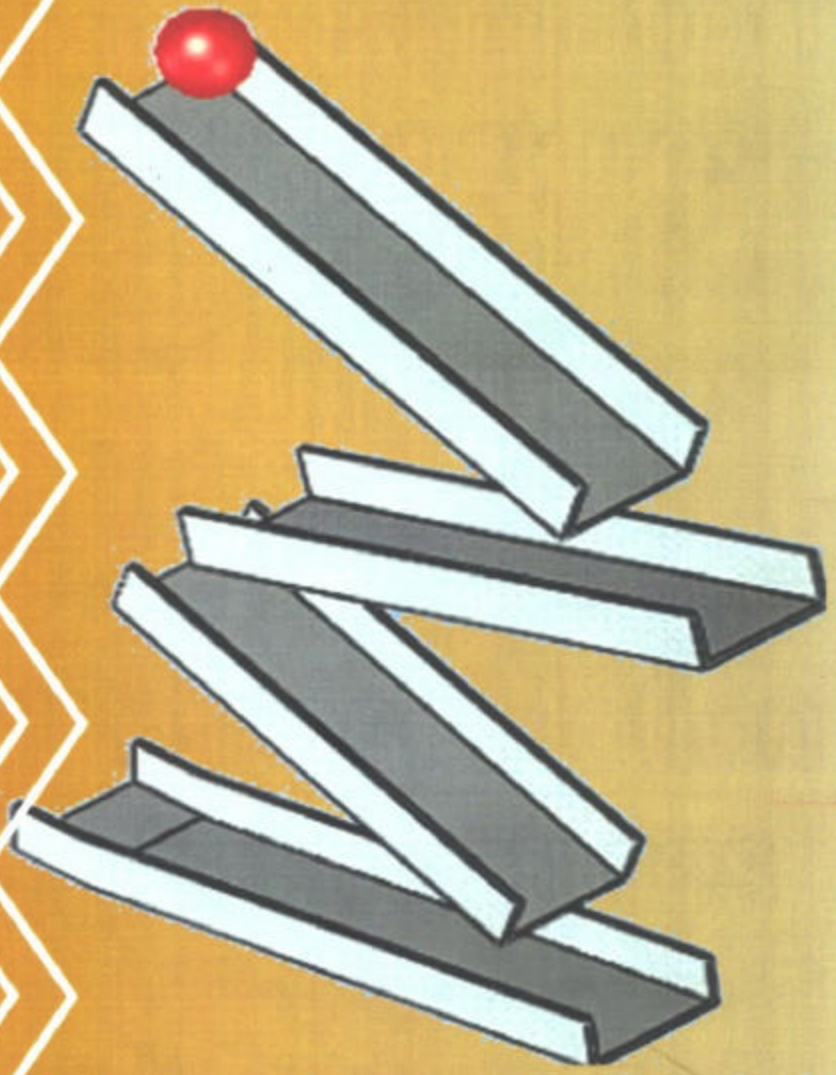
K - 6

Primary Science and Technology

Forces, Motion & Structures



Teachers' Guide

Forces, Motion and Structures

MODULE 1: K – 2

MODULE 2: 3– 4

MODULE 3: 5– 6

Preface

The development of learning outcomes for the core curriculum in OECS primary and lower secondary schools is an essential part of the harmonization of OECS educational systems. The curriculum harmonization process commenced seven years ago with discussions between the OECS Education Reform Unit (OERU) and educational personnel in all member countries (See *Eastern Caribbean Education Reform Project: Initiative on curriculum and remediation – Design Mission report*, *February 1998*).

The initiative in Primary Secondary Science and Technology commenced in 2001, with a meeting of science and technology educators in St. Vincent and the Grenadines. Time was spent initially on defining science and technology, mainly because the primary curriculum concentrated on science only. A working definition has been developed and has been used consistently throughout the development of the programme.

Draft learning outcomes were developed and circulated for comments throughout the curriculum units in the OECS. Subsequent meetings of the working group were held in St. Kitts and Nevis, St. Lucia and Antigua and Barbuda. At each of these meetings teacher educators, teachers and principals formed part of the discussion groups. After the learning outcomes were adopted by the curriculum officers, instructional modules to serve as teachers' guides were planned and developed by members of the working groups. The learning outcomes and modules were all reviewed and edited by the two consultants who worked through all phases of the project.

Time did not permit a formal piloting of the learning outcomes and modules. Since in most cases the same curriculum officer worked on the lower secondary curriculum, also, there is the possibility of the primary curriculum benefiting from the experience gained in the piloting of the lower secondary programme.

The purpose of developing the learning outcomes and instructional modules is to ensure that all children in OECS primary schools attain an acceptable level of knowledge, skills and attitude associated with science and technology. Each member country retains the right and responsibility for integrating these outcomes into the national primary science and technology curriculum. As usual, teachers will continue to use their initiative and resourcefulness in the implementation of the programme through the use of indigenous resources creating relevance.

The OERU is extremely grateful for the contribution made by all persons and institutions that have been involved in this developmental exercise. First, OERU expresses thanks to the Canadian International Development Agency (CIDA) for the high level of interest shown and the funding provided for the Eastern Caribbean Education Reform Project (ECERP). The Ministries and Departments of Education have contributed resource personnel, accommodation, refreshment, ground transportation, and some materials for workshops. Most important, however, have been the high level of cooperation and commitment to the reform effort displayed by both the administrative and professional sections of Ministries of Education.

The following science education professionals have made significant contribution over the four-year period.

Country	Participant	Designation
Anguilla	Mr. Worrell Brooks	Education Officer, Science
	Mrs. Maria Webster	Secondary School Teacher
Antigua and Barbuda	Mr. Earl Skerritt	Science Coordinator
	Ms. Kendra Thomas	Primary School Teacher
	Ms.Celia Frederick	Secondary School Teacher
	Ms. Gracelyn Ireland	Primary School Teacher
British Virgin Islands	Ms. Beverlie Brathwaite	Education Officer, Science
Dominica	Mr. Frank Newton	Education Officer Science
	Mr. Gerald Corbette	Lecturer, Dominica State College
Grenada	Mr. Jervis Viechweg	Curriculum Officer, Science
	Ms. Janis Henry	Lecturer, T. A. Marryshow Com. College
Montserrat	Mr. Gregory Julius	Primary school Principal

St. Kitts And Nevis	Mr. Hilton Clarke	Curriculum Officer, Science
	Dr. Lincoln Carty	Former Curriculum Officer, Science
St. Lucia	Mr. Winston Blanchard	Curriculum Officer, Science
	Ms. Imelda Polius	Former Primary School Teacher
St. Vincent and the Grenadines	Mrs. Arlene Keane-Browne	Former Curriculum Officer, Science
	Mrs. Amaala Muhammad	Curriculum Officer, Science
	Mr. Kenroy Johnson	Principal, Secondary School

The OERU also expresses gratitude to the dozens of teachers, principals and students who have participated in discussions and consultations.

The actual planning and subsequent developmental process for the learning outcomes and Teacher's Guide became the responsibility of Dr. Cheryl Remy, former Senior Lecturer at Sir Arthur Lewis Community College, St. Lucia and Professor Winston King, Senior Lecturer, School of Education, UWI, to whom the OERU is very grateful. As a team, Dr. Remy and Professor King have encouraged workshop participants and module writers to think and to create ideas as the work progressed.

The staff at OERU together contributed in no small measure to these modules. Ms. Deborah Alphonse, Accounts/Administrative Assistant, Ms. Natasha Deterville, now Secretary to the Director of Economic Affairs in the OECS, and Ms. Cleotha Randolph, Documentation Officer, worked tirelessly arranging workshops and reproducing materials. Ms. Natalie Compton of Nagio Creations competently designed the layout of the modules and learning outcomes for printing and electronic reproduction.

Dr. Henry Hinds, formerly Curriculum Specialist at OERU, was responsible for the curriculum project. Mrs. Lorna Callender and Ms. Candia Alleyne, both former Heads of OERU, have supported the project organizationally and morally. Mr. Johnson Cenac, ECERP Officer, made significant contributions in various ways and at various times throughout the development of this work.

The Primary Science and Technology modules provide an excellent example of the fusion of talent, creativity, rigorous science and technology and cooperation to develop a valuable resource for teachers.

The OERU hopes that principals and teachers will continue to play their roles in making the outcomes and modules come to life in classrooms throughout the OECS. The commitment and effort surely will contribute to the enhancement of knowledge, and skills and the development of positive attitudes towards science and technology.

Henry Hinds, Head, OERU
August, 2006

Forces, Motion and Structures

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RATIONALE

Force is a fundamental aspect of the physical sciences. We all experience the effects of forces and motion at every moment of our lives. For example, we are quite familiar with motion of vehicles and objects in free-fall on a daily basis.

motion plays a central role in every observable event. It helps to explain how things start, move and stop. Force has also been shown to have effects on structures. For example, structures of a certain shape and design are better able to withstand the force of heavy winds thereby causing less damage to property. However, young children's perception of force and its role in motion may be different from that of the scientist. Therefore, the work of the teacher in addressing some of the basic misconceptions of the students in this regard should allow for a better understanding and explanation of these concepts.

INTRODUCTION

These modules look at the topic "Force, motion and structure". They include a number of activities which, if well implemented, would contribute to students understanding of concepts related to force and motion.

The modules also seek to integrate the technological application of force with regard to its effect on structures. In addition, examples of simple machines in the home and workplace are discussed. The use of hands-on activities utilizing these machines are designed to promote a greater student interest and understanding.

