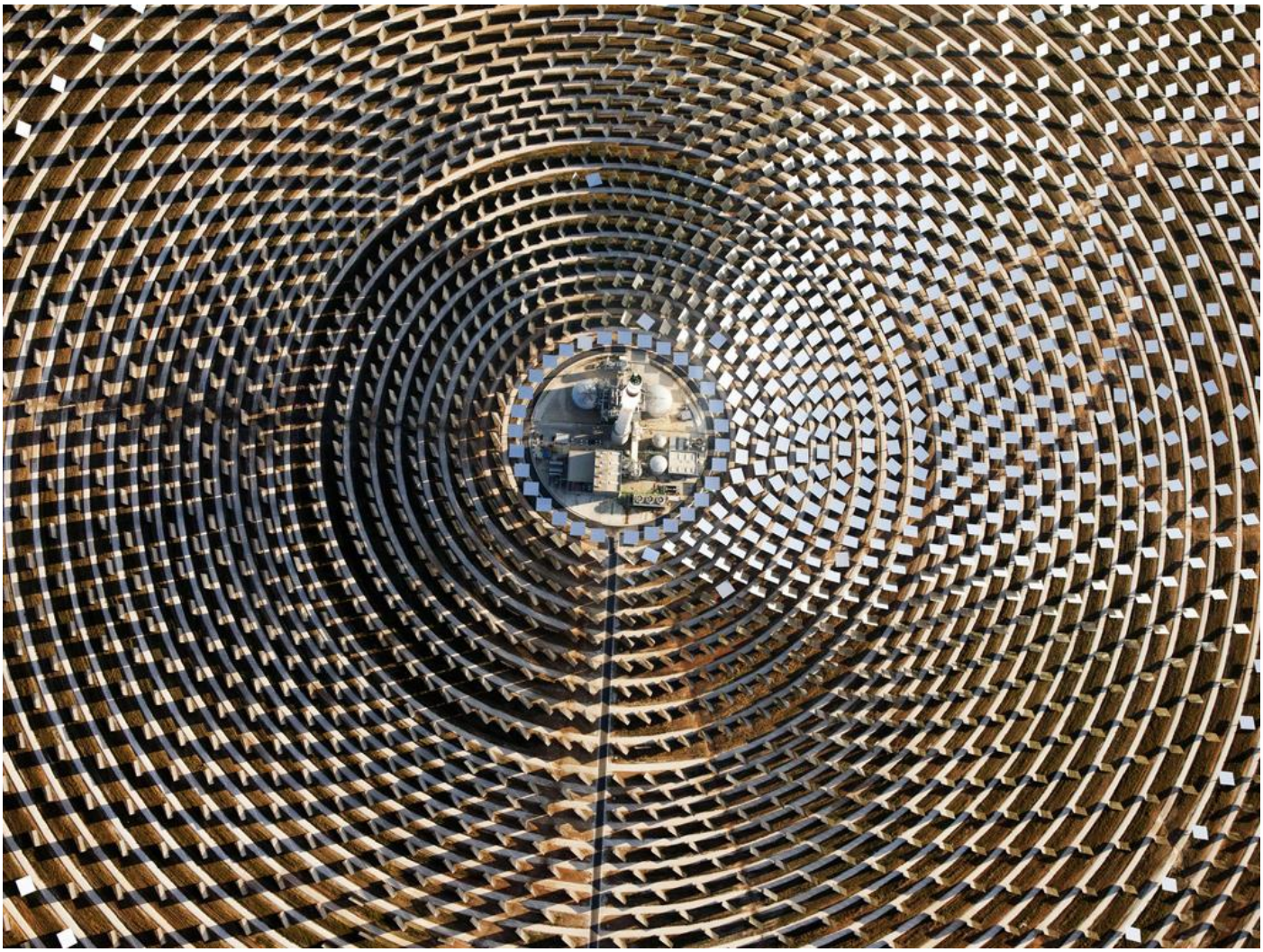


Gemasolar solar power tower, Seville, Spain. 20 MW power output.

Future Post-Carbon Energy Sources: Student Handbook

Digitech Studio School – 2016-2017

Pupil Name_____

Teacher Name: Mr. Cottam

Contents

Timetable 3
Individual learning aims 4
Mark scheme 4
Course map 5
Glossary of key words 6
Why study renewable energy? 8
Learning team and learning aims 9
Tutorial 1: Energy and energy stores 10
Vocabulary Pre-Teaching 11
Activities 12
Homework 16
Tutorial 2: Energy transfer 17
Vocabulary Pre-Teaching 17
Activities 18
Homework 22
Tutorial 3: Efficiency 23
Vocabulary Pre-Teaching 23
Activities 24
Homework 25
Tutorial 4: Fossil fuels 26
Vocabulary Pre-Teaching 26
Activities 26
Homework 36
Tutorial 5: What is renewable energy? 37
Vocabulary Pre-Teaching 37
Activities 38
Homework 43
Tutorial 6: Writing to Mr. Skidmore, your MP 44
Student feedback report 45

Timetable

Fill this in with your teacher.

Timetable – Tutorials

Tutorial	Date	Time	Location
1			
2			
3			
4			
5			
6			

Timetable – Homework Assignments

Homework Assignment	Description	Due Date
Tutorial 1		
Tutorial 2		
Tutorial 3		
Tutorial 4		
Tutorial 5		

Individual Learning Aims

Everyone can improve **how** they learn.

You should choose two aims to work on to improve how you learn.

For example, you could choose:

- Asking for help when you need it
- Not getting angry with your own mistakes.
- Being proud of your work.
- Going to bed early.
- Staying focussed on your work.

You will choose two aims in your first tutorial. We will discuss them every week.

Mark Scheme

This isn't only about learning science. Developing your confidence and enthusiasm will also help you learn.

Confidence and Self-Belief

Together with your teacher, you will show yourself how able you are. Your teacher has a lot of confidence that you are a good student and they want you to as well!

