Energy

3.1 Energy can be transferred

Teacher notes (pages 40–43)

Introducing the chapter

Students should have prior knowledge of energy forms and transfer and transformation processes from their science learning in their primary years. This chapter will build on previous knowledge and skills and extend it to a greater depth. Energy appears in many different forms, including movement (kinetic energy), heat, potential energy, nuclear and biomass. The wide variety of energy forms allows something to be done, be it due to an object’s height or chemical make-up, in its motion, its temperature or in the way that it is stretched or compressed.

Any detailed study of energy begins by identifying the different forms that energy can take. All devices we use transform or modify the energy type from one form to another.

Teaching tips: Establishing prior knowledge

Questioning of students or using a pre-test would be useful in revealing student understanding and any misconceptions. The concept of energy is difficult to communicate to students. The most effective way to introduce the idea of energy is to describe it as the ‘ability to do something’. If there were no energy, then nothing would change. ‘Show me how you look when you’ve got no energy’, might be a good statement to pose to the class.

Differentiation

For less able students:

Students could be instructed to focus on the energy forms that are more familiar, such as movement, sound and electricity. This will help boost their confidence.

Students may benefit from being shown examples of the different energy forms as an ‘energy line-up’ (similar to a criminal line-up) and asked to identify, for example, the chemical energy.

Some students may need assistance with some calculations in this chapter’s experiments.

For more able students:

Students could investigate the nuclear energy processes occurring in the Sun.

Additional activity: Common misconceptions

It may be helpful to discuss any common misconceptions early on. These are some examples:

• ‘There is only one meaning of energy’ (The term ‘energy’ is hard to define because it has many meanings depending on the context in which it is used.)

• ‘Energy is associated only with movement.’ (Non-moving objects have potential energy; the composition of an object or its position determines what kind of energy it has.)

• ‘Energy is a fuel.’ (Fuel is a source of energy, but is not itself energy.)

Additional activity: Sound energy

Increase students’ awareness of sound energy by having them:

• compare how sound travels through different objects

• examine and contrast the sounds made by different objects

• demonstrate how sound travels through solids, liquids and gases (specifically via vibrations)

• learn about how the vocal cords produce sound

• explain how the ears transmit sound and how the brain interprets it.

Additional activity: Energy uses

Ask students to draw up a table similar to the one below, leaving the second column ‘Use’ blank. They can work in groups of three or four to brainstorm as many uses of each energy as possible. Below are some suggested answers.

|  |  |
| --- | --- |
| Energy | Use |
| light energy | helps us to see in the dark, allows for life on Earth |
| heat energy | used in cooking, keeping warm |
| electrical energy | used in electrical devices |
| elastic potential energy | the stored energy in trampolines, elastic bands and springs |
| gravitational potential energy | the stored energy when an object is lifted up to a height that can be converted into other types of energy |
| chemical potential energy | the energy found in food, drinks, batteries and fuels |
| biomass energy | the energy that is stored in plants and animals; a type of chemical potential energy |
| nuclear energy | used in explosive weapons |
| kinetic energy | the energy found in all moving objects |
| sound energy | a type of kinetic energy that produces sound (e.g. in musical instruments) |

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

**Energy story**  
This website contains comprehensive information about all aspects of energy.

3.2 Potential energy is stored energy

Teacher notes (pages 44–45)

Introducing the topic

This section explores potential energy – energy that is stored in objects and available to be used. There are several different types of potential energy. This section focusses on gravitational potential energy, chemical potential energy and elastic potential energy.

Additional activity: Elastic potential energy

Students could investigate the elastic potential energy of different types and sizes of rubber bands. Students could let go of the rubber band, aiming it towards a wall, to measure the kinetic energy. The elastic potential energy is converted to kinetic energy when the rubber band is released.

Additional activity: Gravitational potential energy

Have students hold a basketball over their heads and release it onto a firm surface. They should note the height it reaches each time it bounces. Ask students why the ball doesn’t maintain the same bounce height. (Gravity pulls the ball towards the Earth, creating kinetic energy as the ball drops until it hits the ground, converting the energy back into gravitational potential energy as the ball rises again. This conversion from gravitational potential to kinetic energy is repeated as the ball bounces up and down. For the ball to bounce back to the same height at which it was dropped would require that all the gravitational potential energy is converted into kinetic energy. This is not the case because gravitational potential energy and kinetic energy are not the only two types of energy involved. Students can be prompted to think of what other energy forms are involved.)

Additional activity: Chemical potential energy

Have students create a lemon battery. A lemon battery is a simple way to show chemical potential energy. Students make a small incision at either end of the lemon. In one end insert a small piece of copper, in the other end a piece of zinc. Connect these to wires which in turn connect to a light emitting diode (LED). Multiple lemons are lined up in order to produce enough energy. Full instructions can be found online.

