperature | Carry out a demonstration in which temperature of water is measured as it is heated, changing from ice through water to steam. Similarly, cooling curves can be plotted, using the solidification of stearic acid. This can be related to cooling effect of evaporation. Students could carry out investigations into this by wrapping wet and dry paper or cotton wool around tubes of hot water, and drawing cooling curves. Relate to the cooling effect of sweating. | An interesting animated mystery for students to solve. http://teams.lacoe.edu/documentation/classrooms/gary/heat/activities/myster/Mystery.html IGCSE Physics, Hodder, Duncan T and Kennet H, pages 150–152 |
| | understand the meaning of the term <i>specific heat capacity</i> | 1 kg blocks of different metals can be heated with immersion heaters to show their different thermal capacities. | IGCSE Physics, Hodder, Duncan T and Kennet H, pages 147–149 |
| | know and be able to make simple calculations using the relationship: <i>energy transferred (J) = mass (kg) x specific heat capacity (J / kg °C) x temperature rise (C)</i> | This can be extended to a quantitative determination of specific heat capacity. | |

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| | <p>understand the meaning and implications of the phrase <i>conservation of energy</i></p> <p>be able to apply the concept of energy conservation in a variety of energy transfer processes</p> | | IGCSE Physics, Hodder, Duncan T and Kennet H, page 86 |