THE EXPERIENCES IN THESE MODULES WILL HELP THE STUDENTS TO DEVELOP THE FOLLOWING MAJOR IDEAS:

FORCES, MOTION AND STRUCTURES

- **Many types of forces such as gravity, magnetism, friction, are encountered in everyday life.**
- **Forces have many effects on materials and objects, such as, changing shape and direction and these affect our daily activities.**
- **Forces affect structures.**
- **Simple machines are devices that use forces to make work easier.**
- **Forces can change motion and do work.**

TECHNOLOGY

- **Technological methods involve the use of problem solving, technological processes and resources to find solutions to people's wants and needs.**
- **Technology is a human activity.**
- **Individuals can take part in Technological activity.**
- **Technology involves the uses of materials, energy, tools/machines and information.**
- **Technological processes include Biotechnology, Production Technology and Transportation.**
- **Technology changes over time.**
- **Technology is neither good nor bad, but the way we use it can have positive or negative effects on our lives.**
- **The use of technology has side effects.**

SCIENCE TECHNOLOGY, SOCIETY AND THE ENVIRONMENT

- **Science and Technology affect human life, the society and the environment.**
- **The impact of Science and Technology can be positive or negative, unplanned or planned, immediate or delayed.**
- **There should be sustainable use of resources and efforts should be made to minimize ecological disturbances.**
- **People's values, beliefs and attitudes influence Scientific and Technological activity and use.**

MODULE 1

FORCES, MOTION AND STRUCTURES

GRADES K – 2

GENERAL OBJECTIVES

The students should be able to:

1. Develop awareness of forces exerted by their own bodies and other objects.
2. Describe the effects of forces.
3. Develop an awareness of common structures and their uses.
4. Develop an awareness of simple mechanical devices and their uses.

SPECIFIC OBJECTIVES

The students should be able to:

1. Demonstrate pushes and pulls.
2. Give examples of situations where force is used.
3. Identify forces at work in common situations.
4. Demonstrate ways in which motion can be changed (start movement, increase speed, reduce speed, change direction).
5. Identify structures in our everyday lives (houses, walls, bridges, vehicles, trees, coral reefs) and state their functions.
6. Classify structures in different ways (e.g. size, shape, material from which they are made, natural or human made).
7. Make models of structures from materials provided.
8. Identify simple mechanical devices (e.g. hinges, screws, screw drivers, etc.).

LEVELS OF ATTITUDES, SKILLS & TECHNOLOGY EXPECTED AT GRADES K - 2

ATTITUDES:

Students should be encouraged to:

Curiosity:	✓ Ask questions about objects and events. ✓ Find out more about events and objects on their own.
Inventiveness:	✓ Suggest new ways of doing things.
Respect For Evidence	✓ Explain their results and conclusions. ✓ Listen to other students' results and explanations.
Persistence	✓ Complete activities. ✓ Persist at tasks.
Respect For Living Things	✓ Show sensitivity to living things.
Cooperation	✓ Share with others. ✓ Work together with others.
Concern For Safety	✓ Observe safety instructions.

SKILLS:

In developing their skills of inquiry, problem solving and design, the students are expected to:

Observing	✓ Use as many senses as are appropriate and safe to gather information. ✓ Identify differences and similarities between objects and events. ✓ Identify sequence in events.
Measuring	✓ Use simple measuring instruments or models of measuring instruments. At first use comparative terms such as bigger, smaller and later use actual figures.
Manipulating	✓ Set up simple experiments to compare results. ✓ Manipulate simple equipment.
Recording	✓ Use pictures and charts to report results. ✓ Fill out simple tables to report results .
Classifying	✓ Group objects according to one or two criteria.
Communicating	✓ Talk freely about their activities and the ideas they have, with or without making a written record. ✓ Use appropriate vocabulary to describe their observations. ✓ Listen to others' ideas and look at their results. ✓ Report events by using demonstrations, role play, simple drawings, paintings and simple sentences.
Inferring	✓ Notice patterns in simple measurements and events.
Interpreting data	✓ Discuss what they find out in response to questions.
Experimenting	✓ Freely ask a variety of questions and suggest how they might be answered. ✓ Suggest how they could investigate to find out answers to questions.
Predicting	✓ Attempt to make predictions (even if not based on patterns).
Problem Solving	✓ Suggest solutions to simple problems .
Designing	✓ Construct models either by following instructions or by using their own designs. ✓ Select appropriate material to make models and gadgets.

TECHNOLOGY

Technological Methods	✓ Given problems, the students will be able to discuss and make simple gadgets.
Nature Of Technology	✓ Realize that people use natural things. and also make other things from them. ✓ Realize that they can design and make things which may be different from what others make. ✓ Share information with others. ✓ Realize that safety is important in using tools and making things.
Use Of Technology	✓ Appreciate the use of devices, tools and structures made by humans in the home and community. ✓ Appreciate the advantages of using these products. ✓ Realize that human-made things can pollute the environment.

UNIT : FORCES, MOTION AND STRUCTURES (GRADE: K)

TOPIC: FORCES

DURATION: 2 Lessons

OBJECTIVE:

Students should be able to:

1. Demonstrate pushes and pulls.

PROCESS SKILLS

Observing, Manipulating, Problem solving, Classifying

MATERIALS

Balls, toy cars, trucks etc., doors, windows, furniture, string, pictures of objects.

CONTENT SUMMARY

- Pushing and pulling are forces that move objects/things.

SUGGESTED ACTIVITIES

1. Begin lesson in the vicinity of a door. Have several students demonstrate closing and opening of the door. Question students in an effort to introduce the concepts of push and pull. Use simple questions: What did Tom do to the door to get it open? What did Mary do to the door in order to close it? Have several other students demonstrate pushing and pulling.

2. Place a large ball on a marked spot and have students demonstrate how they would move the ball to another point in the room (kicking, rolling, throwing, and dragging). Let students state whether the action was that of pushing or pulling. Discuss what happened to the ball, in each case, when it was pushed or pulled (it moved).

3. Ask students for examples of common objects that we push or pull to produce movement. A picture chart may be used as stimulus material at this point. Such objects as a baby stroller, wheel barrow, cart,

scooter, church bell can be included on chart. Engage students in role playing and have them imagine moving the various objects. Let them identify the type of movement involved (push or pull).

4. Involve students in a tug-of war activity. Which side's pull is bigger?

ASSESSMENT

- Create a situation in which students are required to move an object from one point in the class to another without kicking, lifting or moving directly with hands, legs, or any other body part. Provide them with the object, a piece of string, a piece of stick, pieces of tape, etc. This may be done as a team or individual activity.

TOPIC: USING FORCES

DURATION: 2 Lessons

OBJECTIVES

Students should be able to:

1. Give examples of situations where force is used.
2. Identify forces used to create movement in given situations.

PROCESS SKILLS

Observing, Classifying, Manipulating

MATERIALS

Picture in which objects are being pushed or pulled, hammer, nails, pieces of board, screws, screw driver, food storage containers, bottled drink, opener.

CONTENT SUMMARY

- Pushing and pulling forces are used in many situations in our lives.
  - We push or pull on a door to close it.
  - We push on screws to secure them.
  - We push (pound) on nails to secure them and pull on them to have them removed.
  - We push on a bicycle pedal to make the bicycle move.
  - We pull on a string to move some toys.
  - We push a soccer ball (kick it) to move it.
  - We pull on a bottle stopper to remove it.

SUGGESTED ACTIVITIES

1. Display the hammer and nail and quiz students about their use. Introduce the pieces of board into the scenario then **demonstrate** the use of the hammer and nail. Engage students in discussion about the force used (push or pull). Ask students for directions as to what to do in order to remove the nail from the pieces of wood. Remove nail with hammer and then conduct another discussion as to the force used (push or pull).

2. Conduct similar activities using the screw and screw driver, the bottled drink and the opener, the food storage container. Involve students in the safer activities.

3. Ask students for examples of situations in which a push force or a pull force is used.

4. Display a set of pictures which suggest some form of movement and let students identify the force (push or pull) that is being used. Examples of questions may include: What is happening in this picture? How is the person able to move the ***object?*** Is that a push force or a pull force? What would happen if a push/pull force was used instead?

ASSESSMENT

- Divide chalkboard into two columns: a push column and a pull column. Display pictures and let students place each picture in the correct column on the chalkboard.

TOPIC: STRUCTURES

DURATION: 3 Lessons

OBJECTIVES

Students should be able to:

1. Identify structures in our everyday lives.
2. State the functions of these structures.
3. Classify structures according to size and shape.
4. Classify structures as natural, human-made or animal-made.
5. Make models of structures from materials provided.

PROCESS SKILLS

Observing, Classifying, Designing

MATERIALS

Classroom furniture pictures of buildings, bridges, vehicles, fences, furniture, etc., structures in the community, pieces of cardboard, Bristol board, drinking straws, tape, play dough.

CONTENT SUMMARY

- There are many different structures in our environment.
- Some structures occur naturally while others are human or animal-made.
- Natural structures include stones, rocks, and mountains.
- Animal-made structures include wasp nests, spider webs, and bird nests. Human-made structures include houses, bridges, furniture, vehicles.
- We build structures to make our lives more comfortable.
    - Bridges are built to make it easier and safer to cross rivers.
    - Houses are built to protect us from the weather.
    - Furniture is built to make us more comfortable in our home, school and work place. Chairs support our weight while we sit. Beds support us while we sleep. The space savers support our television set, VCR's, etc.
    - Walls are built for security *(fences*) and support (*retaining walls*).
    - Electricity poles/pylons are made to support electrical wires and street lights.

SUGGESTED ACTIVITIES

1. Ask students to identify the structures within the classroom (desks, chairs, tables, cupboards, shelves, etc). Pictures can be used to compile list on board. Move to the outside and let students identify other structures in their environment (extend chalk board list). Engage students in discussion about the use of the structures listed.

2. An alternative start could take the form of a nature walk in the community. Students would be able to observe and appreciate the many different structures in their community: buildings, such as churches, schools, houses; bridges, fences, retaining walls, electric poles, rocks, stones, etc. Engage students in immediate discussion to bring out such concepts as origin and use. Compile list for further discussion.

