## MINISTRY OF EDUCATION
## SECONDARY ENGAGEMENT PROGRAMME
## INTEGRATED SCIENCE
## TERM 3
## GRADE 9

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Heat is a form of energy and is measured in joules (J). Solids, liquids and gases are all made from tiny particles. These tiny particles moved due to kinetic energy. This and the attraction between the particles means that the material all have internal energy. When we heat a substance we give it more energy and the particles move faster because they have more energy. We notice this as a rise in temperature.

Heat travels from an area/object of higher temperature to an area/object of lower temperature.

Good conductors of heat are materials that allow heat to flow through them very easily.

Generally, metals are good conductors of heat.

Examples of good conductors of heat are:

- Silver
- Copper
- Aluminium
- Brass
- Iron
- Lead
- Gold
Poor conductors of heat are materials that do not allow heat to flow through them very easily.

Examples of poor conductors of heat are:

- Glass
- Wood
- Water
- Air
- Styrofoam
- Cotton wool
- Paper
- Rubber

Because metals are good conductors of heat, they are used to make cooking utensils (pots, pans), kettles, irons etc.

Poor conductors of heat are used as protectors. They give protection against heat.
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Week: One
Lesson: One

Activity sheet

Complete the following statements by choosing the correct word from the brackets.

1. a. Heat is a form of ____________. (temperature, energy)
   b. Heat is measured in ___________. (joules, degrees Celsius)
   c. When we heat a substance, we give it ________________ energy. (more, less)
   d. When particles gain energy, they move _______________. (slower, faster)

2. List two (2) good conductors of heat. ______________ and ________________

3. List two (2) poor conductors of heat. ______________ and ________________

4. Sarah was helping mother to cook, when she notices that most kitchen utensils were made from metals while their handles were made from rubber/plastic. Explain to Sarah why this is so.
   ______________________________________________________________________________
   ______________________________________________________________________________
   ______________________________________________________________________________
   ______________________________________________________________________________


There are three main methods of heat transfer:

1. Conduction
2. Convection
3. Radiation

**Conduction**

Conduction is the transfer of heat through collision of particles. Conduction can take place in all three states of matter (solids, liquids and gases). However, it takes place more readily in solids than liquids and gases. Because the particles in solids are closer together than in liquids and gases.
When one end of the metal rod is being heated, the particles at that end are heated and move faster. They have gained more energy in the form of heat. As the particles move faster they bump into or hit the next particles harder, passing on this energy. These particles also move faster, bumping into each other transferring the energy as they go along. Hence, there is a transfer of heat energy from one end of the rod to the other, causing the entire rod to be heated. This method of heat transfer is called **conduction**.

When heat is transferred by conduction, heat passes from particle to particle within the material by collision but the material itself as a whole **does not move**.
Week: One
Lesson: Two

Activity sheet

Answer the following questions.

1. List the three (3) main methods of heat transfer.
   ___________________, ___________________ and ___________________

2. State whether the following statements are true or false.
   a) Conduction only takes place in solids. _______________
   b) During conduction the material does not move. ______________
   c) Conduction takes place very efficiently in metals. ______________
   d) During conduction energy is transferred from particle to particle. _______________
   e) Particles move slower when they gain heat energy. ______________

3. John accidently left the metal spoon in the pot whilst cooking. After sometime, he observed that the entire spoon felt very hot. Briefly explain how the spoon got hot.

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   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
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Week: One
Lesson: Three
Topic: Conductivity of different metals

All metals do not conduct heat at the same rate.

The following was done to compare the rate of heat conduction of different metals:

- four different metals of same length and thickness were obtained (aluminium, copper, iron and brass).

- they were labelled $P_1$ (aluminium), $P_2$ (copper), $P_3$ (iron) and $P_4$ (brass).

- a pin was placed 2cm from the end of each metal rod using vaseline.

- the rods were mounted on a stand.

- a flame was placed at the junction of the rods as shown in the diagram below.

- observations were made.
Diagram showing the metal rods being heated.

**Observations**

After heat was applied to the rods, the pins started to fall off after sometime.

All the pins did not fall off at the same time.

P₂ fell off first followed by P₁, P₄, and finally P₃.

**Discussion**

From the experiment it shows that metals conduct heat at different rates, since all the pins did not fall off at the same time.

Copper is the best conductor of heat from the four metals, since the pin on P₂ fell off first.

Iron will be the worst conductor of heat, from the four metals, since the pin on P₃ fell off last.
A grade 9 student conducted an experiment to determine the heat conductivity of 4 different materials. She attached 1 pin each to the 4 different rods (labelled A, B, C and D), at the same distance. Heat was applied to the rods and the time taken for each pin to fall off was noted and recorded. She obtained the following results.

<table>
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<tr>
<th>Pin</th>
<th>Time taken to fall off/seconds</th>
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<tbody>
<tr>
<td>A</td>
<td>20</td>
</tr>
<tr>
<td>B</td>
<td>15</td>
</tr>
<tr>
<td>C</td>
<td>19</td>
</tr>
<tr>
<td>D</td>
<td>30</td>
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Table showing time taken for pins to fall off

Answer the following questions.