Enthusiasm

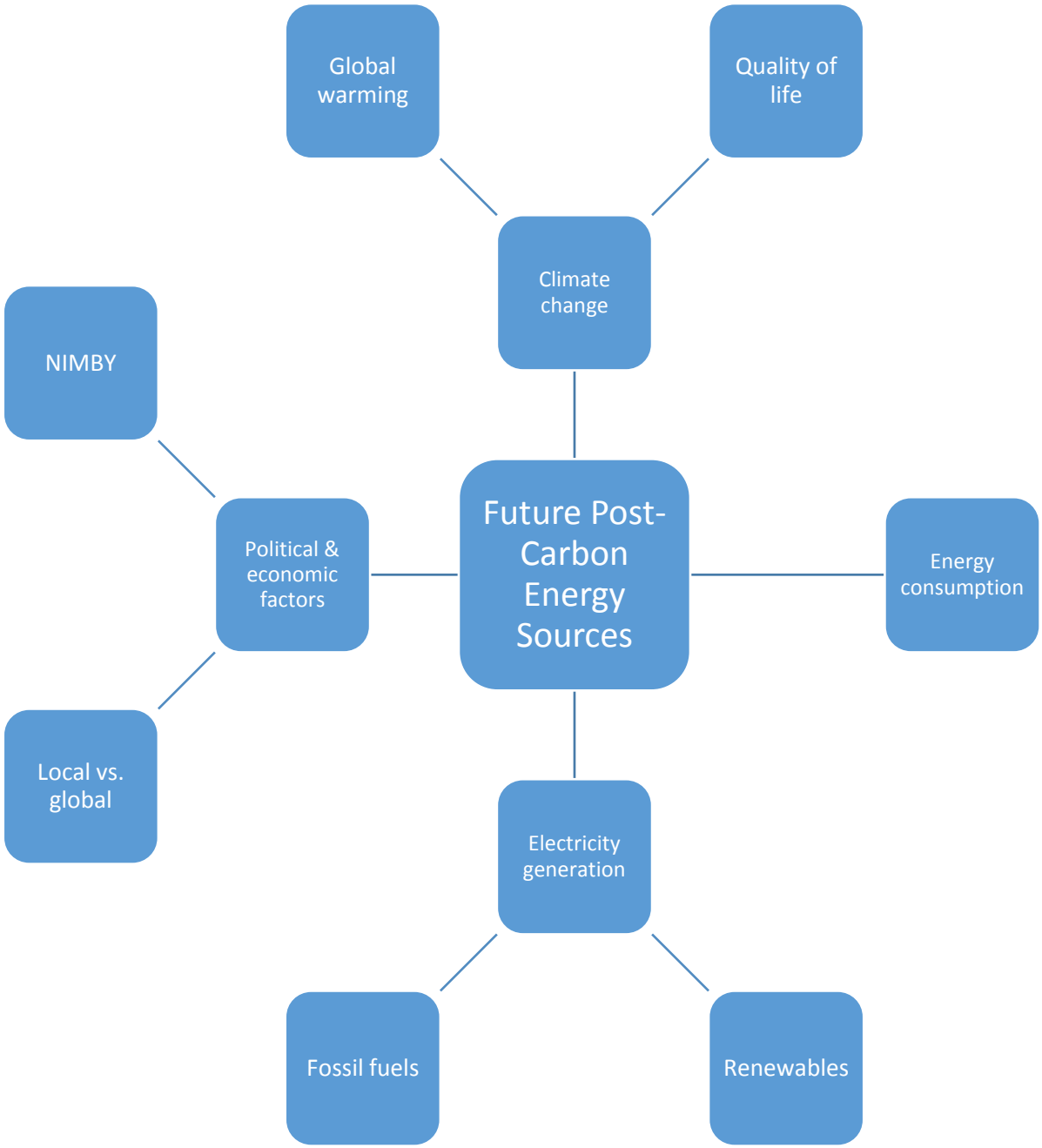
You were chosen for this course because of your enthusiasm for science. With fewer students on this course, you can work more closely with your teacher to increase your enthusiasm for science even further. They will help you to learn how science affects all parts of our lives.

Citizenship

Your country, the United Kingdom, is a democracy. This means that everyone over the age of 18 can vote to choose who makes decisions about this country. We elect **Members of Parliament** to make these decisions. You have a Member of Parliament who represents you, and you have the right to speak to him about issues that worry you.

Together with your teacher, you will write a letter to your Member of Parliament about climate change, an issue that affects us all, where science can help hugely. You are a **citizen** of this country, you have a right to have your voice heard.

Course Map


Global warming
Quality of life
Climate change
NIMBY
Political & economic factors
Future Post-Carbon Energy Sources
Energy consumption
Local vs. global
Electricity generation
Fossil fuels
Renewables

Glossary of Keywords

Word	Definition	In a sentence…
Energy	A measure of something's ability to have an impact upon something else.	Oil contains a lot of **energy**, which is released when we burn it.
Generating / generation	Making useful energy from a different form of energy.	**Energy generation** involves converting energy from one form (e.g. solar) to another (e.g. electricity).
Renewable energy	An energy source which doesn't damage the planet and can be used forever.	Wind power is a promising form of **renewable energy**.
Energy transfer	Moving energy from one place to another.	Flowing hot water **transfers** thermal energy from the boiler to the radiator.
Energy transformation	Changing energy from one form into another.	A power station **transforms** the chemical energy in coal into electrical energy for use around the country.
Energy stores	Different forms in which energy can be stored.	A car engine converts the energy from the chemical store (petrol) to the kinetic store (car acceleration).
Joule (J)	The unit of energy.	Eating an apple gives a human being 52 000 Joules of energy.
Kinetic	To do with movement.	A car converts energy from the chemical store (petrol) to the kinetic store (movement).
Thermal	To do with heat.	A boiler converts energy from the chemical store (gas) to thermal energy (heat) to heat your home in winter.
Gravitational potential	To do with height.	A climber climbing a mountain is transferring energy from her chemical store (sugar, fats in the body) to her gravitational potential store (gaining height).
Chemical potential	To do with energy released through chemical reactions.	Petrol is a useful form of chemical potential energy.
Elastic potential	To do with energy stored in stretched materials.	Stretching an elastic band increases the energy stored in its elastic potential store.
Electricity	Means of transferring energy using high-energy electrons.	The National Grid distributes energy around the country via electricity.

Sound	Means of transferring energy by the vibration of air molecules.	Energy is transferred into a speaker by electricity and transferred out by sound.
Light	Means of transferring energy by light waves.	Energy is transferred into a light bulb by electricity and transferred out by light.
Thermal dissipation	Means of transferring energy from the thermal store to the environment.	A poorly-insulated boiler will dissipate (leak) heat to its environment.
Efficiency	The ratio of useful energy out to total energy in.	Modern cars are more efficient than older cars.
Sankey diagrams	A means of showing where all the energy input goes for a given machine.	
Fossil fuels	A fuel extracted from underground formed from fossilised material many millions of years ago. They are burned to release energy. They also release gases which damage the environment.	Natural gas, coal and oil are all fossil fuels.
Greenhouse effect	Carbon dioxide in the atmosphere traps additional heat from the Sun in our atmosphere, causing climate change.	Carbon dioxide increases the greenhouse effect.
Renewable	Something which can be renewed and does not run out.	The world needs to use more renewable energy to stop climate change.
Kilowatt-hour (kWh)	A measure of energy used (like Joules).	1 kWh = 3 600 000 Joules.
Solar thermal	A type of solar power generation where the Sun's energy is used to heat a fluid (normally water).	Solar thermal technology is often used to generate electricity in deserts.
Solar photovoltaic	A type of solar power generation which converts the Sun's energy directly to electricity.	Many people in the UK install solar photovoltaic panels of their roof to generate electricity.
Turbine	A machine which converts the flowing fluid (liquid or gas) into electricity.	Solar thermal power plants feed the hot fluid into a turbine to generate electricity.