3. Let students examine birds' nests, snail shells, spider webs and other structures made by animals or found in animals. Let them talk about these structures and say how the animals use them.

4. Engage students in a discussion about differences between selected structures. (How were they made? How are they different? Why are they different? What would happen if the small ones were large and the large ones were small? etc.).

5. Have students classify the objects (picture representations).

6. Challenge students to make a structure and to say what it could be used for. Provide them with materials (paper, match boxes, empty containers, string, straw, crown corks, play dough, etc.), and let them make a structure.

ASSESSMENT

- Provide students with opportunities to talk about the structures they made. (What it is made from. What it is used for. etc.).
- A game of musical chairs may be used to reinforce the uses of the structures dealt with in lesson. Label each player to represent a structure. As each player (structure) gets out let students talk about what our lives would be like without that structure.

UNIT: FORCES, MOTION AND STRUCTURES (GRADE: 1)

TOPIC: BUILDING STRUCTURES

DURATION: Lessons

OBJECTIVES

Students should be able to:

1. Identify the materials from which selected structures are made.
2. Suggest reasons for the choice of materials used.
3. Classify structures on the basis of the type of materials used.
4. Identify the shapes of and within selected structures.
5. Design and build a structure that will withstand a predetermined mass.

PROCESS SKILLS

Observing, Manipulating, Problem solving, Classifying, Designing

MATERIALS

Picture chart, pieces of wood, cardboard, paper, tape, masses/stones

CONTENT SUMMARY

- Structures are built from a variety of materials: wood, metals, concrete, plastic, etc.
- The use to which the structure is to be put influences the type of material used.
- Some materials are stronger than others. For example, wood is stronger than card board, steel is stronger than wood and plastic, concrete is stronger than wood.
- A variety of shapes can be identified in structures. These shapes include circles, arches, triangles, and rectangles. These shapes help to make the structures strong and functional.

SUGGESTED ACTIVITIES

1. With the help of students make a list of structures within the classroom (desks, chairs, tables, cupboards, boxes, etc.); within the community (houses, schools, bridges, motor vehicles, etc.). A picture chart may be used as stimulus material.

2. Engage students in discussion about the materials from which the structures are made and let them classify the structures on this basis. Have further discussions on the reasons for the choice of materials used to make selected structures. For example, why are desks, chairs and tables made of wood, plastic or metal instead of concrete, and instead of cardboard? Why is the bridge made out of concrete instead of wood and cardboard?

3. Let students observe shapes of different structures used for support and name these shapes. Students' attention should be drawn to such things as bicycles, roof beams, rails, columns supporting bridges, buildings. Shapes such as triangles, circles, arches, rectangles can be seen.

4. Make construction materials (paper, cardboard, pieces of wood, tape) available. Divide students in groups. Give each group a mass/stone and ask them to use some of the construction materials available to build a resting stand for the mass.

ASSESSMENT

- Play a pretend game in which students pretend to be a structure. The student will stand; identify self as the structure; state what he/she is used for; state what he/she is made from; state why he/she was made from that kind of material.

Unit: FORCES, MOTION AND STRUCTURES (GRADE 2)

TOPIC: EFFECTS OF FORCES

DURATION: 2 Lessons

OBJECTIVES

Students should be able to:

1. Identify forces used to create movement or change in given situations.
2. Demonstrate ways in which motion can be changed (start movement, increase speed, reduce speed, change direction).

PROCESS SKILLS

Observing, Manipulating.

MATERIALS

Play dough, balls, toy car/truck, piece of string

CONTENT SUMMARY

- Push and pull forces can be used to cause objects/things to move, stop moving, slow down, increase speed, change direction, change shape.

SUGGESTED ACTIVITIES

1. The closing and opening of a door can be used to reintroduce the concept of push and pull.

2. Use ball (soccer ball would be ideal) to demonstrate the following: use of force to start motion; use of force to change direction; use of force to increase speed; use of force to stop the ball. In each case create the situation and either ask students for directions as you demonstrate the action or ask students to perform the action. Engage students in in-depth discussion to enable them to identify the force used in the particular situation. Let them give examples of other similar situations.

3. Present students with pieces of play dough and let them turn dough into various shapes: flat, long, round, etc. Let students explain what had to be done to acquire the various shapes. Establish that push and pull forces can be used to change the shape of objects. Let them give examples of other situations in which force brings about change of shape.

4. Toy cars/trucks may be used to have students demonstrate the use of force to bring about the various changes.

ASSESSMENT

- Display a cricket bat and a ball and let students explain and demonstrate situations in the game of cricket when a force is used to increase the speed of the ball; to stop the ball; to change direction of the ball, etc.

TOPIC: SIMPLE MECHANICAL DEVICES

DURATION: 2 Lessons

OBJECTIVES

Students should be able to:

1. Identify simple mechanical devices.
2. State the functions of these devices.

PROCESS SKILLS

Observing, Manipulating

MATERIALS

A mounted door (door to the classroom, cupboard door), hinges, locks, door bolts, bolts and nuts screws, screw drivers, hammer, nails, brackets, braces.

CONTENT SUMMARY

- In order to put a structure together several different parts are needed. These parts have different functions.
- Hinges are used to support doors and enable them to swing to close and open.
- Some bolts are used to secure doors and windows.
- Locks are used to secure doors and prevent them from being opened easily. Screws and nails are used to hold parts together.
- Braces are used along with screws to hold parts of a structure together (an example is where they are used to fasten the sides of a bed to the legs). Brackets are used to support shelves.
- Bolt and nuts are used to hold parts of a structure together (an example is the wheels on a vehicle or a bicycle).

SUGGESTED ACTIVITIES

1. Examine the door to the classroom and have students identify all the things that were used to put the door together. Make a list of these things. This activity can be repeated looking at another type of door such as one to a cupboard. Engage students in a discussion in order to

establish the use of the various devices (nails, screws, hinges, locks, bolts).

2. Group students and distribute devices such as locks and keys, bolts, hinges, bolt and nuts, brackets, braces, etc. to each group and let students manipulate them in order to gain a better understanding as to how they work. Let students explain the uses of such devices, and demonstrate where possible.

3. Let students identify and list such devices in use at home. Let students share and discuss their findings.

ASSESSMENT

- Do a what-if quiz. (What if our door had no hinges? What if our door had no lock? What if our door could not lock?)
- Let students match appropriate device to pictures of different places of use.

Picture of Object/structure	Device
Door	
Shelf	
Vehicle wheel	
Window, etc.	

MODULE 2

FORCES, MOTION AND STRUCTURES

GRADES 3 - 4

GRADES 3 - 4

GENERAL OBJECTIVES

The students should be able to:

1. Understand that objects can exert forces (such as magnetic force, electrostatic force and gravity) on other objects from a distance.
2. Realize that forces affect structures.
3. Develop the capability to alter the shape and strength of structures to minimize the effect of forces.

SPECIFIC OBJECTIVES

The students should be able to:

1. Identify force as a push or pull by one body on another.
2. Investigate the ways in which different forces, e.g. magnetism, static electricity, muscular force, gravitational force, can change the speed and direction of a moving object.
3. Observe the effects of magnets on the motion of different materials (e.g. iron filings will be moved by a magnet whereas grains of sugar will not).
4. Observe different kinds of motion and indicate whether the motion is caused by gravity, static electricity, magnets or applied force, etc.
5. Observe different phenomena and formulate questions.
6. Describe the visible effects of forces acting on a variety of everyday objects:
   - A toy car when pushed - goes forward
   - A ball when dropped - falls
7. Demonstrate how a magnet works.
8. Suggest novel ways of using magnets.
9. Describe, using their observations, ways in which the strength of different materials can be altered.

10. Investigate ways in which the strength of materials can be altered (e.g. additing layers).
11. Observe that the materials used in a tower affect its strength.
12. Infer that the strength and stability of an object are dependent upon its shape.
13. Observe and describe how natural and human-made structures are strengthened.
14. Describe, using their observations, forces that can alter the shape of materials and structures (e.g. bending, squashing, stretching and pulling).
15. Describe ways in which forces alter the shape of different structures and materials.
16. Observe the cross-section of a tree.
17. Observe animals with exo-skeletons and endo-skeletons.
18. Describe, using their observations, the role of struts (e.g. to resist compression) and ties (e.g. to resist tension) in structures under load.

LEVELS OF ATTITUDES, SKILLS & TECHNOLOGY EXPECTED AT GRADES 3 - 4

ATTITUDES:

Students should be encouraged to:

Curiosity:	✓ Ask questions about objects and events. ✓ Find out more about events and objects on their own.
Inventiveness:	✓ Suggest new ways of doing things. ✓ Use equipment in novel ways.
Respect For Evidence	✓ Explain their results and conclusions using some evidence. ✓ Listen to other students' results and explanations. ✓ Begin to recognize when conclusions do not fit the evidence.
Persistence	✓ Complete activities. ✓ Persist at tasks.
Respect For Living Things	✓ Show sensitivity to living things.
Cooperation	✓ Share with others. ✓ Work together with others. ✓ Accept responsibilities.
Concern For Safety	✓ Observe safety instructions.

SKILLS: **In developing their skills of inquiry, problem solving and design, the students are expected to:**

Observing	✓ Use as many senses as are appropriate and safe to gather information. ✓ Identify differences and similarities between objects and events. ✓ Identify sequence in events.
Measuring	✓ Use simple measuring instruments or models of measuring instruments. At first use comparative terms such as bigger, smaller, and later use actual figures.
Manipulating	✓ Set up simple experiments to compare results. ✓ Manipulate simple equipment.
Recording	✓ Use pictures and charts to report results. ✓ Fill out simple tables to report results.
Classifying	✓ Group objects according to several criteria.
Communicating	✓ Talk freely about their activities and the ideas they have, with or without making a written record. ✓ Use appropriate vocabulary to describe their observations. ✓ Listen to others' ideas and look at their results. ✓ Report events by using demonstrations, role play, simple drawings, paintings and paragraphs. ✓ Use bar graphs, pictures, tables and charts to report results. ✓ Use books and other sources to find information.

SKILLS CONT'D

Inferring	✓ Notice patterns and relationships in simple measurements and events.
Interpreting data	✓ Discuss what they find out in response to questions. ✓ Compare their findings with their predictions. ✓ Notice changes when one variable is changed.
Experimenting	✓ Freely ask a variety of questions and suggest how they might be answered. ✓ Suggest how they could investigate to find out answers to questions. ✓ Have some idea of the variable that has to be changed or what different things are to be compared in an investigation. ✓ Suggest equipment, materials and procedure for conducting investigations.
Predicting	✓ Attempt to use evidence in making predictions.
Hypothesizing	✓ Attempt to explain things that are consistent with evidence. ✓ Suggest how something may have happened.
Problem Solving	✓ Suggest solutions to simple problems.
Designing	✓ Construct models either by following instructions or by using their own designs. ✓ Select appropriate material to make models and gadgets. ✓ Formulate problems, do appropriate research, and devise solutions. ✓ Select appropriate material to make models and gadgets. ✓ Evaluate their own designs using simple criteria.

TECHNOLOGY

Technological Methods	✓ Students will be able to formulate problems, do appropriate research and devise solutions (e.g. construct gadgets).
Nature Of Technology	✓ Look at past inventions in their historical context. ✓ Understand that products are replicable. ✓ Understand that others may be working on the same idea. ✓ Realize that *they can use scientific knowledge in doing* technology and that technology helps to develop reliable scientific information. ✓ Understand the importance of precision and safety in developing new products. ✓ Understand that technology is novel and creative. ✓ Understand that if the people in a country are creative and innovative, their country can progress. ✓ *Understand that people use processes involving living things (Biotechnology) and materials (Production Technology) to satisfy their needs.*
Use Of Technology	✓ Appreciate the use of devices, tools and structures made by humans in the home and community. ✓ Appreciate the advantages of using these products. ✓ Realize that human-made things can pollute the environment. ✓ Look at advantages and disadvantages to help them make decisions of what is the best technology that can be used in a particular situation. ✓ Realize that people may abuse and misuse technology. ✓ Understand that technology may have unintended consequences.

UNIT: FORCES, MOTION AND STRUCTURES (GRADE 3)

DURATION: 2 Lessons

TOPIC: WHAT FORCE CAN DO

OBJECTIVES

Students will be able to:

1. Identify forces as pushes or pulls.
2. Describe the effects of forces acting on a variety of every day objects.

PROCESS SKILLS

Observing, Manipulating

MATERIALS

Boxes, toy car, string, charts showing objects being pushed and pulled, rope

CONTENT SUMMARY

- A push usually moves an object away from the body, while a pull moves an object towards the body. (N.B. the human body is used as the reference point.)

- Forces:
  - can start an object in motion.
  - can also stop an object.
  - can also bring about a change in shape.

STUDENT ACTIVITIES

Activity 1:

- Attach string to small car.
- Let student push the car to initiate movement.
- When the car stops let students to pull the car towards them.
- Two groups of students could be used for a-tug-of-war activity.

Activity 2:

- Let students demonstrate using the car and string that they can set the car in motion and also stop it.
- Let students make spherical balls with plasticine; then let them drop it from table top and make observations.
- Place plasticine in one hand and press it with other hand.

Activity 3:

- Let students view pictures of the following:
  - Material being bent, for example, a PVC pipe being bent by someone.
  - A person lying on an inflated tube in the sea.
  - Houses being blown by the wind.
  - Students identify the force and the effect of the force.

ASSESSMENT

- Let students study charts with objects set in motion under forces, and then let them identify which is a push or pull.
- Let them list other ways they could change the shape of the plasticine ball.

TOPIC: MAGNETS

DURATION: 4 Lessons

OBJECTIVES

Students will be able to:

1. Demonstrate how a magnet works.
2. Distinguish between magnetic and non-magnetic materials.
3. Identify ways magnets are used in the home.

PROCESS SKILLS

Observation, Communication, Inferring

MATERIALS

Magnets, paper clips, pieces of wires (copper, aluminium) plastic ruler, wood, paper, screw driver with magnetic tip, steel screws.

CONTENT SUMMARY

- Some objects can exert forces on other objects from a distance
- Magnets are materials (metals) that attract other metals.
- Magnets can also repel other magnets.
- Not all metals are attracted to magnets, metals such as aluminum and copper will not be attracted by magnets.
- Plastic, wood ,and paper are non-metallic and are not attracted by magnets.
- Magnets exert a magnetic force that attracts or pulls magnetic materials towards them.

SUGGESTED ACTIVITIES

1. Place students in groups.
   Let them predict which objects will be attracted by the magnet.
   Let them now place magnet close to objects and observe what happens.
   Let them place results in table form as shown below

Materials	Attracted	Not Attracted

Key: V Attracted
X Not Attracted

2. Demonstrate the use of a magnetic tip screwdriver.
Show picture with refrigerator with objects stuck to the door.
Have small piece of rug from the home normally found in the living room. Place a few steel pins on the rug so that they are not visible. Then use the magnet to search for pins.

3. Show students how magnets can also exert pushing forces by placing two north poles or two south poles of magnets close together.

4. Give students magnets. Challenge students to suggest:

(a) how they might determine the maximum distance from which the force of their magnet can be felt. Let students, in groups, plan their investigations and perform them, record their results and draw conclusions;
(b) how they might compare the strength of different magnets. Let students plan their investigations, make their predictions and perform them, and record their results and draw conclusions.

ASSESSMENT

Questions based on activity:

- What are the items in the magnetic group made of?
- Suggest a way you would remove iron from a mixture of iron dust and small pieces of plastic materials.
- Let students list all materials at home that are attracted by magnet. Let them identify the effect of the force of the magnet.
- Let students suggest novel ways for using magnets in the home. Assess the originality of their ideas.

TOPIC: STRENGTHENING STRUCTURES

DURATION: 3 Lessons

OBJECTIVES:

Students should be able to:

1. Describe ways in which the strength of materials can be altered.
2. Observe and describe how natural and human-made structures are strengthened.

PROCESS SKILLS

Observing, Manipulating

MATERIALS

Wooden blocks, thin cardboard, small masses

CONTENT SUMMARY

- The strength of a material relates to how much load the material can bear without bending/breaking.
- Materials can be strengthened in many ways e.g.:
    - Materials can be reinforced by increasing their thickness e.g. by adding additional layers, (having layers of blocks, sheets of paper).
    - Small twigs can be prevented from bending by having them tied to a stick in the ground.
    - Building blocks can be filled so as to strengthen them.
    - Materials such as paper can be strengthened by folding.

SUGGESTED ACTIVITIES

Activity 1 :

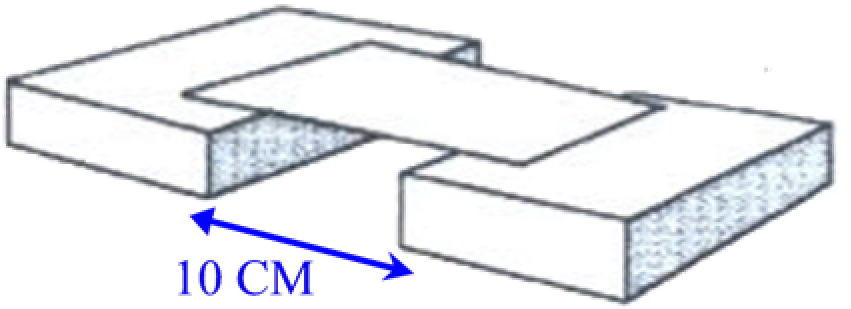
- Place wooden blocks in a pile.
  Have a single block placed next to the pile.
  Let students in small groups apply forces to both groups of blocks, until they begin to move.
  Let them identify which groups used the greater force to be moved.
  Let students discuss their findings.

Activity 2

- Let students observe instances in their experience of strengthening by the means listed in the content summary.

Activity 3

- Place wooden blocks about 10 cm apart.
  Lay a card like a bridge between the blocks.
  Place one mass at the centre of the bridge and observe what happens.
  Continue to add masses one at a time until the card bridge starts bending.



Students must find ways to prevent the card from bending (glueing several cards together, folding in different ways, e.g. accordion shaped, curved, U-shaped, etc.)

ASSESSMENT

- Assess students' efforts in Activity 3.

Unit : FORCES, MOTION AND STRUCTURES (grade 4)

DURATION: 6 Lessons

OBJECTIVES

Students should be able to:

1. Observe that the material used in a tower affects its strength.
2. Infer that the strength and stability of a structure depend on its shape.

PROCESS SKILL

Observing, Manipulating, Inferring

MATERIALS

Drinking straws, cardboard, pair of scissors, tape, small sticks, pins, paper fasteners

CONTENT SUMMARY

- The strength of a structure is its ability to maintain its shape and to remain in one piece.

- The stability of a structure is its ability to maintain its original position despite the forces that push on it. Unstable structures will topple over easily.

- The shape of structures affects their strength.
- Structures may have shapes such as triangles(pyramids), circles (spheres) , squares (cubes), rectangles.
- Rectangular structures with the long side at the bottom are very stable.
- Rectangular structures with the short side at the base are not very stable.
- Triangular structures are very stable.

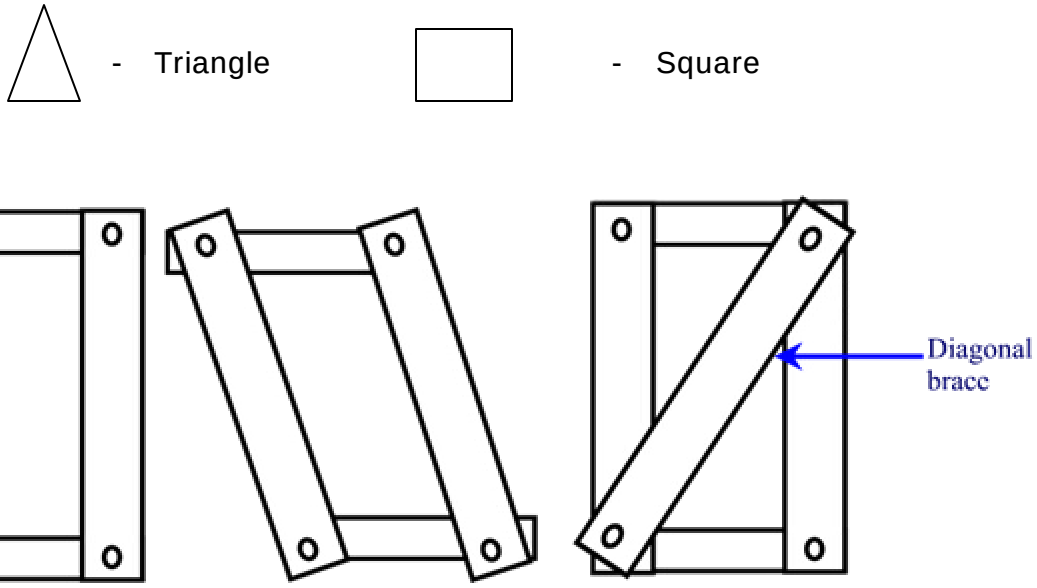
- Towers are very tall structures. The materials from which they are made must be very strong.

Activity 1:

Let students construct a tower using two different materials-drinking straws, and sticks. Let them apply approximately the same force on both structures, and compare the results.

Activity 2:

Let students make simple rectangle with strip of card. Let them secure the corners with paper fasteners. Let students also make triangles with strip of the same card. Let students press down on the structures with their fingers and see what happens. Let students add a diagonal strip as a brace to the rectangular structure and see what happens to its strength.



Activity 3:

Pictures of structures of bridges, roofs of houses, arches and other suitable structures could be presented for discussions.

ASSESSMENT

- Paper and pencil test
- Let groups compete in designing structures with greatest strength and stability.

TOPIC: THE FORCE OF GRAVITY

DURATION: 2 Lessons

OBJECTIVE:

The students should be able to:

- Observe the effects of gravity on the motion of objects.

PROCESS SKILLS

Inferring, Observing

MATERIALS

Strings of different thickness, objects of differing masses,
strong chairs.

CONTENT SUMMARY

- All objects pull on other objects around them with a force called **gravity.**
- Very large objects like the earth have very strong gravity and their pull affects the motion of other objects.
- All objects on Earth experience the earth's gravity which pulls them vertically towards the centre of the Earth..
- Gravity, like magnetism, is a force that can affect an object from a distance (without touching it).

SUGGESTED ACTIVITIES

1. Students consider the following:

    - When they throw up a ball (in an upward direction), it eventually changes direction and falls.
    - Fruits fall from trees.
    - Water falls to the Earth, etc.

2. Students are asked to jump up on to a strong chair and to jump down from the same chair. They indicate which is easier to do and suggest why?

3. Students consider how we keep things from falling, e.g. by strings, by hanging, by putting supports under them. They suggest why these things do not fall. What happens if you remove the support?

   Students investigate the thickness of string needed to keep objects of different masses suspended from the same height, and make inferences.

4. Students consider examples where objects do not fall or remain suspended e.g. aeroplanes. Students try to explain how this happens.

5. Students consider the effects of the Earth's gravity and what would happen without it. Teacher mentions that the Earth's gravity also affects other heavenly bodies. Teacher points out that all objects have gravity but unless the object is very large, their gravity cannot easily be detected and does not affect human activities.

ASSESSMENT

- Students write an essay on "The Earth without gravity".

Module 3

Forces, motion and structures

Grades 5 - 6

GRADES 5 – 6

GENERAL OBJECTIVES

The students should be able to:

1. Understand that the effects of forces vary with the magnitude of the force.
2. Understand that simple machines transfer forces.
3. Investigate factors that affect the stability of structures.
4. Appreciate the use of simple machines in everyday life.

SPECIFIC OBJECTIVES

The students should be able to:

1. Name the instrument used to measure force and name the unit of force.
2. Measure the force acting on an object using a spring balance.
3. Design a simple instrument/device that can be used to measure force.
4. Predict the position of forces in balancing a non-uniform object.
5. Identify a number of common levers and describe how they work.
6. Appreciate that levers make work easier.
7. Name the different points of a lever.
8. Measure the mass of an object using a simple lever.
9. Predict the force that will balance a lever with an off-centre fulcrum.
10. Identify the parts of a wheel and axle.
11. List examples of wheels and axles.
12. Explain the function of the wheels and axles listed in the examples.
13. Research the use of wheels in a variety of situations and discuss their impact.
14. Operationally define a simple machine.
15. List examples of simple machines.
16. Appreciate the fact that machines make work easier.

LEVELS OF ATTITUDES, SKILLS & TECHNOLOGY EXPECTED AT GRADES 5 - 6

ATTITUDES:

Students should be encouraged to:

Curiosity:	✓ Ask questions about objects and events. ✓ Find out more about events and objects on their own.
Inventiveness:	✓ Suggest new ways of doing things. ✓ Use equipment in novel ways.
Respect For Evidence	✓ Use evidence to justify their conclusions. ✓ Listen to other students' results and explanations. ✓ Recognize when conclusions do not fit the evidence. ✓ Change their ideas in response to evidence. ✓ Point out contradictions in reports by their classmates. ✓ Show a willingness to review procedures and evaluate their work.
Persistence	✓ Complete activities. ✓ Persist at tasks. ✓ Repeat experiments when previous attempts have failed.
Respect For Living Things	✓ Show sensitivity to living things.
Cooperation	✓ Share with others. ✓ Work together with others. ✓ Accept responsibilities.
Concern For Safety	✓ Observe safety instructions.

SKILLS:	**In developing their skills of inquiry, problem solving and design the students are expected to:**
Observing	✓ Use as many senses as are appropriate and safe to gather information. ✓ Identify differences and similarities between objects and events. ✓ Identify sequence in events. ✓ Distinguish from many observations those that are relevant to an investigation.
Measuring	✓ Use simple measuring instruments or models of measuring instruments. ✓ Use units in measurement.
Manipulating	✓ Set up simple experiments to compare results. ✓ Manipulate simple equipment.
Recording	✓ Use pictures and charts to report results. ✓ Fill out simple tables to report results.
Classifying	✓ Group objects according to several criteria.
Communicating	✓ Talk freely about their activities and the ideas they have, with or without making a written record. ✓ Use appropriate vocabulary to describe their observations. ✓ Listen to others' ideas and look at their results. ✓ Write reports on their investigations. ✓ Use bar graphs, pictures, tables and charts to report results. ✓ Regularly and spontaneously use books and other sources to check or supplement investigations. ✓ Select appropriate methods to report events. Include drawings, reports and multi-media.

SKILLS CONT'D

Inferring	✓ Notice patterns in data. ✓ Draw reasonable conclusions from data.
Interpreting data	✓ Discuss what they find out in response to questions. ✓ Compare their findings with their predictions. ✓ Make associations with change in variables and results.
Experimenting	✓ Freely ask a variety of questions and suggest how they might be answered. ✓ Formulate problems to be investigated. ✓ Suggest how they could investigate to find out answers to questions. ✓ Plan to conduct investigations. Select equipment, materials and procedures for conducting investigations. ✓ Understand what is a fair test. ✓ Keep appropriate variables constant and vary the independent variable in experiments.
Predicting	✓ Use evidence in making predictions. ✓ Show how they have used evidence in making predictions.
Hypothesizing	✓ Attempt to explain things that are consistent with evidence. ✓ Suggest how something may have happened.
Problem Solving	✓ Suggest solutions to simple problems. ✓ Identify needs, formulate questions, conduct research and design solutions to problems.
Designing	✓ Construct models either by following instructions or by using their own designs. ✓ Select appropriate material to make models and gadgets. ✓ Formulate problems, do appropriate research, and devise solutions. ✓ Select appropriate material to make models and gadgets. ✓ Evaluate their own designs and the designs of others using simple criteria.

TECHNOLOGY

Technological Methods	✓ Students will be able to formulate problems, do appropriate research and devise solutions (e.g. construct gadgets).
Nature Of Technology	✓ Look at past inventions in their historical context. ✓ Understand that products are replicable. ✓ Understand that others may be working on the same idea. ✓ Realize that *they can use scientific knowledge in doing* technology and that technology helps to develop reliable scientific information. ✓ Understand the importance of precision and safety in developing new products. ✓ Understand that technology is novel and creative. ✓ Understand that if the people in a country are creative and innovative, their country can progress. ✓ *Understand that people use processes involving living things (Biotechnology) and materials (Production Technology) to satisfy their needs.*
Use Of Technology	✓ Appreciate the use of devices, tools and structures made by humans in the home and community. ✓ Appreciate the advantages of using these products. ✓ Realize that human-made things can pollute the environment. ✓ Look at advantages and disadvantages to help them make decisions of what is the best technology that can be used in a particular situation. ✓ Realize that people may abuse and misuse technology. ✓ Understand that technology may have unintended consequences.

UNIT: FORCES, MOTION AND STRUCTURES (Grade 5)

TOPIC : MEASURING FORCES ON OBJECTS

DURATION: 4 Lessons

SPECIFIC OBJECTIVES

Students should be able to:

1. Name the instrument used to measure force and name the unit of force.
2. Measure the force acting on an object, using a spring balance.
3. Design a simple instrument/device that can be used to measure force.

PROCESS SKILLS

Manipulating, Observing, Communicating. Designing

MATERIALS

Spring balance (N), plasticine, masses, paper clips, rubber bands, rulers

CONTENT SUMMARY

- Forces can be measured.
- The unit of force is the Newton. That is, forces are measured in Newtons.
- A spring balance is used to measure force.

SUGGESTED ACTIVITIES

Activity 1 : Collapsing a paper bridge

For this activity you would require two blocks of wood (4 inches x 4 inches), one sheet of letter size paper, a spring balance, and a quantity of paper clips for each working group.

Instruct students to place wooden blocks about 8 inches apart, and then place the sheet of paper across the span so that one end rests on each of the blocks. Students would then place paper clips on the paper bridge one at a time until the bridge collapses. Let students record, and then state the number of paper clips it took to collapse the bridge. Explain that it is possible to know/measure the amount of force the paper clips brought to bear on the bridge causing it to collapse; and that the spring balance can be used to determine that.

Activity 2. Looking at the spring balance.

- For this activity each working group should have at least one spring balance.

  Let students examine the spring balance and try to gain an understanding as to how it works. Pay attention to the markings and numbers. Let students make a rough diagram of the spring balance on paper.

Activity 3: Measuring force

- Let students use the spring balance to measure the force that caused the bridge to collapse in activity 1. Let the groups compare their findings.

Activity 4: Dragging masses

- Provide each group with a set of masses (*pebbles of various sizes can be used but there must be some way of attaching the spring balance to them. Bits of string can be tied around them for this purpose*). Let students measure the force required to drag the masses across the table top. Students record their observations on a table.

Mass #	Force needed to move mass
1	
2	
3	
4	

Activity 5: *Designing and making a force-measuring device*

- Provide each group with a set of rubber bands and challenge them to try to come up with a device similar to the spring balance which they may use to measure and compare force.

  Students should be given about a week to complete this assignment. Once it has been completed each group should demonstrate its use and explain how the group went about making it.

ASSESSMENT

- Let students measure and record the force exerted by a set of known masses using a spring balance. A table similar to that in activity 4 can be used for this exercise. Check their results for correctness/accuracy.

- Activity 5 can be assessed as follows:

  Each group should be given a grade based on the following criteria:

  - having a completed project – 10 points.
  - demonstrating the use – 5 points.
  - explaining how it was made – 5 points.
  - design – 10 points.

TOPIC: LEVERS

DURATION : 1 Lesson

SPECIFIC OBJECTIVES

Students should be able to

1. Predict the position of forces in balancing a non-uniform object.

PROCESS SKILLS

Manipulating, Observing, Measuring, Predicting and Communicating.

MATERIALS

Non-uniform objects (e.g. pen, pencil with eraser at the end), a non-uniform stick, strips of cardboard of varying lengths (4 – 12 inches) and shapes, 12-inch rulers, paper clips.

CONTENT SUMMARY

- **Lever -** a simple machine consisting of a rigid bar pivoted about a central point called the fulcrum.
- A metre rule balances at the mid-way point, while for a non-uniform object the balance point is closer to the heavier end.

SUGGESTED ACTIVITIES

Group students for these activities. Each group should be provided with a triangular block, a twelve-inch ruler, a variety of objects both uniform and non-uniform for balancing.

Activity 1: Balancing the ruler

- Direct students to balance the ruler on the triangular block. Let them observe closely the point that rests on the block when the ruler balances. Let them make a diagram of the apparatus as it was at the time of balance. Introduce and explain terms such as lever and fulcrum.

Activity 2: Balancing other objects

- Direct students to balance the other objects (pencil, pen, non-uniform pieces of cardboard etc.). In each case let students mark the point that rests on the block at the time of balance, and then measure the distance between that balance point and the two ends. These measurements should be recorded and should form the basis of a whole class discussion.

ASSESSMENT

- Present students with a set of non-uniform objects to determine their balance points. First let them predict and mark the point at which they think the object would balance, and then perform the experiment to test their prediction.

TOPIC: LEVERS AS SIMPLE MACHINES

DURATION: 4 Lessons

SPECIFIC OBJECTIVES

Students will be able to:

1. Identify a number of common levers and describe how they work.
2. Appreciate that levers make work easier.
3. Name the different points of a lever.

PROCESS SKILLS

Observing, Manipulating, Interpreting, Communicating.

MATERIALS

A pair of scissors, bottle opener, crowbar, hammer, pliers, tongs, knife, metre ruler, empty cans, charts showing other simple machines, a bottle of carbonated beverage, a piece of wood with a nail three quarters of the way in.

CONTENT SUMMARY

- Levers are simple machines that make work easier. They allow us to use smaller forces to raise heavy objects. They also make the application of the force much easier.
- Levers have three major points: (i) pivot, or balance point (fulcrum); (ii) the point where the effort or force is applied; and (iii) where the work is done.
- The closer the load is to the fulcrum the easier it is to lift with the lever.

SUGGESTED ACTIVITIES

Activity 1 : *The story of Mr. Joe*

- Mr. Joe had a very large stone in the middle of his yard. He wanted to shift it to the side of his house to beused as a seat, but it was too heavy for him to move. He had no one to help him either. He went into his store room and found a thick long plank. He tried to push the stone with it but the stone did not move. "How am I going to get this stone to move?" he asked. "What advice would you give to Mr. Joe?" Let students share their ideas and demonstrate them.
  Use this scenario to bring out the idea that levers make work easier and that it is one of a group of devices called simple machines.
  The different points of the lever should be introduced here as well. As the demonstration is done, identify and explain the points of fulcrum, effort and work. Let students draw a diagram and label these points.

Activity 2: Demonstrating the use of other common levers

- Display a bottled drink and try to remove the crown cork with hands only. (This would not be possible). Let students suggest how that problem may be solved. (Object to the use of the teeth since this may damage the enamel) Ask a student to demonstrate the use of the bottle opener. Explain that this is also a lever then challenge students to identify the three points of the lever in that operation.

Activity 3: Identifying other common levers

- Ask class for suggestions of other common devices that may be classified as levers. Each time a suggestion is given let the student draw a rough diagram and explain how it is used. In each case challenge them to identify the different points. Look out for such things as hammer (when removing nails), crow bars, see-saw.

Activity 4: <u>Demonstrating that a lever makes work easier and that the length matters</u>

- For this activity you will require a text book, a rubber band, two rulers, a paper/clip with one end straightened to form a right angle. (This activity may be done in groups).

  Distribute the materials to each group and direct students to follow these steps:

  (a) Fix the rubber band to the remaining curved area of the paper clip.

  (b) Place the text book flat on the desk then place the straightened part of the paper clip under the book.

  (c) Try to raise the book off the desk one inch, and measure the length of the rubber band when this is accomplished. Record the measurement in a table.

  (d) Lay one of the rulers flat on the desk with a part hanging over the edge (about 3 inches); then place the text book on the other end.

  (e) Attach the paper clip to the free end of the ruler and pull downward in an effort to raise the book 1 inch. Measure and record the length of the rubber band.

  (f) Move the book closer to the edge by increasing the overhang of the ruler by an inch. Then repeat step (e).

  (g) Repeat step (f) until the book is very close to the edge of the desk.

  (h) Use results to make a graph and guide students in the interpretation of the data. (*This part of the activity can form part of assessment*)

ASSESSMENT

1. Present a work sheet with diagrams of several levers and let students label the three points on each leaver.

2. Alternatively, a chart with the diagrams could be placed on the chalk board. In this case, students will be required to draw diagrams and label them.

TOPIC : BALANCING MASSES

DURATION : 2 Lessons

SPECIFIC OBJECTIVES

Students will be able to:

1. Measure the mass of an object using a simple lever.
2. Predict the force that will balance a lever with an off-centre fulcrum.

PROCESS SKILLS

Manipulating, Observing, Communicating, Predicting, Manipulating variables

MATERIALS

Metre ruler, scale pans, strings, clips, wooden rod, rails, a clamp stand or a wooden stand from which to suspend balance, rice, flour, beans, object of known mass.

CONTENT SUMMARY

- When two masses are placed on either side of the fulcrum of a lever at equal distance from the pivot, the balance point is obtained at the point where the arm of the lever is in a horizontal position. At this point the masses are equal (Diagram A). Some scales operate on this principle.
- A smaller force is necessary to balance out a larger force on a lever with an off-centre fulcrum. (Diagram B)

Diagram A

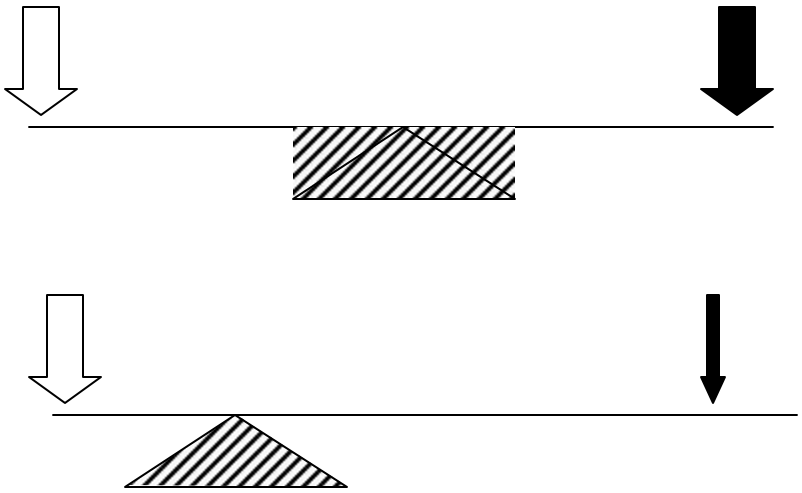
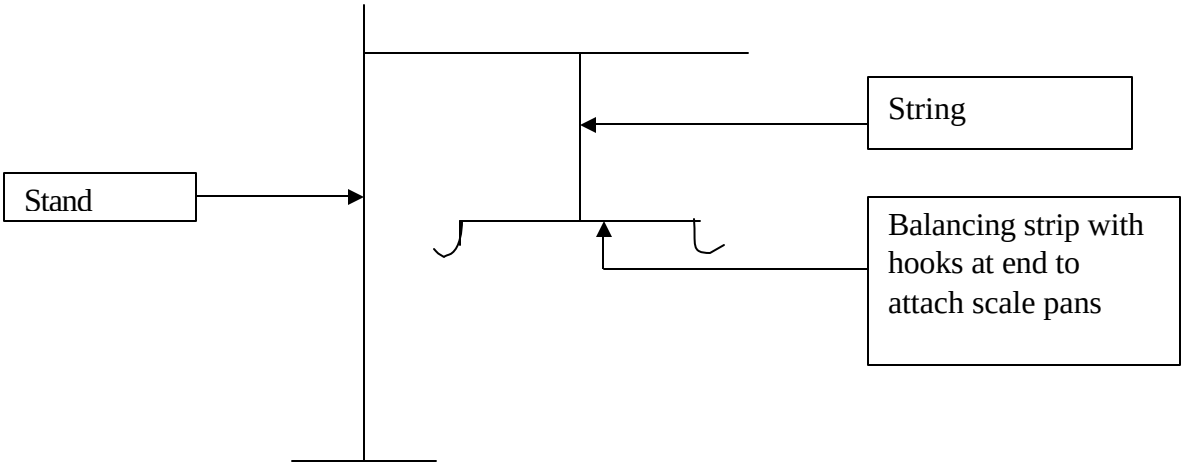


Diagram B

SUGGESTED ACTIVITIES

Activity 1: *Constructing a balance*

- For this activity you will require a clamp stand or its equivalent, a piece of string, a strip of wood with two hooks securely fastened at both ends, two scale pans (these could be made from jar covers and string), some dried peas or rice.
- Let students design and construct a simple balance with the materials. The balance may look like this:



Let students attach the scale pans to the balancing rod and make whatever adjustments are necessary to restore the balance. Once this has been achieved, let students place a known mass (a small one) in one scale pan and direct them to place some of the peas or rice in the other until balance is restored.

Question students in an effort to establish that balance was restored because the two sets of objects in the scale pans are of equal mass. Having done this, using known masses, allow students to experiment freely in an effort to determine the mass of a variety of objects.

Activity 2: <u>Balancing an off-centre lever</u>

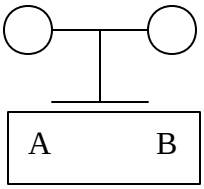
- For this activity you will need a scale, the balance constructed earlier and objects to serve as masses.
- Using the lever constructed earlier, let students shift the fulcrum from the central point so that the distance between the fulcrum and the two ends are no longer equal. Let them place a known mass in one pan and then balance it by placing objects in the other pan. Use the scale to determine the second mass. This process could be repeated several times, with the results recorded on a table. However, students should

first be asked to predict what mass would be required to balance the other.

Shift the fulcrum even further away from the centre and repeat the process. By using the known masses with the fulcrum in this new position, students should be able to infer that as the distance between the fulcrum changes a different mass is required to restore balance, and that the greater the distance between the fulcrum and the mass, the greater the force the mass creates.

ASSESSMENT

Present work sheet something like this:



Scale pan A	**Scale pan B**	Will balance (Yes/No)	Will not balance (Yes/No)	What to do to make it balance
4 ounces	3 ounces			
10 grams	9 grams			
12 grams	12 grams			

TOPIC: WHEELS AND AXLES

DURATION: **3 Lessons**

SPECIFIC OBJECTIVES

Students will be able to:

1. Identify the parts of a wheel and an axle.
2. List examples of wheels and axles.
3. Explain the function of the wheels and axles listed in the examples.
4. Appreciate the fact that this machine makes work easier.

PROCESS SKILLS

Observing, Communicating, Designing, Measuring.

MATERIALS

Chart showing wheel-and-axle and their operations: Door knobs, knobs from radio, pedal of bicycle, etc. Where possible the actual devices could be used.

CONTENT SUMMARY

- A wheel-and-axle is another simple machine.
- It is made up of two basic parts: a wheel and an axle. Both the wheel and the axle are cylindrical in shape. However, the axle is usually smaller than the wheel. The axle is fastened to the wheel so that they turn together.
- When the axle is turned, the wheel moves a greater distance than the axle but less force is needed to move it. It is easy to move things from place to place with a wheel-and-axle.
- Examples of wheel and axle include door knobs, bicycle pedals, vehicle wheels, roller skates, clocks, radio dials.

SUGGESTED ACTIVITIES

Activity 1: Identifying the parts of a wheel-and-axle

- For this activity you will require examples of wheel-and-axles or a set of pictures of these devices.

  Present students with the objects and ask them to identify them. Then write down the things that are common to the devices. Establish the fact that the wheel-and-axle is another simple machine. Let students identify the parts of the wheel-and-axle presented, and compare the size of the wheel and the axle in the examples presented.

  Ask students to suggest other examples of this simple machine. For each example given, let students explain the use/importance of that device.

Activity 2: Making a wheel-and-axle (this could be done in groups)

- For this activity you will require pieces of cardboard, a pair of blunt end scissors, cylindrical rods (razor-grass flower stalks can substitute) about 6 inches long, rulers or metre rules, jar covers of varying sizes.
- Follow these steps:

  (a) Direct students to mark and cut out a pair of wheels of equal size, and then fasten them to the cylindrical rod to make a wheel-and-axle.

(b) Once this is done, have them place a mark at a point on the wheel close to the outer edge, and a similar mark on the axle.

(c) Next, line up both marks then roll the wheel-and-axle forward until the mark on the wheel makes one complete revolution.

(d) Mark that point on the desk and then use the ruler to measure the distance between the two points. Record this measurement.

(e) Dissect the wheel-and-axle then repeat steps b to d using the axle (cylindrical rod). Compare the distances.

(f) Repeat the entire process using wheels of different sizes diameters). Let students measure the diameters of the wheels and the distances they cover in one revolution, and display the information on a table. Next, let them display the data on a bar chart.

ASSESSMENT

- Grade students' table and bar charts.
- Let students research the topic, and make up their list of wheel-and - axle systems which are used as simple machines. Students should be given the opportunity to present their findings. In their presentations, students should be challenged to suggest the difficulties we would face without these machines.

UNIT: FORCES, MOTION & STRUCTURES (GRADE 6)

TOPIC: FALLING OBJECTS I

DURATION: 2 LESSONS

SPECIFIC OBJECTIVES

Students should be able to:

1. Determine experimentally that varying the **mass** of an object and the **height** from which it is dropped will vary the force exerted by the object.
2. Design a device to prevent an egg from breaking on impact after being released from a raised platform.

PROCESS SKILLS

Manipulating, Observing, Communicating, Interpreting, Manipulating variables, Measuring

MATERIALS

A scale to measure weight of plasticine, metre ruler plasticine or clay, string, known masses.

CONTENT SUMMARY

- The greater the height and mass from which an object is released the greater the force exerted by the object on reaching the surface beneath.

SUGGESTED ACTIVITIES

Activity 1:

- Distribute materials to students in small groups. Let students mould plasticine or clay balls of equal mass. Let them release the plasticine/clay balls from different heights (using the metre ruler to measure the heights).

  Let the students observe the shape of the ball after each drop.

  (Balls are to be kept after each fall so as to compare with balls from successive falls).

  Repeat activity this time keeping the height constant with varying sizes of balls.

Activity 2:

- For this activity you will require a set of known masses with some way of attaching a piece of string to them, several lengths of string (5 to 50 cm), the metre ruler, a rubber band with a paper clip attached to each end.
- Place metre ruler in a vertical position. Attach the string of one mass to one of the paper clips. With the other paper clip held firmly between the index finger and thumb and the mass held in the hand, place hand at the top of the metre ruler and then release the mass. (Close attention should be paid to determine the extent of maximum stretch in the rubber band). Record this distance.
- Repeat the procedure several times using a different mass in each case with the same length of string.
- Having done this, repeat the entire procedure this time keeping the mass constant and varying only the length of the string.
- Use the information obtained to plot a bar chart. (This could form part of assessment).

ASSESSMENT

- Let students write down statements explaining (a) the relationship between distance of fall and the force generated and (b) the relationship between the mass of a falling object and the force generated. (These are actually concluding statements for the activities carried out).
- Challenge students to design and build a device which will prevent an uncooked egg from breaking on impact after being released from the platform. (**This activity could be done as Activity 3**)

TOPIC: FALLING OBJECTS II

DURATION: 2 Lessons

SPECIFIC OBJECTIVES

Students will be able to:

1. Determine experimentally that the surface area of a free-falling object affects the time for free-fall.

PROCESS SKILLS

Manipulating, Observing, Communicating, Predicting, Classifying, Designing.

MATERIALS

Library cards, tape, feathers, aluminium foil, small stones (different masses).

CONTENT SUMMARY

- Objects of different masses released from the same height at the same time will reach the surface at the same time.
- When the surface area of a falling object is large, then it offers more resistance to air. This slows down the object.

SUGGESTED ACTIVITIES

Activity 1: Free falling pebbles (different masses, same shape)

- This activity should be conducted from a raised platform or balcony. Students should be placed in working groups. Each group should be provided with three pebbles of varying sizes/masses. Students

should be told that they would be having a race between the pebbles to see which one will hit the ground first after being released from the platform. Students are asked to make a prediction of the order in which the pebbles will hit the ground. Having done so, one member of the group will release the pebbles while the others observe closely to determine which hits first. Repeat the experiment to verify results.