1. Do all the metal rods conduct heat at the same rate? ______________________________
2. Give a reason for your answer above.
   __________________________________________________________________________
   __________________________________________________________________________
3. Which rod is the best conductor of heat? _______________________________________
4. Which rod is the worst conductor of heat? _____________________________________
5. Rank the rods in order of increasing heat conductivity. (from worst to best conductor of heat). _________________________________________________________________
Convection is the way in which heat is transferred through liquids and gases by movement of the particles in the liquids and gases.

If a liquid or gas is heated it expands and becomes less dense. Cooler, more dense fluid then sinks, forcing the less dense material upwards against gravity. This circulating movement of heated fluid is called a convection current.

Convection current occurs because liquids and gases expand when they are heated. This expansion makes them less dense so that they rise up and are replaced by cooler material.

The following was done to demonstrate heat transfer by convection.

- A 250 cm³ beaker was three-quarter filled with water.

- The beaker was placed on a tripod stand.

- A straw was used to place a few crystals of potassium permanganate in water near the end of the beaker, as shown in the diagram below.

- A slow flame was then placed under the potassium permanganate crystals.

- Observations were made
Diagram demonstrating convection

From the experiment it was observed that coloured streaks (from the potassium permanganate) rose slowly upwards as the beaker was heated. This upward movement of the streaks shows what is happening to water as it is being heated. The particles of water, which is a fluid, are free to move. Heated particles at the bottom, expands, becomes less dense and rise to the top. It is replaced by the cooler, dense water which surrounds it. The process continues, a convection current is set up and heat is transferred through the water in the beaker.
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Week: Two
Lesson: One

Activity sheet: Create your own convection current

Perform the following activity at home. (ensure you are supervised by an adult)

Things you will need:
- ice cube tray
- water
- food coloring
- clear drinking glass/ jar

Procedure:
- Mix water and food coloring, then pour the colored water into an ice cube tray.
- Put the ice cube tray in the freezer until frozen solid.
- Fill a clear glass with warm water.
- Add one ice cube to the glass of water.
- Observe what happens, make note of the observations.
Week: Two
Lesson: Two
Topic: Land and sea breezes

The land gets hot faster than the sea. On a hot day the warm air on the land rises and cooler sea breezes come in to replace the rising warm air.

At nights the process is reversed; the sea cools more slowly than the land. Thus, warm air on the sea rises and the cooler land breezes replace it.

Diagram showing land and sea breezes
Answer the following questions.

1. During the day time, we mostly experience _____________ breeze. (land, sea)

2. During the night time, we mostly experience _____________ breeze. (land, sea)

3. What type of breeze forms when the land cools faster than the ocean?

__________________

4. What happens to the air above a hot surface?

____________________________________________________________________________

5. Draw a labelled diagram showing either land or sea breeze.
Ventilation of houses

The air in a room is warmer than the air outside. The warm air in the room rises and escapes through air vents and cooler fresher air comes in through windows or doors.

Diagram showing Ventilation.
An electric hair dryer

This appliance has a fan which blows air over a heating element. The air that passes over the heating element comes out as hot air.

Diagram showing how the electric hair dryer works

Hot water systems

A hot water system contains a hot water tank in which water is heated. Cold water is let in at the bottom of the tank, heated by the heating element and is taken through pipes for household use.

Diagram showing a hot water system.
1. Sally rented a new room to set up an office. After spending sometime in the room, she felt very hot and uncomfortable. Upon observation, she notices that the room has no windows or vents. She immediately called for the construction workers to install windows and vents in the room. Explain how the windows and air vents will solve Sally’s problem of feeling hot.

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______________________________________________________________________________

2. What is the purpose of a fan in an electric hair dryer?

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

3. What is the function of the heating element in hot water systems?

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
Apart from conduction and convection, thermal energy can be transferred by radiation. Radiation is the process whereby heat energy is transferred from one place to another by means of electromagnetic waves. This process does not require a medium (solid, liquid or gas) for transmission and can occur in a vacuum. Heat energy from the sun reaches earth by radiation.

A simple activity to demonstrate that radiation does not require a medium is bell jar experiment similar to that to show that sound cannot travel through a vacuum. A sealed bell jar enclosing a connected electric bell, and a heating coil which is part of an electric circuit is set up. The air is pumped out of the jar until the sound is not heard on the outside. The circuit containing the heating coil is then closed. After a while, the outside of the bell jar becomes hot because radiant energy passing through the evacuated space is transmitted to and absorbed by the walls of the bell jar.
Activity sheet

Answer the following questions.

1. Define the term ‘Radiation’.

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

2. Describe a simple experiment to demonstrate that heat transferred by radiation does not require a medium.

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Week: Three
Lesson: Two
Topic: Emitters and Absorbers of heat

Some surfaces emit heat better than others. Black surfaces are the best absorbers of heat radiation. Shiny surfaces are the best reflectors of heat radiation.

**Demonstration of how heat is absorbed by different surfaces**

![Demonstration Diagram]

Absorption of radiant energy by different surfaces
In this experiment, two copper plates are clamped beside each other. The inner surface of one of the plates is blackened all over using the soot from the candle, while the other is brightly polished until shiny. A cork is fixed by wax to the outside face of each plate and a lit Bunsen burner is placed mid-way between them, so that each surface receives the same amount of radiation.