Why study energy?

Our energy needs are increasing.
There are 7 billion people on the planet, and that number is rising fast, especially in large developing countries such as India and China.

Many people around the world do not have access to the same things we do, such as cars, televisions, central heating, washing machines, and so on. These things require energy to run. The energy one person uses in the UK would be enough for five people in India.

India and many other countries are developing fast. This is a good thing because it means that people can live safer, longer and more comfortable lives. It also means that they need more energy. The planet's energy needs as a whole are increasing.

We use fossil fuels to generate energy and they damage our planet.
Coal, oil and gas are referred to as "fossil fuels". They provide 81 % of all energy that we use today. When we burn fossil fuels we emit harmful gases which damage the environment and cause the atmosphere to warm up. This is causing serious problems for humans and other animals on the planet.

We are running out of fossil fuels.
We have already shown that we need more and more energy. However, we only have a limited amount of fossil fuels and we have used most of them already. We need to find another way to generate electricity, otherwise we will continue harming the planet and we will run out of fossil fuels.

Renewable energy is safe and doesn't damage the environment.
Scientists and engineers have invented new ways of generating energy without producing harmful gases. We can generate energy from the Sun, the wind, and the tides of the oceans.

We won't ever run out of renewable energy.
If we have the right technologies to use renewable energy, we will be able to use them forever and they won't run out, unlike fossil fuels.

In this course, we will study the different types of renewable energy and investigate what work still has to be done to stop fossil fuels damaging our planet.

These are important problems which will affect everyone's lives. Together we will write a letter to our local Member of Parliament (someone who represents us in the Government) to ask him to work to solve these problems.

Our Learning Team:

Photo of the group goes here.

My Learning Aims:

Learning Aim 1: I will improve my learning by _____

_____

_____

Practical things I can do to work towards Learning Aim 1:

1. _____

   _____

2. _____

   _____

3. _____

   _____

Learning Aim 2: I will improve my learning by _____

_____

_____

Practical things I can do to work towards Learning Aim 2:

1. _____

   _____

2. _____

   _____

3. _____

   _____

Tutorial 1 – Energy and Energy Stores

Figure 1. A large power plant generating electrical energy for us to use in our homes and businesses.

Today's Key Question(s):

- What is this course about?
- What are our learning aims?
- What is energy?
- What are the different energy stores?

Vocabulary Pre-Teaching:

Word	Definition	In a sentence…
Energy	A measure of something's ability to have an impact upon something else.	Oil contains a lot of energy, which is released when we burn it.
Energy transfer	Moving energy from one place to another.	Flowing hot water transfers thermal energy from the boiler to the radiator.
Energy stores	Different forms in which energy can be stored.	A car engine converts the energy from the chemical store (petrol) to the kinetic store (car acceleration).
Joule (J)	The unit of energy.	Eating an apple gives a human being 52 000 Joules of energy.
Kinetic	To do with movement.	A car converts energy from the chemical store (petrol) to the kinetic store (movement).
Thermal	To do with heat.	A boiler converts energy from the chemical store (gas) to thermal energy (heat) to heat your home in winter.
Gravitational potential	To do with height.	A climber climbing a mountain is transferring energy from her chemical store (sugar, fats in the body) to her gravitational potential store (gaining height).
Chemical potential	To do with energy released through chemical reactions.	Petrol is a useful form of chemical potential energy.

Activities

Task 1: Missing words

Read the following sentences and fill in the blanks using the words in the box:

transferred	**created**	**transformed**
destroyed	**Joules (J)**	**change**

Energy is the ability to bring about _____. Energy cannot be _____ or _____. Energy can however be _____ from one store to another. It can also be _____ from one form to another. Energy is measured in _____.

Task 2: Types of energy store

Find descriptions of different energy stores around the room to stick in the grid below:

Kinetic energy store		**Thermal Energy store**	
Definition	Example	Definition	Example
Chemical potential energy store		**Gravitational potential energy store**	
Definition	Example	Definition	Example

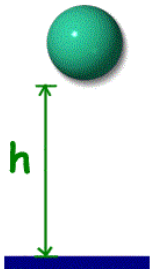
Task 3: Match the stores of energy

Gravitational potential store

Kinetic store

Chemical potential store

Thermal store



Activities Photo

Photo of your activities goes here.

Tutorial 1 Self Evaluation:

Learning aim 1:

Learning aim 2:

Baseline Assessment

This homework is here to help the teacher understand what they need to do to help you learn. Don't worry if you don't know the answers! Use your notes from Tutorial 1 to help.

Question 1:

Give a definition of energy.

_____

_____

_____

_____

Question 2:

Which store contains more energy for a fast-moving car than a slow-moving car?

A. Thermal

B. Kinetic

C. Gravitational potential

D. Chemical potential

Question 3:

A man decides to go bungee jumping while on holiday. When during the jump does he have the **least** energy in the gravitational potential energy store?

A. At the start before he jumps

B. During his fall downwards

C. At the lowest point with the bungee rope stretched

Question 4:

Freezers cool food below 0°C. Which of these statements best describes how the freezer operates in terms of energy?

