Chapter 3 : Energy

3.1 Energy can be transferred

Student book answers (pages 40–43)

Check your learning 3.1

Remember and understand

1 What is energy?

Energy is the ability to do work. It is how things change and move. It cannot be created or destroyed.

2 What type of devices could the following flow diagrams represent?

a wires → motor → air

Fan

b battery → wires → light globe

Torch

c sun → muscles → bicycle

Riding a bike

3 Make a summary of the entertainment devices mentioned in this section and draw flow diagrams for the energy transformations they perform.

CD and DVD players: electrical energy → light energy (laser) → sound and light energy

Speakers: electrical energy → kinetic energy → sound energy

TV remote control: chemical energy → electrical energy → light energy → electrical energy

4 Why is the direction the arrows point in a flow diagram important?

The direction the arrow points in an energy flow diagram shows the new form the energy becomes.

5 Copy Figure 3.16 and label each stage in the flow diagram.

battery → wires → stereo

Apply and analyse

6 Why do country trains mostly use diesel instead of electrical wires?

Country trains mostly use diesel because mounting electrical wires over large distances would be costly and hard to maintain.

7 How important is energy for transport?

Energy is vital for transport. Energy conversions are essential in every type of transport to allow movement from one area to another.

8 What is the ultimate source of all energy?

Our Sun is the ultimate source of all energy on Earth.

3.2 Potential energy is stored energy

Student book answers (pages 44–45)

Check your learning 3.2

Remember and understand

1 List four examples of devices or situations that involve potential energy.

Student answers will vary. Examples of devices or situations that involve potential energy include any four of the following: trampoline, wind-up toys, bow and arrow, a child climbing the ladder of a slide, energy drinks, fuels (e.g. natural gas and petrol).

2 What type of energy is stored in a battery?

Chemical

3 We get our energy from the chemicals in food. What type of energy is this?

Chemical

4 Biofuel is an alternative source of energy that comes from burning the energy stored in plants. What type of potential energy is biofuel?

Chemical

5 Describe four devices, other than those mentioned already, that possess elastic energy.

Student answers will vary. Some devices that possess elastic energy include elastic bands, rubber bouncy balls, hair ties and Lycra bike shorts.

Apply and analyse

6 Describe how a person might use a bow to shoot an arrow. What type of potential energy is used in this process?

Pulling back on the bowstring stores elastic potential energy (EPE). When the string is released, the EPE of the string is converted into the kinetic energy of the arrow.

7 Name three countries that use nuclear power to generate electrical energy.

Student answers will vary because nuclear power is used in over 30 countries, including most European countries, USA, Russia, Korea, Japan, Canada and South Africa.

3.3 Moving objects have kinetic energy

Student book answers (pages 46–47)

Check your learning 3.3

Remember and understand

1 What is the scientific term for ‘movement energy’?

Kinetic energy

2 What is moving in electrical energy?

Negative electric charges (or electrons) are moving in electrical energy.

3 What is moving when a guitar produces sound energy?

The string of a guitar moves to produce sound.

4 What is another name for heat energy?

Thermal energy

5 What are solar cells used for?

Solar cells are used to generate electrical energy from sunlight.

6 What features of a car would absorb the driver’s kinetic energy in a collision?

The seatbelts, airbags and car seats would absorb the driver’s kinetic energy in a collision.

3.4 Energy can be transformed

Student book answers (pages 48–49)

Check your learning 3.4

Remember and understand

1 For each of the electricity generators above, draw a flow diagram of the energy transformations.

For Figure 3.29: kinetic → electrical

For Figure 3.30: chemical → kinetic → electrical

For Figure 3.31: potential → kinetic → electrical

2 Where does the energy stored in coal come from?

Student answers will vary. Typically, the energy stored in coal comes from the chemical bonds inside the coal OR from the energy within the dead plant matter that formed the coal.

3 What is the difference between energy transformation and energy transfers?

When energy is changed from one type of energy to another, we say it has been transformed. Energy is transferred when it is passed from one object to another.

4 Suggest one way energy can be transferred without being transformed.

Student answers will vary. As an example, in a coal-fired power station, the kinetic energy of the steam is transferred to the kinetic energy of the turbine. It has been transferred but is still in the form of kinetic energy.

Apply and analyse

5 Draw a flow diagram for the main energy transformation for a car.

chemical energy (petrol) → kinetic energy (moving car)

6 Draw an energy chain for how we get our energy from eating an apple. (Hint: Start with the Sun!)

light energy (Sun) → biomass energy (apple on an apple tree) → kinetic energy (biting and chewing the apple) → chemical energy (obtaining the nutrients from the apple)

3.5 Energy cannot be created or destroyed

Student book answers (pages 50–51)

Check your learning 3.5

Remember and understand

1 What is the law of conservation of energy?

The law of conservation of energy states that energy cannot be created or destroyed and that the total amount of energy present remains constant.

2 The sun provides heat and light energy to our planet every day. If this energy is not destroyed, where does it go?

Student answers will vary. Typically, the heat and light energy that strikes our planet every day goes into warming our air and soil and producing our climate, as well as giving our plants the energy they need to grow.

Apply and analyse

3 If you release a rubber band that had 10 units of elastic energy, 12 units of movement energy cannot be produced. Why not?

There were only 10 units of energy to start with; to get 12 units of movement energy from 10 units of elastic energy, 2 units of energy would need to be created and energy cannot be created or destroyed.

4 For the rubber band in question 3, what would its percentage efficiency be if 7 units of movement energy were produced? Where have the remaining 3 units of energy gone?

Efficiency = 7 ÷ 10 × 100 = 70%. The remaining 3 units of energy have been transformed into other types of energy such as heat, sound, static electricity etc.

5 A student claimed energy was lost when she bounced a ball. Was she correct?

No. Strictly speaking energy cannot be ‘lost’, although it may look that way. The ‘lost’ energy was probably transformed into heat and sound.

6 What are the by-product energy transformations for a car?

The by-product of energy transformations in a car include electrical energy, sound energy and thermal energy.

3.6 Science as a human endeavour: Energy efficiency can reduce energy consumption

Student book answers (pages 52–53)

Extend your understanding 3.6

1 Draw flow diagrams for the energy transformation process that happens in your house for:

a heating during winter

Student answers will vary. Typically, chemical (gas) → thermal OR electrical → thermal

b cooling during summer.

Student answers will vary. Typically, electrical → kinetic (in a fan or air conditioner)

2 A refrigerator cools the food inside it.

a How do you think it does this?

A refrigerator cools the food inside it by transferring heat from inside the refrigerator to the outside. (As liquids evaporate, they absorb heat from their environment. A refrigerator contains a liquid called the ‘refrigerant’, which helps create the cold temperature. A condenser within the refrigerator forces the refrigerant to liquefy. It is then pumped within coils inside the refrigerator, causing the refrigerant to evaporate. As it evaporates, the refrigerant absorbs the heat, making the refrigerator cold.)

b Suggest possible energy transformations that may occur in a refrigerator.

electrical energy → kinetic energy (mechanical movement of condenser) → kinetic energy (as the refrigerant condenses) → kinetic energy (as the refrigerant evaporates) → thermal energy (as the refrigerant absorbs the heat)

3 How does an architect use their knowledge of energy efficiency?

An architect uses their knowledge of energy efficiency to reduce places where thermal energy can escape from inside the house to outside, or where it can enter the house from outside. This will maximise the thermal energy efficiency of the house.

4 How do window awnings and verandas keep a house cool in summer?

Window awnings and verandas shelter the inside of the house from the Sun’s rays. This prevents heat being transferred to the inside of the house.

5 The temperature inside and outside a house was measured over 24 hours and displayed in Figure 3.34. From the graph, determine if the house was insulated. Give evidence to support your answer.

Because the indoor temperature of the house remains reasonably steady when the outside temperature drops over many days, the house must be insulated. If the house was not insulated, heat would easily escape from the inside to the outside and the temperature inside the house would drop.

6 Study Figure 3.35, which shows how much energy is used by different household appliances.

a Which appliance uses the most energy?

Spa (pump and heater)

b The clothes dryer uses more energy than the electric blanket. Use energy transformations to explain why.

A clothes dryer transforms electrical energy to thermal energy and kinetic energy (internal rotating barrel). This requires more energy than an electrical blanket that transforms electrical energy to thermal energy only.

c Many people switch their appliances off at the wall rather than use the standby function (where the television is still on but the screen is dark). Use energy efficiency to explain possible reason for this.

The standby function still transforms some electrical energy to heat and light. If the appliance is turned off at the wall, no electrical energy is used at all. This saves energy and money.

3.7 Science as a human endeavour: Solar cells transform the Sun’s light energy into electrical energy

Student book answers (pages 54–55)

Extend your understanding 3.7

1 What advantages will solar cars have over petrol cars?

Solar cars use much less fuel (zero) and emit fewer emissions (zero) than petrol cars. They are also much quieter.

2 What do we call a cell that captures the light energy from the Sun?

A photovoltaic (PV) cell

3 Why does light energy often need to be stored as chemical energy before it can be used?

Light energy is not needed during the day, so it is stored as chemical energy in batteries.

4 Use Table 3.1 to determine which city has the highest average amount of sunshine. How does this compare to your nearest city?

Alice Springs has the highest average amount of sunshine as it produces the most kWh. How this compares with students’ closest city will vary.

5 Research when the next World Solar Challenge will occur. How far is the race? Where does it start and finish?

Student answers will vary.

3.8 Science as a human endeavour: Engineers use their understanding of energy to solve problems

Student book answers (pages 56–57)

Extend your understanding 3.8

1 Write a definition of ‘engineering’.

Student answers will vary. Typically, engineering is the application of science to building things, such as roads, machinery, engines, ships, aircraft etc.

2 What is the difference between civil engineers, electrical engineers, chemical engineers and mechanical engineers?

Civil engineers research, plan and design structures. Electrical engineers design and organise electrical equipment. Chemical engineers combine existing materials and develop new materials. Mechanical engineers deal with forces and motion, designing and improving things that have moving parts or have physical forces pushing or pulling them.

3 What are some reasons to build a prototype of your design before finalising the project?

Building a prototype before finalising the project allows investigation of different aspects of the design to see whether the design will actually work before costs or safety risks are involved on a larger scale. A better solution may also be found when the prototype is built and tested.

4 What type of criteria might be considered by an engineer before starting a project?

Projects are designed and evaluated using many different criteria. Appropriate criteria include all the aspects you want to design for and measure.

5 What would be the social impact of a water slide?

The social impact of a water slide would be that it creates a fun environment for people to come and enjoy themselves.

Review 3

Student book answers (pages 58–59)

Remember and understand

1 Match these words and phrases with their correct meanings:

Kinetic energy: Possessed by all moving objects

Nuclear energy: Used widely throughout the world to generate electricity from atoms

Potential energy: Another name for stored energy

Elastic energy: The energy stored in a compressed spring

Gravitational energy: The energy of an object when lifted up

2 Are the following true or false? For false statements, rewrite them to make them correct.

a Springs only hold stored energy when they are stretched.

False. Springs hold stored energy when they are stretched or compressed.

b When an object is thrown up in the air it gains gravitational potential energy.

True

c Sound energy is a type of potential energy.

False. Sound energy is a type of kinetic energy.

d Petrol contains nuclear energy.

False. Petrol contains chemical energy.

3 What is the main form of energy in each of the following situations?

a Water flowing slowly over a waterfall.

Gravitational potential energy (some kinetic energy)

b A rollercoaster at the lowest point of the ride.

Kinetic energy

c The Sun coming in through a window on a sunny day.

Light energy

d A boy riding his skateboard.

Kinetic energy

e A stretched rubber band.

Elastic potential energy

4 Name a device that transforms:

a electrical energy into light energy

Student answers will vary, but may include light bulb, torch or TV.

b elastic energy into kinetic energy

Student answers will vary, but may include rubber band stretched and released or bouncing a bouncy rubber ball.

c electrical energy into sound energy

Student answers will vary, but may include a speaker or buzzer.

d gravitational energy into electrical energy

Student answers will vary, but may include a turbine in the production of hydroelectricity.

e kinetic energy into electrical energy.

Student answers will vary, but may include a non-battery operated torch that you shake to make it shine or an electric generator at a power station.

5 Why might you employ a chemical engineer if you were designing a new clothing range?

A chemical engineer may be useful when designing a new clothing range to test how the material could be manipulated (e.g. dyed), the suitability and durability of a material in the type of environment the garment would be worn and how best to care for the garment.

Apply and analyse

6 Use numbers in an example of your own to explain the law of conservation of energy.

Student answers will vary, but should show that the total amount of energy before and after the transformation remains constant.

7 Use numbers in an example of your own to explain energy efficiency.

Student answers will vary, but should show the useful output energy divided by the input energy multiplied by 100 with the answer expressed as a percentage.

8 What is the percentage efficiency of a device if it transforms:

a 20 units of input energy into 12 units of useful output energy?

12 ÷ 20 × 100 = 60%

b 600 units of input energy into 500 units of useful output energy?

500 ÷ 600 × 100 = 83%

c In (a) and (b) above, where did the other energy (i.e. 8 units in (a) and 100 units in (b)) go?

The other energy was transformed into non-useful or waste energy forms.

9 The main job of a car travelling on the road is to produce kinetic energy in its wheels. What other parts of a car may demonstrate kinetic energy?

The other parts of a car that may demonstrate kinetic energy include the steering wheel, the brake, accelerator and clutch pedals, the pistons inside the engine, the crankshaft, the speedometer needle, the fan, the fanbelt and the drive shaft.

10 Think of your day today. How many different energy forms have you come across, possessed, used or witnessed? List them in order of use during the day. Which one was the most common and why?

Student answers will vary.

11 Visit a local playground and examine the play equipment. Take a digital photo or draw a picture of a piece of equipment and work out what types of energy are demonstrated as a child plays on the equipment.

Student answers will vary.

12 List the places and structures in your school that you think an engineer was involved with. Justify your decisions.

Student answers will vary. Typically, engineers would be involved in the design of classrooms, laboratories, playground, kitchens, drinking taps, toilets etc. These structures and places all needed different kinds of engineers to provide solutions and generate ideas.

Evaluate and create

13 Energy comes in many different forms. Create a poster that illustrates each type of energy with visual examples.

Student answers will vary.

14 The massive earthquake and tsunami in Japan in March 2011 caused extensive damage to the Fukushima nuclear power plant, north of Tokyo, and created an emergency situation. Research this disaster and present a 2 minute news report to the class that highlights the issues surrounding the use of nuclear energy.

Student answers will vary.

15 Energy types rarely exist alone. They are always on the move, making things happen. Think about some of the things energy can do. For at least two of these, identify the type or types of energy involved. If more than one type of energy is involved, link the different types with arrows. Try to include as many different scenarios as you can.

Student answers will vary.