



Energy and Heat

S1 Physics

Unit 2

Pupil Booklet

Wallace Hall Academy

Types of energy

Learning Outcome:

- ◆ I can name several types of energy.
- ◆ I can state the law of conservation of energy.

Flash Card Words:

- ◆ **Energy conversion** – When one type of energy is converted into another type of energy.



This Lesson

Energy is a property that all objects have. There are many different forms of energy.

GROUP ACTIVITY – In a small group write down as many forms of energy that you know about. The pictures below might be able to help you. Once you have completed this task the teacher will ask all groups in the class to help create a list of different types of energy which can be copied down.



The law of conservation of energy states that energy can neither be created nor destroyed only converted from one type of energy to another. Your teacher will show you some examples of where energy is converted from one type into another.

GROUP ACTIVITY – In a small group complete the energy conversion activity to describe some situations where energy is changed from one type into another. Copy some of the examples into your jotter.

CLASS ACTIVITY – Watch the Bill Nye video on energy which will give further examples of energy and how it can be converted from one type to another.

What should be in your notes:



- ◆ Some examples of different types of energy.
- ◆ The law of conservation of energy.
- ◆ Some examples of where energy is converted from one type to another.

Homework 1 – Energy

You have learned about various types of energy and how it is converted from one type to another. For your homework you must write a story which includes some examples of energy conversions. The key things to think about when writing your story are shown below:

- Your story must be interesting.
- Your story should include as many **different** energy conversions as possible (eg. 5 examples of electrical energy converting into heat isn't as good as 5 different energy conversions).
- You must clearly state in your story what the energy conversion taking place is.

Choice of activity

Your story can be done as an extended piece of writing or as a comic strip cartoon.

Heat energy

Learning Objective:

- ◆ I can describe the difference between heat and temperature.
- ◆ I can describe how particles are organised in solids, liquids and gases.
- ◆ I can state examples of good heat conductors.

Flash Card Words:

- ◆ **Temperature** – A measure of how hot or cold something is. Measured in Degrees Celcius.
- ◆ **Heat** – A type of energy. Measured in Joules.
- ◆ **Heat conduction** – The transfer of heat energy from particle to particle.



This Lesson

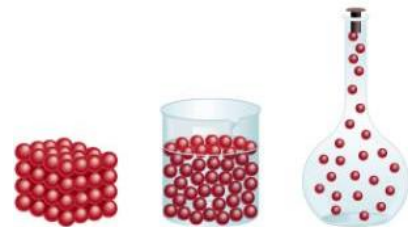
Temperature and Heat are often described as the same thing and while they are related they are also very different things. Temperature is a measure of how hot or cold something is. Heat is a type of energy which describes how much energy the particles in a material have. Often things which are hotter have more heat energy but this is not always the case.

For example a sparkler that a child would be allowed to hold on bonfire night reaches temperatures of over 1000°C while a bath full of water will be around 50°C . The sparkler has a much higher temperature than the bath water but as the sparkler is so small and the volume of the bath water is so big the bath water carries much more heat energy than the sparkler.



CLASS ACTIVITY – Your teacher will show you a simulation of how particles are organised in solids, liquids and gases.

Heat energy can be used to increase the temperature of a solid and make it melt into a liquid. Even more heat energy can be used to increase the temperature of the liquid and make it boil into a gas.



Heat is transferred in different ways in solids, liquids and gases. In solids heat is transferred by conduction. In conduction heat is transferred from particle to particle.

CLASS ACTIVITY – Your teacher will show you a simulation showing how conduction works in solids.

GROUP ACTIVITY – You will now investigate some solids to see which are good conductors and which are poor conductors (insulators).



What should be in your notes:

- ◆ A note of the difference between heat and temperature.
- ◆ A diagram of the particles in a solid, a liquid and a gas.
- ◆ A list of solids which are good conductors or poor conductors (insulators)

Conduction

Learning Objective:

- ◆ I can state examples of heat conductors.
- ◆ I can state examples of heat insulators.