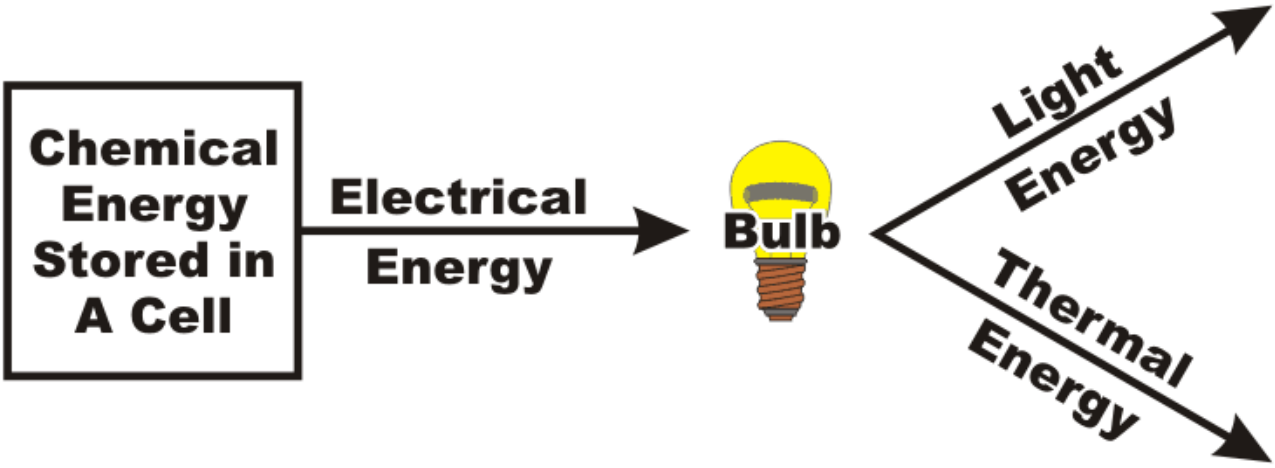
A. The freezer removes energy from the thermal store of the food within it.

B. The freezer adds energy to the thermal store of the food within it.

C. The freezer removes energy from the kinetic store of the food within it.

D. The freezer removes energy from the chemical potential store of the food within it.

Tutorial 2 – Energy Transfer, Input and Output



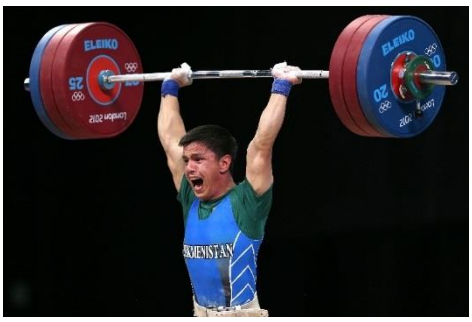
Today's Key Questions:

- How do we transfer energy between different energy stores?
- Can you show any examples of energy stores and transfers at school? Or at home? Or can you think of any in factories?

Vocabulary pre-teaching:

Word	Definition	In a sentence…
Transfer	Movement of energy from one store to another.	Electricity is a useful form of electricity transfer.
Elastic potential	To do with energy stored in stretched materials.	Stretching an elastic band increases the energy stored in its elastic potential store.
Electricity	Means of transferring energy using high-energy electrons.	The National Grid distributes energy around the country via electricity.
Sound	Means of transferring energy by the vibration of air molecules.	Energy is transferred into a speaker by electricity and transferred out by sound.
Light	Means of transferring energy by light waves.	Energy is transferred into a light bulb by electricity and transferred out by light.
Thermal dissipation	Means of transferring energy from the thermal store to the environment.	A poorly-insulated boiler will dissipate (leak) heat to its environment.

Task 1: Energy in the Olympics



Olympic sports are all about expending (using) energy! Choose three Olympic sports and show the energy transformation process which enables the athletes to win. An example has been done for you.

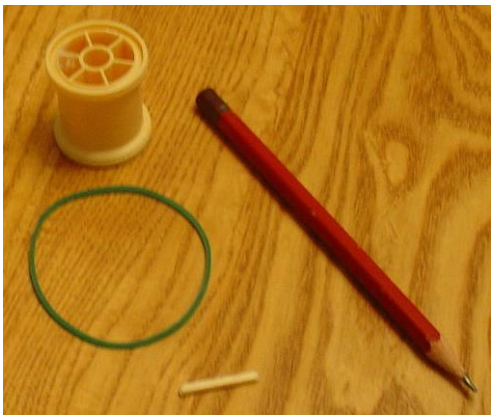
Sport	Energy store + explanation
High jump	Gravitational potential energy store – the athlete aims to reach the greatest height possible. The athlete is transferring as much energy as possible into the gravitational potential store.

Task 2: Cotton reel tank

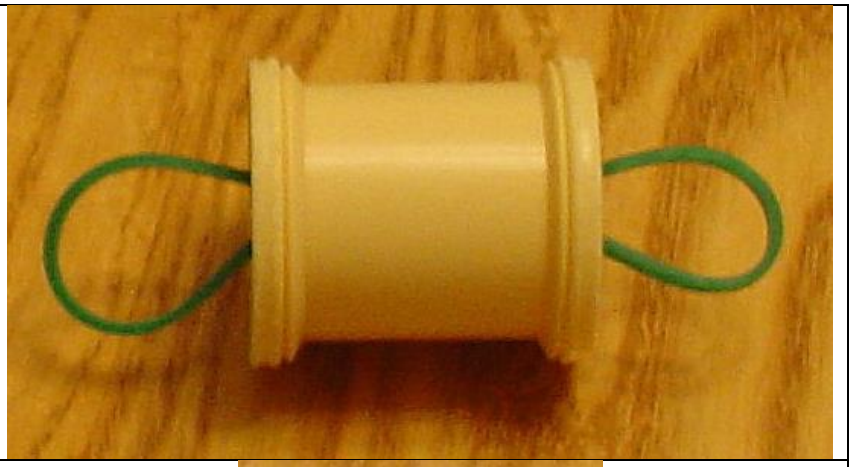
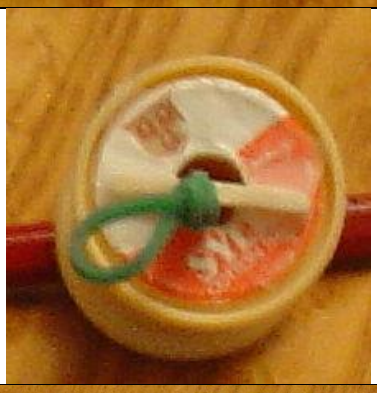
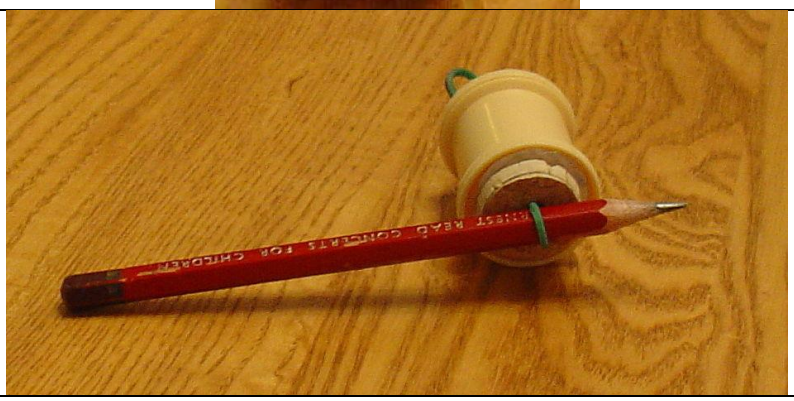
Let's make a cotton reel tank! We provide the energy input into an energy store, and then to an energy output. Can you identify the energy input, stores and output?