Additional activity: Chemical potential energy in energy drinks

A discussion about energy drinks may be useful to gauge students’ perceptions. Most students don’t know or understand the risks associated with these drinks, especially in people under 18 years of age.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

**Brain pop: Potential energy**  
This website contains an animated video about potential energy.

3.3 Moving objects have kinetic energy

Teacher notes (pages 46–47)

Introducing the topic

This section investigates the energy of motion: kinetic energy. Heavy, fast-moving objects have the greatest kinetic energy. Whenever objects or people move, they are using kinetic energy. This section discusses light energy, electrical energy, heat energy and sound energy.

Teaching tips: Types of energy

Some energy forms will be more familiar to students than others (e.g. kinetic over biomass or nuclear) and students may be familiar with an energy example (e.g. fireworks) but not know the name (chemical potential energy). Making these connections and grouping energy examples under headings of their type is important. Students may be aware of nuclear power through TV shows such as *The Simpsons*.

Teaching tips: Thermal energy

**Conduction**

Heat is transferred from one object to another when the objects touch each other. This transfer is most effective in solids, but can happen in fluids. For example, a spoon in a cup of hot soup becomes warmer because the heat from the soup is conducted along the spoon.

**Convection**

Heat is transferred through the mass movement of molecules within fluids. Convection currents circulate the warm and cool molecules: warm molecules are less dense, so they rise, whereas cool molecules sink because of their increased density.

Teaching tips: Electrical energy

Electrical energy can be demonstrated through a battery in a torch. In batteries, chemicals are used to separate electrons (negative charge) from protons (positive charge). When a battery is connected to an electric circuit (e.g. the torch is switched on), the electrons leave the negative terminal of the battery and move (flow) through the circuit to the positive terminal.

Differentiation

For less able students:

Students could use the principles of kinetic energy to explain why a heavier ball used in bowling might have greater kinetic energy than a lighter one. How would this affect the results of the game?

For more able students:

Students could be tasked with designing an experiment that shows two different levels of kinetic energy. This could take the form of something simple (two different weighted balls) or something more complicated (a miniature roller coaster).

Additional activity: Movement energy

Increase students’ awareness of kinetic/movement energy by using the following activities:

• Identify objects with kinetic energy in the classroom, outside and at home.

• Identify the differences and similarities between fast- and slow-moving objects.

• Examine and compare how various objects move (e.g. walk, roll, jump). Students could also investigate different types of walking; for example, how a dog walks compared with how a giraffe walks. (A dog has a diagonal walk, in that it uses diagonally opposing legs when walking, namely the front left and right back legs, then the front right and left back legs, and so on. A giraffe, however, moves both legs on one side and then both legs on the other side.)

• Analyse whether still objects are really moving (e.g. a plant, bottle, pencil case).

• Investigate and determine what makes objects move.

• Explain how muscles enable human movement.

Assessment: Mousetrap cars

This section transfers students’ existing knowledge of how energy transforms to an unfamiliar context. Completing this activity should further consolidate students’ understanding of the topic and test their awareness. In order for students to complete this task they need a comprehensive understanding of this chapter. In particular, they need to understand how devices transform energy from one form to another – in this case, using the potential elastic energy in the mousetrap to propel a simple machine (a car).

Many videos and instructions for how to build mousetrap cars are available online.

Students could conduct research as part of their planning and designing stage. After constructing their car, they should test and improve it until they are happy with their mousetrap car.

At the conclusion of the task, the class could have a race to determine, for example, which car is the fastest, most streamlined, or best design.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

**Energy in a roller coaster**  
This website contains an animation that shows the kinetic and potential energy conversions during a roller coaster.

3.4 Energy can be transformed

Teacher notes (pages 48–49)

Introducing the topic

This topic looks at how energy conversions occur. We regularly need to change energy from one form into another to meet our needs. For example, a hairdryer turns electricity into heat or thermal energy. A battery converts chemical energy into electricity. A power station coverts the chemical energy in fuels to electricity through a number of steps.

Teaching tips: Transformation versus transfer

It is important to make sure students know the difference between a transformation and a transfer of energy for this section. The essential concept for students to understand is that the total amount of energy in a system remains constant over time. So, the only thing that can happen to energy is that it can change form.

Teaching tips: Flow diagrams

Students need to remember that the arrows point in the direction of the change and, in essence, the arrow is showing the transformation between the input and output.

Differentiation

For less able students:

Less able students may require assistance in creating their flow charts to show energy transformation. Physical models or specific examples (i.e. turning on a light) may benefit them greatly.