Flash Card Words:

- ◆ **Heat conductor** – A material which allows heat energy to pass through it.
- ◆ **Heat insulator** – A material which does not allow heat energy to pass through it.



This Lesson

A material which allows heat energy to pass through it is a heat conductor. A material which does not allow heat energy to pass through it is a heat insulator. As you investigated during the previous lesson metals are good heat conductors but most other materials are heat insulators.

GROUP ACTIVITY – You will now investigate to see how well different metals conduct heat by heating 4 different metals and timing how long it takes heat energy to travel along them.



CLASS ACTIVITY – You will now be shown a video which will revise conduction and introduce other forms of heat transfer.

What should be in your notes:

- ◆ An experimental write up of the metal conduction experiment.



Convection

Learning Objective:

- ◆ I can state that heat travels by convection in liquids and gases.
- ◆ I can describe that convection is the rising of hot particles and the falling of cold particles.

Flash Card Words:

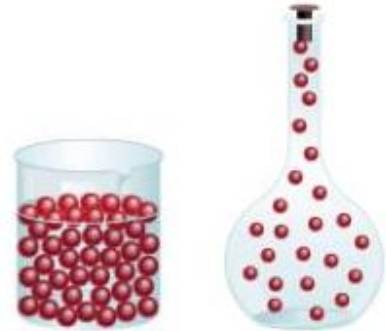
- ◆ **Fluid** – A material which is a liquid or a gas.
- ◆ **Convection** – The transfer of heat energy by particles moving in a fluid.
- ◆ **Convection current** – A flow of particles created when hot particles rise and cold particles fall in a fluid.



This Lesson

Materials which are either a liquid or a gas are called fluids. They are called fluids as in both liquids and gases the individual particles are free to move around each other.

CLASS ACTIVITY – Your teacher will show you a simulation of how particles are organised in a liquid and a gas.



In fluids energy is transferred by convection. In convection hot particles rise and cold particles fall. This creates a movement of particles called a convection current. You may have heard people say that 'heat rises'. This is not true. The heat itself cannot rise but the hot fluids which carry the heat energy can rise. It is therefore better to say that 'hot fluids rise' rather than 'heat rises'.

GROUP ACTIVITY – You will now investigate convection by heating a beaker of water with a purple substance in it to see what the purple substance does when it is heated.

CLASS ACTIVITY – Your teacher will show you a demonstration of convection very similar to the experiment you have just conducted.

CLASS ACTIVITY – Your teacher will show you a simulation of convection to help you understand what happens when a fluid is heated by convection.

What should be in your notes:



- ◆ A note about what a fluid is.
- ◆ A note about what convection is.
- ◆ A diagram of what happened when you heated the purple substance in the beaker.

Radiation

Learning Objective:

- ◆ I can state that heat travels by radiation through free space.
- ◆ I can describe that radiation is the transfer of heat using invisible waves.

Flash Card Words:

- ◆ **Radiation** – The transfer of heat using invisible waves.



This Lesson

You have already seen that heat travels through solids by conduction and through fluids by convection. The third method of heat energy travel is by radiation.

The sun heats the Earth using radiation. Heat radiation is invisible waves of light which are given off by the sun and other hot objects. These invisible waves do not need particles to be transferred, which is why they can travel through space where there are no particles.



CLASS ACTIVITY – You will now investigate how heat loss by radiation affects a beaker of water.



GROUP ACTIVITY – Your teacher will now show you a photo and discuss with the class the differences between heat transfer by conduction, convection and radiation.

What should be in your notes:



- ◆ A note about what radiation is.
- ◆ An experimental write up about how a beaker of water lost heat energy by radiation.

Insulation

Learning Objective:

- ◆ I can state that heat insulation can be used to reduce heat loss by radiation.
- ◆ I can state examples of insulators.

Flash Card Words:

- ◆ **Heat insulator** – A material which does not allow heat energy to pass through it.