Materials

- Cotton reel
- Matchstick
- Elastic band
- Pencil
- Candle
- Sellotape and scissors



Construction

1: Thread the elastic band through the cotton reel.	
2: Cut the matchstick in half. Put the matchstick through the elastic band as shown.	
3: Thread the candle piece over the elastic band and then thread the pencil through the elastic band.	

Wind the pencil up and watch your tank move!

Cotton reel tank – Fill in the blanks:

Use the following energy stores to fill in the blanks below:

Energy stores:

Kinetic (movement)	Thermal (heat)	Elastic potential (stretchy materials)
Chemical potential (food, fuel)		

Fill in the blanks:

Energy is transferred in to the _____ energy store of the elastic band by twisting it. Energy is then transferred to the _____ energy store, moving the cotton reel tank along the desk.

Cotton Reel Tank Photo

Photo of your cotton reel tank activity goes here.

Tutorial 2 Self Evaluation:

Learning aim 1:

Learning aim 2:

Today's Homework is:

- Find some energy stores at home and discuss them with your parents/carers.
- Pick a few items at home (e.g. washing machine). See if you can identify the type of energy store and the type of energy transfer used to get the energy in and out of that store. An example has been done for you.
- If you have a phone you can take pictures of your chosen item to show your teacher.

Item	Energy input	Energy store	Energy output
Car	• Chemical potential store in fuel	• Kinetic (movement of the car)	• Thermal dissipation (hot engine) • Sound.

Homework notes from parents / carers:

Tutorial 3 – Efficiency

Figure 2. A filament light bulb; a neon gas light bulb and a light-emitting diode (LED). Which is the most energy efficient?

Today's Key Questions:

- What are the different types of energy loss?
- What is energy efficiency?
- How do Sankey diagrams show the efficiency of an item?

Vocabulary pre-teaching:

Word	Definition	In a sentence…
Efficiency	The ratio of useful energy out to total energy in.	Modern cars are more efficient than older cars.
Sankey diagrams	A means of showing where all the energy input goes for a given machine.	

Task: Energy efficiency demonstration

- Using skittles to represent energy and labelled cups to represent energy stores, can we see how energy is lost during the electricity generation process? Remember energy is never created or destroyed, it just goes elsewhere!
- Using the same practical method, can we label the energy stores ourselves for an example of our choosing (e.g. kettle)?
- By laying the skittles out on paper, can we see how Sankey diagrams are created to represent energy efficiency?

Activities Photo

Photo of your skittles efficiency activity goes here.

Tutorial 3 Self Evaluation:

Learning aim 1:

Learning aim 2:

Today's Homework is:

- Now that you have studied some main forms of energy loss, have a chat with your parents or carers and think about what might be the main types of energy loss when you heat your home in winter.
- How could you reduce these losses?

Homework Notes for Parents / Carers:

Tutorial 4 – Fossil fuels

Figure 3. Power plant chimneys emitting harmful gases.

Figure 4. An oil rig drilling for oil under the sea bed.

Today's Key Questions:

- What are fossil fuels?
- How are they damaging our planet?
- Where did they get their energy from?

Vocabulary pre-teaching:

Word	Definition	In a sentence…
Fossil fuels	A fuel extracted from underground formed from fossilised material many millions of years ago. They are burned to release energy. They also release gases which damage the environment.	Natural gas, coal and oil are all fossil fuels.
Greenhouse effect	Carbon dioxide in the atmosphere traps additional heat from the Sun in our atmosphere, causing climate change.	Carbon dioxide increases the greenhouse effect.

