8th Grade: ENERGY

(The Meaning, Conversion and Importance of Energy)

Rational of this unit

The Kenyan national development policy sets plans to industrialize the industrial structure and improve the standard of living by 2020 as its aim. Therefore, while the matter of improving the rate of electrification is urgent, at present the country is relying on hydroelectric power for a little over 70% of its power generation. Electricity generated by hydroelectric power is insufficient, and stable electricity cannot be provided during the dry season. Thermal power generation, which is hoped to provide electrical generation capacity in abundance, currently provides an insignificant 5.4% as of December 1999. Because thermal power generation can become a contributing factor to deteriorating the environment and rapid destruction of nature, the demerits for promoting it are significant.

In order to protect Kenya's nature along with the advance of industrialization, mutual balance of the two must be considered at all times. Accordingly, utilizing the advantages of a country directly below the equator, efficient power provision is possible through photovoltaic power generation and solar thermal power generation. In addition, the Great Rift Valley runs through the central portion of Kenya, concealing great possibilities for geothermal power generation. Effectively utilizing these clean power resources is what will brighten the future of Kenya.

Thusly, energy-related learning in science education shall be laid out in order to cultivate our youth as rounded individuals and the future formers of a society promoting industrialization.

Objectives: what pupils are expected to achieve in this unit

- To know through experiments about energy that there are different states of energy such as kinetic energy, potential energy, electricity, heat and light, and that energy transforms between these states.
- To deepen recognition about the relation between use of energy resources and environmental conservation and the connection of science and technology to human life while relating them to daily life and cultivate scientific thought.
- To recognize that effective use of energy is important while learning that Kenya is using many various types of power production such as hydroelectric power, thermal power, geothermic power, wind power and solar power.

（ENERGY／8th grade）

Interrelation of contents of each grade

** The order below is as shown in the syllabus.*

Grade	What to teach (Energy)
1st Grade	• Sources of light (the sun, fire, torches, candles, lamps, electricity, fireflies and glow worms, matches) • Sources of sound (animal's calls, drums, bells, whistles, and vehicles)
2nd Grade	• Casting shadows • Making sound by plucking strings • Making sound by beating something
3rd Grade	• Reflection of light • Direction of sound (how sound travels in all directions) • Special sounds (laughter, ambulance sirens, screams, telephone ringing tone, fire engine sirens) • Measuring centigrade temperatures
4th Grade	• Using light • Importance of electrical lighting at home (e.g. providing a clear view, safe movement, to keep harmful insects/pests under control and enabling comfortable reading) • How to light the home (from windows, sky lights, artificial light sources, etc.) • Heat sources (the sun, flames, electricity, gas, etc.) • Uses for heat (cooking, heating, ironing, drying, etc.)
5th Grade	• Types of sounds (noise and quiet) • Noise (damage to ears from continuous and irritating sounds) • Thermal conduction (conduction, convection and emission) • Materials that easily conduct heat and materials that do not conduct heat easily • How to use materials that conduct heat easily or with difficulty ---------- • Meals and nutrition (energy sources and supporting substances for life activities: carbohydrates, protein, fat, vitamins, minerals, water) • Diseases from malnutrition (the extreme dystrophy of African children from lack of protein, gradual exhaustion symptoms from malnutrition, apathy from emaciation, anaemia symptoms, anaemia from inorganic substances) • Work (mass and weight as related with potential energy and kinetic energy)
6th Grade	• Under what conditions will light reach? • Transparent, translucent and opaque substances • Reflection of light

	• Light sources and light reflected by smooth, shiny surfaces. • Refraction of light • Apparent refraction of light in the air and water (using a ruler or pencil) • Demonstrating how rainbows are made --- • How to store food（smoking, drying, low-temperature preservation, canning, honey, salt, and other preservation methods） • Motion (moving objects, stopping of moving objects) • Work (meaning of work, units of work (N))
7th Grade	• Sources of electricity (torch cells, the battery in a car, a bicycle's dynamo, hydroelectric generators, gasoline and diesel engines, geothermal power generators, wind-driven turbines (wind power generator), and solar panels) • Simple circuits • Conductive and non-conductive materials • How to use home electrical appliances (irons, radios, TV sets, cookware, and electric kettles) • Safety measures when electrical appliances are used (do not touch with wet hands, do not insert a pencil or wire into the power supply socket in the wall, and avoid overloading the wall socket) • Safety measures to prevent damage or injury from lightning (lightning arresters, avoidance of walking in open areas during rain, and avoidance of sheltering under a tree during rain) --- • Meaning of friction • Advantages and disadvantages of the work of friction • Ways to increase and decrease friction • Lever fulcrums, the point of action and positions of leverage (hammers with a nail puller, crowbars, hand-pushed wheelbarrows and plows)
8th Grade (This unit)	• Meaning of energy • Different types of energy (chemical, thermal, light, magnetic, electrical, and sound energy) • Transformation of energy (electric circuits, food, fuel, radios, and simple electromagnets) • Conserving energy (moderate use, efficient appliances, and renewable energy including wind, the sun, natural gas, and tree planting for fuel wood) --- • Food and nutrition (Nourishment of a pregnant mother, nourishment of a nursing mother, nourishment of infants, nourishment of a mother's milk) • Nutrition of HIV/AIDS patients

	• Causes of rotting in food (bacteria, viruses) and methods of preventing rotting • Scientific substances which enter the human body with food (pesticides, harmful chemical substances) • Inclined slopes (ladders, stair case landings, winding roads climbing hills) • One fixed pulley systems (Items using one pulley, such as the post to raise a flag)

Before starting this unit

Current learning status of the pupils

"Energy" is a word pupils frequently hear in their daily lives, and from the 5th grade on energy-related content and words have come up in their studies. However, this unit studies the general concept of energy and is a good opportunity to consolidate the lesson content that was decentralized up until this point. It is necessary to develop teaching that, along with reminding pupils of prior lessons and establishing lesson content, also in terms of unknown material makes pupils understand the power generation situation of their country (Kenya) and includes its connection to the economy in its outlook.

Preparatory notes

- Working in groups of four is fine. If you clarify who is going to be the speaker for the group before having them perform the experiment, then you can conduct the experiment efficiently in a short amount of time.

  Example distribution of roles: A is the main performer of the experiment, **B** and **C** help with the experiment and **D** records the results

  By making pupils aware of their roles and responsibilities, they also learn how to be sociable.

Objectives to be achieved by competency

Interest, motivation, and attitude

1. Taking an interest in the familiar phenomena of light, participating in experiments examining the properties of light, and willingly trying to investigate any points of question.
2. Considering the importance of effective use of energy and connecting it to daily life.
3. Taking an interest in energy resources and power generation by, water power, steam power and nuclear power, and willingly investigate them.

Scientific thinking and communication activities

1. Ability to discover the problems with energy-related affairs and phenomena and think about their solutions. Ability to solve problems through observation, experiments and discovering rules.
2. Taking an interest in the various kinds of energy and being able to actively investigate their characteristics.
3. Ability to think about methods of effective use of energy and consider things scientifically.
4. Ability to analyze the merits and demerits of various power generation methods and to scientifically consider the balance between Kenya's future industrialization and nature conservation.

Knowledge, understanding, and skills in observation and experimentation

1. Ability to explain the basic concepts, principles and rules of energy.
2. Ability to distinguish between "work" as used in daily life and in science, clarify the definition of work, and explain its connection to energy.
3. Ability to call the energy of an elevated object potential energy and explain that that energy will change based on the object's height from the reference plane and its mass.
4. Ability to call the energy of an object in motion kinetic energy and explain that that energy will change based on the moving object's mass and speed.
5. Ability to explain the various kinds of energy.
6. Ability to explain the transformation of energies happening around us.
7. Ability to learn about energy conversion efficiency and explain the importance of using resources efficiently.
8. Ability to explain that there are various methods of power generation in Kenya through investigation of Kenya's electrical power situation.
9. Ability to investigate hydroelectric power generation and explain its merits and demerits.
10. Ability to investigate thermal power generation and explain its merits and demerits.
11. Ability to investigate clean methods of power generation that do not pollute and explain the merits and demerits of such power generation methods.

（ENERGY／8th grade）

Ideas behind the structuring the unit

After learning about the connection between work and energy, the pupils are to scientifically consider potential and kinetic energy they can think of occurring in daily life. This will allow them to understand the concepts of energy and learn that there are various states of energy other than potential and kinetic energy.

Next they will learn through giving familiar examples of how energy is used while it comes and goes between the various states of energy.

Pupils will also understand the various forms of power generation from the power situation of Kenya. They will learn that they have the power to maintain the balance between the protection and industrialization of the natural environment into the future, while at the same time bearing in mind not to waste energy in their daily lives.

Unit teaching plan

(15 periods + 1 period for the Final Unit Evaluation Test)

* The numeric value in parentheses represents the corresponding period (e.g. 1) means the first period).

* *(Evaluation: Knowledge and Skills 1), (Evaluation: Interest 1)*, etc. indicate the points at which teachers can check whether the pupils have attained the goals specified in the section *Objectives based on the viewpoint*.

Sub-Unit	Description
1. Energy (4 Periods)	1) For the introduction of the unit, pin down the concept of energy. Look back on the kinds of "energy" we use in daily life. *(Evaluation: Interest 1, Knowledge and Skills 1)* 2) First off, upon understanding energy define the term work. Distinguish between "work" as used in daily life and in science, clarify the definition of work, and explain its connection to energy. *(Evaluation: Knowledge and Skills 2)* 3) For the energy of elevated objects, understand through experimentation that the amount of energy will change based on the object's height from the reference plane and its mass. *(Evaluation: Knowledge and Skills 3)* 4) For the energy of objects in motion, understand through experimentation that the amount of energy will change based on the object's speed and mass. *(Evaluation: Knowledge and Skills 4)*
Intermediate Review (No time allotted)	Give the "1st **Sub-Unit Review Test**". (Homework can be given depending on the progress of the class.)
2. Different types of energy	5 – 7) Learn that besides potential and kinetic energies there are also electrical energy, magnetic

(3 periods)	energy, sound energy, light energy, chemical energy and heat energy. Also understand the characteristics of these different types of energy. *(Evaluation: Interest 2, Knowledge and Skills 5)*
Intermediate Review (No time allotted)	Give the "2nd **Sub-Unit Review Test**". (Homework can be given depending on the progress of the class.)
3. Transformation of Energy (3 periods)	8 – 10) Understand that the radios and televisions we are all familiar with and use transform electrical energy into sound energy and light energy. Also understand that even within the bodies of animals, energy is taken from food in order to live. Understand that energy is also transformed from animal dung by drying them to use as fuel. *(Evaluation: Thinking and Representation 1, Thinking and Representation 2, Knowledge and Skills 6)*
Intermediate Review (No time allotted)	Give the "3rd **Sub-Unit Review Test**". (Homework can be given depending on the progress of the class.)
4. Energy Conservation (5 periods)	11) Through an experiment with water temperature increase using heat from the sun, learn about energy transformation efficiency and understand the importance of using resources efficiently. *(Evaluation: Thinking and Representation 3, Knowledge and Skills 7)* 12) Learn that there are various methods of power generation in Kenya through investigation of Kenya's electrical power situation. *(Evaluation: Interest 3, Knowledge and Skills 8)* 13) Investigate hydroelectric power generation and learn its advantages and disadvantages. *(Evaluation: Knowledge and Skills 9)* 14) Investigate thermal power generation and learn its advantages and disadvantages. *(Evaluation: Knowledge and Skills 10)* 15) Investigate non-polluting clean methods of power generation and learn the advantages and disadvantages of such power generation methods. Consider the balance of Kenya's future industrialization and nature conservation, and try to create more efficient energy. *(Evaluation: Thinking and Representation 4, Knowledge and Skills 11)*
Intermediate Review (No time allotted)	Give the "4th **Sub-Unit Review Test**". (Homework can be given depending on the progress of the class.)
Unit End Review (2 periods)	16 – 17) Teacher gives the "**Final Unit Evaluation Test**."