This Lesson

When cups of hot coffee or warm baths cool down they are losing heat through radiation. These heat losses can be reduced by using insulation. Insulation is when heat insulators are used to surround objects to prevent them from losing heat.

An example of this is when coffee is stored in a flask. The flask contains two layers of metal with a layer of heat insulator in between. The heat insulator does not allow heat energy to pass through it so keeps the coffee warmer for longer than if it were just in a cup.



Materials which are good insulators include wool, carpets, clothing and bubble wrap. These materials do not allow heat energy to travel through them.



As well as keeping things warm heat insulators can also be used to keep things cool. This means that heat energy from outside the package cannot get inside to warm the package up. An example of this is cool bags used for packed lunches or picnics to keep the food and drink cool and fresh.

GROUP ACTIVITY – You will now design some insulation for a beaker of water and investigate whether it can now stay warmer for longer. You will be in competition with the rest of the class to see which group can have the smallest temperature loss over a 10 minute period.

What should be in your notes:



- ◆ A list of examples of heat insulators.
- ◆ An experimental write up about how a beaker of water and an insulated beaker of water lost heat energy by radiation.

Insulation investigation

Learning Objective:

- ◆ I can state that heat insulation can reduce heat losses in the home.

Flash Card Words:

- ◆ **Trapped air insulator** – A material which is an excellent heat insulator.



This Lesson

We have done experiments on a range of ways of transferring heat and have now started to investigate how heat loss can be reduced.

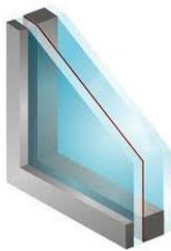
One of the most important ways we need to reduce heat losses is in the home. It costs a lot of money to heat our homes to keep us warm at night and in the winter. It is also very damaging to the environment if we waste heat energy as more electricity is being wasted. We therefore take many steps to insulate our homes against heat loss to save money and the environment.



In our homes we lose heat energy through the walls, through the roof, through the floor and through windows and doors.

INDIVIDUAL ACTIVITY – Draw a picture of a house and show all of the different ways that heat energy is lost.

One of the main ways we insulate our homes from heat loss is through trapped air insulators. Air is a very good insulator and if we are able to trap it then it acts as a very good insulator.



Two ways that we do this in our homes are through double glazing and loft insulation. Double glazing traps air between 2 layers of glass. Loft insulation traps air in between softly packed fibres.



GROUP ACTIVITY – You will be given a model of a house and measure the heat loss when it is not insulated. You will then insulate the roof of the house by choosing a material to insulate the roof with. You must then measure the heat loss when the roof has been insulated and compare your results with the un-insulated roof.

What should be in your notes:



- ◆ A diagram showing the ways that heat is lost from our homes.
- ◆ An experimental write up comparing heat losses from an insulated and an un-insulated model of a house.

Energy savings in a house

Learning Objective:

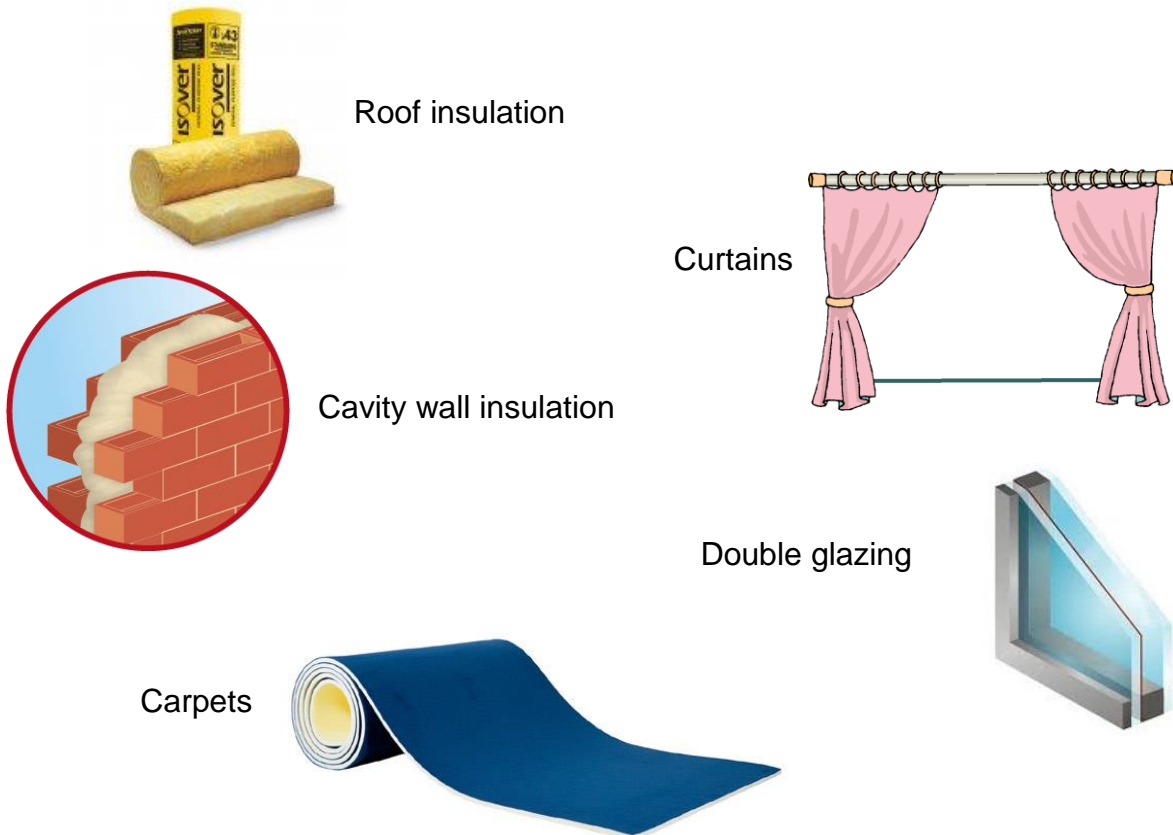
- ◆ I can describe methods of reducing heat loss from a house

This Lesson

We have completed a range of activities looking at heat transfer and reducing heat loss. We will now investigate the full range of options available for reducing heat loss from our homes.

CLASS ACTIVITY – You will be shown a video to give some ideas about how heat loss from our homes can be reduced.

Some of the ways of reducing heat loss from our homes is shown below.



GROUP ACTIVITY – You will now be asked to design a complete insulation system for a house. You will have many things you will have to consider and your teacher will give you details of this. You should use the internet to provide as much information as possible on your final poster about how the different forms of insulation work.

What should be in your notes:



- ◆ A note about the different types of home insulation and how they work to reduce heat loss.

Homework 2 – Heat

1. Describe what conduction is.
2. Describe what convection is.
3. Describe what radiation is.
4. A local company has decided to build a new primary school in Closeburn. They have asked you for advice on how they can make the new school more energy efficient.

Choice of activity

You should create either:

- A clear description of what they should do including diagrams in a formal letter.
- An information leaflet describing what they should do.
- A poster describing what they should do.

Energy generation

Learning Outcome:

- ◆ I can describe the advantages and disadvantages of various forms of energy generation.

Flash Card Words:

- ◆ **Fossil fuels** – Non-renewable sources of energy including coal, oil and gas.
- ◆ **Renewable energy** – Non-polluting sources of energy including solar, wind and wave power.
- ◆ **Nuclear power** – A non-polluting source of energy created by splitting atoms.



This Lesson

We have looked in detail about how we can avoid energy losses from our homes and we will now look at how the electrical energy gets into our homes in the first place through electricity. Electricity can be created in many ways, all of which have advantages and disadvantages.

CLASS ACTIVITY – Your teacher will show you a video about electricity generation using different methods.

The methods of generating electricity on a large scale can be roughly sorted into three main categories; Fossil fuels, renewable sources and nuclear power.