The wax on the dull, black plate soon melts and the cork slides off. The shiny plate remains cool and the wax unmelted.

The blackened surface absorbs radiation much better than the bright polished surface.

In conclusion, black surfaces absorb more heat, while shiny surfaces reflect more heat.
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Week: Three
Lesson: Two

Activity sheet
Perform the following experiment.

Things you will need.
- Two identical metal cans/ ‘tins’
- Black paint/ spray/ marker
- Margarine/ butter

Procedure
- Remove the labels from the two metal cans.
- Paint one can black, leave the other can shiny.
- Place one spoon of margarine/ butter in each can.
- Cover the cans.
- Place the cans in direct sunlight.
- Check every 5 minutes to observe the melting of the butter.
- Observe which container melts the butter faster.
- Stop the experiment when either of the butter has melted.
- Record and explain your observations.
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________________________________________________________________________
Week: Three
Lesson: Three
Topic: The vacuum flask

A vacuum flask
The vacuum flask keeps hot liquids hot or cold liquids cold for a very long periods of time. The flask is constructed so as to make it difficult for heat to travel out of or into the flask. The flask reduces heat loss by conduction, convection and radiation.

The heat loss is prevented by:

1. Making the flask a double – walled glass vessel with a vacuum between the walls. Thus, heat loss by conduction and convection is minimised.
2. The stopper traps air and the material (e.g. cork) of the stopper is a poor conductor of heat.
3. Silvering both glass walls on the vacuum side. This reduces heat loss due to radiation reflecting back the heat radiation into the flask.
Veer has just entered primary school. He is accustomed to having his home – cooked meal warmed up at lunch time in the microwave oven at his Nursery school. He misses this and a suggestion was made to his parents that they buy him a flask similar to the one shown below.
Using the information in the diagram, explain how the home – cooked meal is kept warm.
Materials expand when they are heated. This means that they will get larger when their temperatures increase. This effect is called expansion. Expansion can take place in solids, liquids and gases.

Expansion of solids can be demonstrated using the ball and ring experiment.

Diagrams showing the ball and ring experiment to demonstrate expansion of solids.

Before heat is applied the ball fits easily through the ring. After heat is applied to the ball, the ball could not pass through the ring. This is because the ball becomes too large, it expanded.
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Week: Four
Lesson: One

Activity sheet:

Answer the following questions.

1. Define the term ‘expansion’.

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

2. Susan conducted the experiment above to demonstrate expansion of solids. What do you think will happen to the ball after it is being heated? ______________________________

3. Give an explanation for your answer above. (Question 2)

______________________________________________________________________________
______________________________________________________________________________
Expansion of liquids

A flask, as shown below, is filled with coloured liquid. The flask is fitted with a stopper carrying a long narrow glass tube. The glass is filled completely so that when the stopper is placed on the neck some liquid goes up the tube.

Expansion of a liquid

When the flask is heated the level of the liquid drops at first and then rises. The drop after the first few seconds is due to the expansion of the glass vessel itself. This means that the volume of the container increases. The rise in the liquid means that the liquid has expanded.
Week: Four
Lesson: Two

Activity sheet:

With the aid of a labelled diagram, describe an experiment to demonstrate the expansion of liquids.

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______________________________________________________________________________
______________________________________________________________________________
Expansion of gases

The expansion of gases can be demonstrated by trapping a bead of coloured water in a narrow glass tube which goes through the stopper. The flask is immersed into a bath of hot water. The bead of water moves up showing that the air expands. If the flask is placed in a bath of ice-cold water the bead moves down showing that the air contracts.
Week: Four  
Lesson: Three

Activity sheet:
Conduct the following experiment at home. (Ensure you are being supervised by an adult)

Things you will need:
- 1 glass bottle
- 1 balloon
- 1 large container
- boiling water

Procedure
- Set up the experiment as shown below.

![Diagram showing expansion of gases](image)

- Observe what happens to the balloon.
- Make note of the observations
The electric iron has a thermostat. A thermostat contains a bimetallic strip. A bimetallic strip consists of two different metals welded together. A bimetallic strip can be found in the electric iron.

The purpose of a thermostat on any electrical appliance is to control its temperature.

![Diagram showing how a bimetallic strip works in an electric iron.](image)

When current flows through the iron, the bimetallic strip is warmed, along with the appliance. As the bimetallic strip is heated it expands. Brass expands more than steel, so the strip bends away breaking the circuit; thus, preventing the temperature of the iron from increasing further. After a while the iron starts to cool down, and at the same time the bimetallic strip starts to cools and straightens out again to complete the circuit. The current will now flow again. The control knob changes the distance through which the bimetallic strip has to bend so as to break the circuit.
Activity sheet

Two metals are attached to a bimetallic strip as shown below.
Metal A is at the top and Metal B is at the bottom.

Draw a diagram to show the bimetallic strip after heating if

1. (i) Metal A expands more than Metal B

(ii) Metal B expands more than Metal A.

2. List two (2) appliances in the home (other than the electric iron) that has a thermostat.
Week: Five
Lesson: Two
Topic: Applications of expansion

Bridges

Bridges must have an expansion gap to allow for the expansion and contraction in very hot or cold weather or they may collapse. The gaps are often covered by a metal plate. Some large bridges, such as those over motorways, may also move slightly on large rollers. The gaps are often filled with foam rubber so that they are not filled with stones.

Railway lines

Railway lines are made in long lengths and taper at the ends so that the rails can slide past one another when they expand. If the gaps are not large enough the lines will be buckled by the expansion forces.

Steel tyres

Steel tyres are fitted to train wheels by making them very slightly small. The tyre is then heated so that it expands and can be fitted over the wheel. When the metal cools, it will be so tightly fitted that it would have to be cut off to replace it. An alternative would be to cool the wheel in liquid nitrogen so that it becomes smaller, fit the tyre, and wait for the wheel to warm up. Gear wheels can be tightly fitted to their shafts in the same way.
Week: Five  
Lesson: Two  

Activity sheet:

1. Explain why bridges must have an expansion gap.

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

2. Explain why steel tyres are heated before it is placed on the wheel.

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
Some other examples of the application of thermal expansion are:

- the removal of metal lids from glass jars by heating the lids under hot water; they expand and can be loosened easily.

- use, by dentists, of fillings that have the same rate of expansion as teeth.

- reinforcing steel must have the same expansion rate as concrete.

- pipelines carrying hot liquids or gases need to have bends to allow for the forces caused by expansion e.g. steam lines in a hospital, oil field pipelines.

- the thermometer is based on expansion and contraction. The liquid in the bore of the thermometer has the ability to expand when heated, thus indicating a rise in temperature.

- very hot liquids poured into thick glass containers could cause the containers to crack because of the unequal expansion between the inside and outside of the glass.
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Week: Five
Lesson: Three

Activity sheet

Describe THREE applications of thermal expansion.
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Topics per lesson

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Fuel is any material which when burnt supplies energy for any purpose.

The following is the equation showing combustion of fuel.

\[ \text{Fuel} + \text{Oxygen} \rightarrow \text{Energy} + \text{Carbon dioxide} + \text{Water} \]

The fuels used today are wood, coal, charcoal, petroleum and its by-products. Some of these fuels are referred to as fossil fuels. These are fuels which were formed from organisms (plants and animals) which lived millions of years ago. These substances cannot be replenished within the lifetime of man, so they are said to be non-renewable. Once they are used up, they can be no more.

Fuels can be divided into three cases namely;

- solid fuels
- liquid fuels
- gaseous fuels

Solid fuels are: wood, peat, charcoal and coal.

Liquid fuels are: crude oil, petrol, and other products of crude oil.

Gaseous fuels are: natural gas, coal gas, bio gas.

The oldest known solid fuel to man is wood. Oil is the main source of our liquid fuels.

Most of the appliances used in the home today are electrically operated. The main source of electricity has been fossil fuels.
Week: Six
Lesson: One

Activity sheet

Answer the following questions.

1. What is meant by the term ‘fuel’?

______________________________________________________________________________
______________________________________________________________________________

2. Complete the following equation to show the burning of fuels.

Fuel + _______________ $\rightarrow$ Energy + ____________________ + Water

3. What are ‘fossil fuels’?

______________________________________________________________________________
______________________________________________________________________________

4. Give one example of each class of fuels listed below.

Solid fuels ____________________________________________

Liquid fuels __________________________________________

Gaseous fuels _________________________________________

5. List 3 appliances in the home that uses electricity.

________________________________
________________________________
________________________________
The origin of crude oil is not known for sure. However, one of the most popular theories says that millions of years ago most plants and animals live in the sea. When these organisms die their remains slowly decompose owing to the action of bacteria, pressure and heat. As time progressed the extreme heat, pressure and the absence of air caused the partly decayed organic matter to be converted into crude oil.

Movement of the earth’s crust causes changes in the structure of the earth. These changes help to trap the oil in hollows formed in impervious rocks. The oil is therefore trapped between non-porous rocks. A layer of natural gas is usually found above crude oil.

The extraction of oil

Before the oil can be extracted the area is surveyed. This survey is known as a seismic survey. It involves the ‘firing’ of small explosives underground. These explosives produce tremors. The echoes that rebound are recorded on a special instrument, which produces a seismograph. From this geologist could determine if oil is present. Sometimes temporary drilling is done to collect samples of the core rocks. The rocks indicate the type of fossil plants and animals. If the fossils are associated with the formation of oil, then oil may be in the location. Several holes may have to be drilled before oil is found. However, when the drill strikes oil, the underground pressure forces the oil up the hole, that is, the well. In cases where the pressure is not high enough, sea water is pumped into the rock to force the oil out.
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Week: Six
Lesson: Two

Activity sheet.

Answer the following questions.

1. What are two conditions that must be present for the formation of crude oil.

_________________________ and ________________________

2. What type of survey is done before oil can be extracted from an area?

________________________________

3. What is meant by ‘firing’ as it relates to the extraction of crude oil.

______________________________________________________________________________
______________________________________________________________________________

4. Why is sea water sometimes pumped into rocks during the extraction of crude oil.

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
Refining oil

Crude oil as it comes out of the well is a very thick, black, viscous liquid. This complex mixture of substances is of no use in its crude form, hence the need to be refined. This is done at a refinery. The refining process involves the separating of the various fractions. These fractions are separated by making use of the difference in boiling points. The process is called fractional distillation and it takes place in a fractioning tower.
Diagram showing fractional distillation of crude oil

The crude oil is pre heated. Upon entering the lower compartment, the temperature increases changing the oil into vapour. As the vapour rises, it cools and condenses. The fraction with the lowest boiling point will be collected at the top of the tower. The fraction with the highest boiling point is collected at the bottom.

**Cracking**

A large percentage of the distillation products consists of large hydrocarbon molecules. Since the demand is greater for smaller molecules such as gasoline and kerosene, these large molecules are broken down by **cracking**. Cracking can be done using heat or catalysts and is a very important process in the oil industry. One of the small hydrocarbons produced is ethane, a colourless gas. It is useful in the making of polythene, which is a plastic from which many household articles are made.
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Week: Six
Lesson: Three

Activity sheet

Circle the letter next to the BEST response.

1. Crude oil is very ____________.
   a. light    b. thick    c. watery    d. hard

2. What is the name of the process that separates the fractions of crude oil?
   a. distillation  b. separating funnel    c. fractional distillation  d. evaporation

3. During the separation of crude oil, the fraction with the ___________ boiling point comes out at the top of the tower.
   a. lowest    b. highest    c. middle

4. During the separation of crude oil, the fraction with the ___________ boiling point comes out at the bottom of the tower.
   a. lowest    b. highest    c. middle

5. The process that breaks down large hydrocarbon molecules into smaller ones is called ____________.
   a. distillation    b. fractional distillation    c. hammering    d. cracking
Formation of coal

Coal is a solid fuel. It has been useful to man for thousands of years. This natural rock-like, brown to black substance has been formed from forest-type plant material which died millions of years and so it is considered as ‘modified wood’.

Coal is the end product of a long gradual change of plant material. One theory is that in the Carboniferous period, the warm, wet climate caused the vegetation to flourish. When this vegetation died, it decayed and formed thick deposits called peat. These deposits became covered with alternative layers of sand and mud. The increased temperature and pressure on the peat lead to the formation of lignite (soft coal) then to bituminous (black coal) and finally anthracite. All the stages of coal formation can be found in the earth’s crust.
Stages in the formation of coal

**Distillation of coal**

Coal has several valuable chemicals; however, in its raw state coal does not burn efficiently in open air. If coal is heated in the absence of air, a process called destructive distillation of coal takes place. The main function of destructive distillation of coal is to produce coke, other smokeless fuels (coal gas) also benzene and tar. The products of the destructive distillation of coal are also used to make nylon, plastics, paints, explosives, disinfectants, cleaning agents, printing ink, perfumes, pesticides, detergents and other products.
1. Complete the following flow chart to show the formation of coal.

![Flow chart showing the formation of coal](image-url)
2. What is meant by ‘destructive distillation of coal’.


3. List 5 things in the home, that are made from the destructive distillation of coal.

• __________________________
• __________________________
• __________________________
• __________________________
• __________________________
Week: Seven
Lesson: Two
Topic: Charcoal

Charcoal is a black porous solid containing about 85 to 98 % carbon.

How charcoal is made?

It is produced by heating wood, peat or bituminous coal at 500 -600 °C in the absence of air (oxygen). Farmers in the Caribbean usually dig pits and pack them with wood. The wood is then covered with soil, ignited and allowed to burn for days.

Uses of Charcoal

Charcoal known as ‘coals’ in Guyana and the rest of the Caribbean is used as fuel for cooking both indoors and outdoors. It is used mainly in the rural area and in camps and picnics. Its by-products, wood ash, can be used as fertilizer to supply potassium and calcium. Wood ash is also used as an abrasive to clean pots, as tooth paste and as a disinfectant. It is put on yams before planting.

Diagram showing charcoal
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Week: Seven
Lesson: Two

Activity sheet

Circle the letter next to the BEST response

1. Which element is found mainly in Charcoal?
   a. carbon dioxide  b. carbon  c. boron  d. oxygen

2. Charcoal is produced by heating wood in the absence of _________________.
   a. oxygen  b. carbon dioxide  c. hydrogen  d. nitrogen

3. Charcoal is known as _______________ in Guyana.
   a. crude oil  b. petroleum  c. coals  d. peat

4. Wood ash is rich in calcium and _________________.
   a. potassium  b. fluorine  c. chlorine  d. oxygen

5. All of the following are uses of wood ash EXCEPT
   a. to clean pans  b. as tooth paste  c. as fertilizer  d. food
Advantages of fossil fuels/oil/coal

- It is used to produce electricity, which is used to operate thousands of appliances in the home, workplace and industries.

- Since it is used to power vehicles, it shapes the design of the engine and the vehicle. (vehicles don’t have to be huge compared to if they were powered by steam or wood).

- These fuels are reliable and dependable. Once they are available the energy will be constant and ready to use.

- There are numerous by products of fossil fuels, these products are very useful to us, as they make our lives easier.

- Burning of these fuels produce huge amounts of energy.
Disadvantages of fossil fuels/oil/coal

- The earth’s resources are rapidly consumed.
- They are non-renewable resources. Their supply is limited and they will eventually run out.
- They are not readily available.
- They are bulky and thus difficult to transport.
- Dangerous to produce. The mining of coal is dangerous. Men usually lose their lives in case of the caving in of the roof of the mine.
- It causes pollution. When these fuels are burnt, they produce dangerous gases (Sulphur dioxide, carbon dioxide, nitrogen oxide and dioxide, etc.). These gases cause air pollution, acid rain, the greenhouse effect, global warming, etc. These gases also endanger the health of living things.
- For the process of finding, extracting, producing and transporting fossil fuels, habitats are destroyed, trees are removed and wildlife is also destroyed/harm in this manner.
- Oil spills are common and cause severe damage to the marine environment and organisms living in the area.
Week: Seven
Lesson: Three

Activity sheet

Answer the following questions.

1. State 2 advantages of using fossil fuels.

   - __________________________________________________________________________
   - __________________________________________________________________________
   - __________________________________________________________________________

2. State 2 disadvantages of using fossils fuels.

   - __________________________________________________________________________
   - __________________________________________________________________________
   - __________________________________________________________________________

3. Do you think the advantages of fossil fuels outweigh the disadvantages? ________________

4. Give a reason for your answer above (question 3).

   __________________________________________________________________________
   __________________________________________________________________________
   __________________________________________________________________________
The rate of consumption of fossil fuels in the world today is increasing rapidly and this source of energy will one day come to an end. This concern has led many countries to sought alternative sources of energy.

Alternative energy is best defined as the use of energy sources other than traditional fossil fuels.

The three main alternative of energy are:

- Hydro energy
- Solar energy
- Wind energy

**Hydro energy or Hydro power**

Hydro energy is a form of renewable energy that uses the power of moving water to generate electricity.

Falling water from a tap is sufficient to turn the wheel of a toy car/truck. The same principle is used in hydroelectricity. Water falling from a height e.g. the top a waterfall or a high reservoir has a lot of potential energy which can be used to do work. The fast moving water falls on to the blades of a turbine and the force of the water turns the turbine. This mechanical energy is converted by a generator or dynamo into electrical energy. Therefore, there is a change from potential energy to electrical energy.

Hydroelectricity is useful in cities where there is need for a large supply of cheap electricity.
Advantages of hydro energy

- **Renewable energy** which means it will never run out, unless the water stops flowing.

- **Reliable energy**, since water usually have a constant and steady flow.

- **Pollution-free** the creation of hydroelectricity does not release pollutants in the atmosphere.

Disadvantages of hydro energy

- **High initial cost** huge sums of monies have to be spent to set up plants.

- **Drought potential** the ability to create electricity can be severely affected if there is a drought and not enough water is flowing into the plant.

- **Limited reservoirs** it is challenging to find a suitable spot that has a large year round water supply with the right amount of water and close enough to existing power lines.
Activity sheet

1. Draw a diagram to show a model of a hydroelectric station.

2. State 2 advantages of hydro energy.

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

3. State 2 disadvantages of hydro energy.

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
Solar energy is energy from the sun that is converted into thermal or electrical energy. Over the years man has been successful in acquiring techniques for exploiting solar energy. Some of these devices made are solar cells, solar cookers, solar stills, solar panels and solar dryer.

**Solar dryer**

Solar dryers are devices that use solar energy to dry substances, especially food. A solar dryer is a box (usually made of wood) fitted in a tray into which crops are placed. The box has a transparent top that is made of glass or plastic material.

You will observe holes in the walls of the box. These allow the passage of warm air over the crops and aids the drying process, at the same time preventing the temperature from getting too high.

**Solar panels**
The diagram below shows a set of solar panels and is used a lot in the Caribbean to provide hot water for domestic purposes. Cold water is pumped through the tubes of the water heater. As the water heats up it passes out into the storage tank ready for use. If the water gives up its energy before use, it returns to the panels.

Solar cells

A solar cell is a photoelectric cell. It converts solar energy directly into electricity. Solar cells are found in calculators, watches, satellites, ship signal lights, etc.

When the sun’s rays hit the solar cells the light energy is converted to electricity. The direct current is stored in batteries. If alternating current is required, a power converter is used. The electricity obtained could be used by refrigerators, air-condition units, televisions, radios etc.

Diagram showing solar cells
Advantages of solar energy

- It is renewable energy source
- Solar power is pollution free
- It does not consume any of the earth’s resources
- It is plentiful
- Low maintenance cost
- Reduces electricity bills

Disadvantages of solar energy

- The initial cost is high
- It is difficult to store
- Its intensity is irregular
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Week: Eight
Lesson: Two

Activity sheet

Circle the letter next to the BEST response.

1. Energy from the sun is called?
   a. wind energy     b. solar energy     c. hydropower     d. geothermal energy

2. Solar panels are mostly used for drying__________
   a. clothes     b. wood     c. food     d. sand

3. Solar cells convert solar energy into__________ energy.
   a. electrical     b. kinetic     c. potential     d. sound

4. All of the following are advantages of solar energy EXCEPT.
   a. pollution free     b. high initial cost     c. it is plentiful     d. reduces electricity bills

5. All of the following are disadvantages of solar energy EXCEPT.
   a. high initial cost     b. difficult to store     c. its intensity is irregular     d. pollution free
Week: Eight
Lesson: Three
Topic: Wind energy

Wind energy is the use of wind to generate electricity. Wind energy is obtained from the force of the wind. In the generation of electricity, giant propellers of wind turbines are turned by the winds. Each turbine is connected to a generator. The amount of electricity depends largely on the size of the propellers and the amount of wind blowing.

Diagram showing how wind turbines work

Most Caribbean countries are windswept. This means that there is plenty of wind all year round. Wind power can be used to power televisions, computers, light bulbs, etc.
Advantages of wind energy

- It is clean and pollution free
- It is readily available when needed
- It does not use up the earth’s resources
- It is cost effective

Disadvantages of wind energy

- The speed of the wind varies
- Lightning may damage equipment
- Difficulties in maintaining equipment high above the ground
- Initial cost may be high
- Wind plants can cause death of birds as they can fly in the spinning blades and be killed.
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Week: Eight
Lesson: Three

Activity sheet

Answer the following questions.

Briefly explain how the forces of the wind can be used to generate electricity.

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

2. List 2 advantages of wind energy.

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

3. List 2 disadvantages of wind energy.

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
Biodiversity refers to the variety of living species on Earth, including plants, animals, bacteria, and fungi. While Earth’s biodiversity is so rich that many species are yet to be discovered, many species are being threatened with extinction due to human activities, putting the Earth’s biodiversity at risk.

Why is Biodiversity Important?

Biodiversity boosts ecosystem productivity where each species, no matter how small, all have an important role to play.

For example,

- A larger number of plant species means a greater variety of crops
- Greater species diversity ensures natural sustainability for all life forms
- Healthy ecosystems can better withstand and recover from a variety of disasters.

And so, while we dominate this planet, we still need to preserve the diversity in wildlife.

Conservation

Conservation is the act of protecting the earth’s natural resources for current and future generation. Earth’s natural resources include air, minerals, plants, soil, water, wildlife etc. It is the care and protection of these resources so that they can remain for future generations.

Biodiversity conservation refers to the protection, upliftment and management of biodiversity in order to derive benefits for the present and future generation.
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Week: Nine
Lesson: One

Activity sheet

Answer the following questions

1. What is meant by the term ‘Biodiversity’?
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

2. Why is Biodiversity important?
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

3. Do you think it is important for us to conserve our Biodiversity? _______________________
4. Give a reason for your answer above.
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
Forest consists of both living (plants, animals, etc.) and non-living (soil, water, air, etc.) factors.

Our forest forms an active part of the environment. They do affect and are affected by the environment playing several roles at the same time.

**How the forests serve us?**

1. Our forest produce a more regular flow of water in streams and rivers. The fact that Guyana is a land of many waters is directly related to the extensive forested area.

   When the rain falls, it lands on the leaves and trunks and trickles down the soil, where the humus and other materials trap the water and allow it to soak gradually into the soil. This slow movement of water from the leaves and branches on to the soil surface contributes to a regular flow of water to the water table.

2. The forests help to maintain suitable temperatures of the surrounding areas. This is due to their normal biological function of transpiration.

3. Forests yield a wide variety of products such as wood, resins, balata, medicinal substances, fruits etc.

4. Forests are home to lots of organisms.

5. Forests help to fight climate change.

6. Provides us with fuel.

7. Serves as tourism site.
State three (3) benefits of the forests to man.

- ____________________________________________________________
  ____________________________________________________________

- ____________________________________________________________

- ____________________________________________________________

- ____________________________________________________________
Deforestation refers to the cutting, clearing and removal of forest/trees by humans.

The forests are mainly destroyed for:

- Mineral extraction
- Logging
- Establishment of irrigation schemes
- Extension of urban areas

Guyana is largely involved in mineral extraction, as Guyana is rich in minerals. The forests have to be cleared for the extraction of these minerals. When trees are removed, tons of soil are also removed and in the cases of sloping land much of the soil is washed down into water bodies ‘choking’ streams, creeks and reservoirs and also changing the water level. This sedimentation causes destruction of the forests. Habitats of animals, including birds, and other valuable plants are destroyed. The use of chemicals in the mining process also kill aquatic plants and animals.

Logging is another way by which our forests are destroyed. Some companies cut down timber for export far faster than the trees can reproduce and replace themselves. In the movement of timber from one place to another many other plants are destroyed. The cutting down of trees for fuel and charcoal is also a problem.

Fires also destroy our forests. The fires that are experienced in Guyana’s forest, are often due to the careless use of coal pits.
The establishment of irrigation schemes require the building of canals and dams from the forest area into the farm lands. This operation involves the joining of large bodies of water by cutting across forest lands. The clearing of lands for agriculture also results in the destruction of the forests.

Extension of urban areas because of overpopulation of town and cities in sometimes done at the expense of forests. However, in most cases the needs of the people would seem greater since people need to be properly housed.
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Week: Nine
Lesson: Three

Activity sheet

State whether the following statements are True or false.

1. Deforestation is the cutting down of trees. _____________________

2. During the extraction of minerals, the forest is NOT destroyed. ______________

3. The use of chemicals in mineral extraction can cause the death of fishes. _____________

4. Logging becomes a problem when companies cut down trees faster than the trees can replace themselves. ______________

5. People do not cut down trees for fuel these days. ______________

6. People destroy the forest for agricultural purposes. ______________

7. The forest is never destroyed for building houses for people to live. ________________

8. Deforestation leads to erosion of the soil. _________________
Week: Ten
Lesson: One
Topic: Effects of deforestation

1. The soil

When trees are removed, the topsoil is exposed. The wind and rain then easily removes the topsoil. The absence of plants increases the rate of erosion.

2. Ecosystems

The removal of trees means the ecosystems are destroyed. The lives of all the living organisms in that area are destroyed or seriously affected. The underground organisms that are essential to maintaining a fertile soil die out due to the dryness of the soil and also the lack of food.

3. Wildlife

The lives of wildlife are also affected. Their habitats and feeding areas are affected negatively which results in a decrease of their population.

4. Gene Bank

Known and unknown plants are destroyed, maybe forever. The world’s gene pool is being rapidly reduced. Most of the world’s medicine are obtained from plants. Many plants with the potential to improve our medicines are rapidly disappearing.

5. Climate

The rapid deforestation process is causing a higher concentration of carbon dioxide in the atmosphere, which has resulted in an increase in the greenhouse effect.
6. Pollution

The rapid runoff of rainwater carries many small particles and chemicals, into rivers and creeks causing the waters to be discoloured, muddy and a danger to health. Under these conditions, the water is no longer good/safe for the people. Aquatic life is also negatively affected.
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Week: Ten
Lesson: One

Activity sheet

Write a letter to the minister of natural resources, explaining three reasons why trees should not be cut down.
Week: Ten
Lesson: Two
Topic: Taking care of the forest

Our forest is very beneficial to us. It is the home of our unique plants and animals. If we do not take care of it, the plants and animals will disappear and become extinct.

Taking care of the forest

- There must/should be legislation governing the use of the forest. There should be hunting, logging and mining laws. Persons involved should be aware of the laws. All efforts should be made to ensure persons are complying with the laws.

- Persons should be educated so that they know the importance of the forest. Some basic facts on how resources are managed and what is being done to conserve them should also be known.

- There should be reforestation and afforestation programs.

(Reforestation is the planting of trees in areas where trees once existed. Afforestation is the planting of trees where trees never existed.)

- Control over forest fires – destruction or loss of forest by fire is fairly common, because trees are highly exposed to fires and once started it is difficult to control. In order to save the forest from fires, it is necessary to adopt latest techniques of firefighting.

- Proper utilization of forest and forest products. Recycling should be practiced. Waste from cutting trees (including stumps, limbs, branches and foliage) should be utilized to make other products.
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Week: Ten
Lesson: Two

Activity sheet

Below is a poster showing ways in which we can conserve/protect our forest. Create your own poster and submit to your teacher for grading. (be creative)
As defined by international tourism society, ecotourism refers to ‘responsible travel that conserves the environment and improves the well-being of local people’.

**Principles of Ecotourism**

Ecotourism unites conservation communities and sustainable travel. This means that those who implement and participate in ecotourism activities should take the following principles into consideration:

- Minimize social, physical, behavioral and psychological impact.
- Build environmental and cultural awareness and respect.
- Provide positive experiences for both visitors and hosts.
- Provide direct financial benefits for conservation.
- Provide financial benefits and empowerment for local people.
- Raise sensitivity to host countries’ political, environmental, and social climate.
- Respect local culture and human rights.

**Advantages of ecotourism in Guyana**

- It helps to educate/ showcase Guyana’s rich culture and resources
- Provides funds for conservation.
- Fosters respect for different cultures
- Create jobs for local people
- Benefits the economic development of local communities
- The generation of foreign exchange

Disadvantages of ecotourism in Guyana

- High air travel cost
- Inadequate infrastructure
- Lack of marketing
- Limited government funds

Ecotourism places in Guyana

- Iwokrama Forest
- Surama (an Amerindian village)
- Kaieteur falls and Kaieteur National park
- Shell beach
- Mainstay lake

In the year 2019, Guyana has been named the number 1 ‘Best of Ecotourism’ destination in the world.
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Week: Ten
Lesson: Three

Activity sheet

1. Define the term ‘Ecotourism’.
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

2. List one benefit of ecotourism to Guyana.
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

3. State one hindrance to effective ecotourism in Guyana.
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

4. Prakash, an Indian national, has never visited Guyana. He asks you, his online friend, to recommend giving reasons two places he MUST visit when he comes to Guyana.
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________