Lesson Plan

1. Energy (4 periods: 1th – 4th period)

Goals of this sub-unit

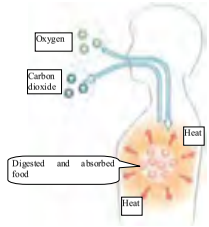
- For the introduction of the unit, pin down the concept of energy. Look back on what kinds of things exist in the "energy" we use in daily life.
- Upon understanding energy, distinguish between "work" as used in daily life and in science, clarify the definition of work, and explain its connection to energy.
- Learn what potential energy is. Through experimentation, understand that the amount of energy will change based on the object's height from the reference plane and its mass.
- Learn what kinetic energy is. Through experimentation, understand that the amount of energy will change based on the object's speed and mass.

Material Preparations

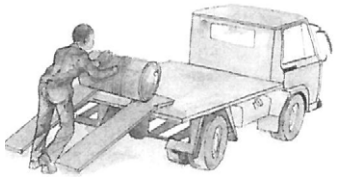
- Stand, meter stick (long object), stick, weights (round object the stick can pass through), poster board, paperclips, clay and softballs or iron balls can be used in experiments.
- Stake, weights, meter stick

Period 1: What is Energy?

	Learning flow and activity	Teaching Hints and Advice
Introduction 10 minutes	• We use the word energy all the time, but what does energy really mean?	• Make the pupils review energy in their daily lives and take as many notes as possible. *(Evaluation: Interest 1)* Taking an interest in the familiar phenomena of light, participating in experiments examining the properties of light, and willingly trying to investigate any points of question.
Questions	Try to find terms that have the word "energy" to them.	
Presentation 20 minutes	• Think of terms formed as "xxx energy." →What about electrical energy? →What about solar energy? • Think of words formed as "energy xxx." →What about human energy resources?	• Have the pupils present freely. • Aim for the connection between energy, plants, food

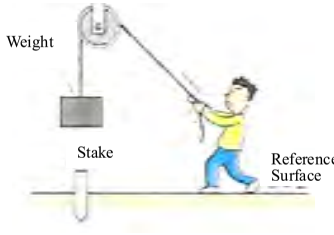
	Carbohydrates, fat, proteins  →What about a bird's energy resources? →What about an elephant's energy resources? →What about an automobile's energy resources? →What about an airplane's energy resources?	and nutrition. →Carbohydrates →Glucose (cellular respiration) →Fat →Fatty acids and glycerine (cellular respiration) →Proteins →Amino acids (body-building materials) →When there is not enough glucose in your body, fatty acids are converted and used in cellular respiration. • Have the pupils think about how if they ate the same things birds or elephants did, then maybe they could fly like birds or grow big like elephants. • Have the pupils think about whether airplanes fly with the same fuel (petrol) as automobiles.
Summary 5 minutes	• Summarize what you have learned. →Energy is the ability to do work. →Understand that energy resources are the food or fuel needed to do work.	*(Evaluation: Knowledge and Skills 1)* Ability to explain the basic concepts, principles and rules of energy.

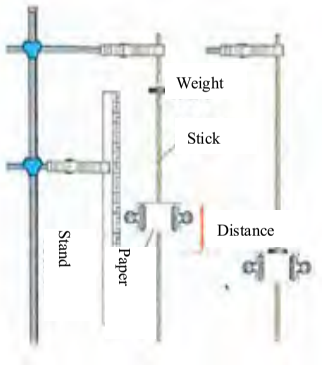
Period 2: Connection between Energy and Work

	Learning flow and activity	Teaching Hints and Advice
Introduction 10 minutes	• We use the word work all the time, but what does work really mean? →Think about what work as it is used in daily life means. →Think about what work as it is used in science means.  • Definition of work →When a force is applied to an object and makes it move, the force is said to have done work on the object.	• Make the pupils review work in their daily lives and take as many notes as possible. • Give the pupils an example such as the figure to the left and explain work as it is used in science. ***Reference:*** **Amount of Work** = *force* x *distance* moved **W = FS** **→Units of distance** : *metres* **(m)** **→Units of force** : *newtons* **(N)** **→Units of work** : *joules* **(J)** **1(J) = 1(N) x 1(m)** • Solidly grasp the scientific definition of work.
Questions	Think about work around us.	
Presentation	• You have applied a force to a cow and it moved.	• Present an example which the pupils can reflect on in

20 minutes	→Have you done work? →What had energy before doing the work? **Example:** • You have applied a force to a cow, and it moved. →You possess energy. • You have applied a force to the cow, but it did not move. →Energy is 0.	their daily lives. • Have the pupils write 3 or more notes on work (scientifically speaking) in their daily lives and present what they have written.
Summary 5 minutes	• Understand the relation between energy and work. • Understand the difference between work as used in daily life and work as used in science.	• Ask questions to confirm understanding. *(Evaluation: Knowledge and Skills 2)* Ability to distinguish between "work" as used in daily life and in science, clarify the definition of work, and explain its connection to energy.

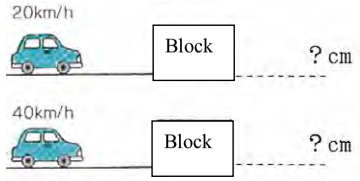
Period 3: Potential Energy

	Learning flow and activity	Teaching Hints and Advice
Introduction 5 minutes	• Drop a weight, striking a stake. →If you take your hand away, what happens to the stake?  The energy an elevated object possesses is called potential energy.	• Have the pupils record the results in their worksheet. • (*Refer to pg. 307 regarding worksheet)* • Make the pupils think about the problem. • Make them think about what changes in the amount of potential energy are dependent upon.
Questions	Examine the energy of an elevated object.	
Experiment	• Examine the relationship between the height of the	* Take sufficient care when using weights to drive

20 minutes	weight and the length the stake is driven. • Examine the relationship between the mass of the weight and the length the stake is driven.  *Experimenting in the school yard recommended*	stakes. 
Summary 10 minutes	• Present the results of the experiment. • Record results in the report. • Understand that potential energy changes depending upon the object's height and mass.	• Based on the experiment data, give the pupils advice so they can consider things using the proper wording. *(Evaluation: Knowledge and Skills 3)* Ability to call the energy of an elevated object potential energy and explain that that energy will change based on the object's height from the reference plane and its mass.

Period 4: Kinetic Energy

	Learning flow and activity	Teaching Hints and Advice
Introduction 5 minutes	• At the same speed, **A** was struck by an elephant, and **B** was struck by a cat. What is the relation between the energy of the two? **A** > **B** • The same elephant strikes **C** at a walking pace, and strikes **D** at full speed. What is the relation between the two? **C** < **D** • Energy possessed by an object in motion →Kinetic energy	• Make the pupils think about the problem and give you their reasons. • Make the pupils think about the problem and give you their reasons.
Questions	Examine the energy possessed by an object in motion.	

Experiment 20 minutes	• A toy car collides with a wooden block. → Examine how the distance moved by the block changes when the speed of the toy car changes. → Examine how the distance moved by the block changes when the weight of the toy car changes. 	• Have the pupils record the results in their worksheet. • *(Refer to pg. 307 regarding worksheet)* • Make them think about what changes in the amount of kinetic energy are dependent upon. * If you do not have a toy car, conducting the experiment by rolling a ball is acceptable. For the difference in weight, have a different ball ready.
Summary 10 minutes	• Consider the results of the experiment. • Record results in the report. • Understand that kinetic energy changes depending upon the object's mass and speed.	• Based on the experiment data, give the pupils advice so they can consider things using the proper wording. *(Evaluation: Knowledge and Skills 4)* Ability to call the energy of an object in motion kinetic energy and explain that that energy will change based on the moving object's mass and speed.

4. Energy Conservation (5 periods: 11th – 15th period)

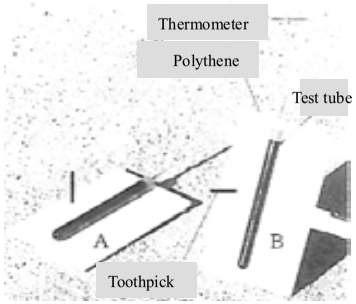
Goals of this sub-unit

- Through experiments, learn about energy transformation efficiency and understand the importance of using resources efficiently.
- Learn about Kenya's power situation, understand the power generating system and be able to evaluate it. Consider the balance of industrialization and nature conservation, and become able to create more efficient energy.
- To be concerned about air pollution and environmental devastation that could come with the advance of future industrialization in Kenya. Also, to consider effective application of cleaner energy in order to protect a rich natural environment.

Material Preparations

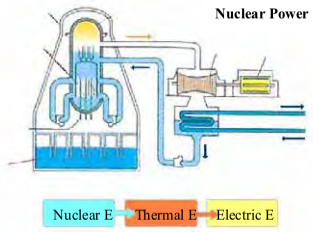
- Polythene (2), test tube (2), rubber stopper (2), thermometer (2), water

Period 11: Energy Conversion Efficiency

	Learning flow and activity	Teaching Hints and Advice
Introduction 5 minutes	• Think about whether there are any devices around you which use sunlight. • Think about what methods there are to effectively use a solar water heater.	• Have the pupils think about things sitting on top of the roof of homes, schools and public facilities. • Make them realize that these methods are the same as with solar panels.
Questions	How does installation of solar water heaters and solar panels allow us to get energy efficiently?	
Experiment 20 minutes	• Put the same amount of water in two test tubes painted black. Examine the rise in temperature of the water when the angle relative to the sun is changed.  • Record the experiment results in the report.	• Have the pupils record the results in their worksheet. • *(Refer to pg. 308 regarding worksheet)* • Work in groups of 4. • Pass out the report sheets and briefly explain the experiment objective, preparations, handling and results. • Have the groups talk and decide roles for the experiment and clarify these roles. • Have the groups prepare their own lab instruments. • Have each group think of their own angle for **B**. Note: If they do not choose an angle over 45 degrees then they will not see much change. • Have the pupils clean up the lab instruments. * Have them put everything as it was such that it is

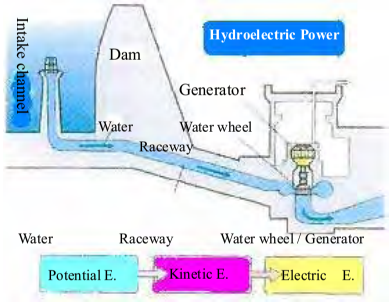
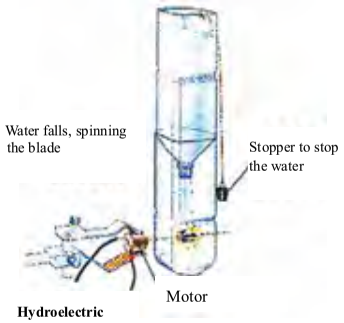
		easy for the next class to use. *(Evaluation: Thinking and Representation 3)* Ability to think about methods of effective use of energy and consider things scientifically.
Summary 10 minutes	• Record observations in the worksheet. • Assess whether solar water heaters and solar panels around us are installed appropriately.	• Tie this in to effectively energy production by figuring out the best angle for installation of solar water heaters and solar panels. *(Evaluation: Knowledge and Skills 7)* Ability to learn about energy transformation efficiency and explain the importance of using resources efficiently.

Period 12: Kenya's Power Situation

	Learning flow and activity	Teaching Hints and Advice
Introduction 5 minutes	• What is Kenya's power generation situation?	• Make the pupils adequately aware of and spark interest in their own country's power situation. *(Evaluation: Interest 3)* Taking an interest in power generation by energy resources, water, steam and nuclear power, and willingly investigate them.
Questions	How is our country's power generation produced? Examine.	
Presentation 20 minutes	*Kenya's power situation, as of* Dec. 1999 1) Hydroelectric 70.5% 2) Diesel 10.0% 3) Gas turbines 8.7% 4) Thermal power 5.4% 5) Geothermic 5.3% 6) Wind power 0.1% • Compare generation capacity from hydroelectric power in Kenya (highest source) and Japan (3rd highest source). • Think about what kinds of things this difference in power conditions can be tied into. →Industrial structure differs. • Think of current issues facing industrialization in 2010. →Merits of industrialization Convenience, ease of living, etc.	*Japan's power situation*, 1998 1) Thermal power 50% 2) Nuclear power 37% 3) Hydroelectric 11% 4) Other 2% (Geothermal, wind, etc.) • Make them aware of the differences and understand Kenya's situation. • Touch on how nuclear power is in mainstream use in advanced countries. Also touch on how it uses uranium as its energy resource. 

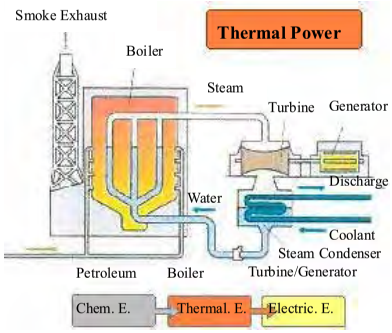
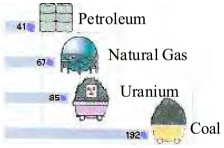
	→Demerits of industrialization Leads to environmental devastation due to air pollution, acid rain, global warming, etc.	• Have them talk in groups and present on current issues.
Summary 10 minutes	• Take an interest in the power situation of your country and understand that it is under development for industrialization.	• Make them aware that they are the ones that will be building the future of Kenya. *(Evaluation: Knowledge and Skills 8)* Ability to explain that there are various methods of power generation in Kenya through investigation of Kenya's electrical power situation.

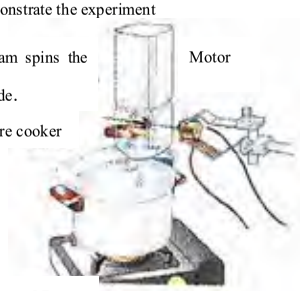
Period (13): Hydroelectric Power Generation

	Learning flow and activity	**Teaching Hints and Advice**
Introduction 5 minutes	• What kind of energy resources are being used in Kenya to make electricity?	• Remember the last period and confirm what Kenya's number one source of electricity production is.
Questions	Examine hydroelectric power, 1st in Kenya's electricity production.	
Presentation 20 minutes	• Hydroelectric power (1st in electricity production, Kenya)  • What is used as an energy resource? → Water • What kind of system is used to create electrical energy? → It spins a generator. • How is energy being transformed to finally make electrical energy? →Potential energy→kinetic energy→electrical energy • Learn the basic hydroelectric system from watching	• Present the figures and have the pupils think about them. • Demonstrate the experiment  **Hydroelectric Power Generation** - Have the pupils present their thoughts.

	the experiment demonstrated. • What does change in the amount of electricity generated depend upon?	
Summary 10 minutes	• Understand that hydroelectric generation is good for the environment but cannot provide stable power generation.	• Make the pupils think about hydroelectric power. • Merit →Good for the environment • Demerit →Not stable *(Evaluation: Knowledge and Skills 9)* Ability to investigate hydroelectric power generation and explain its merits and demerits.

Period 14: Thermal power generation

	Learning flow and activity	**Teaching Hints and Advice**
Introduction 5 minutes	• Besides hydroelectric power, what kinds of energy resources are being used in Kenya to make electricity?	• Confirm what Kenya's number 2-4 methods of power production are. Power generation from gas turbines, diesel and steam all work on the same system.
Questions	Examine thermal power generation in Kenya.	
Presentation 20 minutes	• Thermal power generation  • What is used as an energy resource? →Fossil fuels such as petroleum (diesel), coal and natural gas, etc. • What kind of system is used to create electric energy? → It spins a generator. • How is energy being transformed to finally make electrical energy? →Chemical energy→kinetic energy→electrical energy	• Present the figures and have the pupils think about them. • Petroleum, coal and natural gas are called fossil fuels because they are made over a long time from ancient creatures. The number of years these resources can be mined is currently believed to be about 41 years for petroleum, 67 years for natural gas and 192 years for coal.  Years of mining capability for energy resources (2003 est.). Estimated by dividing reserves by 2003 production output.

	• Learn the basic thermal generation system from watching the demonstrated experiment. • What does change in the amount of electricity generated depend upon?	• Demonstrate the experiment Steam spins the blade. Motor Pressure cooker  **Thermal Power**
Summary 10 minutes	• Understand that thermal power generation can provide great amounts of electricity, but is bad for the environment and consumes limited resources.	• Make the pupils think about thermal power. • Merit → Can get stable power. • Demerit → Bad for the environment. Limited resources. *(Evaluation: Knowledge and Skills 10)* Ability to investigate thermal power generation and explain its merits and demerits.

Period 15: Clean Energy

	Learning flow and activity	**Teaching Hints and Advice**
Introduction 10 minutes	• Is there a non-polluting system for electrical energy? → Hydroelectric (micro hydro power generation) → Geothermic power generation → Wind power generation → Photovoltaic generation → Solar thermal power generation • What kinds of systems are these?	• Within hydroelectric generation there is micro hydro generation, which can be set up locally. These can help in providing electricity to villages.
Questions	Examine clean energy.	
Presentation 15 minutes	• Consider the possibilities of each system. • Geothermic power → It is clean and stable. • Photovoltaic and solar thermal power generation → It is clean, but not stable. → Little electricity is generated. • Wind power → It is clean, but not stable. → Little electricity is generated.	• Have the pupils present their thoughts. • Because the Great Rift Valley crosses Kenya, geothermic power can be effectively applied. • Photovoltaic power generation could be effective since Kenya is directly below the equator and there is much solar radiation throughout the year. • Depending on placement, this could provide stable electricity. As with micro hydro generation, this could provide electricity for localized areas.

（ENERGY／8th grade）

	• What can we do to provide stable electricity? → Pursue multiple systems.	*(Evaluation: Thinking and Representation 4)* Ability to analyze the merits and demerits of various power generation methods and to scientifically consider the balance between Kenya's future industrialization and nature conservation.
Summary 10 minutes	• Understand that there are many various power generation systems. • Understand that Kenya is facing industrialization. • Be aware of the necessity for nature conservation.	• Make them aware that they are the ones that will be building the future of Kenya. *(Evaluation: Knowledge and Skills 11)* Ability to investigate clean methods of power generation that do not pollute and explain the merits and demerits of such power generation methods.

[Worksheet] ---------- * To be used in 3rd Period

What changes the amount of potential energy?

Date: **Class:** **Name:**

1. Preparation

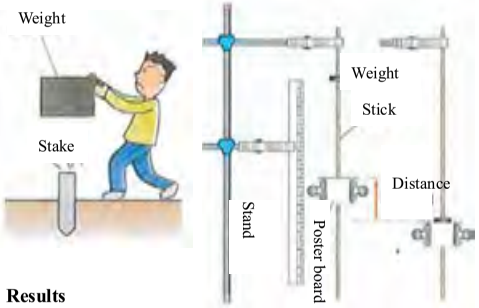
(If in classroom) Stand, ruler (long object), stick, weight (round object the stick can pass through), poster board, paperclips, clay and softballs or iron balls can be used in experiments.

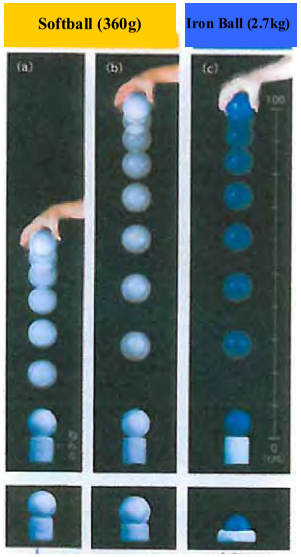
(If done outside) stake, weight, meter stick

2. Procedures

1) Changing the height of the weight, examine the distance moved by the stake (poster board).

2) Changing the mass of the weight, examine the distance moved by the stake (poster board).





3. Results

Relation between height of weight and distance moved by poster board

Height of weight (cm)	50	100
Stake (paper) distance (cm)		

Relation between mass of weight and distance moved by poster board

Mass of weight (g)		
Stake (paper) distance (cm)		

4. Observations

By changing the distance dropped or mass of the weight, how does the amount of work the weight does on the stake change?

** Keep this worksheet for the next class.*

[Worksheet] ---------- * To be used in 4th Period

What changes the amount of kinetic energy?

Date: **Class:** **Name:**

1. Preparation

Toy car, wooden block (something for the car to run into), ruler (long object)

2. Procedures

1) Examine the distance moved by the block when the speed of the toy car changes.

2) Examine the distance moved by the block when the mass of the toy car changes.

3. Results

Relation between the speed of the toy car and distance moved by the block

Speed (cm)	20	40
Distance moved by block(cm)		

Relation between the mass of the toy car and distance moved by the block

Mass(g)		
Distance moved by block(cm)		

4. Observations

By changing the speed and mass of the colliding object, how does the amount of work the object applies to the wooden block change?

** Keep this worksheet for the next class.*

[Worksheet] ---------- * To be used in 11th Period

Examining how to efficiently heat water with solar heat

Date: **Class:** **Name:**

1. Preparation

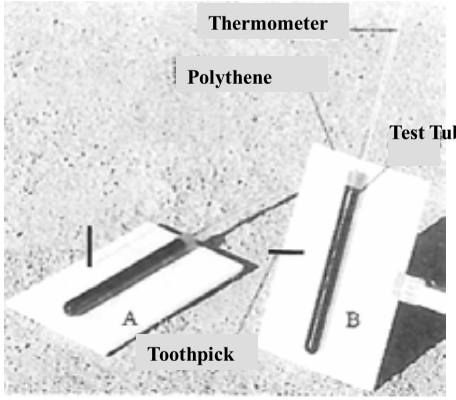
Polythene (2), test tube (2), rubber stopper (2), thermometer (2), water

2. Procedures

1) Prepare two test tubes A and B with the front surface painted black and pour the same amount of water into each.

2) Choose a place with plenty of sunlight like in the figure, placing **A.** flat on the ground and **B.** at an angle (more than 45 degrees).

3) Read the thermometer once a minute and record the results.



3. Results

Time (minutes)	0	1	2	3	4	5	6	7	8	9	10
Temp. of A(deg.)											
Temp. of B (deg.)											

4. Observations

1) What kind of difference did you see between the temperature change in **A.** and **B.**?

2) What changes in the condition of **B.** changed the results, and in what way?

3) What did you learn from the results of this experiment?

1)

2)

3)

** Keep this worksheet for the next class.*

1st Sub-Unit Review Test

* given after end of 4th period

Class: Name:

1. Answer these questions about energy and work as used in science.

1) What is energy? Explain using the word ***work***.

(**Energy is the ability to do work**)

2) What is work? Explain.

(**Work is when a force moves another object**)

2. What kinds of energy are there? Give some examples.

Electrical energy, light energy, heat energy, sound energy, chemical energy,
Nuclear energy, potential energy, kinetic energy, etc.

3. Answer these questions about potential energy.

1) What is potential energy? Explain.

(**The energy possessed by an object placed higher than the reference plane**)

2) Enter the correct words in the blanks below.

The higher an object is the (**bigger**) its potential energy becomes, and the larger the mass of an object the (**bigger**) the potential energy becomes.

4. Answer these questions about kinetic energy.

1) What is kinetic energy? Explain.

(**The energy possessed by an object in motion**)

2) Enter the correct words in the blanks below.

The faster an object is the (**bigger**) its kinetic energy becomes, and the larger the mass of an object the (**bigger**) the kinetic energy becomes.

3rd Sub-Unit Review Test

* given after end of 15th period

Class: Name:

1. Answer the following questions about energy conservation methods.

1) In the experiment to raise the temperature of the test tube filled with water using solar heat, what degree angle between the sunlight and the test tube was best to efficiently raise the temperature?

(**Putting the test tube at a right angle to the sunlight will most efficiently heated the test tube**)

2) Which heated up faster, the test tube painted black or the one with nothing painted on it?

(**The black test tube absorbs heat better and heats up faster**)

2. Answer the following questions about energy.

1) Which of these power generation methods generates the most electricity in Kenya? (**c.**)

a. Geothermal power b. Nuclear power c. Hydroelectric power d. Thermal power

2) Which of the above does diesel power generation belong to? (**d.**)

3) What are the energy resources of thermal power generation? Give three examples.

(**Petroleum, coal, natural gas**)

4) How many more years can we expect the reserves of the resources listed in (3) to last?

(**Petroleum - 40 years, coal - 200 years, natural gas – 70 years**)

5) Being made over a long time from ancient creatures, what general term is used for these energy resources?

(**Fossil fuels**)

6) What kinds of power generation have great expectations as sources of clean energy?

(**Geothermal power, photovoltaic power, solar thermal power, wind power**)

7) What is the advantage of the power generation methods in the answer for (6) above?

(**They are environmentally friendly**)

（ENERGY／8th grade）

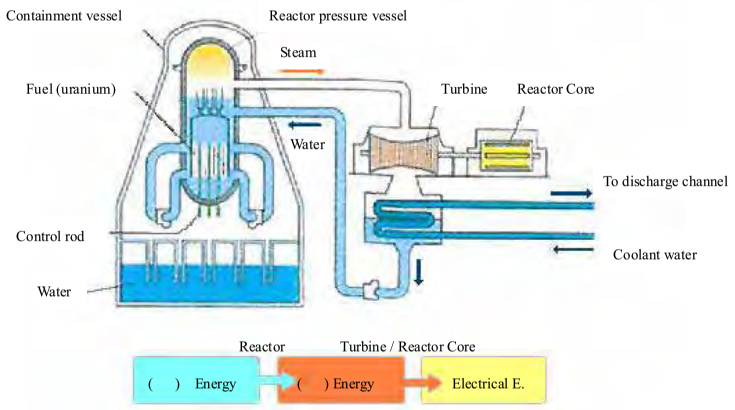
8) In the lower right is a power generation system that is in mainstream use in advanced countries. What kind of power generation is this, and what is its energy resource?

Type of power generation: (**nuclear power generation**)

Energy resource: (**uranium**)

9) What form of energy does the power generation method in 8) above use and transform to produce electrical energy? Put the name of the states of energy in the blanks below.

(**Nuclear**) energy → (**heat**) energy → electrical energy

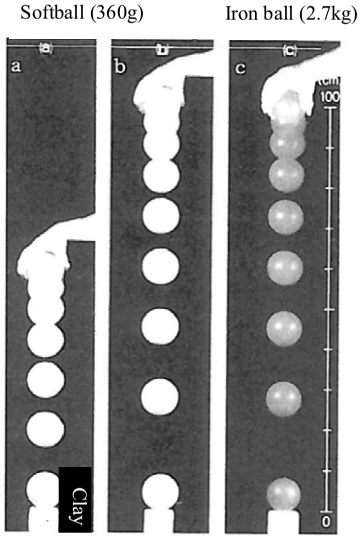


Final Unit Evaluation Test

* Done at Unit End

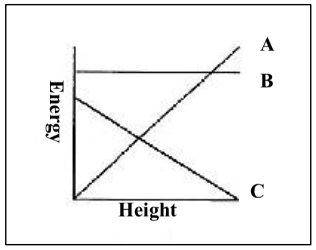
Class: Name:

1. An experiment was done as in the figure to the right to examine the energy possessed by elevated objects. The experiment took place with a softball (360g) in **columns a. and b.**, and a iron ball (2.7kg) in **column c**.



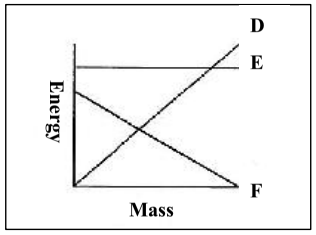
1) Can you imagine which of the lines **A to C** in the graph below could be a comparison of the experiment results for **columns a. and b**?

(A)



2) Can you imagine which of the lines **D to F** in the graph below could be a comparison of the experiment results for **columns b. and c.**?

(D)



3) If you were to show the size relationship of the amount of clay displaced in **columns a. to c.** in an equation, which of the following could it be?

(D)

A. a = b < c **B.** a = b = c **C.** a < b = c **D.** a < b < c

4) The elevated softball and iron ball can do work by displacing the clay. What does work as used in science mean? Choose the correct item from **A to D** below.

(D)

A. Work is the size of the force it takes to move 1 cm^2.

B. Work is the same thing as labour, so it means a force.

C. Work is the force it takes to move 1 m^2.

D. When a force is applied to an object and makes it move, the force is said to have done work on the object.

5) What is the energy possessed by an object placed higher than the reference plane called?

(Potential energy)

2. Answer the following questions about energy and work, referring to the figure of the bicycle on the right.

1) When the wheel spins fast, what happens to the brightness of the light?

(it becomes brighter)

2) What kind of energy is the generator using to convert into electrical energy?

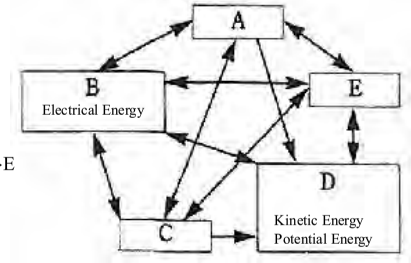
(Kinetic energy)

3) Can you think of what relationship between the energy that spins the generator and electrical energy is?

(If the energy spinning the generator increases (if it spins faster), the electrical energy increases)

3. The figure to the right and **(1) through (6)** below show the flow of energy. Which of **a) through g)** correspond to energies **A, C, and E** in the figure?

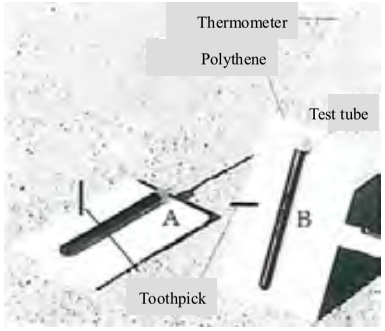
1) A solar battery turns a motor. C→B→D
2) A fan moves air. B→D
3) Electricity is run through water. B→E
4) Plants make their nutrients with photosynthesis. C→E
5) An electric stove boils water. B→A
6) Kerosene burns, producing heat. E→A



a) Geothermal energy　b) Light energy　c) Living creature　d) Wind energy
e) Nuclear power　f) Heat energy　g) Chemical energy

A (f)　C (b)　E (g)

4. On a day with good weather, we put water in test tubes painted black like in the figure on the right and examined how the temperature rises when changing the angle which light from the sun strikes them. Test tube **A** was laid flat on the ground and test tube **B** was stood up vertically. The polythene is blocking the heat from the ground. Answer the following questions.



1) If left alone for 30 minutes, which of the test tubes would have raised in temperature more, **A or B**?

(B)

2) Choose from **A through D** below for the reason why.

(A)

A. Amount of light per unit area increases when sunlight hits the test tube standing up perpendicularly.

B. Amount of light per cm^2 decreases when sunlight hits the test tube standing up perpendicularly.

C. Amount of light per cm^2 increases when putting the test tube laying the test tube horizontally.

D. Amount of light per cm^2 decreases when putting the test tube laying the test tube horizontally.

3) Given the same conditions as above, if the test tubes were painted black or white, which colour would have raised in temperature faster?　(The ones painted black)

5. Figures A to C below show models for power generation patterns. The graph shows annual electrical energy generated per year **(replace Japanese production figures with Kenyan figures)**. Answer the following questions.

1) Which of **1 to 3** on the graph is equivalent to the amount of electrical energy provided by generation patterns **A through C**?

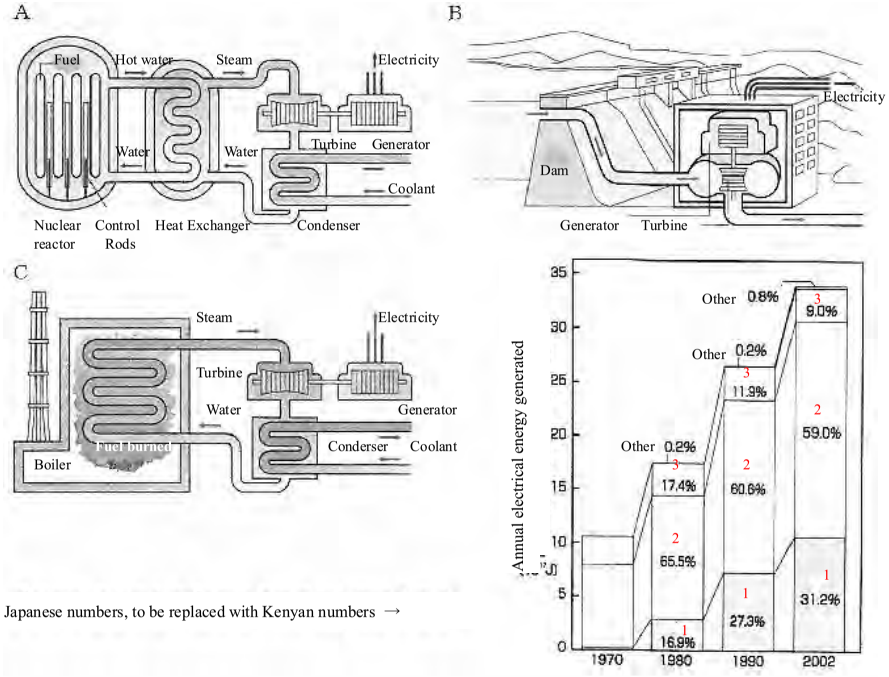
A (1)　B (3)　C (2)

2) Which of generation patterns **A through C** will be in danger, or in other words is believed will fall from current generated output, because of petroleum reserves in the future (in around 40 years)?

(C)

3) What other materials could be used besides petroleum for the power generation in **(2)** above?

(coal, natural gas)



Japanese numbers, to be replaced with Kenyan numbers →

Student Questionnaires

1. What kinds of studying have you done in the past for the above test problems?

0.	None at all	This was done 10% of the time for all problems.
1.	No	This was done 30% of the time for all problems.
2.	Average	This was done 50% of the time for all problems.
3.	Yes	This was done 70% of the time for all problems.
4.	Absolutely yes	This was done over 90% of the time for all problems.

Answering Questions using Pictures and Diagrams in the Textbook or Illustrations Drawn on the Blackboard

1. The Students answered the questions by walking up to the board and drawing diagrams or writing words.

0. 1. 2. 3. 4.

2. The teacher asked and answered the questions by drawing diagrams or writing words on the board.

0. 1. 2. 3. 4.

3. Questions were answered using pictures and diagrams in the textbook.

0. 1. 2. 3. 4.

Experiments

1. Did the students conduct any experiments or observations?

0. 1. 2. 3. 4.

2. The teacher conducted the experiments.

0. 1. 2. 3. 4.

3. The students conducted the experiments by following the teacher's instructions.

0. 1. 2. 3. 4.

Discussion and Thinking

4. We talked with friends in the class and thought about the problems.

0. 1. 2. 3. 4.

5. We thought about the problems carefully with friends and stated our ideas logically.

0. 1. 2. 3. 4.

6. We thought about the problems carefully when coming up with a hypothesis and after the experiment.

0. 1. 2. 3. 4.

Understanding Ideas

7. I was able to understand new ideas.

0. 1. 2. 3. 4.

8. I was able to see new viewpoint of looking at and thinking about science.

0. 1. 2. 3. 4.

9. I was able to grasp the principles hidden beneath the facts.

0. 1. 2. 3. 4.

Application of Knowledge

10. I was able to apply the new knowledge that I learned in school in my daily life.

0. 1. 2. 3. 4.

11. The teacher has explained that the new knowledge things the students are learning in school are connected with actual life.

0. 1. 2. 3. 4.

12. I was able to learn that the new principles and viewpoints toward science can be applied to a variety of different phenomena.

0. 1. 2. 3. 4.

Pursuing Knowledge through Problem Solving

13. We were first given a problem and then were to solve that problem.

0. 1. 2. 3. 4.

14. We made predictions, put then to the test, formulate scientific explanations, and put them to practical use.

0. 1. 2. 3. 4.

15. The students were asked to verify through the experiment that they had created a hypothesis as well as a plan for the observation.

0. 1. 2. 3. 4.

2. When you learned each unit for the above test problems, did you become interested in the material?

0.	None at all	This was true 10% of the time for all problems.
1.	No	This was true 30% of the time for all problems.
2.	Average	This was true 50% of the time for all problems.
3.	Yes	This was true 70% of the time for all problems.
4.	Absolutely yes	This was true over 90% of the time for all problems.

Interest and Motivation

1. I was very interested in science lessons.
0. 1. 2. 3. 4.
2. I became more motivated to learn.
0. 1. 2. 3. 4.
3. I was interested in what we were learning from start to finish.
0. 1. 2. 3. 4.

Concentration and Involvement

4. I was actively engaged in learning the topic.
0. 1. 2. 3. 4.
5. I enjoyed learning the topic so much I lost track of time.
0. 1. 2. 3. 4.
6. I was very focused on learning topic material but at the same time, I was also very excited and enjoyed myself.
0. 1. 2. 3. 4.

Cooperation and Collaboration

7. I enjoyed the learning process while collaborating with friends.
0. 1. 2. 3. 4.
8. I was able to learn through cooperation and mutual support with my friends.
0. 1. 2. 3. 4.
9. I shared my experiments and ideas with my friends and we all had a fun time learning together.
0. 1. 2. 3. 4.

（ENERGY／8th grade）

Level of Earnestness and Enjoyment during Experiments

10. The experiments were very enjoyable.
0. 1. 2. 3. 4.
11. Since experiments need five senses, I carefully moved my hands and eyes when collecting the data.
0. 1. 2. 3. 4.
12. During the experiments, I recorded my observations accurately and carefully.
0. 1. 2. 3. 4.

Spirit of Inquiry

13. I began to have more an inquiring mind toward new discoveries.
0. 1. 2. 3. 4.
14. I became very excited and curious about challenging the unknown.
0. 1. 2. 3. 4.
15. I made a strong effort to learn what is known by trying to find examples, drawing illustrations, and through discussions and experiments.
0. 1. 2. 3. 4.

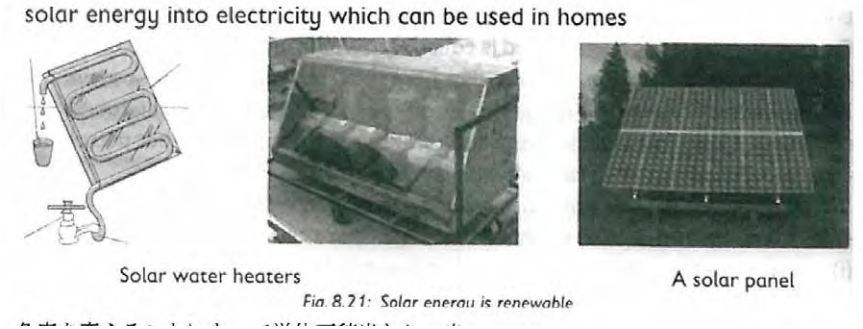
Logic and Objectivity

16. I attempted to find plenty of evidence and facts to check whether my hypothesis held true.
0. 1. 2. 3. 4.
17. I was able to confirm that the principles and concepts were true by applying them to actual life.
0. 1. 2. 3. 4.
18. The explanations were very convincing and easy to understand for the entire class. I was very satisfied with the interpretations which were logical and accorded with the truth.
0. 1. 2. 3. 4.

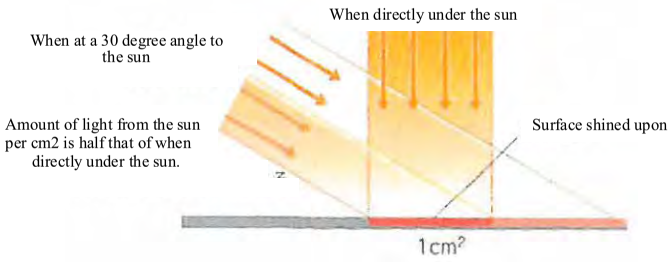
Appendix

Teaching guidelines for the experiment of heating water with solar heat (p.13)

- The polythene is used to prevent radiated heat from the ground. If you do not have any polythene then you can use any highly insulating material (thick wooden board, etc.) as a substitute.
- Tie this in to effectively getting energy by deciding the angles of installation for solar water heaters and solar panels.



- The reason to change the angle is that this changes the amount of light per unit area. This is why there is a difference in temperature increase.



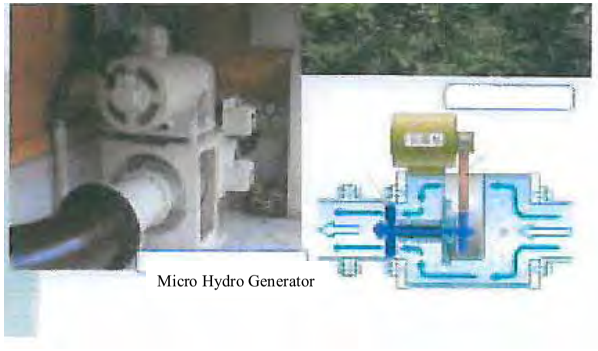
- During *observation*, you can make pupils aware of tricks like using a clear test tube and colouring the water itself. When you conduct the experiment, there must be one variable with everything else being in the same condition. For example, preparing two test tubes in **state A**, then changing only the colour of the test tubes is fine.

（ENERGY／8th grade）

Appendix

Micro hydro generators

- You can make a micro hydro generator if you can get a head of 2 meters of water. Put the generator in the path of the water and the turbine will be spun by the difference in water levels. These are used in Japan to generate power in agricultural irrigation.


Micro Hydro Generator

Great Rift Valley

from Japanese Wikipedia

- The Great Rift Valley is surrounded by a region of tall mountains and volcanoes with hot spots having been confirmed to exist. Due to this geothermic temperatures are high, making possible efficient use as power generation.

Appendix

Examples of assessment questions which is used in Kenyan text books

1. Energy is defined as the
   A. ability to lift things.　　B. ability to push things.
   C. ability to pull things.　　D. ability to do work.
2. Which one of the following is **not** a form of energy?
   A. Heat　　B. Sound　　C. Electricity　　D. Temperature
3. The energy in our bodies comes from
   A. food.　　B. machines.　　C. lifting.　　D. pulling.
4. Kerosene, petrol and charcoal are
   A. chemical energies.　　B. fuels.
   C. heat energies.　　D. work.
5. Which one of the following forms of energy is present in food?
   A. heat　　B. fuel　　C. chemical　　D. electrical
6. Burning wood produces
   A. chemical energy and heat.　　B. heat energy and light.
   C. solar energy and light.　　D. solar energy and heat.

(Oxford; Science in Action 8　P.77)

Kiio's radio uses batteries. When he switches it on, the energy transformations that occur are:
A. Chemical → sound → electric
B. Chemical → electric → sound
C. Sound → electric → chemical
D. Electric → chemical →sound

(JKF; Primary Science Education Foundation Science 8　P.124)

Which one of the following describes correctly the energy transformations in a simple electromagnet?
A. Electromagnet → electrical → chemical → attraction
B. Chemical → electrical → electromagnetic → attraction
C. Chemical → electrical → electromagnetic
D. Electrical → chemical → attraction → electromagnetic

Three of the following statements are correct about heat transfer. Which one is not?
A. Heat travels through solids by conduction
B. Heat travels through a vacuum by radiation
C. Heat travels through liquids by convection
D. Heat from the sun reaches us by conduction

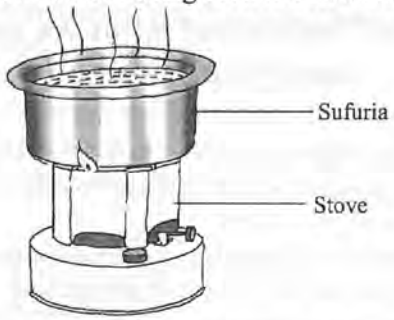
(KLB; Primary Science Pupils' Book for Standard Eight　P.159)

Magnets made by electricity flowing in a coil are called
A. magnetic fields
B. magnetic materials
C. electric magnet
D. electromagnets

Which of the following does not conserve energy?
A. Using energy sparingly.
B. Using firewood instead of electricity.
C. Using renewable energy sources.
D. Using solar energy.

(Longhorn; Understanding Science, Pupil's Book 8　P.64)

The diagram below shows a stove being used to boil water.



When the stove was lit the energy transformations that take place are $X \rightarrow Y \rightarrow Z$.
Write down the forms of energy represented by X, Y, Z.

(JKF; Primary Science Education Foundation Science 8 P.125)

Which one of the following shows the energy transformation when using charcoal?
(A) chemical —> heat —> light
(B) heat —> chemical —> light
(C) light —> heat —> chemical
(D) heat —> light —> chemical

Which of the following is not a source of energy?
(A) the earth (C) the sun
(B) water (D) wind

(Macmillan; Macmillan Primary Science, Pupil's book 8 P.98)

In biogas production the energy changes involved are represented in one of the following. Which one is it?

A. Heat Energy → Kinetic energy → Light energy → Chemical energy
B. Kinetic Energy → Heat energy → Light energy → Chemical energy
C. Chemical Energy → Kinetic energy → Heat energy → Light energy
D. Kinetic Energy → Chemical energy → Heat energy → Light energy

Energy stored in fuels is called:
A. Heat B. Chemical
C. Light D. Electricity

(KLB; Primary Science Pupils' Book for Standard Eight P.158)

Which one of the following is a way of conserving energy?
A. Making charcoal wet so that it does not burn very fast
B. Burning the charcoal in a strong *jiko* whose body is all metal
C. Making charcoal balls by mixing charcoal dust with animal dung
D. Using firewood which is chopped into smaller pieces instead of charcoal

Most improved charcoal stoves conserve energy mainly because:
A. Heat loss is reduced by the clay lining insulator
B. They have small air spaces on the charcoal holder
C. They have small charcoal space
D. They last longer than the traditional *jikos*

(KLB; Primary Science Pupils' Book for Standard Eight P.157)

Appendix

Examples of materials which is used in Kenyan text books

Energy and energy transformation

The meaning of energy

Energy is the ability to do work. Work is done when a force moves an object by pushing, pulling or lifting. Digging is work. Riding a bicycle is work. Walking is work. To do work one needs energy. The energy we use to do work comes from the food we eat.

Pushing


pushing a wheelbarrow


tightening a screw


pushing a log of wood

Pulling


oxen pulling a cart


pulling a bag

(Oxford; Science in Action 8　P.68)

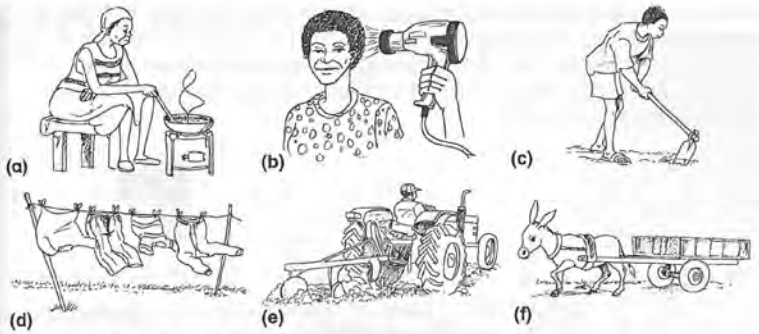


Figure 8.1 *Energy at work*

Name the activities that are taking place in the figure above?
What enables these activities to take place?

(Macmillan; Macmillan Primary Science, Pupil's book 8　P.83)

Types of energy

Energy exists in many forms. The most common forms of energy are heat, light, sound, chemical, electrical and magnetic energy.

Heat energy

Heat is a form of energy. Another name for heat energy is **thermal energy**. Hot objects have heat energy. Heat boils water and causes things to expand. Heat energy is the energy that flows from one place or object to another as a result of a difference in temperature. The sun has heat energy. Burning fuels such as wood, charcoal, kerosene, gas and diesel produce heat energy.


burning wood


gas cooker

Figure 10.2: Sources of heat

(Oxford; Science in Action 8　P.69)

Figure 8.3 *Heat energy*

(Macmillan; Macmillan Primary Science, Pupil's book 8　P.84)

Light energy

Light is a form of energy. Objects that give out light have light energy. The human eye is an organ that senses light. We are able to see our surroundings because of the presence of light. The sun and stars are natural sources of light energy. Artificial sources of light energy include candles, torch cells, electric bulbs, batteries and lanterns.

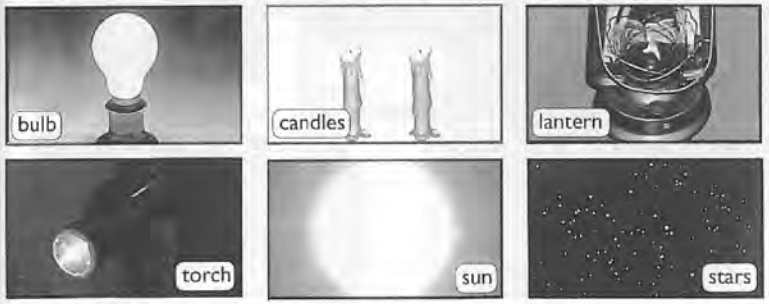


Figure 10.3: Sources of light

(Oxford; Science in Action 8　P.69)

Sound energy

Sound is a form of energy. It is produced when objects vibrate. To vibrate is to move to and fro. When we talk we produce sound. Musical instruments such as the guitar, piano, trumpet, flute and drum produce sound. A car horn, a singing bird and a bell produce sound.

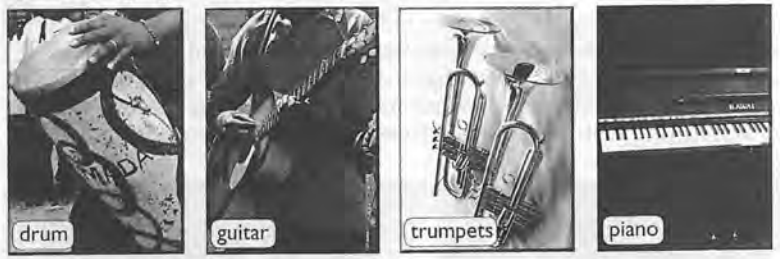


Figure 10.4: Sources of sound

Electrical energy

The energy produced by electricity is called **electrical energy**. Electrical energy can be used to produce:

(a) light in electrical bulbs and tubes.

(b) heat in electrical appliances such as an electric kettle, an electric cooker, an electric emersion heater and an electric iron.

Figure 10.6: An electric bulb

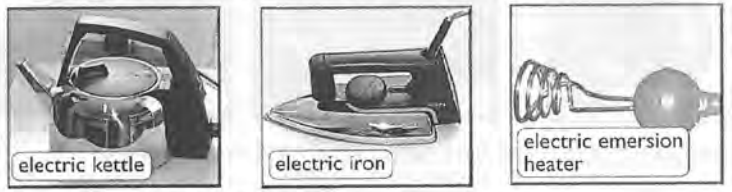


Figure 10.7: Electric appliances

(Oxford; Science in Action 8　PP.70-71)

Magnetic energy

- Take a magnet.
- Pass it over different things such as pin, needles, nails, razor-blade, pins, geometrical set, rubber and ruler as shown below.

Testing magnetic materials

- Which objects are attracted?
- Which objects are not attracted?

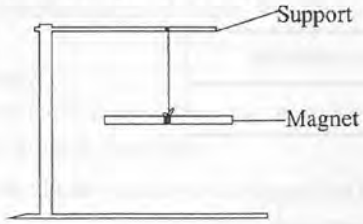
- Take a magnet.
- Roll it on iron filings as shown below.

Rolling a magnet on iron filings

- What do you notice?

Activity: Finding out how the poles behave towards each other

- Take a string and use it to hang a magnet on a support.

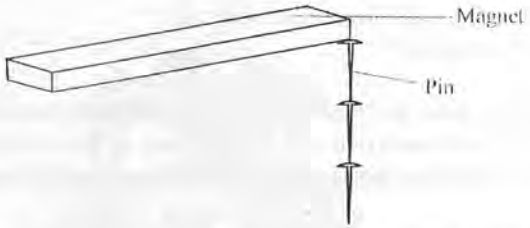


- Take a magnet and hang it on a support.
- Bring a pin close to one of the poles of the magnet as shown below.

Making magnet by induction

- What happens to the pin?
- Now bring another pin close to the attracted pin
- What do you notice?

The fist pin is attracted to the magnet. It can now attract another pin because it has become a magnet. It becomes a magnet by a method called induction. The other pins also become magnets by the same method.



When the first pin is removed, the other pins that were held by it fall off. This is because the pin loses its magnetism when removed from the permanent magnet.

(JKF; Primary Science Education Foundation Science 8　PP.111-114)

Chemical energy

Chemical energy is the energy stored in substances such as oil, charcoal, gas, wood, food and chemicals in batteries and dry cells.

Food gives our bodies energy. The energy contained in food is released when digested food is absorbed and used up by the body. **Fuels** such as kerosene, petrol, gas and charcoal have chemical energy. When these fuels are burnt, they produce energy that does work such as cooking food, warming a house and moving vehicles.

A car battery has stored chemical energy. This energy can be used to start motor vehicle engines or produce light. A candle has chemical energy. When it is lit it produces heat and light.

Figure 10.5: Sources of chemical energy

(Oxford; Science in Action 8　P.70)

Other forms of energy are:

(a) **Elastic energy** found in objects that can stretch such as a rubber band.

(b) **Potential energy** that is due to the position or structure of an object. A tightly coiled spring or a raised body has potential energy.

(c) **Kinetic energy** found in moving objects such as a moving car and falling objects.

Figure 10.10: Objects that have elastic, kinetic and potential energies

(Oxford; Science in Action 8　P.72)

Transformation of energy

Transformations of energy in food

Food contains chemical energy. When food is used in the body, the chemical energy is changed to heat energy and mechanical energy. The heat energy keeps us warm and the mechanical energy helps the body to do work.

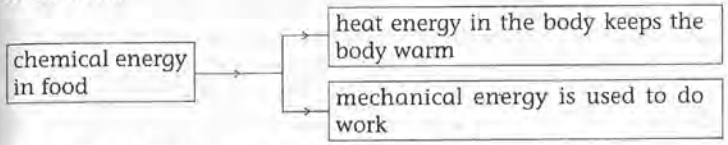


Figure 10.14: The energy transformations when food is eaten

Energy transformations when fuels burn

Fuel is anything that can be burnt to produce heat. Charcoal, wood, kerosene, petrol and petroleum gas are fuels. Fuels contain chemical energy. When they are burnt, the chemical energy converts to heat energy and light energy.

When charcoal burns, the stored chemical energy is changed to heat energy. Heat energy is used to cook food. When a kerosene lantern is lit, the chemical energy in the kerosene is changed to heat energy then to light energy which enables us to see.

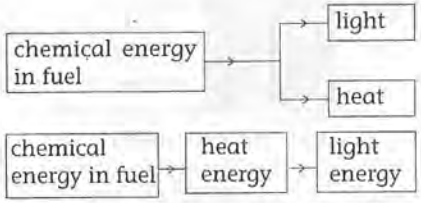


Figure 10.15: The energy transformations when fuel burns

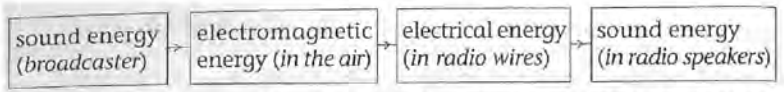


Figure 10.16: The energy transformations from the broadcaster to the speaker in a radio

When the batteries are connected, chemical energy in the batteries is converted to electrical energy. The electrical energy is converted to sound energy at the speakers.

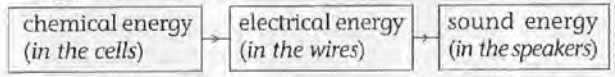


Figure 10.17: The energy transformations from the cells to the speakers of a radio

These transformations can combine to give the diagram shown below.

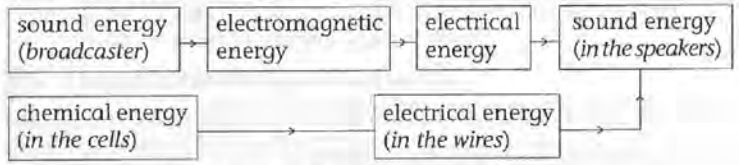
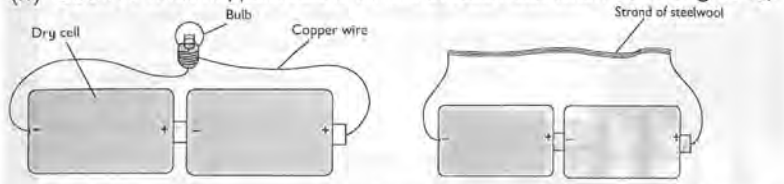


Figure 10.18: The energy transformations in a radio

(Oxford; Science in Action 8 PP.73-74)

Procedure

(i) Connect the bulb to two dry cells using wires as shown in figure 8.14(a).
(ii) Observe what happens to the bulb.
(iii) Also connect a thin strand of steelwool as shown in figure 8.14 (b).
(iv) Observe what happens to the strand of steelwool when electricity flows.



(a) A simple circuit (b) Connecting a strand of steelwool in a simple circuit

Fig. 814:Transformation of electrical energy to light and heat

(KLB; Primary Science Pupils' Book for Standard Eight P.142)

Energy transformations in a simple electromagnet

An electromagnet is a magnet that is formed when an electric current passes through a coil which has been wound round a magnetic material. A magnet can attract or repel magnetic materials. This means that a magnet has energy. Electromagnets are used in electric bells and magnetic cranes.

The electromagnet has magnetic energy. The energy changes that take place are shown in Figure 10.20.

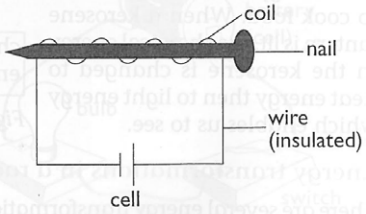


Figure 10.19: An electromagnet

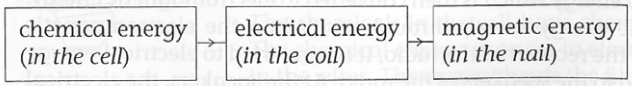


Figure 10.20: The energy transformations in an electromagnet

(Oxford; Science in Action 8　P.74)

Energy transformation; Making toys of magnets

Transforming Magnetic Energy to Kinetic Energy to Make Toys and Tools

Activities in Japan

1) Making ducks

First make a duck figure out of polythene, and then insert something made of iron, such as a nail. The duck will float on water. Tell a pupil to bring some ‘food’ close to the duck to give it to them. Nothing changes. The teacher then puts a magnet in the food such that you can not see the magnet and brings it close to the duck. The duck will take interest in the food and come closer. After solving the problem, float the duck in the water and talk about what to do about the duck trying to run away if you bring something close to it that is not its food.

2) Making a thickness measuring tool

Hang a bar magnet from a spring scale and affix an iron plate or cover to the magnet. Put 10 sheets of paper on top of the iron plate and hang the magnet over top the paper, making contact with it, and then read the measurements on the force meter. Continue this with 20, 30, and 40 sheets of paper, reading the measurements on the force meter each time. Once you know how the readings of the meter work, you can roughly measure the thickness of books at hand, or how many sheets there are on the scale. If hanging from just a spring or rubber band, measure by the difference in extension of the spring or band.

3) Magnetic car maze

Draw a picture of a small car on a piece of paper and cut it out, then tape small, round magnets to it. Next tape a few round magnets to the bottom of an A4-sized sheet of poster board, and then tape another sheet of poster board to the bottom of that. Try to make the car move by moving magnets or iron around underneath the poster board. There will be places the car cannot move in a straight line because of the magnets inside the poster board. Look for a place the car can move forward. Make a starting point and a goal for the car, making a complete maze for the car to pass through using both paths which the car can and can not travel along. Have the pupils try to see who can get the best time from start to finish.

4) Making frogs or snakes that pounce at food

Cut out two pieces of equal size to serve as the bottom jaw and top jaw of a frog or snake’s face, then draw the appropriate animal’s face on the top half of the cut-out. Attach one ferrite magnet in both the top and bottom halves such that they will repel each other so the mouth of the frog or snake’s head will always remain open, then attach bodies to the head. Think of what frogs or snakes like to eat and draw a picture of their favourite food, attaching it to one end of a bar magnet. Draw a picture of food they do not like and attach it to the other end. If you bring their favourite food close to the open mouth of the frog or snake, they will lunge out and grab

it with their mouths. If you bring the food they don't like close then the animal with try to escape.

5) Fun with magnetite sand

Rub steel wool from the kitchen with some sandpaper, then grind the shavings down further by sticking them in between the sandpaper to make plenty of magnetite sand. Commercial use magnetite sand is also acceptable. Make paste with hot water and flour, then put the magnetite sand in the paste and stir. Make 5 sheets of paper the same size and spread paste on the entire surface labelling the sheets 1/5, 2/5, 3/5, 4/5, and 5/5 respectively. After they dry, draw 10 yen, 20 yen, 30 yen, 40 yen and 50 yen on the papers and put them in a paper bag. Using a magnet, have pupils guess how much money is in the bag. In supermarkets, there is a machine that calculates the price of items. When you bring the Product code close to the machine, the value comes up. The pupils should discover principles such as this.

6) Musical Christmas cards

Buy an electronic melody card at a teaching goods store and connect the device to a battery so that you can hear the melody. Connect things into this series: battery - conductor wire - switch - conductor wire - melody device - conductor wire - battery. Place the switch in the centre of a rectangular piece of paper and fold it in half, affixing aluminium foil on one side and a paperclip on the other. Connect all the conducting wires, make a box and put the entire device and series inside. Fix the switch to the face of the box. When you bring the magnet close to the switch from outside the box, the magnet pulls the paperclip and makes it touch the aluminium foil. This makes it so you can hear the melody. If you take the magnet away, the melody will stop playing. Place two different melody devices inside a tall box, one on top of the other. Attach the switch for one on the top of the side of the box with the other switch on the bottom. Find a box lid big enough to cover the entire side of the outer box and attach a magnet to the inner side of the lid such that it will touch the outside of the outer box. Pushing in on the lid will make the melody play, and moving the lid downward will play the other melody.

7) When magnets lose their magnetism

Put a compass in an iron saucepan or pot. The compass will always be pointing north and south. If you put a piece of iron in the pot you won't be able to attract it with a magnet. Place an eraser above both ends of a ruler, and then place another ruler on top of the erasers. Tightly fasten rubber bands on each end such that the rulers will not separate. There should be a slight opening between the rulers. Line up alnico magnets or ferrite magnets on top of the rulers. Placing either a paper clip, small nail or thumbtack below the rulers should make them be drawn to the magnet, which works passing through the rulers to draw objects to it. If you stick a thin knife or pair of scissors in between the rulers, the objects drawn by the magnet all fall. Have pupils experience magnetic induction.

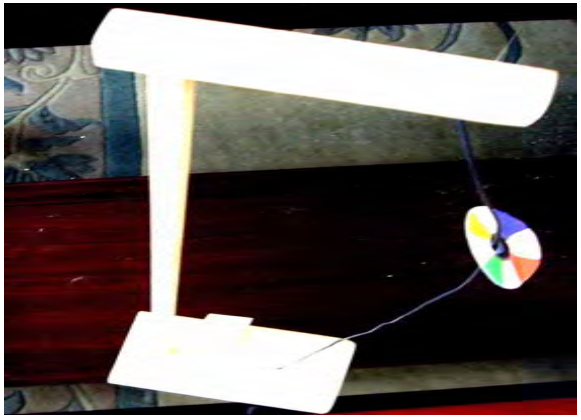
Through these activities you can help develop conceptive ability, expressiveness, discussion ability, and creativity. Try to help the pupils develop rich concepts, diverse thoughts and sensitivity. Extract information, interpret this information and process it, then make something new from it. Humans by nature like creative activities. They love making things, using tools, giving ideas, trying new things and trying to remake things. Children are constantly moving around, constantly thinking and constantly acting on their emotions. Satisfy their true nature as humans and give them a setting where they have the chance to make something.

The human brain comes up with bizarre habits. If you take on an activity, fight through the resistance and succeed, then you will want to take that accomplishment and challenge yourself again. You start to want challenging activities. As a result, you find that you can not help but enjoy such challenges. This is what education is all about.

On the following pages are a number of example pictures.

Example of activity 4 above

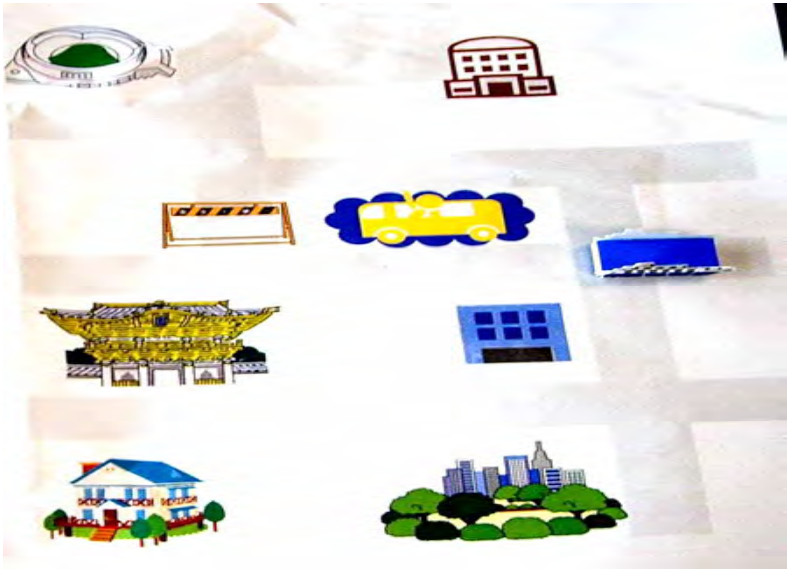
A ring magnet being attracted by a wire and fluttering around as it falls.



Fishing: the fishable items are made of iron. Any items made from aluminium, copper or wood cannot be caught.

With the petals, stem, leaves and soil separated, you can make a flower figure using magnets on the rear side.

Activity 3 above



The butterfly flutters above the flowers, but swoops down on plants hatching eggs. This uses properties of north and south polarity.

Activities in Japan

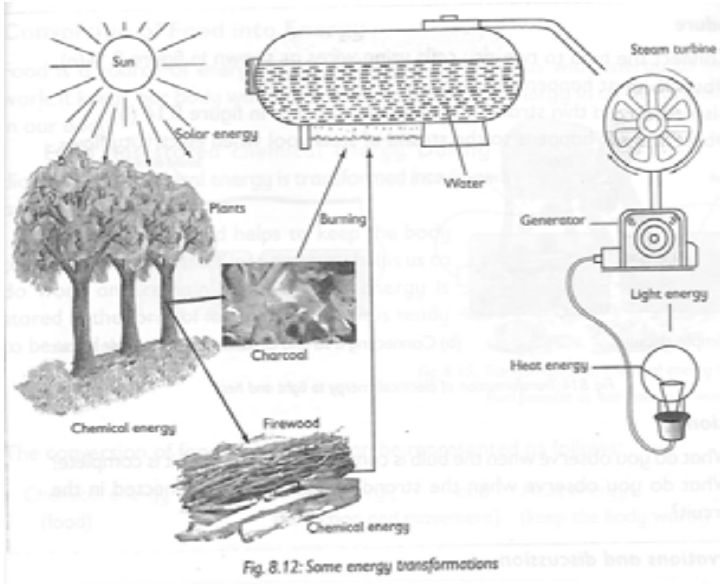


Fig. 8.12: Some energy transformations

(KLB; Primary Science Pupils' Book for Standard Eight　P.141）

Energy conservation

2. USING ENERGY-EFFICIENT DEVICES

There are devices that we can use to make us use less energy. These include:

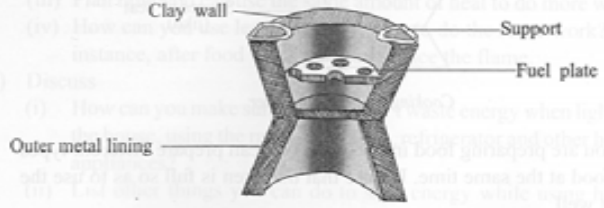
- improved jikos
- improved charcoal
- smokeless baskets
- energy-saving bulbs

(a) Improved jikos

There are different types of improved jikos, as shown below:

(i) Jiko with double wall of clay

The diagram below shows an improved jiko.



Improved Jiko

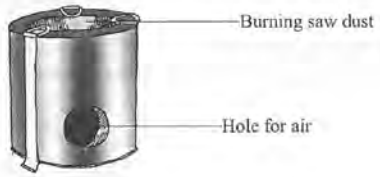
(ii) Improved fireplace

Improved fireplace

This fireplace uses less firewood. The clay or concrete are poor conductors and prevents heat loss.

(iii) Sawdust jiko

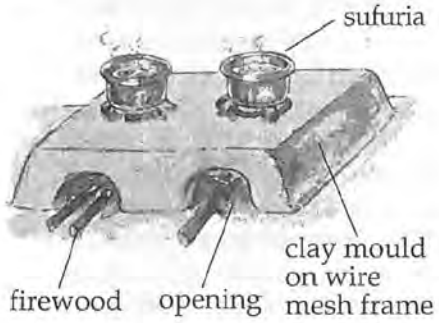
This jiko uses less sawdust which is cheaper.



Sawdust jiko

(JKF; Primary Science Education Foundation Science 8　PP.128-129)

The figures below show a clay cooker and a pressure cooker respectively.



(Longhorn; Understanding Science, Pupil's Book 8　P.61)

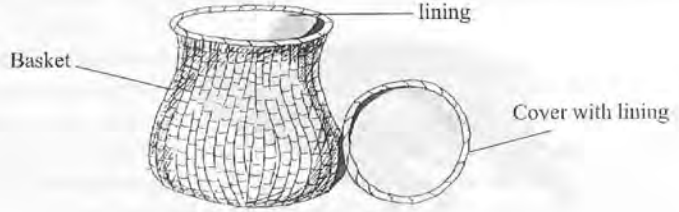
(b) Improved charcoal

This is made by mixing cowdung and fine particles of charcoal. They are rolled into balls which are dried before use.

Improved charcoal

(c) Cooking baskets

You can use cooking baskets to conserve energy. The baskets are shown below.



Cooking basket

Food is cooked to some extent. It is then put in the basket which has an insulating material on the inner sides. This insulating material does not allow heat to be conducted from the hot food. The baset is then covered. The food continues to cook in the basket until it is ready.

(d) Energy saving bulbs

We can use energy saving bulbs instead of ordinary bulbs to conserve energy.

Energy saving bulb

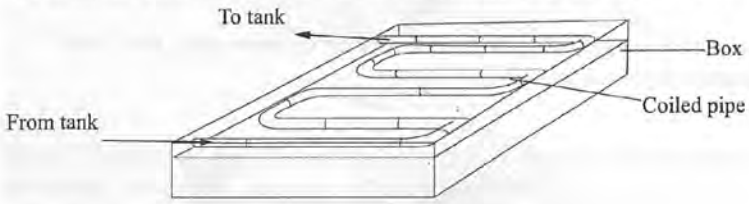
(JKF; Primary Science Education Foundation Science 8　PP.129-130)

(i) Drying

We use energy from the sun for drying different types of food like grains and fish.

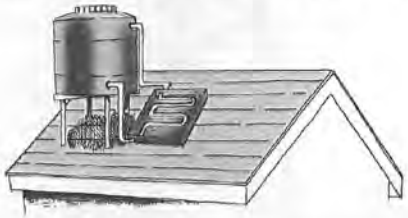
(ii) Heating

Instead of using fuel to boil water, we could heat it using heat from the sun. We could also construct a solar heater that could be used to heat water.



Solar heater

A solar heater is made of a box. On the box there are coiled pipes. The box is painted black for better absorption of heat. The pipes are connected to water in a tank.



Solar heater on roof

(KLB; Primary Science Pupils' Book for Standard Eight P.132)

Biogas

To make biogas you need a digester.
Place two amounts of water to one of cow dung in the digester.
As the dung ferments, biogas is produced. The biogas rises to the top of the small metal drum. A control tap directs the gas to either cooking or lighting. The remaining dung can be removed and used as manure.

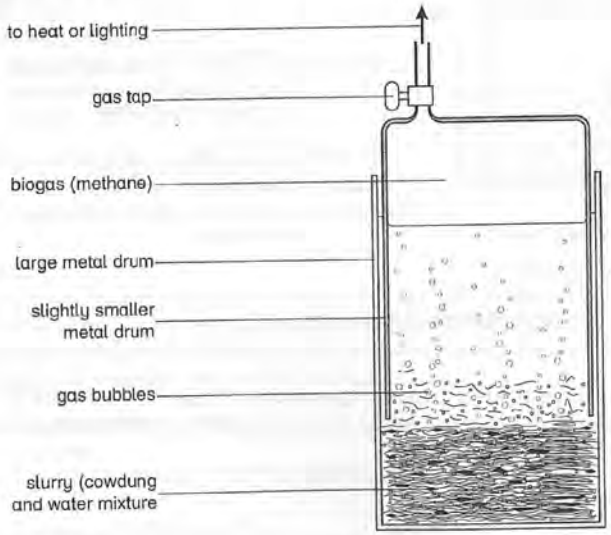


Figure 8.14 *A biogas digester*

(Macmillan; Macmillan Primary Science, Pupil's book 8 P.93)

Using renewable energy

Renewable sources of energy are those in which energy can be replaced naturally or controlled. They can be used without getting finished. Sources of renewable energy include the sun, wind, wood, biogas and water.

The sun

The energy from the sun is called **solar energy**. This energy does not pollute the environment. It can be trapped by solar panels. Solar panels have cells that can convert sunlight to electricity. Special panels can also absorb the heat from the sun to heat water in pipes. Solar reflectors can be used to make solar cookers.

Figure 10.22: Solar panels

(Oxford; Science in Action 8 P.75)

The wind

We use the wind to generate electricity. Wind does not get exhausted. It continues to blow and produce more electricity. The electricity produced can be used for many purposes. Windmills can also be used to pump water from the ground to the surface or to raised ground. Wind is a renewable source of energy.

(Oxford; Science in Action 8　P.76)

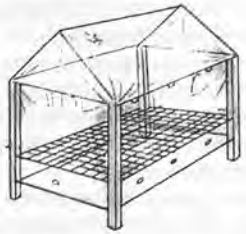


Fig. 8.11: Grains drier

Fig. 8.12: Solar cooker

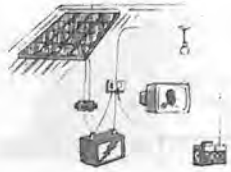


Fig. 8.13: Solar panel

(Longhorn; Understanding Science, Pupil's Book 8　P.62)

NEW SPIAS (Smase Project Impact Assessment Survey)

Annual Questionnaire
School No.:_____ Student ID No.:_____

1. Student Questionnaire (Student Competence Index)

1. About You and your Living Environment

1) Please write down your date of birth.

Month:_____ Day:_____ Year:_____

2) Are you a male or female?

1. Male 2. Female

3) What language do you speak at home?

1. Swahili 2. A local language 3. English

4) Do you have electricity in your home?

1. Yes 2. No

5) How does your family get the drinking water for your home?

1. By boiling rain water 2. By boiling city water 3. Other

6) How many books do you have in your home?

1. Less than 10 books 2. 10-30 books 3. More than 30 books

7) Do you have the following items at home? (1. Yes 2. No)

1.	Your own desk for studying	1.	2.
2.	A science textbook	1.	2.
3.	A science picture book	1.	2.
4.	Science workbooks, exercise books	1.	2.
5.	Notebooks and paper	1.	2.
6.	Pencils and pens	1.	2.
7.	A cell phone	1.	2.
8.	A television	1.	2.
9.	A bicycle	1.	2.
10.	A camera	1.	2.

8) Did your father graduate from a primary or secondary school?

1. He did not graduate from a primary school.
2. He graduated from a primary school.
3. He graduated form a secondary school.

9) Did your mother graduate from a primary or secondary school?

4. She did not graduate from a primary school.
5. She graduated from a primary school.
6. She graduated from a secondary school.

10) What do you think about studying science?

(0. Not at all 1. No. 2. It is okay 3. Yes 4. Absolutely yes)

Is studying science fun?

1.	Studying science is fun.	0.	1.	2.	3.	4.
2.	I want to study more science at school.	0.	1.	2.	3.	4.
3.	I love science.	0.	1.	2.	3.	4.

Preparation, Review, and Homework for Science Class

1.	I prepare and review for science class at home.	0.	1.	2.	3.	4.
2.	I always do my homework at home.	0.	1.	2.	3.	4.
3.	I read and add on to my science notes at home.	0.	1.	2.	3.	4.

2. About your Attitudes towards Studying and Daily Living

(0. Not at all 1. No. 2. It is okay 3. Yes 4. Absolutely yes)

Endurance, Patience, and Tenacity

1. I have the ability to work hard firmly. 0. 1. 2. 3. 4.

2. I never give up even when things are tough and continue to do my best until the end. 0. 1. 2. 3. 4.

3. I have the ability to concentrate on what I need to do and also have an inquiring mind. I am the type of person that will continue what I have started. 0. 1. 2. 3. 4.

Daily Living Routines

4. I always wake up at the same time and eat a breakfast. 0. 1. 2. 3. 4.

5. I live a well-regulated life and allow enough time for studying, helping around the house, and sleeping.

0. 1. 2. 3. 4.

6. I think that I have good living habits and to eat meals, sleep, go to the bathroom, take care of personal hygiene, and change my clothes.

0. 1. 2. 3. 4.

Independence and Autonomy

7. I don't wait for other people to tell me what to do. I tend to make my own plans for my studying and daily life and carry through with them.

0. 1. 2. 3. 4

8. I think that whenever I do anything, I always consider my goals, the significance of my actions and my own personal values before I act.

0. 1. 2. 3. 4.

9. I prefer to do everything on my own without receiving any help or assistance from others.

0. 1. 2. 3. 4.

Creativity

10. I have keen sensibilities, am creative, and enjoy having discussions with people who have different opinions.

0. 1. 2. 3. 4.

11. I enjoy intellectual activities and enjoy games and quizzes that test your knowledge. I also like things that are new.

0. 1. 2. 3. 4.

12. I am good at coming up with new ideas and inspirations. I also enjoy using metaphors, a way of describing something by referring to it as something different, and analogies, which take two similar ideas and draw parallels between them, in explaining my ideas.

0. 1. 2. 3. 4.

Searching, Handling, Creating, and Transmitting Information

13. I enjoy looking up new information in books, asking other people, or referring to dictionaries for problem solving purposes.

0. 1. 2. 3. 4.

14. I enjoy using new words, using numbers and symbols, and explaining ideas by using illustrations and diagrams.

0. 1. 2. 3. 4.

15. I enjoy obtaining information by reading, writing, and talking to people as well as reorganizing information and sharing new information with friends.

0. 1. 2. 3. 4.

Challenging the Unknown

16. I like engaging in new challenges involving the unknown and I am always adventurous.

0. 1. 2. 3. 4.

17. I truly enjoy engaging in new activities and am not afraid of uncertainty.
I energetically strive to achieve my goals that I have set out and I never give up.

0. 1. 2. 3. 4.

18. I like expressions such as "No pain, no gain.", "Nothing ventured, nothing gained", and practice makes perfect."

0. 1. 2. 3. 4.

3. Student Participation Index for Learning Science

1. What kinds of studying have you done in the past for the above test problems?

0.	None at all	This was done 10% of the time for all problems.
1.	No	This was done 30% of the time for all problems.
2.	Average	This was done 50% of the time for all problems.
3.	Yes	This was done 70% of the time for all problems.
4.	Absolutely yes	This was done over 90% of the time for all problems.

Answering Questions using Pictures and Diagrams in the Textbook or Illustrations Drawn on the Blackboard

1. The Students answered the questions by walking up to the board and drawing diagrams or writing words.
   0. 1. 2. 3. 4.

2. The teacher asked and answered the questions by drawing diagrams or writing words on the board.
   0. 1. 2. 3. 4.

3. Questions were answered using pictures and diagrams in the textbook.
   0. 1. 2. 3. 4.

Experiments

1. Did the students conduct any experiments or observations?
   0. 1. 2. 3. 4.

2. The teacher conducted the experiments.
   0. 1. 2. 3. 4.

3. The students conducted the experiments by following the teacher's instructions.
   0. 1. 2. 3. 4.

Discussion and Thinking

4. We talked with friends in the class and thought about the problems.
   0. 1. 2. 3. 4.

5. We thought about the problems carefully with friends and stated our ideas logically.
   0. 1. 2. 3. 4.

6. We thought about the problems carefully when coming up with a hypothesis and after the experiment.
   0. 1. 2. 3. 4.

Understanding Ideas

7. I was able to understand new ideas.
   0. 1. 2. 3. 4.

8. I was able to see new viewpoint of looking at and thinking about science.
   0. 1. 2. 3. 4.

9. I was able to grasp the principles hidden beneath the facts.
   0. 1. 2. 3. 4.

Application of Knowledge

10. I was able to apply the new knowledge that I learned in school in my daily life.
    0. 1. 2. 3. 4.

11. The teacher has explained that the new knowledge things the students are learning in school are connected with actual life.
    0. 1. 2. 3. 4.

12. I was able to learn that the new principles and viewpoints toward science can be applied to a variety of different phenomena.
    0. 1. 2. 3. 4.

Pursuing Knowledge through Problem Solving

13. We were first given a problem and then were to solve that problem.
    0. 1. 2. 3. 4.

14. We made predictions, put then to the test, formulate scientific explanations, and put them to practical use.
    0. 1. 2. 3. 4.

15. The students were asked to verify through the experiment that they had created a hypothesis as well as a plan for the observation.
    0. 1. 2. 3. 4.

2. When you learned each unit for the above test problems, did you become interested in the material?

0.	None at all	This was true 10% of the time for all problems.
1.	No	This was true 30% of the time for all problems.
2.	Average	This was true 50% of the time for all problems.
3.	Yes	This was true 70% of the time for all problems.
4.	Absolutely yes	This was true over 90% of the time for all problems.

Interest and Motivation

1. I was very interested in science lessons.
   0. 1. 2. 3. 4.

2. I became more motivated to learn.
0. 1. 2. 3. 4.

3. I was interested in what we were learning from start to finish.
0. 1. 2. 3. 4.

Concentration and Involvement

4. I was actively engaged in learning the topic.
0. 1. 2. 3. 4.

5. I enjoyed learning the topic so much I lost track of time.
0. 1. 2. 3. 4.

6. I was very focused on learning topic material but at the same time, I was also very excited and enjoyed myself.
0. 1. 2. 3. 4.

Cooperation and Collaboration

7. I enjoyed the learning process while collaborating with friends.
0. 1. 2. 3. 4.

8. I was able to learn through cooperation and mutual support with my friends.
0. 1. 2. 3. 4.

9. I shared my experiments and ideas with my friends and we all had a fun time learning together.
0. 1. 2. 3. 4.

Level of Earnestness and Enjoyment during Experiments

10. The experiments were very enjoyable.
0. 1. 2. 3. 4.

11. Since experiments need five senses, I carefully moved my hands and eyes when collecting the data.
0. 1. 2. 3. 4.

12. During the experiments, I recorded my observations accurately and carefully.
0. 1. 2. 3. 4.

Spirit of Inquiry

13. I began to have more an inquiring mind toward new discoveries.
0. 1. 2. 3. 4.

14. I became very excited and curious about challenging the unknown.
0. 1. 2. 3. 4.

15. I made a strong effort to learn what is known by trying to find examples, drawing illustrations, and through discussions and experiments.
0. 1. 2. 3. 4.

Logic and Objectivity

16. I attempted to find plenty of evidence and facts to check whether my hypothesis held true.
0. 1. 2. 3. 4.

17. I was able to confirm that the principles and concepts were true by applying them to actual life.
0. 1. 2. 3. 4.

18. The explanations were very convincing and easy to understand for the entire class. I was very satisfied with the interpretations which were logical and accorded with the truth.
0. 1. 2. 3. 4.


JICA