Fossil fuels

- Coal
- Oil
- Gas

Renewable sources

- Solar
- Wind
- Wave
- Bio-energy
- Geothermal
- Hydro-electric
- Hydrogen fuel
- Tidal

Nuclear power

- Uranium

GROUP ACTIVITY – Research one of the above methods of generating electricity and present your findings to the rest of the class. During your presentation you must describe advantages and disadvantages and everyone in the class should take a note of these.



What should be in your notes:

- ◆ A list of advantages and disadvantages of the various methods of generating electricity.

Solar cells

Learning Outcome:

- ◆ I can describe the advantages and disadvantages of using solar cells to generate electricity.
- ◆ I can describe the effect of the number of solar cells on the amount of electricity generated by a collection of solar cells.
- ◆ I can describe the effect of light level on the amount of electricity generated by a collection of solar cells.

Flash Card Words:

- ◆ **Solar cell** – A device which converts light energy into electrical energy.



This Lesson

A solar cell is a simple device which converts light energy from the sun into electricity. They are more common in certain parts of the world than others and you will investigate to find out why.



GROUP ACTIVITY – Experiment to determine how the number of solar cells affects the amount of electricity generated. Vary the number of solar cells exposed to the source of light from 8 through to 0 and measure the electricity generated using a Voltmeter. Plot a graph of your results.

GROUP ACTIVITY – Experiment to determine how the distance between a light source and solar cells affects the amount of electricity generated. By increasing the distance between the light source and solar cells we are in fact reducing the amount of light on the solar cells. Plot a graph of your results.

INDIVIDUAL ACTIVITY – Choose one of the experiments you have completed from the two above and write it up as a formal experiment to be assessed by your teacher. Your teacher will provide you with a worksheet and graph paper to allow you to do this. You have worked as part of a group to complete the experiments but must write the experiment up individually.

What should be in your notes:



- ◆ Experimental write up of how the number of solar cells affects the amount of electricity generated by a collection of solar cells.
- ◆ Experimental write up of how the light level affects the amount of electricity generated by a collection of solar cells.

Energy solution for an island

Learning Outcome:

- ◆ I can use my understanding of electricity generation to design an energy solution for an imaginary island.

Flash Card Words:

- ◆ **Pollution** – A side effect of using fossil fuels for the generation of electricity.



This Lesson

In Scotland it is impossible for us to get all of our electricity needs from a single source and we must use a combination of sources. As you have been researching all forms of electricity generation have advantages and disadvantages.

Fossil fuel sources tend to be cheap but cause large amounts of pollution.

Renewable sources are unpredictable so have low electricity outputs.

Nuclear power is very efficient but can be expensive.

All methods of electricity generation do, however, share one thing in common; We all need them but do not want to live near them for a variety of reasons.

GROUP ACTIVITY – You must design a range of electricity generation solutions for an imaginary island taking account of cost, pollution, location and other factors you think are important.



What should be in your notes:



- ◆ Your notes for this lesson should be on the sheets provided detailing your electricity generation plans for the island.

HOMEWORK 3 –ENERGY GENERATION

1. List three fossil fuels that you know about.
2. Describe an advantage of using fossil fuels for the generation of electricity.
3. Describe a disadvantage of using fossil fuels for the generation of electricity.
4. List three forms of renewable energy that you know about.
5. Describe an advantage of using renewable sources for the generation of electricity.
6. Describe a disadvantage of using renewable sources for the generation of electricity.
7. You have been sent the following letter by a government official

Dear Student

We are in the process of building a new primary school in Barcelona. We have to decide which form of energy generation we are to use to generate electricity for the school. As an expert in the field we would like your recommendation on which source of electricity generation we should use. The school will be on the top of a hill with a river nearby in a built up area which gets around 300 days sunshine every year.

Yours Sincerely

Mr J Rodriguez

You should write a letter of response to the government official detailing your plans for the school. You may only select one form of electricity generation for the school and should back up your choice with appropriate reasoning.