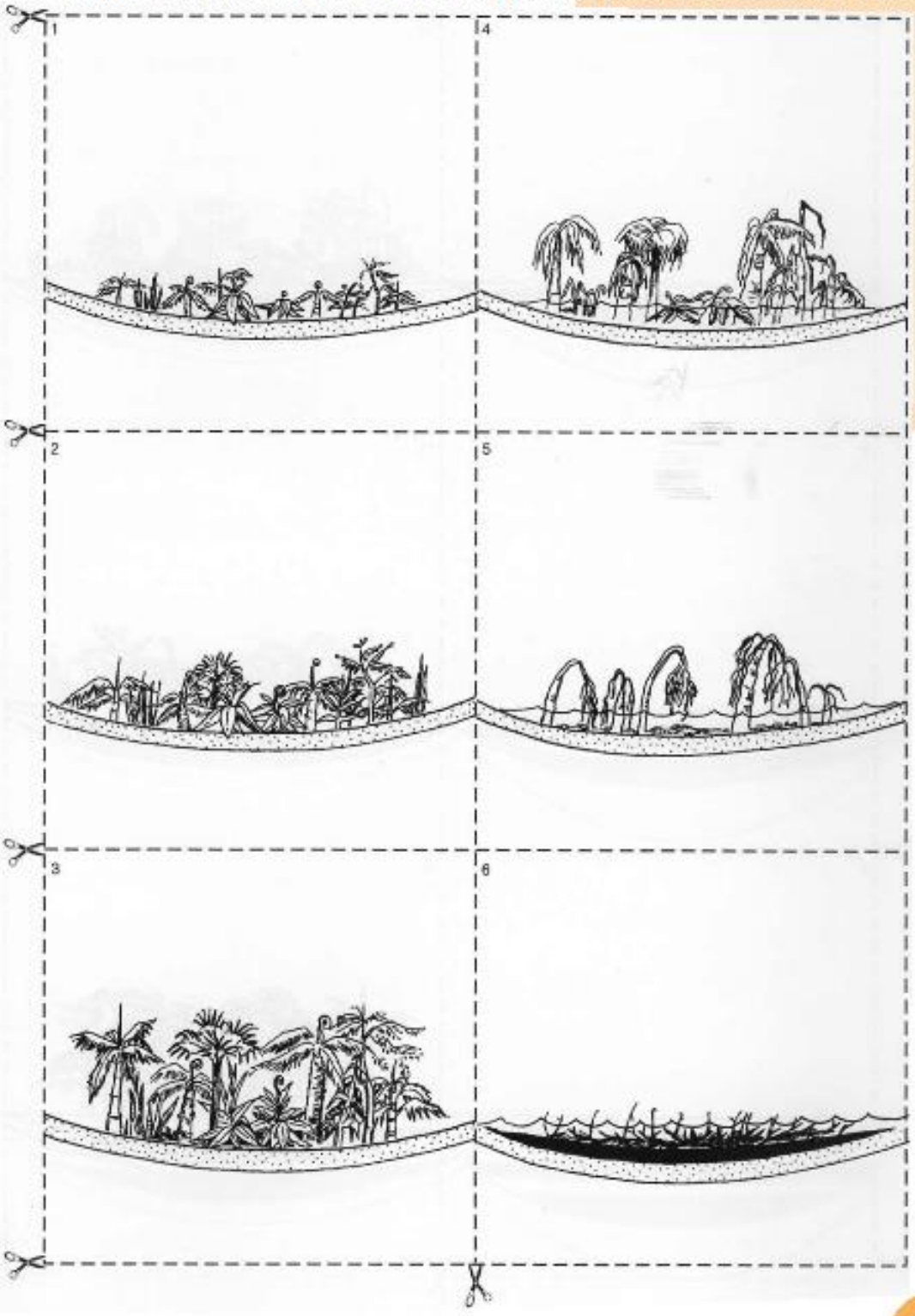
Task 1: Creation of fossil fuels

- Cut out the squares in the next three pages.
- Keep them in order and staple them together.
- You have made your own flipbook showing how fossil fuels were made!

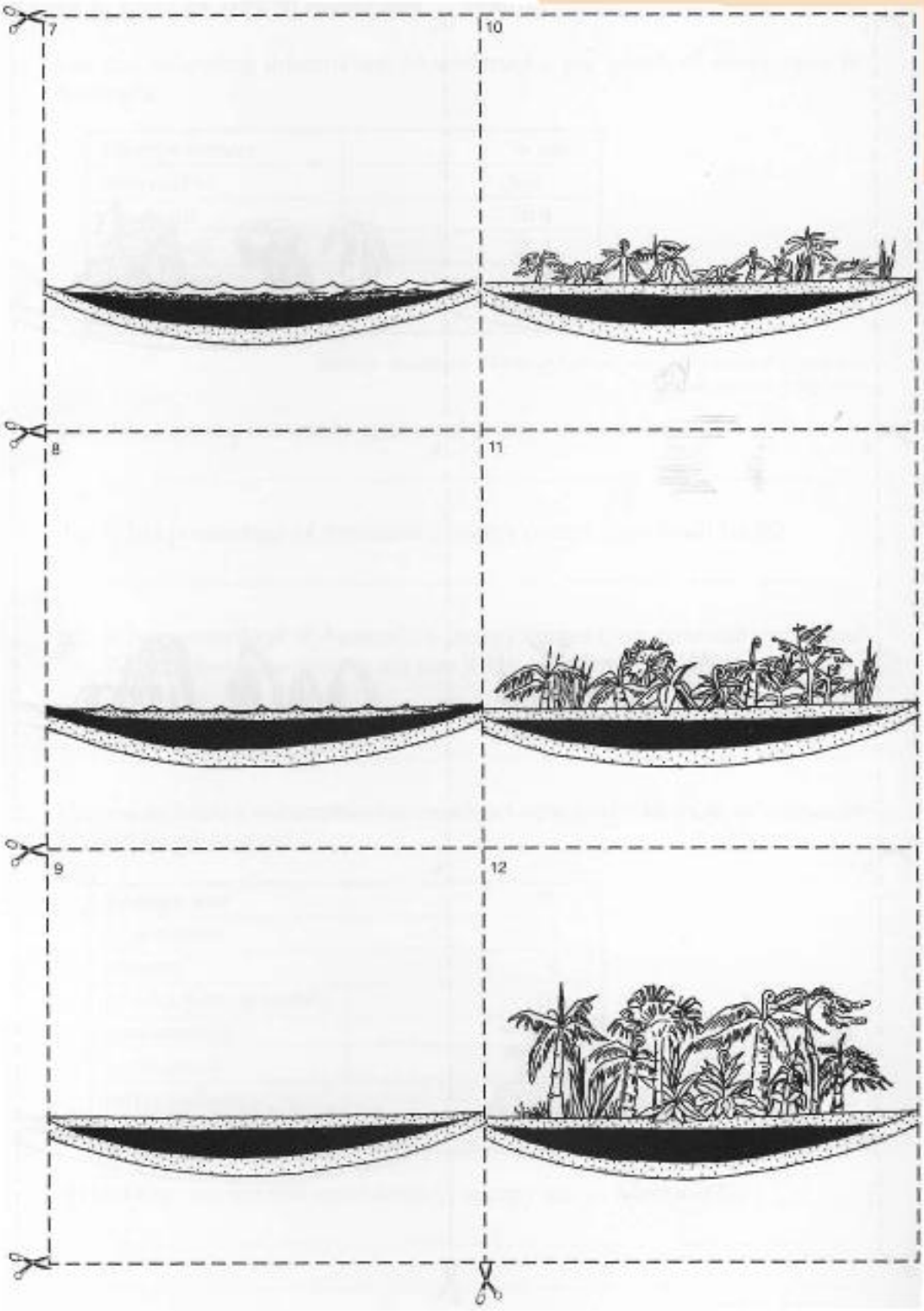
This page is intentionally blank

Fossil Fuel Flip Book

Coal, oil and natural gas are formed below the surface of the earth. These fossil fuels are made from dead plants and animal remains and were deposited around the time when dinosaurs roamed the earth. To see how fossil fuels were formed cut out the squares along the dotted lines and staple together in order.