Activity 2: Free falling objects (same mass, different shapes)

- Cut four pieces of aluminium foil (three-inch square). Let students form them into different shapes and then release them simultaneously from the platform to see which one hits first. Discuss observations.

Activity 3: Free falling objects (different masses and different surface area)

- Let students conduct an activity similar to the previous one, but this time releasing a pebble, a feather and a playing card simultaneously. Students predict which will fall first and then test their predictions

ASSESSMENT

1. Let students write a statement explaining the relationship between surface area and the rate at which an object falls through the air.

TOPIC: FORCES AND MATERIALS

DURATION: 1 session

SPECIFIC OBJECTIVES

Students should be able to:

1. Investigate the strength of materials with reference to the forces materials can withstand.
2. Suggest ways of strengthening materials in an effort to make them more resistant to forces.

PROCESS SKILLS

Manipulating, Communicating, Interpreting. Manipulating variables

MATERIALS

Spring balance, string, objects of known weights, tape, wood, plastic and metal strip of approximately 2 feet in length and equal thickness, ruler for measuring distortion (degree of bending), clamp stands or substitute.

CONTENT SUMMARY

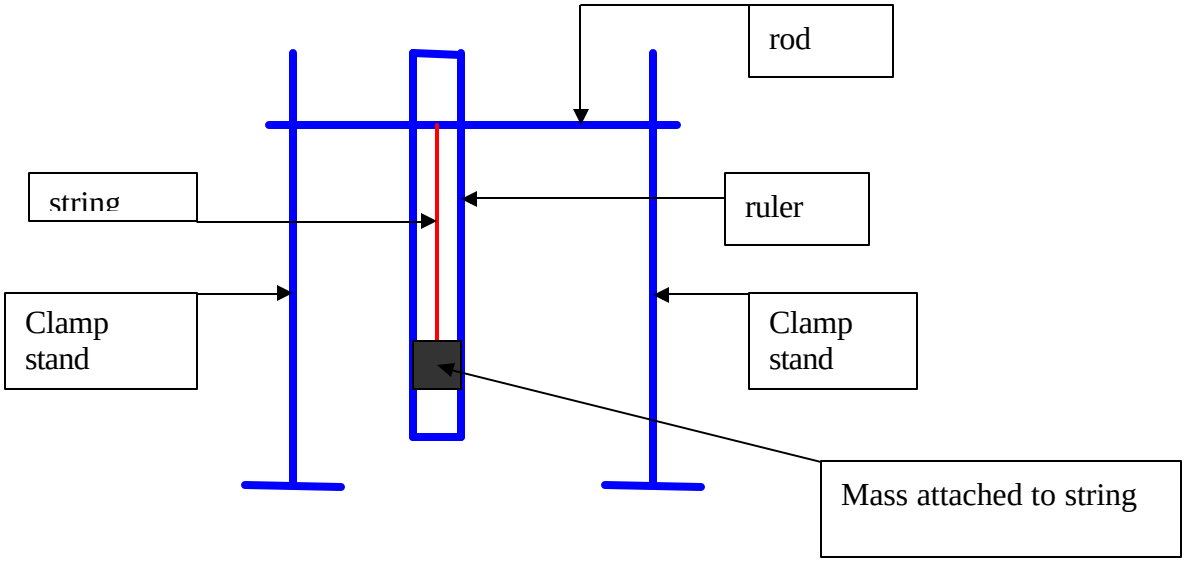
- When heavy masses are attached to a wooden or plastic rod of uniform cross sectional area, it will cause the material to bend. The degree of bending is related to the strength of the material. The stronger the material, the less is the tendency to bend under the load.

- The strength of a material may be changed by altering the mass and the shape.

SUGGESTED ACTIVITIES

Activity 1: Comparing the strength of materials

- Set up apparatus as shown in diagram:



Once this is done let students do the following:

- Attach a known mass to one of the rods and record the degree of bending as indicated by the ruler. Repeat the procedure using the other rods. Record the information on a table and bar chart.
- Increase the amount of mass and repeat the procedure.
- Ask students to suggest ways of reducing the amount of bending observed.

Activity 2: Increasing the strength of materials

- Repeat the procedure using smaller masses and then doubling up the rods to increase thickness. Record and compare results to those obtained previously.

- Let students investigate how folding paper cards in different ways (e.g. accordion, curved, u-shaped, v-shaped, etc.) would alter their strength.

Activity 3:

- Discuss the importance of the strength of materials in daily activities of people.

ASSESSMENT

- Focus on the graphs and tables that arose from the experiments.

TOPIC: SIMPLE MACHINES

DURATION: 2 Lessons

SPECIFIC OBJECTIVES:

Students should be able to:

1. Operationally define a simple machine.
2. List examples of simple machines.
3. Infer that an inclined plane decreases the force required to lift an object.
4. Identify examples of inclined planes in common use.

PROCESS SKILLS

Observing, Communicating, Inferring, Manipulating, Predicting, Manipulating variables.

MATERIALS

Rulers (12"), rubber bands, small weights of known mass, paper clips, string.

CONTENT SUMMARY

- A simple machine is any device that helps to perform work more easily. There are six simple machines: the lever, the wheel and axle, the screw, the inclined plane, the wedge and the pulley.
- An inclined plane is a flat sloping surface. That is, one end is higher than the other. This simple machine can be used to move an object to a lower or higher place.

- Less energy is needed to move an object up an inclined plane than if the object is lifted straight up.
- Examples of inclined plane include a ramp, and a slide.

SUGGESTED ACTIVITIES

Activity 1: How does an inclined plane affect the force needed to lift an object?

- For this activity you will need some large books, a ruler, a quantity of rice or other similar material (about 1 cup), a plastic bag, a spring balance, a thick rubber band strip. Follow these steps:
  (a) Stack the books in one pile, and lean one book or a flat piece of wood against the others to create an inclined plane.
  (b) Place the rice in the plastic bag and secure the mouth of the plastic bag with a twist tie.
  (c) Tie the rubber band strip to the top of the bag.
  (d) Place the bag with the rice on the table and while holding the rubber band, lift the bag of rice straight up to the top of the book stack. Use the ruler to measure the length of the rubber band. Record this measurement.
  (e) Now put the bag of rice at the bottom of the inclined plane and drag it to the top of the book stack by pulling on the rubber band.
  (f) When it is almost at the top, measure the length of the rubber band. Compare this to the first measurement.
  (g) Let students answer this question: Why was the rubber band more stretched when the bag was lifted straight up than when pulled along the sloping book?
  (h) Repeat the activity using a spring balance to quantify the force used in the two trials.

Activity 2: What is the effect of changing the gradient of the inclined plane?

- Increase the gradient of the inclined plane and let students predict whether a larger or smaller force would be required to move the load along the steeper inclined plane. Let students test their predictions by performing the experiment.

ASSESSMENT

Let students list examples of common inclined planes found in the home and workplace and explain how they make work easier.

TOPIC : THE WEDGE

DURATION: 1 Lesson

SPECIFIC OBJECTIVES

Students will be able to:

1 Define the term, wedge.
2 Explain how a wedge functions in making work easier.
3 List examples of wedges in common use and explain how they work.

PROCESS SKILLS

Observing, Manipulating, Communicating.

MATERIALS

Axe, saw, chisel, nails, knife, door wedge, a hammer, a bolt, an orange or another fruit. Pictures of some objects may be used in cases where the actual object may not be available.

Note: The teacher should retain possession of the dangerous items such as saw, knife, chisel and use them only for demonstration purposes.

CONTENT SUMMARY

- A wedge is a simple machine used to push two objects apart. It is made up of two inclined planes. These planes meet to form a sharp edge. This edge can split things apart.
- Examples of wedges include knives, cutlasses, saws, forks, axes, nails.

SUGGESTED ACTIVITIES

1 Perform the following demonstrations:

- Try to hammer a bolt into a block of wood. Let students explain the apparent difficulty.
- Repeat the process using a nail. Let students explain why this was easier.
- Let students compare the bolt and the nail, and draw diagrams to represent each.

2 Perform the following demonstration:

- Try to cut through an orange with the blunt back edge of a knife. Let students explain the difficultly experienced.
- Repeat the process using the sharp edge of the knife. Let students explain why this was easy.
- Direct students to draw a diagram to represent the blunt edge and the sharp edge.
- Make representative diagrams on chalk board as well and use these diagrams to explain the concept of the wedge, and how it works.

ASSESSMENT

- Direct students to list other example of objects considered to be wedges in the home or work place, and explain how each one works.

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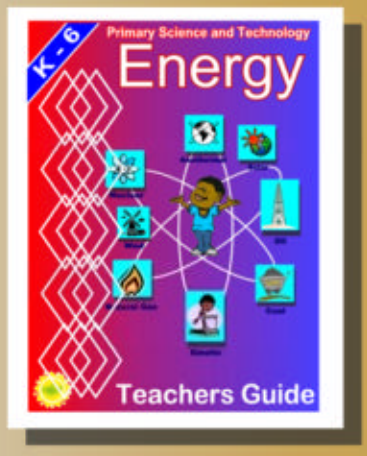

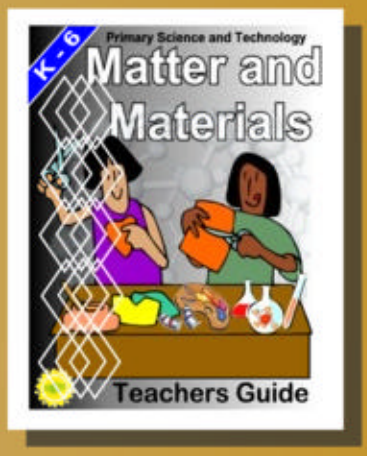

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