6th Grade: ENERGY

（Light）

Rational of this unit

For light, pupils have already learned from 1st grade to 4th grade about sources of light, shadows, reflection of light and appropriate lighting in the home. In daily life making use of light is second nature, but this does not deepen understanding of its properties.

And so, in 6th grade science we will use objects around us to experiment, discover for ourselves both the properties of light to travel in a straight path, reflect and refract as well as the rules behind these properties, and understand them. Using these properties, we hope to be able to devise a means to lead a comfortable daily life.

Objectives: what pupils are expected to achieve in this unit

- To understand that light travels in a straight path in uniform material.
- To understand that there are transparent, translucent and opaque objects.
- To understand through experimentation using mirrors that light reflects when it hits an object.
- To make things themselves and understand how reflection of light is used.
- To understand that reflection and refraction occurs at boundary surfaces when light advances into a different material (for example, from air to glass or glass to air).
- To understand that rainbows occur due to refraction of water droplets in the air.

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
6th Grade (This unit)	• 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
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)

（ENERGY／6th grade）

8th Grade	• 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)

Before starting this unit

Current learning status of the pupils

Regarding light, the pupils have already learned about the sun, lamps, candles, etc. as light sources in 1st grade, about making shadows using light in 2nd grade, about observing the phenomenon of light reflection in 3rd grade, and about the importance of light for illumination in our daily lives in 4th grade.

Light is something commonly and routinely confirmable in daily life. For that reason alone we all witness the phenomena of light's direct line movement, reflection and refraction, but we have not scientifically pursued such regularities and rules in daily life.

Therefore we shall narrow the viewpoint on common light and highlight it, raising interest in the phenomena by making the pupils actually experience these for themselves through experiments with the phenomena.

Preparatory notes

There are no expensive materials or hard to find experimental tools for studying of this unit. In order to have pupils fully experience the phenomena of light, you should prepare multiple materials (at least enough for multiple groups) such that you are not performing the experiment but rather that as much as possible they are actually experiencing it one by one.

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.

Scientific thinking and communication activities

1. Ability to think about the direct movement of light from the results of the experiment.
2. Ability to consider phenomena occurring from reflection of light, such as the law of reflection relating to the position of an image reflected in a mirror or perceptions from light's straight travelling behaviour.
3. Ability to watch the regularity of total reflection of light.
4. Ability to consider phenomena occurring from refraction of light such as how a pencil can appear not to line up when seen through glass, or how a coin in a bowl can appear to be floating.

Knowledge, understanding, and skills in observation and experimentation

1. Ability to understand that light travels in a direct path in air, water and glass.
2. Ability to understand that there are transparent, translucent and opaque objects.
3. Ability to accurately record the movement of light.
4. Ability to explain the rules of reflection.
5. Ability to understand refraction of light at the boundary between mediums such as air to water or air to glass.
6. Ability to understand that rainbows occur due to refraction of water droplets in the air.

Ideas behind the structuring the unit

First pupils will experience a number of phenomena of light, then discover the rules guiding these phenomena through the experiments and come to understand the properties of light. This will make it so that they can make use of these studies in everyday life.

Unit teaching plan

(11 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. Under what conditions will light reach? (2 periods)	1) Investigate how shadows are made both from sunlight and when light strikes an object, and see how the shadow is always on the opposite side of the light source. *(Evaluation: Interest 1)* 2) See how light travels in a straight path by looking through a bendable pipe and match boxes with holes in them. *(Evaluation: Thinking and Representation 1, Knowledge and Skills 1)*
2. Transparent, translucent and opaque substances	3) Know that there are transparent, translucent and opaque objects. 4) Investigate what kinds of places transparent, translucent and opaque objects are used.

(2 periods)	*(Evaluation: Knowledge and Skills 2)*
3. Reflection of Light (2 periods)	5) Investigate what image can be made by a mirror and the appearance of objects when reflected by a mirror. *(Evaluation: Interest 1)* 6) Investigate reflection of light using a light source, slit and mirror, confirming its regularities. *(Evaluation: Thinking and Representation 2,Knowledge and Skills 3, Knowledge and Skills 4)*
4. Light sources and reflected light (2 periods)	7) Investigate the state of total reflection of light. 8) Confirm by experiment the principles which allow us to see objects. Know about irregular (diffused) reflection. *(Evaluation: Thinking and Representation 3)*
5. Refraction of light (2 periods)	9) Observe light refraction that is readily visible by observing how a coin placed in a cup of water appears to float on the top. *(Evaluation: Interest 1, Knowledge and Skills 5)* 10) Understand refraction of light by seeing how letters and landscape seen through a plastic bottle with water in it are distorted and appear bigger or smaller. *(Evaluation: Interest 1, Knowledge and Skills 5)*
6. Making a rainbow (1 period)	11) View sunlight through a plastic bottle and make a rainbow by spraying water mist out of a spray bottle. Think about why rainbows are made and relate it to light refraction and how the various colours are gathered in sunlight. *(Evaluation: Knowledge and Skills 6)*
Unit End Review (1 period)	12) Teacher gives the "**Final Unit Evaluation Test**".

Lesson Plan

1. Under what conditions will light reach? (2 periods: 1st and 2nd periods)

Goals of this sub-unit

- Ability to present the known properties of light and take interest in light.
- Understanding that light travels in a straight path through observation of shadows.
- Ability to explain how light travels in a straight path using objects.

Material Preparations

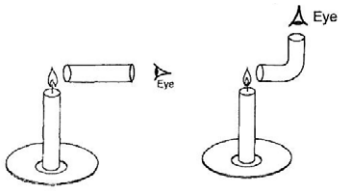
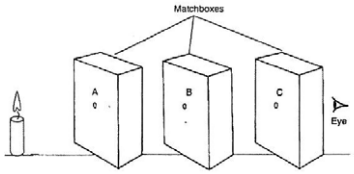
- Pipe, light source (candle, torch), matchbox
- Experiment Worksheet

Period 1: Movement of Light

	Learning flow and activity	Teaching Hints and Advice
Introduction 10 mins.	• Present your thoughts on phenomena related to light properties as seen in everyday life. 	• Have the pupils speak themselves about familiar phenomena of light such as not being able to see things without light, how light from the sun travels in all directions, and how light from a torch spreads out in one direction in order to get them interested in light. *(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	Where is your shadow when you stand under the sun? And if you move then what happens to your shadow?	
Experiment 15 mins.	• Form groups of two. • Go out to the schoolyard and observe where your shadows form when you stand under the sun. • Observe what happens to the shadows when they move. • Record the results. **If observing in the classroom*  • Which side of the light source is the shadow on? • Record the results.	• Work together as a team on the experiment. → Decide 1 person to stand under the sun and one to observe, and have them check the state of the shadow. → Tell them to trade roles over the course of the experiment. **Prepare a plaster bust or other object, dim the room lights and shine light from a torch on it.* **Have the pupils think about where the shadow forms.*
Presentation	• Return to class and present your findings on the sun	• Confirm that shadows form on the side opposite the

10 mins.	and shadows. → Shadows form on the opposite side of the sun (light sources).	sun. Show the pupils that travelling in a straight path is a property of light. • If there is spare time, confirm that light travels in a straight path even through water and glass.