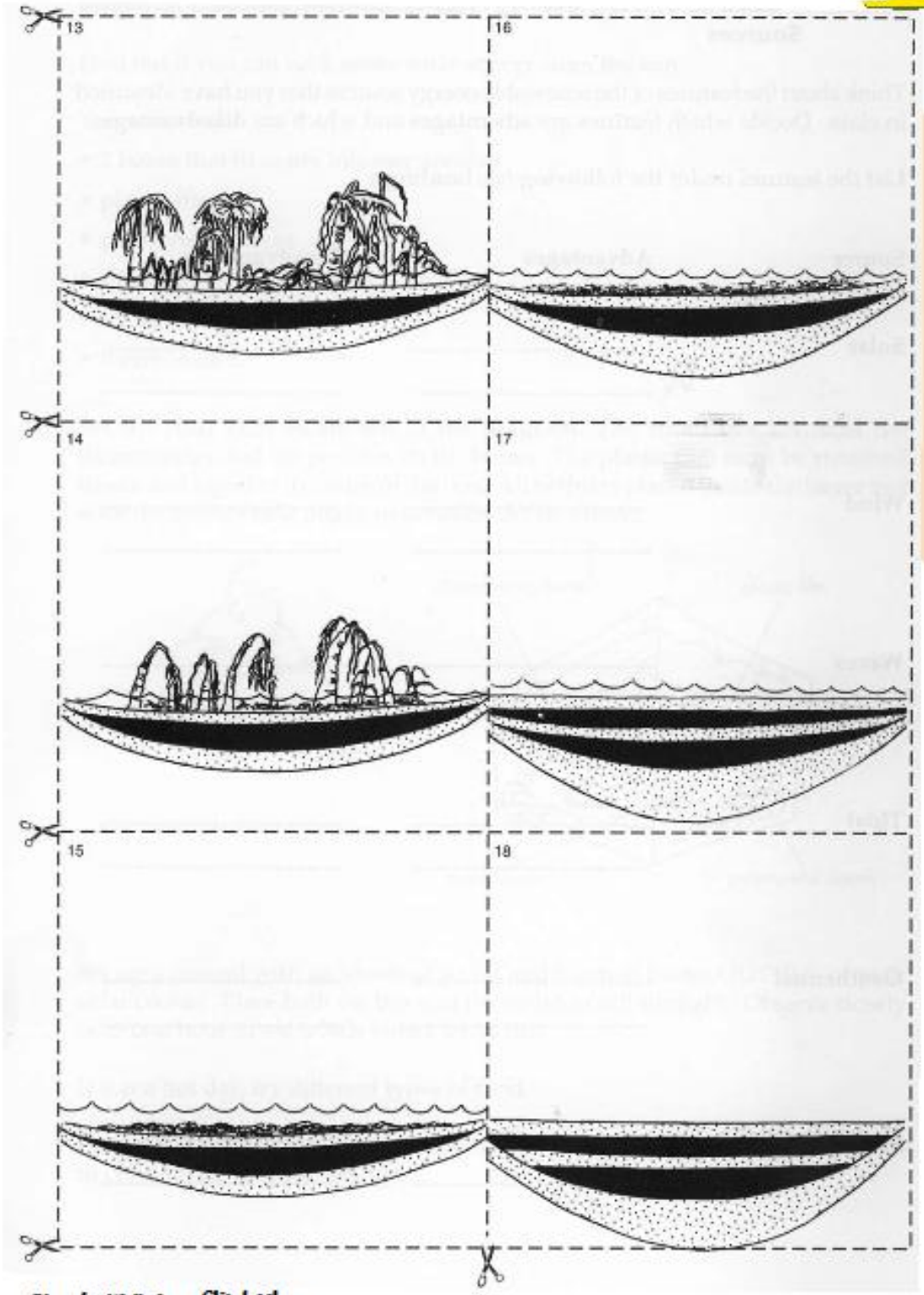
This page is intentionally blank



26

don't waste
your energy!

This page is intentionally blank



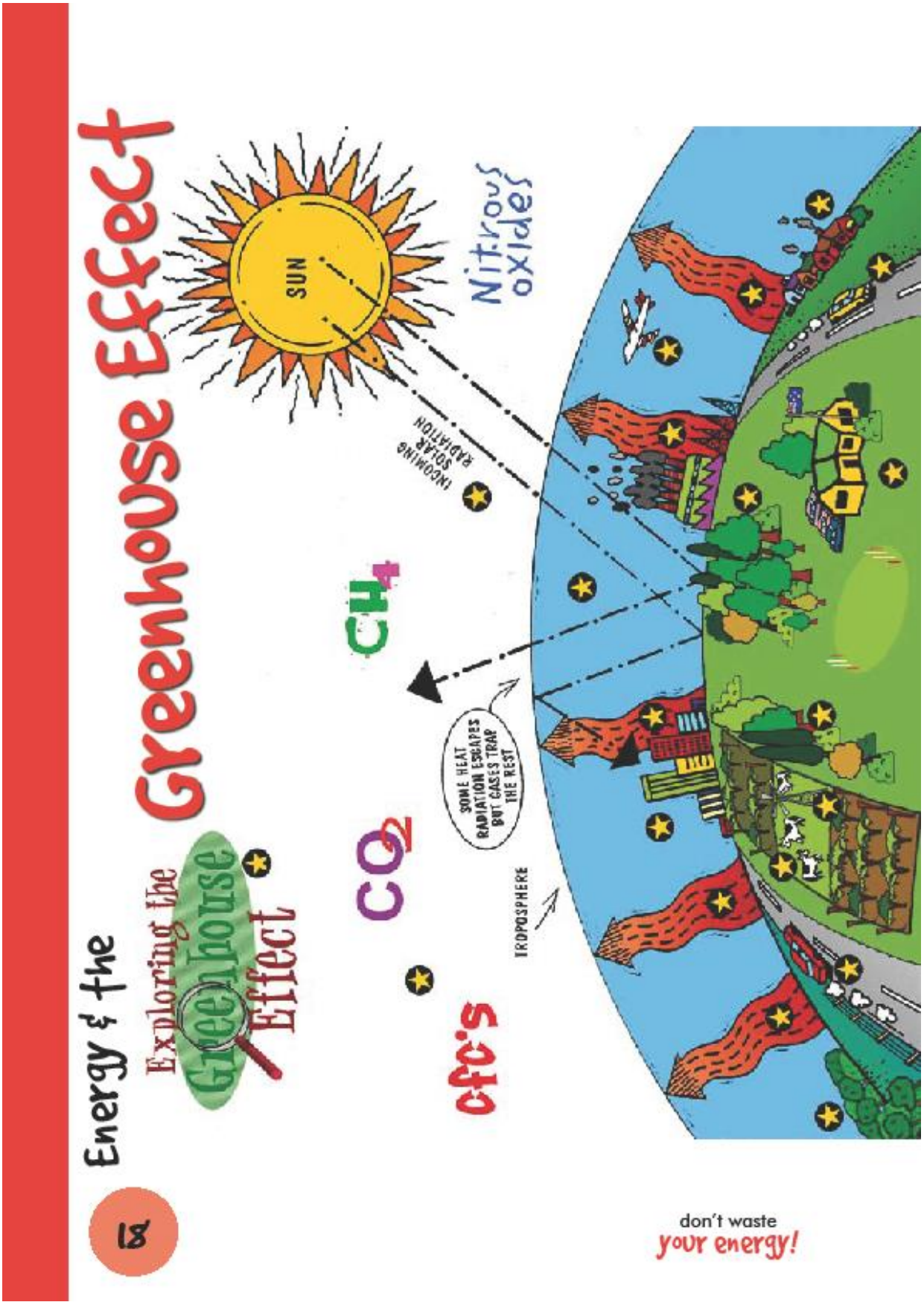
Create your own flip books

Use another source of generating electricity to make your own moving picture book.