For more able students:

Students with higher abilities could investigate remote controls. They could bring in any old remotes they may have at home and carefully dismantle them to identify the components they contain. The same could be done with an old mobile phone. The phones can then be posted off for recycling.

Additional activity: Class discussion

Conduct a class discussion around common misconceptions regarding energy. These are some possible topics:

• ‘Energy can be created and lost.’ (Energy can neither be created nor destroyed.)

• ‘Energy is created as the result of an activity.’ (Energy is transferred from one system to another.)

• ‘Energy types are independent of one another.’ (Energy can change or be transformed from one form into another.)

Additional activity: Transformations for motion

Ask students to consider the forms of transport they have used that day, week, month and/or year. Get them to list the energy used for each transformation that occurred.

Additional activity: Cartoon strip

Ask students to use the information on pages 48 and 49, as well as online research, to prepare a minimum eight-box cartoon strip that shows the generation of electricity from coal. Students could either draw this by hand or use a computer program such as Comic Life.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

**BBC Bitesize: Energy transfer and storage**  
This website contains an interactive presentation and a short quiz about energy transfers.

3.5 Energy cannot be created or destroyed

Teacher notes (pages 50–51)

Introducing the topic

Many students may have heard that energy cannot be created or destroyed. This is the law of conservation of energy and can be seen in any energy transformation. It can be a difficult law to understand and students may require additional time and support to grasp it fully.

Teaching tips: Links to other concepts

You can link the law of conservation of energy to Newton’s laws. For example, an object would remain in motion forever unless another force is exerted on it, the energy doesn’t just disappear.

Differentiation

For less able students:

Less able students may wish to check their understanding by explaining the law of conservation of energy to a peer.

For more able students:

Students with higher abilities should be able to prepare a list of other examples (aside from the given example of a trampoline) and estimate the useful energy output and energy input for each in order to calculate efficiency (see efficiency equation on page 50). For example, 100 units of a hairdryer (input) and useful output of 70 would have an efficiency of 70%.

Additional activity: Racing cars

Ask students to consider a very fast racing car that suddenly brakes – what happens to the energy in this situation? It can’t just disappear. Where does it go? How does this example show the law of conservation of energy?

Additional activity: Hinge questions

A hinge question is a type of formative assessment that allows you to gauge whether students are ready to move on from a concept to a new one. After asking a hinge question, you can tell whether to go on with a new concept, revisit the old one or even completely start again with a different approach. When constructing a hinge question, remember to keep it simple. You want a quick response, not a lengthy one; the whole question and answer should be completed in under a minute. It can be good to give the students a multiple-choice question and ask them to hold up paper with their answer or hold up the correct number of fingers.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

**Scientific American: Fact or fiction?**  
This article discusses the law of conservation of energy.

3.6 Energy efficiency can reduce energy consumption

Teacher notes (pages 52–53)

Introducing the topic

Energy efficiency refers to how efficiently the energy is transformed from one form to another. The less energy being wasted during transformation, the more energy efficient an appliance.

Teaching tips: Energy efficiency

Discuss the energy-efficiency star rating system, which students may have seen before. Examine the concept of conservation of energy (energy cannot be created or destroyed), where the total amount of energy in a system remains constant but the energy can be changed into useful forms or ‘lost’ as non-useful forms. Energy efficiency just means how good an appliance is at converting the energy into the useful form and minimising the non-useful or ‘waste’ energy.

Differentiation

For less able students:

It may be beneficial to complete a few more examples with students, and have them apply this knowledge to other situations in their lives, such as shopping and test scores. This could then be related back to energy-efficiency calculations.

For more able students:

A good starting point for more able students is to turn the lights on in the science room and ask students how flicking the switch makes the lights come on. Develop the idea that electricity needs a pathway of wires in order to reach each light. This will build up the concept of an electric circuit and current travelling along the pathways.

Additional activity: Investigate efficiency

Students could investigate the energy efficiency of appliances at home and at school. Ask students whether old appliances should be replaced purely on energy efficiency, or are there other costs (e.g. environmental and/or economic) that need to be taken into account?

Additional activity: Energy debate

Students could explore the debate that the planet is running out of energy. These are some questions to get students thinking:

• If the Earth is running out of energy, why is the planet heating up?

• If energy is always conserved, how can we run out of energy?

• If we are constantly receiving energy from the Sun, how can we be running out?

• Most of our energy sources are from fossilised animals or plants. Why can’t we just continue to use these, given they are being continually replaced?

Additional activity: Energy use

Ask students to create a list of all the things they do for entertainment that require energy. They could then list the energy used and any transformations that occur.

Additional activity: Personal energy use

As an extension, students could investigate the demand that our current lifestyles have for energy and whether this is sustainable in the long term. Ask students to determine what changes may have to occur to ensure their lifestyle is energy efficient, or at least energy sustainable.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

**Energy animations**  
This video shows an animated cartoon family wasting energy and how their wastage can be easily overcome.

3.7 Solar cells transform the Sun’s light energy into electrical energy

Teacher notes (pages 54–55)

Introducing the topic

This topic considers how energy from the sun can be harnessed through solar cells. The number of households using light energy to heat water or power heating and cooling devices is growing rapidly every year.

Teaching tips: Radiation

Heat is transferred through electromagnetic waves, such as the Sun warming the Earth. Radiated heat travels very quickly because it does not rely on the movement of particles to move energy from one place to another. Every student in the room radiates infrared radiation all the time.

Differentiation

For less able students:

Ask students to make a list of as many things as possible that they can think of that use solar power to function. Some examples may include calculators, solar panels, solar hot water heaters and so on.

For more able students:

Ask students to prepare a table that lists the advantages and disadvantages of solar power. Students will need to perform additional research when undertaking this task.

Additional activity: Thermometers

How do we measure the heat from the sun? A thermometer works because liquids expand as they absorb thermal energy. So the hotter the liquid, the greater its volume and the more it will rise up the tube. A quick practical activity could be to use unmarked thermometers and place them in melting ice, then boiling water, marking the height of the liquid in each case. The thermometer can then be labelled as 0 and 100 degrees at these points. Simple markings can then scale the thermometer into 1 degree (or greater) markings. This process led to the use of centigrade (centi = 100; grade = ‘mark’) as a unit of temperature. Students should only be using Celsius for their units.

Additional activity: Diet Coke and Mentos Solar Flare explosion

Explain to students that this activity is only a representation of a solar flare. Real solar flares are produced when magnetic energy has built up and is suddenly released.

**Materials**

• 1.25-L or 2-L bottle of Diet Coke

• Half to one pack of Mentos mints

• Geyser tube (this is optional but it makes it easier)

**Method**

Note: Only do this experiment outside.

**1** Stand the Diet Coke bottle upright and unscrew the lid. Put the geyser tube on top of it so you can drop the Mentos mints in all at the same time.

**2** Drop the Mentos mints into the Diet Coke bottle and move away from the bottle.

**3** A huge geyser of Diet Coke should spurt out of the bottle.

**4** A 2006 episode of *Myth Busters* (episode 57, ‘Diet Coke and Mentos’) concluded that it is the pitted surface of a Mentos mint that enables millions of carbon dioxide bubbles to form on the surface of the Mentos and rise through the bottle to produce the geyser.

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

**Future sparks: Solar energy**  
This website contains a number of excellent articles about all things solar.

3.8 Engineers use their understanding of energy to solve problems

Teacher notes (pages 56–57)

Introducing the topic

The word ‘engineer’ comes from the Latin words *ingeniator* or *ingenium*, which literally mean ‘ingenious one’. Engineers provide solutions, shape future developments and generate ideas that make life easier. All engineers are problem solvers, but some know how to solve specific problems better than others. People who study to become engineers often choose an area of interest and concentrate their skills in that field.

Teaching tips: Careers

This topic is a good way to introduce careers in science. As such, it can be good to organise an incursion or excursion to allow students to hear from a real engineer. This will allow them to ask questions and interact with them in ways that they can’t when using a text or a video.

Additional activity: Sustainability

Engineers are often faced with ensuring that something is environmentally sustainable. Students could attempt to do the same by investigating the demand that our current lifestyles have for energy and whether this is sustainable in the long term. Ask students to determine what changes may have to occur to ensure their lifestyle is energy efficient, or at least energy sustainable. As an extension, students could investigate the total energy required for public transport (bus, train, tram) and divide this by the number of people this form of transport can carry. They could then compare this to the energy required for the equivalent number people to use another source of transport, such as cars. Using this information, students could make suggestions for transport options in the future. Students could design a transport survey or audit. Students design a questionnaire that investigates the various modes of transport that people use. Students then survey as many participants as possible in order to build up a large pool of useable data. An idea may be to use a free online survey tool such as Survey Monkey. Students then transform the data into a visual medium (a graph) and use it to draw conclusions about the types of energy conversions that are taking place for most people. An extension of this would be for students to compare the use of various methods of transport by age group to see whether there are any trends or patterns and then attempt to explain these. Students could also form recommendations for the school based on the data (e.g. use of school buses, walking school buses).

Going further

A useful weblink is available on your obook/assess. To access it, click the weblink tile on the Dashboard for this unit.

**Engineers Australia**  
This Australian website provides further information on careers in engineering, including what the different types of engineers do.