Period 2: Light Travels in a Straight Path

	Learning flow and activity	Teaching Hints and Advice
Introduction 10 mins.	• Look at the picture on the worksheet and think about where the light is coming from.	• Remind pupils that light travels in a straight path. *(Refer to pg. 240 regarding worksheet)*
Questions	Examine how to view the light of a candle using a pipe or 3 matchboxes with holes opened in them.	
Experiment 15 mins.	• View the candle light with the pipe straight and bent. →What was the shape of the pipe when you could see the candle?  • Record the results. • Line up the matchboxes and view the candle.  • Record the results.	• Be careful not to get burned or hurt yourself cutting the holes. • Make it so the pipe's shape can be freely changed and have pupils conduct the experiment. Remind them that light travels in a straight path. • Have pupils try the experiment with 2 and with 3 matchboxes. *(Evaluation: Thinking and Representation 1)* Ability to think about the direct movement of light from the results of the experiment. • Have pupils enter not only the results but also the reasons behind it.
Presentation 10 mins.	• Present the results of the experiment.	*(Evaluation: Knowledge and Skills 1)* Ability to understand that light travels in a direct path in air, water and glass.

3. Reflection of Light (2 periods: 5th and 6th periods)

Goals of this sub-unit

- Ability to take interest in the phenomena of light reflection.
- Ability to discuss phenomena occurring from reflection of light after conducting an experiment, such as the rules of reflection relating to the position of an image reflected in a mirror or perceptions from the straight travelling behaviour of light.
- Ability to explain the laws of reflection.

Material Preparation

- Mirror (1 per pupil), torch, object with a slit (makeshift paper box is fine)
- Experiment Worksheet

Period 5: Mirror Reflections

	Learning flow and activity	Teaching Hints and Advice
Introduction 10 mins.	• Look at your face in the mirror and see how it is reflected.	• Give pupils directions such as "Close your right eye," or "Put your left hand on your cheek." Have them check the mirror to see how they are reflected as they are following your directions. *(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	See how it looks when objects are reflected in a mirror.	
Experiment 20 mins.	• Work along using the worksheet. • Look at the word 'Kenya' in the mirror and see what it looks like. • Try to guess what the letters will look like reflected in the mirror and write them down. • Reflect what you have written and see if it is correct. • Have 2 other pupils try to guess your age using a mirror. →Try putting the mirror in various positions. • Write half a letter and complete it with the mirror.	• Remind pupils that light travels in a straight path. *(Refer to pg. 240regarding worksheet)* • Before doing the experiment, it is important to have them remember what you did during the introduction and write based on what they expect it to look like. • Tell them that the point of the exercise is to remember what they did in the first experiment and be mindful of where they place the mirror. • This touches on left to right symmetry.

Presentation 5 mins.	• Present the results of the experiment.	• Make sure the pupils have a solid grasp on the concept that light travels in a straight path.

Period 6: The Rules of Light Reflection

	Learning flow and activity	Teaching Hints and Advice
Introduction 5 mins.	• Check to see how much you can see when using a mirror to look behind yourself.	• Show them that their visible range is set. • Confirm that you can see things behind you because light has bounced back off the mirror.
Questions	Check how light moves after hitting the mirror.	
Experiment 20 mins.	• Take the box with the mirror, torch and slotted box (prepared beforehand) • Put the slotted box over the torch to make the light source device. • Have the light hit the mirror from a constant orientation and record the line of light bounced back on the paper. →Have the light hit the mirror from various directions to search for what rules it might be following.	• Have the pupils draw an arrow showing the direction the light is travelling for the line of light. *(Evaluation: Knowledge and Skills 3)* Ability to accurately record the movement of light. *(Evaluation: Thinking and Representation 2)* Ability to consider phenomena occurring from reflection of light, such as the law of reflection relating to the position of an image reflected in a mirror or perceptions from light's straight travelling characteristics.
Presentation 10 mins.	• Present the results of the experiment.	• Tell the pupils that light bouncing back from the mirror is called reflection. • Have pupils confirm that rays of light are symmetrical when light is bent as it hits a mirror. • Make the pupils understand that there are rules for light when it is reflected. *(Evaluation: Knowledge and Skills 4)* Ability to explain the rules of reflection.

5. Refraction of Light (2 periods: 9th and 10th periods)

Goals of this sub-unit

- Ability to take interest in the phenomena of light refraction.
- Ability to discover the rules for light when it is refracted at the boundary surface of a substance in an experiment.
- Ability to explain how light refracts.

Material Preparations

- Glass, ceramic cup, (opaque object), pencil, coin, water
- Plastic bottle

Period 9: Refraction of Light

	Learning flow and activity	Teaching Hints and Advice
Introduction 10 mins.	• Watch the experiment demonstration. • Stand a pencil up in a water-filled cup. • Observe how the pencil appears in the water.	• Demonstrate the experiment, asking pupils sitting in various positions what the pencil looks like in the water. → You will get different opinions, like it appearing thicker or it not lining up with the top portion. *(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	Investigate how the object looks in the water.	
Experiment 20 mins.	• Conduct experiment 1. →Place the coin at the bottom of a cup. Stand in a position such that the coin is just out of view. Confirm that you can start to see the coin if water is poured into the cup. • Conduct experiment 2. →Pour water into a cup. Put a pencil in the cup diagonally. Observe how the pencil appears and record the findings. • Conduct experiment 3. →Pour water into a glass and stand the pencil up inside it. Have them observe from various angles. • Record the results of the experiment.	• Working in groups is fine. With everyone standing around the cup, one pupil should slowly pour the water in the cup. →Observe from various angles. • Have the pupils record what it looked like and think about why. →Have them observe from various angles. *(Evaluation: Thinking and Representation 4)* Ability to consider phenomena occurring from refraction of light such as how a pencil can appear not to line up when seen through glass, or how a coin in a bowl can appear to be floating.
Presentation 5 mins.	• Present the results of the experiment.	• Explain the rules of refraction in water.

Period 10: Refraction of Light Seen Underwater

	Learning flow and activity	Teaching Hints and Advice
Introduction 10 mins.	• Prepare a plastic bottle filled with water. Place the plastic bottle above some text and view the letter from various angles. *(Bring in a plastic bottle from home)*	• Have the pupils confirm that the text will look bigger or distorted. *(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	Check how light moves through the water in the plastic bottle.	
Experiment 20 mins.	• Pour water into the plastic bottle. Place the plastic bottle above the word Kenya written on paper and view the word from various angles. → See if there is any regularity to how the word distorts. • Place a plastic bottle filled with water in front of your eyes and view the things close by.	• Show the pupils that the word will appear distorted and parts will look bigger. • Show them that how the word appears depends on the shape of the plastic bottle. • Have them check what happens when the plastic bottle is empty. • Show them that things are distorted the same as when they looked at the word. ** The hole in coins can also be used as a lens.*
Presentation 5 mins.	• Present the results of the experiment.	• Have the pupils understand about appearing distorted, bigger or smaller due to refraction of water. *(Evaluation: Knowledge and Skills 5)* Ability to understand refraction of light at the boundary surfaces between air and water or air and glass.

6. Making a Rainbow (1 period: 11th period)

Goals of this sub-unit

- Understand refraction of light and make a rainbow using its properties.

Material Preparation

- Plastic bottle, wash basin, mirror and spray bottle

Period 11: Refraction of Light

	Learning flow and activity	Teaching Hints and Advice
Introduction 5 mins.	• Listen to talk about rainbows.	• Explain that light can be broken down into light of many different colours due to refraction.

Questions	Try various methods to figure out how to make a rainbow.	
Experiment 20 mins.	• Pupils can choose one of experiments 1-3 below. • Conduct experiment 1. → Have light hit a plastic bottle filled with water. If you look at the ground, you will then see a rainbow. Make a rainbow by moving the plastic bottle to different angles.	• Do not conduct this experiment over grass, but on some surface that will be easy to see the rainbow on (preferably concrete).
	• Conduct experiment 2. →Pour water into a wash basin and stand a mirror up inside it. Place the mirror in a position such that light from the sun will strike it, making a rainbow on the wall.	• What colours can be seen will change with the angle of the light, so have the pupils try various angles. • Have them record the colours of the rainbow made.
	• Conduct experiment 3. → Go out to the school yard and spray water into the air with a spray bottle. • Record the results.	• Tell the pupils to stand with their backs to the sun and spray the mist in the opposite direction of the sun. • Pupils do not have to do all 3 experiments, so you can just choose one. Alternatively, you can have the pupils choose which they would like to try and do that one.
Presentation 10 mins.	• Present the results of the experiment.	• Explain what colours of light are found in sunlight. *(Evaluation: Knowledge and Skills 6)* Ability to understand that rainbows occur due to refraction of water droplets in the air.

[Worksheet] ---------- * To be used in 2nd Period

When we can see light?

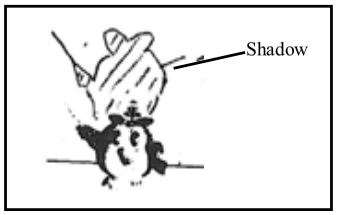
Date: **Class:** **Name:**

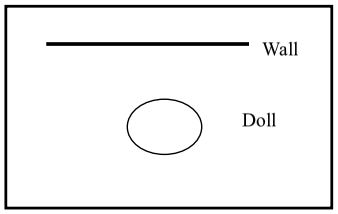
1. Preparation

Mirror, object, (bendable) pipe, candle, matchboxes with holes in the same position

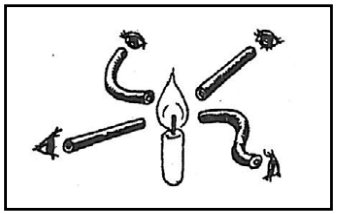
2. Procedures

1) Look at the picture below. Where do you think the light is coming from?



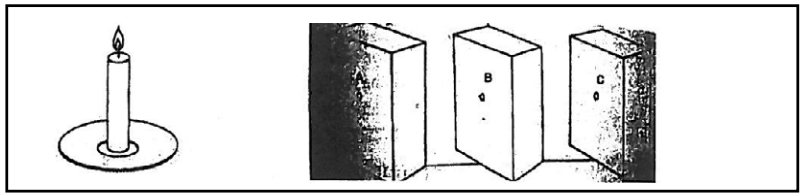


2) Which of the tubes can see the light from the candle?



Why?

3) How would you line up the 3 matchboxes to see the light of the candle?



How to line them up?

** Keep this worksheet for the next class.*

[Worksheet] ---------- * To be used in 5th Period

Using mirrors

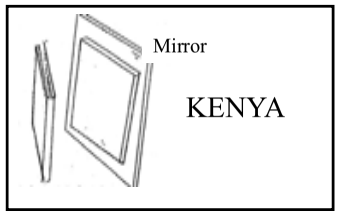
Date: **Class:** **Name:**

1. Preparation

Mirror, something with words written on it

2. Procedures

1) How would the words on the cover of a book look reflected in the mirror? Try and sketch it.



2) Putting a mirror somewhere in the figure below look at the number of candles and figure out how old the sister and her younger brother are.

How old is the sister?

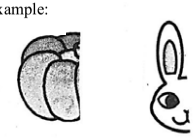
Why?

How old is the younger brother?

Why?

3) Just half the picture is drawn. Complete it with a mirror.

Example:

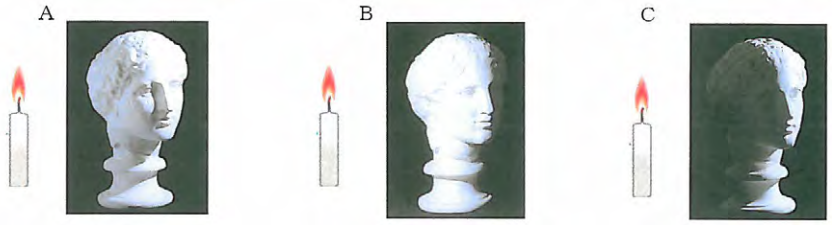


Final Unit Evaluation Test

*Done at Unit End

Class: Name:

1. Answer looking at the figure below.



1) When the plaster bust and candle are placed as in the figures, which figure correctly shows the relationship between light and shadows?

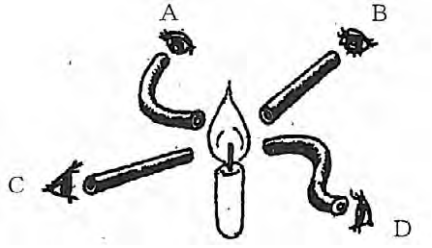
(B)

2) Tell why this is so.

(*Because the bust is light on the candle lit side and has a shadow on the opposite side*)

2. Which pipes in the figure below can see the candle light?

(B, C)

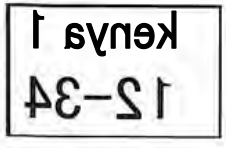


3. Which of the following correctly shows how you would see the license plate of the car behind you in the rear view mirror?

(B)

A

B



4. Which of the following is the correct explanation for why you can see the coin as you fill the coffee cup with water? (A)

A. Because light is refracted at the water surface

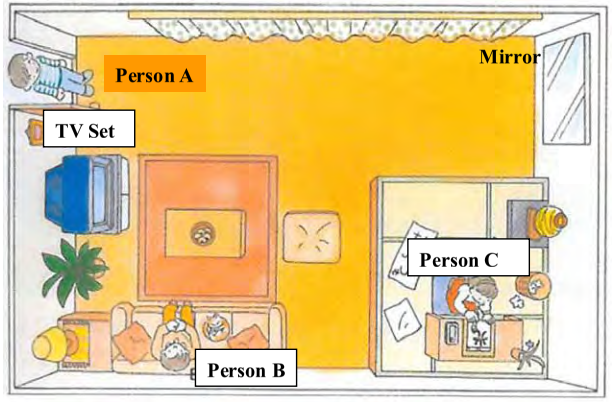
B. Because light is reflected at the water surface

C. Because light is transmitted at the water surface

5. In the figure below, who or what can person **A** see through the mirror?

(b)

a. Person B b. TV set c. Person C d. All of the above

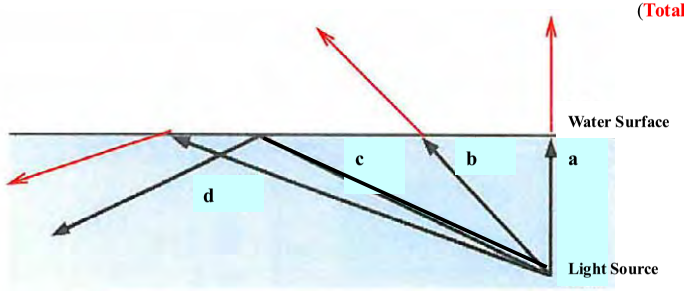


6. There was an experiment in which light was given off underwater in rays a, b, c and d.

1) How will light rays a, b and d advance? Draw arrows on the figure below.

2) When light does not advance from water out into the air like with c and all the light is reflected, what do we call this?

(Total reflection)



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／6th 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

Examples of assessment questions which is used in Kenyan text books

1. Which of the following statements is **not** true?
   A. Light travels in a straight line.
   B. Opaque objects form shadows.
   C. Light travels only through translucent materials.
   D. Light rays can be broken into colours.
2. Light can pass through
   A. transparent materials only.
   B. translucent materials only.
   C. both transparent and translucent materials.
   D. opaque materials only.
3. We see our faces in the mirror because of
   A. reflection of light. B. refraction of light.
   C. absorption of light. D. distortion of light.
4. Which of the following statements **best** describes the behaviour of light?
   A. Light is best reflected by a smooth dark surface.
   B. Light is best reflected by opaque objects.
   C. Light is best reflected by a smooth shiny surface.
   D. Light is best reflected by a transparent material.

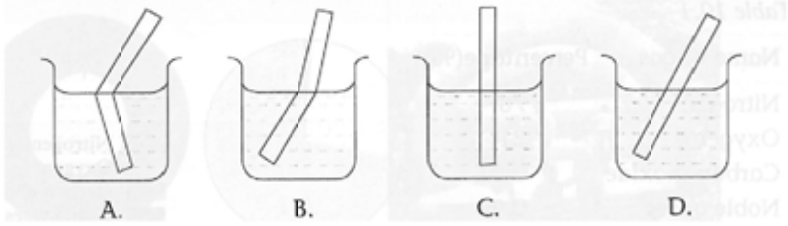
(Oxford; Science in Action 6 P.70)

A candle was lit and observed using these two pipes
(i) a straight hollow pipe
(ii) a bent hollow pipe

This experiment was to investigate
A how light travels through a pipe
B how light can only travel through a hollow pipe faster than in air
C how light travels in a straight line
D how it is always good to observe light using a pipe

(Macmillan; Macmillan Primary Science, Pupil's book 6 P.115)

Which of the following diagrams correctly represents the appearance of a ruler in a glass of clean water?



(Oxford; Science in Action 6 P.71)

4 A shoe lying at the bottom of a river appears close to the surface of the water. This is because of _____.
A reflection of light **B** refraction of light
C water is transparent **D** the shoe has water in it

5 We are able to see things around us because
A our eyes are very powerful
B much light travels from the eyes to the things
C much light comes from the things to our eyes
D of much sunlight around us

6 Our eyes cannot see round corners because
A light travels in a straight line **B** light bends easily
C light is reflected away from corners **D** corners have no light

(Macmillan; Macmillan Primary Science, Pupil's book 6 P114)

7. The rainbow is formed when there is:
   A. Mirror and water only
   B. Sunlight only
   C. Sunshine and water droplets
   D. Water and air
8. When light bounces off a smooth shiny surface, we say it is:
   A. Refracted
   B. Reflected
   C. Transmitted
   D. Split

(KLB; Primary Science Pupils' Book for Standard Six P.81)

10 Light consists of all the colours of the_____. The colours of the spectrum are red, _____, yellow, _____, _____, indigo and_____.

11 Holes were made at the same position in three equal-sized pieces of cardboard which were placed in front of each other with a candle lit at one side as shown in the diagram. An observer's eye is seen looking at the candle.

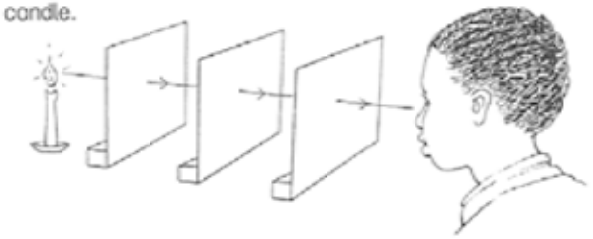


Figure 9.19 *Looking at the candle.*

This experiment was done to investigate.

A refraction of light **B** reflection of light
C how light travels **D** candles can pass through cards

(Macmillan; Macmillan Primary Science, Pupil's book 6 P.115)

1. A ray of light bends when it passes through a sheet of glass. This bending of light is known as:
   A. Transmission
   B. Reflection
   C. Deflection
   D. Refraction
2. A group of rays is called a:
   A. Spectrum
   B. Reflection
   C. Beam
   D. Dispersion
3. Materials through which light cannot pass are said to be:
   A. Opaque
   B. Transparent
   C. Mirror
   D. Translucent
4. Materials which allow some light to pass through them but one cannot see through them clearly are said to be:
   A. Reflectors
   B. Transparent
   C. Opaque
   D. Translucent

(KLB; Primary Science Pupils' Book for Standard SixP.80)

2. Mary was trying to view the candle through a bent tube but she did not succeed. What does this experiment prove?

3. What description do we give to a material through which light cannot pass?

A. Transparent
B. Translucent
C. Opaque
D. Black

Which of the following would make the best mirror?

A. Transparent material.
B. An opaque shiny smooth surface.
C. An opaque rough surface.
D. A transparent rough surface.

Which of the following gives the correct order of the colours of the rainbow?

A. Red, yellow, orange, green, indigo, blue and violet.
B. Violet, red, orange, yellow green, blue and indigo.
C. Violet, indigo blue, green, yellow, orange and red.
D. Red, orange, green, yellow, blue, indigo and violet.

(Longhorn; Understanding Science, Pupil's Book 6 P.87-88)

2. Materials that allow light to pass through and you can see through them clearly are said to be _____.

3. Materials that allow light to pass through but you cannot see through them clearly are called _____ materials.

4. _____ materials cannot allow light to pass through.

5. Give two examples of transparent materials.

6. Examples of opaque materials are _____ and _____.

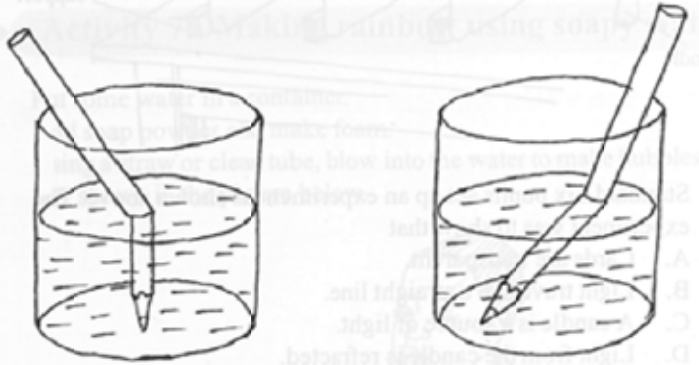
7. An example of a translucent material is _____.

8. Bouncing back of light is called _____.

9. Write the word below as it appears in a mirror placed in front of it.

SIX

10. (a) Amina placed a pencil in a glass of water. Which of the following diagrams show the correct observation?



A B

(b) Explain why Amina's ruler appears bent.

(JKF; Primary Science Education Foundation Science 6 P.78)

Appendix

Examples of materials which is used in Kenyan text books

How light travels

Light the candle and put it at the opposite side.
Look at the candle through the three cardboard holes.

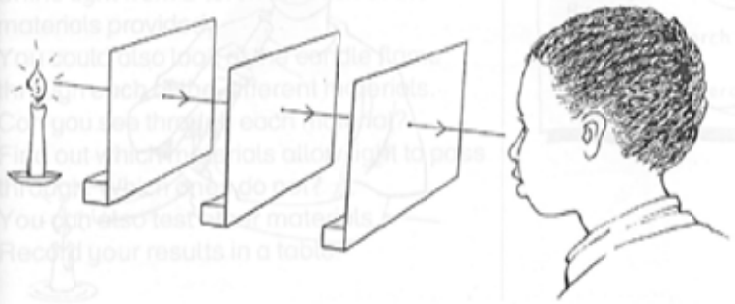


Figure 9.4 *Light travels in a straight line*

Move one of the cardboards out of line.

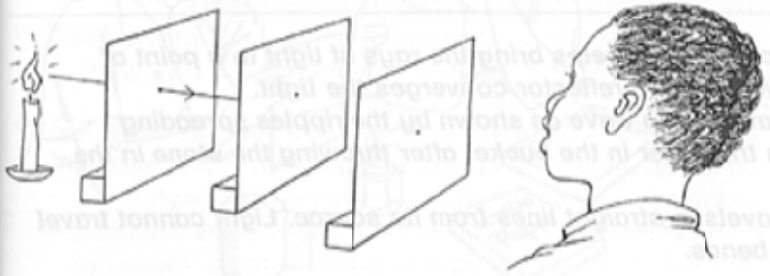


Figure 9.5 *Light can only travel in a straight line*

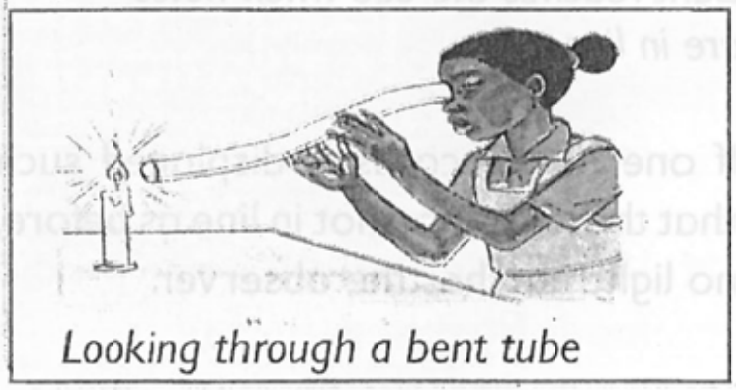
Can you still see the candle flame?

(Macmillan; Macmillan Primary Science, Pupil's book 6　P.103)

Light the candle and place it on th
table. Observe the candle through th

Looking through a straight tube

tube, having the tube pulled straight.
Are you able to see the candle flame
Now bend the tube and once agair
try to observe the candle.



Looking through a bent tube

(Longhorn; Understanding Science, Pupil's Book 6　P.82)

From the above activities, we have observed that **light travels in a straight line**. These straight lines that show the path of light and its direction of travel are called **rays**. A group of rays is called a **beam**.

Light travels in all directions from its source, but in straight lines. That is why light from a lamp spreads in all directions and lights the whole room.

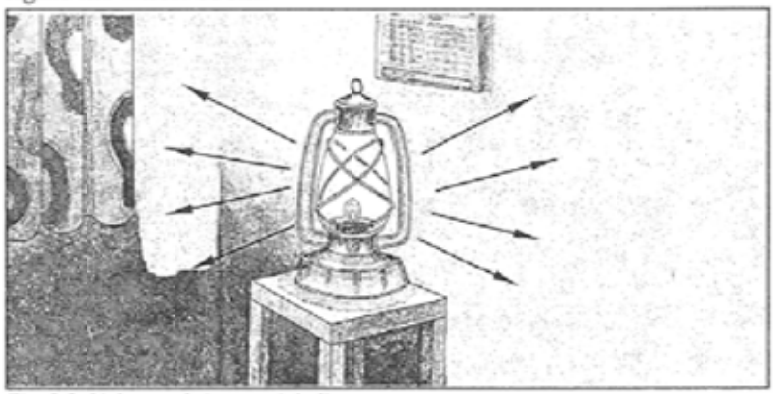


Fig. 9.5: Light travels in a straight line

(KLB; Primary Science Pupils' Book for Standard Six P.68)

Transparent, translucent and opaque materials

Copy the table below in your exercise book. Record your results in the table.

Type	Name of material
Can see through clearly (transparent)	1.
	2.
	3.
	4.
Cannot see through clearly (translucent)	1.
	2.
	3.
	4.
Cannot see through at all (opaque)	1.
	2.
	3.
	4.

(Oxford; Science in Action 6 P.64)

Transparent materials

Transparent materials allow light to pass through them. Figure 9.6 shows some of the transparent materials.

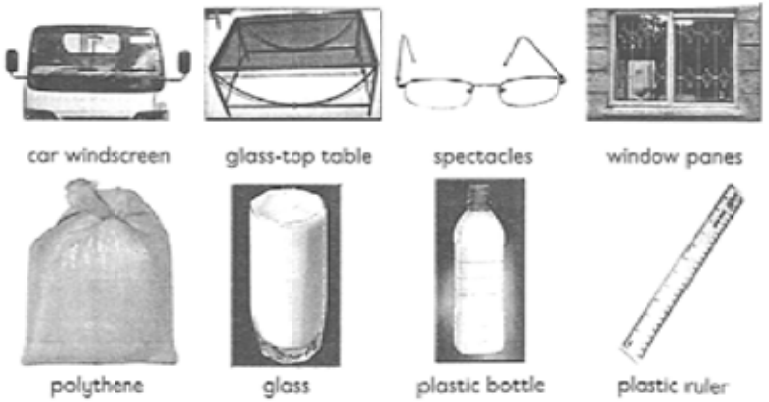
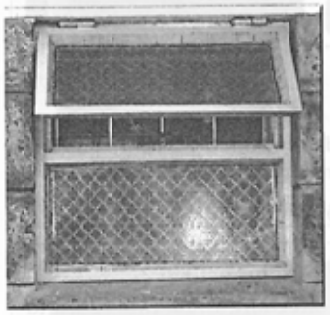


Figure 9.6: Transparent objects

Translucent materials

Translucent materials allow some light to pass through them. One cannot see through them clearly.



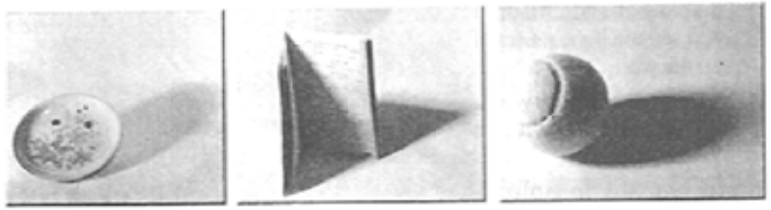
translucent window

tinted vehicle windows

Figure 9.7: Translucent materials

Opaque objects

Opaque materials do not allow light to pass through them. One cannot see through them. They form dark shadows when they are in the path of light.



shadow of a plate　　shadow of a book　　shadow of a ball

Figure 9.8: Shadows made by opaque objects

Shadows take the shape of the opaque object that is blocking the light. The size of the shadow depends on the position of the source of light. When the object is near a source of light, the shadow it forms is big.

When the source of light is far, the shadow of an opaque object is smaller.

(Oxford; Science in Action 6　PP.64-65)

Now study the diagram to show some everyday use of materials.

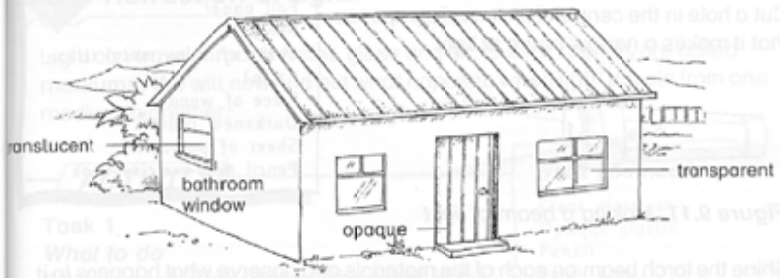


Figure 9.9 *Some transparent, translucent and opaque materials in a building*

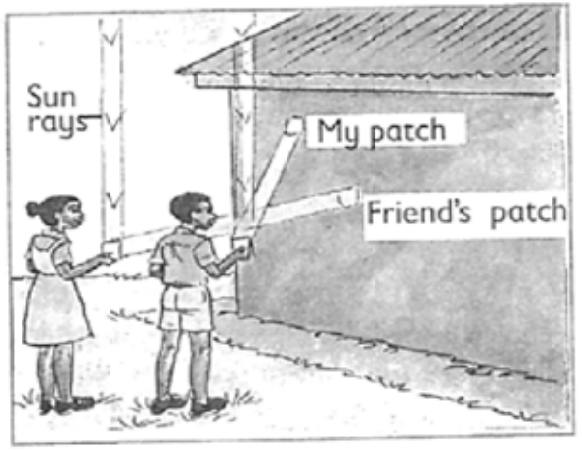
(Macmillan; Macmillan Primary Science, Pupil's book 6　P.107)

Uses of transparent, translucent and opaque materials

- Transparent materials are used to make vehicle windscreens, window panes, lamps and spectacles.
  State other uses of transparent materials.
- Frosted glass is translucent. One cannot see through it clearly. It is used to make sky lights. A sky light is a glass-covered opening in a roof of a building to let in light. Frosted glass is also used to make toilet and bathroom window panes.
  State other uses of translucent materials.
- Opaque materials include stone walls of a house and most clothes that we wear. People cannot see through opaque materials. These materials therefore give privacy.
  State other uses of opaque materials.

(KLB; Primary Science Pupils' Book for Standard Six　P.70)

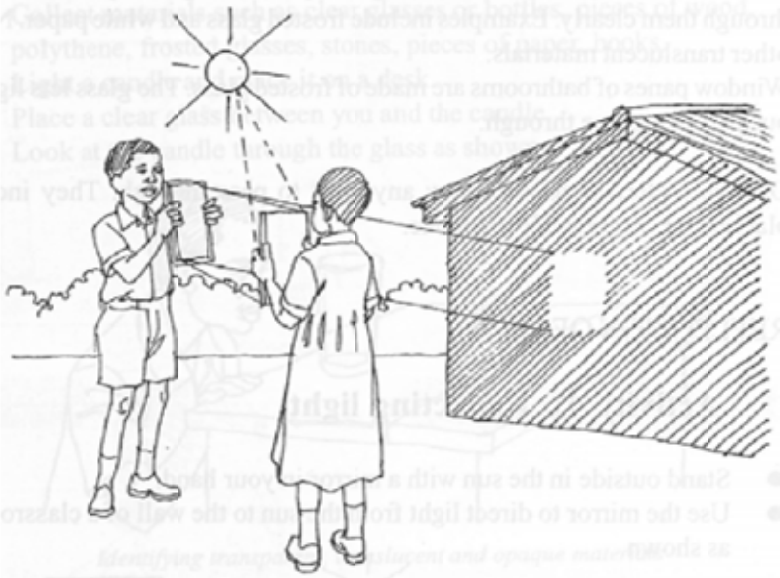
Reflection of Light



Playing "chase my patch"

(Longhorn; Understanding Science, Pupil's Book 6　P.85)

Now use your mirror to reflect light from the sun to your friend's mirror. Let your friend reflect the light to the wall as shown below.



Demonstrating reflection of light

(JKF; Primary Science Education Foundation Science 6　P.72)

Shine the torch beam on each of the materials and observe what happens to it.

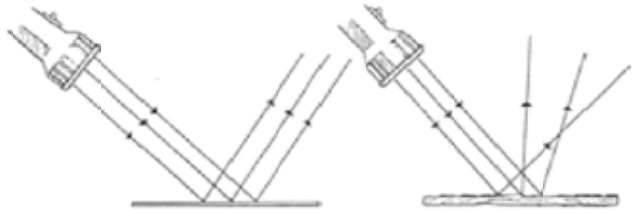


Figure 9.12 *Types of reflection*

Record your observations in a table form in your exercise books.
Some examples have been given.

Material tested	What happens to the ray of light
Mirror Sheet of writing paper Cigarette foil paper Window glass Tin Wood Polythene bag	Ray reflected in one direction Ray scattered

(Macmillan; Macmillan Primary Science, Pupil's book 6　P.108)

The rays that fall on the mirror are called **incident rays** and those bouncing off the surface of the mirror are called **reflected rays**. This is shown in the diagram below.

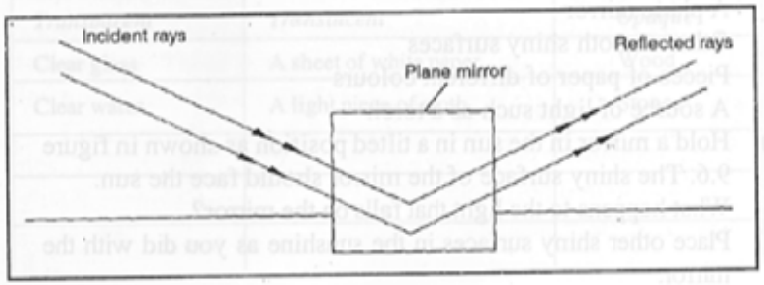


Fig. 9.7: Reflection of light

The rays that fall on the surface of the mirror are reflected.

Most shiny smooth surfaces reflect nearly all the light that falls on them in one direction. This is called a **regular reflection**.

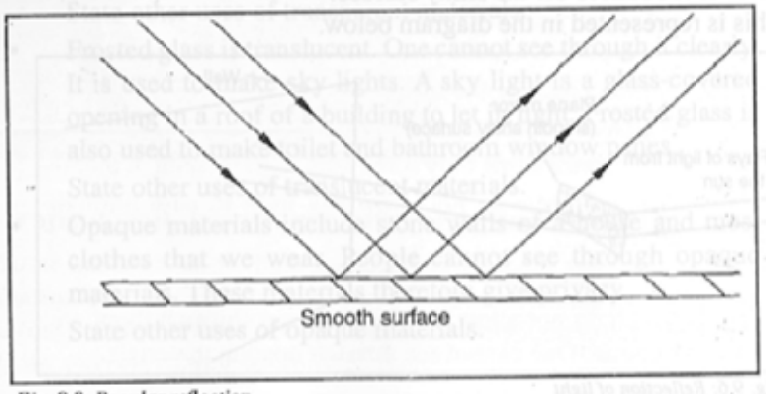


Fig. 9.8: Regular reflection

Objects with rough shiny surfaces reflect light in different directions. This is called **irregular (diffuse) reflection**.

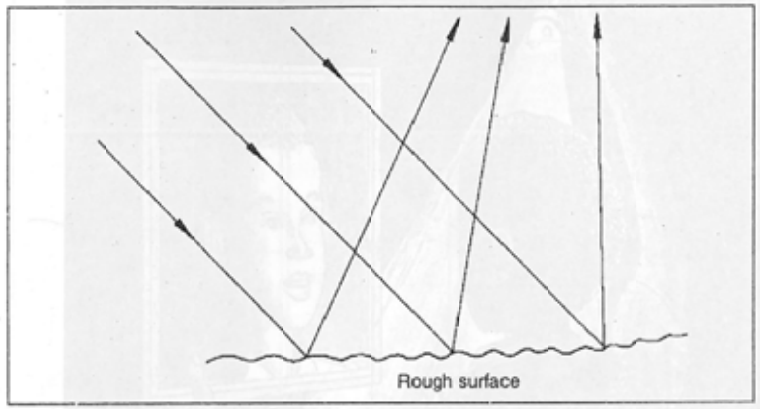


Fig. 9.9: Irregular (diffuse) reflection

(KLB; Primary Science Pupils' Book for Standard Six P.72-73)

- Write each of the following letters A, E, P on a piece of paper. Hold a mirror in front of the letters as shown below.

Write the letters as they appear in the mirror.

(JKF; Primary Science Education Foundation Science 6 P.73)

This is a periscope.

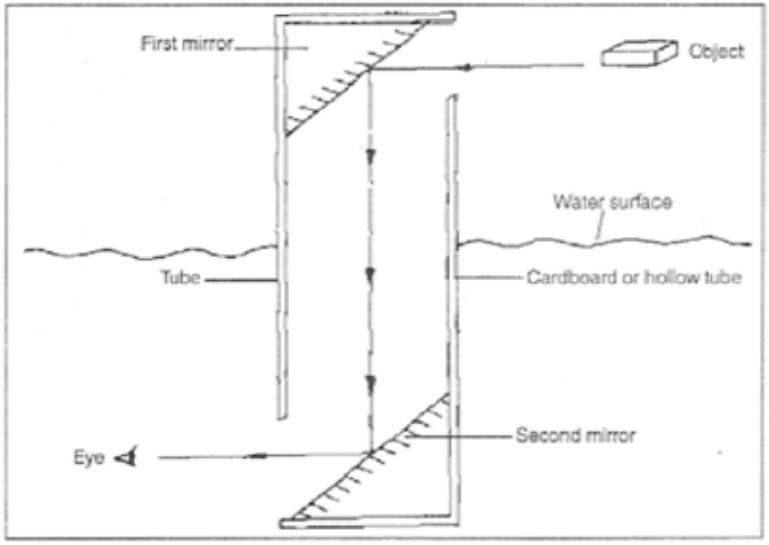
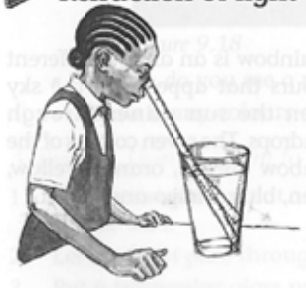


Fig. 9.11: A periscope

(KLB; Primary Science Pupils' Book for Standard Six P.75)

Refraction of light

Refraction of light



When light travels from one transparent medium to another, for example, air to water or air to glass, it changes direction. This bending of light is called **refraction**.

When a stick or pencil is put in a glass of water, it appears bent at the point where it enters the water.

Figure 9.12: Observing a ruler in clear water

(Oxford; Science in Action 6 P.67)

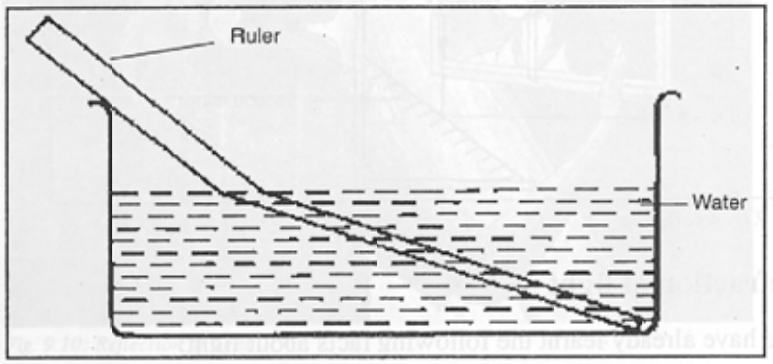


Fig. 9.12: Refraction of light

(KLB; Primary Science Pupils' Book for Standard Six P.76)

Ask your friend to keep their head in that position.
Now slowly pour water into the container. Can your friend see the coin now?

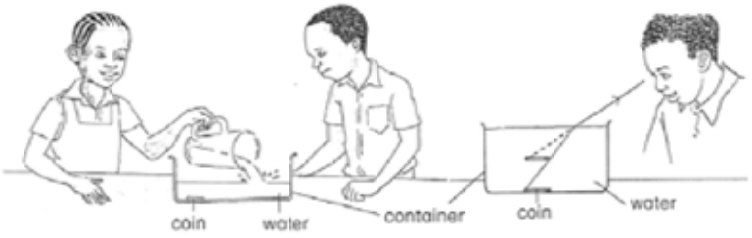


Figure 9.15 What happens to the coin?

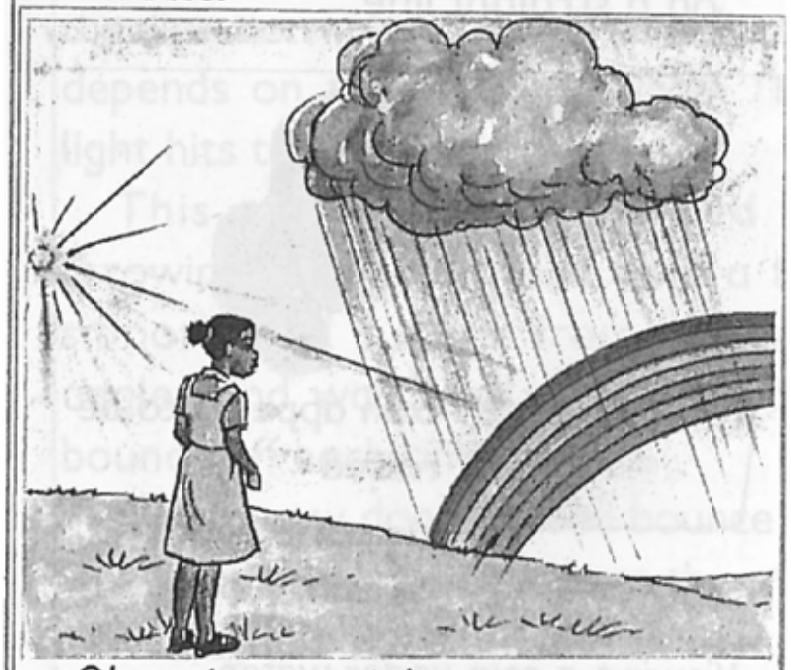
As water is added the coin reappears. This is because when light travels from one medium to another, it bends.
The bending of light when it travels from one medium to another is called refraction.
Because light is refracted when it travels from water to air, the pencil appears bent.
Because light is refracted when it travels from water to air, the coin could be seen over the edge of the container.
This effect makes pools of water appear shallower than they really are.

(Macmillan; Macmillan Primary Science, Pupil's book 6 P.110)

Rainbow

(c) *The rainbow*

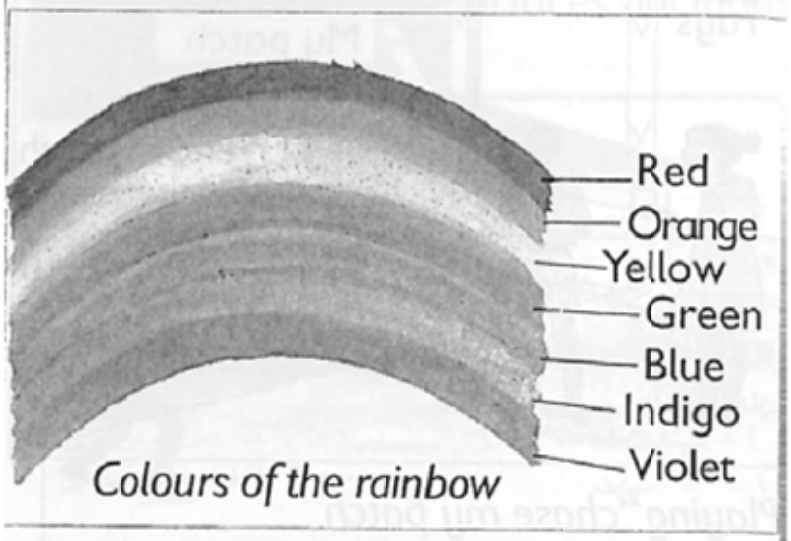
We see a rainbow when rain and sunshine are both present at the same time. For the rainbow to be seen, one has to face away from the sun with the rain falling **in front.**



Observing a rainbow

(ENERGY／6th grade)

The colours of the rainbow appear as shown in the diagram.



Colours of the rainbow

The red is on the outside and violet on the inner side of the semicircle.

(Longhorn; Understanding Science, Pupil's Book 6 P.86)

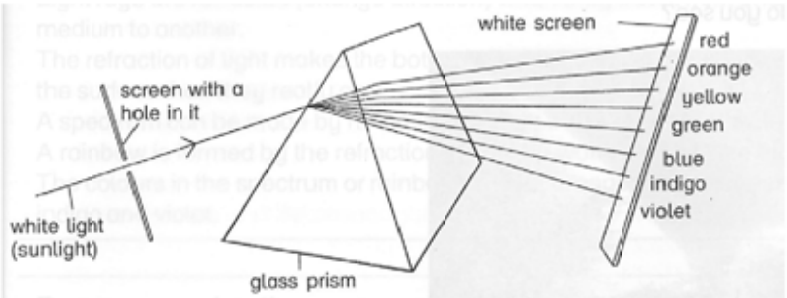


Figure 9.16 *A spectrum is formed when a glass prism splits up light*

Record your observations.

(Macmillan; Macmillan Primary Science, Pupil's book 6　P.111)

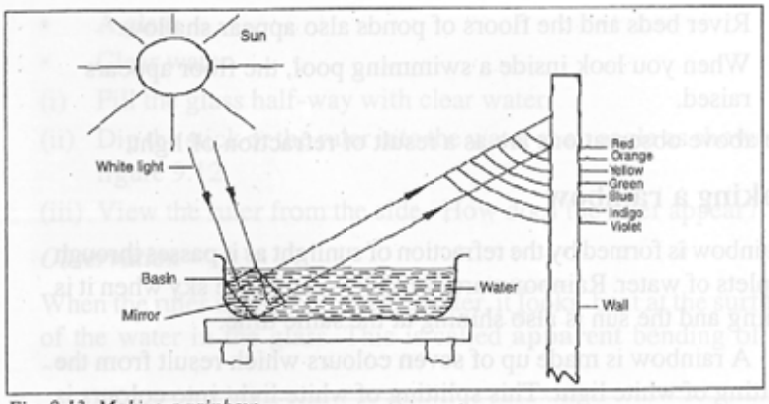


Fig. 9.13: Making a rainbow

(KLB; Primary Science Pupils' Book for Standard Six　P.78)

Appendix

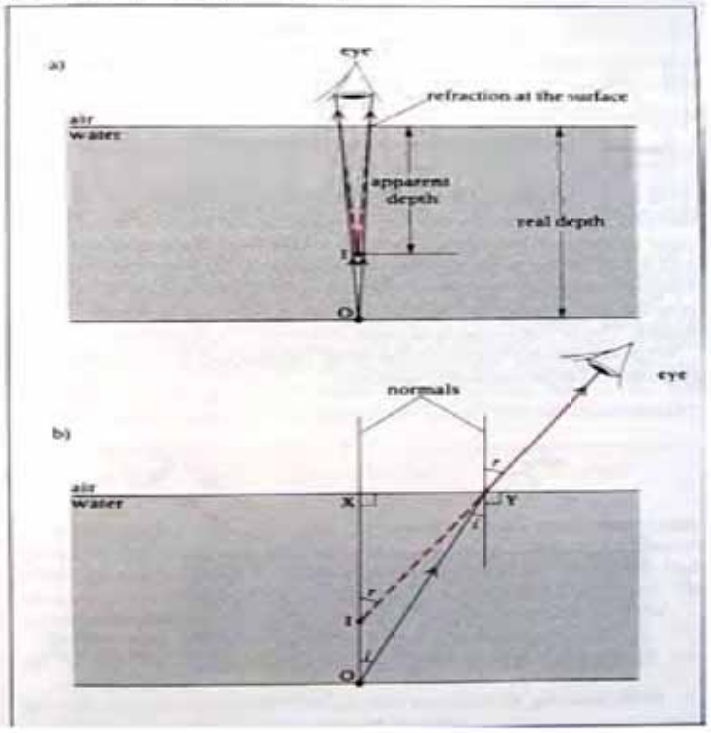
Materials which explain the effect that an object looks closer than it really is by refraction at the surface of the water.

Real and apparent depth

If you look into a clear pool of water it appears to be shallower than it really is. A swimming pool, for example, which is really 4 metres deep will appear to be only about 3 metres deep.

In fig. 2.5 we see how an object O, seen through a transparent medium like water, appears closer than it really is. This effect is caused by refraction at the surface of the water. Rays of light coming from the object O are bent *away from* the normal as they leave the water so that they appear to come from a virtual image I which is above the object O.

Figure 2.5 *Real and apparent depth*

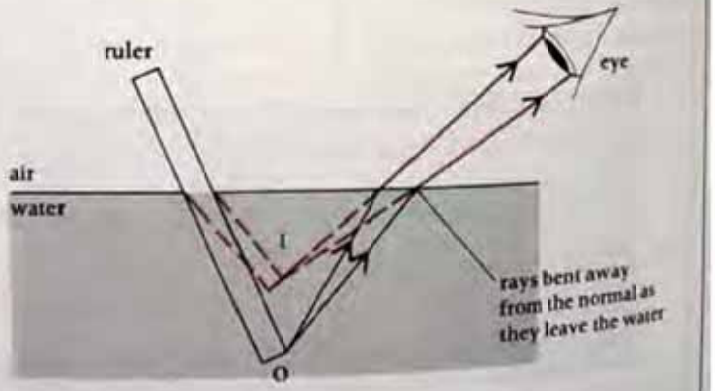


(J. Avison, The World of Physics, Nelson International Editions, 1989, P.25)

How water appears to bend a ruler

This effect can be seen by half immersing a ruler in a sink or bowl full of water as shown in the figure. The rays of light from the end of the ruler at **O** are refracted at the surface of the water (away from the normal, entering an optically less dense medium) so that they appear to come from the virtual image **I**. The real ruler is not bent, and is drawn straight. The virtual image is, as usual, drawn with broken lines.

What appears to happen to the length of the ruler and the size of its graduations below the water surface?



(J. Avison, The World of Physics, Nelson International Editions, 1989, P. 26)