You could use waves, the sun or a wind turbine that will appear to move as you flip through.

This page is intentionally blank

How do fossil fuels damage the environment?



Class discussion:

- Fossil fuels produce carbon dioxide and other gases which cause the Earth's atmosphere to heat up.
- Why might the atmosphere heating up be a problem?

Activities Photo

Photo of your flipbook activity goes here.

Tutorial 4 Self Evaluation:

Learning aim 1:

Learning aim 2:

Today's Homework is:

- Fill in fossil fuels book!

Parents' / Carers' notes:

Tutorial 5 – What is renewable energy?

Figure 5. Solar panels generating electricity from the Sun's energy.

Today's Key Questions:

- What is renewable energy?
- Why do we need renewable energy?
- What different types of renewable energy are available?
- Which types are most suited to the UK?

Vocabulary pre-teaching:

Word	Definition	In a sentence…
Renewable	Something which can be renewed and does not run out.	The world needs to use more renewable energy to stop climate change.
Kilowatt-hour (kWh)	A measure of energy used (like Joules).	1 kWh = 3 600 000 Joules.
Solar thermal	A type of solar power generation where the Sun's energy is used to heat a fluid (normally water).	Solar thermal technology is often used to generate electricity in deserts.
Solar photovoltaic	A type of solar power generation which converts the Sun's energy directly to electricity.	Many people in the UK install solar photovoltaic panels of their roof to generate electricity.
Turbine	A machine which converts the flowing fluid (liquid or gas) into electricity.	Solar thermal power plants feed the hot fluid into a turbine to generate electricity.

Task: Renewable energy mind maps

- Complete a mind map for each different type of renewable energy.
- Include the advantages and disadvantages.

Advantages:

Cost:
£0.025 - £0.082
per kWh

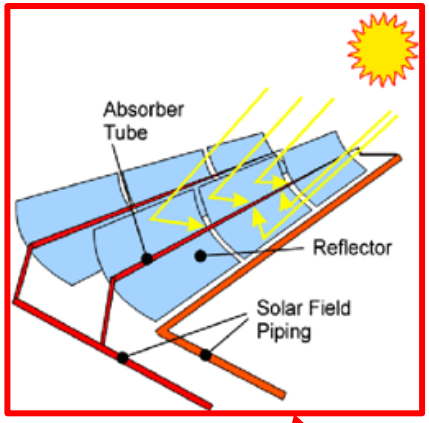
Solar photovoltaic panels

Disadvantages:

Directly converts the Sun's energy into electricity.

Advantages:

Cost:
£0.098 - £0.148
per kWh



Solar thermal power

Disadvantages:

Uses the Sun's energy to heat water and drive a turbine to generate electricity

Advantages:

Cost:
£0.026 - £0.063
per kWh

Wind turbines

Disadvantages:

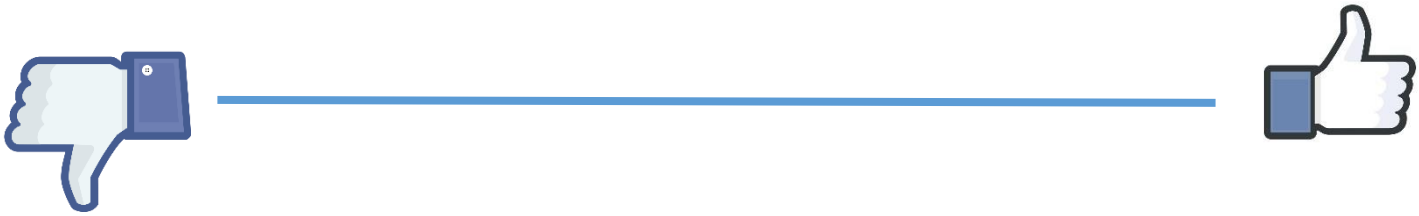
Uses the kinetic energy store of the wind to generate electricity.

Activities Photo

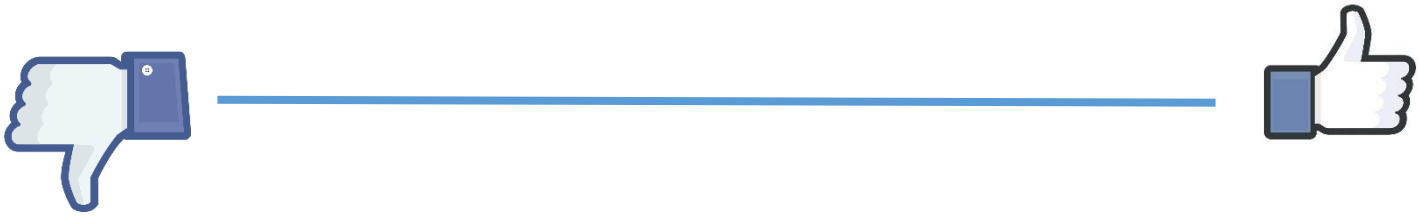
Photo of your mind map activity goes here.

Tutorial 5 Self Evaluation:

Learning aim 1:



Learning aim 2:



Today's Homework is:

Have a think and discuss with your parents / carers:

- What do **you** think should be done about climate change?
- Do **you** think renewable energy is important? Why?
- How would you **persuade** someone else that it is important?

Parents' / Carers' notes:

Tutorial 6 – Writing to Mr. Skidmore, your MP.

Figure 6. The Houses of Parliament, where Members of Parliament (MPs) make decisions on how to run the country. Small picture (inset): Chris Skidmore, the Member of Parliament who represents Digitech Studio School and its neighbourhood.

Today's key questions:

- What do I want to say to Mr. Skidmore about the environment, renewable energy and fossil fuels?
- How do I write a polite letter to a Member of Parliament?

Task: Write a letter to Mr. Skidmore about renewable energy

- Decide what sort of action you would like the Government to take regarding climate change and renewable energy.
- Plan a letter to Mr. Skidmore, the Member of Parliament who represents you and helps the Government to run the country.

In your letter:

- Explain to Mr. Skidmore what you have learned about climate change and renewable energy.
- Ask him and the Government to take action to protect our environment. Be specific! What action would you like him to take? Why?
- For example, you might ask him to build more wind farms, as the UK has a lot of wind.
- Finish the letter politely and positively.

Student Feedback Report

Learning Aim 1: _____ _____	
What you did:	How you could improve in the future:
Learning Aim 2: _____ _____	
What you did:	How you could improve in the future:
Resilience – How well you cope with making mistakes and continuing to learn	
How you showed resilience:	How you could build resilience in the future:

Feedback - Student confidence:
Feedback – Science enthusiasm:
Feedback – Active citizenship: