Science Unit: *Force and Motion*
Lesson 1: *Force and Motion – Part 1*

School year:	2004/2005
Developed for:	Queen Alexandra Elementary School, Vancouver School District
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Grade level:	Presented to grades 1 - 2; appropriate for grades 1 – 5 with age appropriate modifications.
Duration of lesson:	1 hour and 20 minutes
Note:	This lesson requires 1 adult per station.

Objectives

1. Learn about different forces and how they act on matter.
2. Learn that gravity is a force that pulls matter downward and that gravity pulls on all matter equally.
3. Learn that friction can slow down or stop the movement of an object.
4. Learn that an object stays still unless a force causes the object to move, and that force can stop a moving object.
5. Gain experience testing and making observations of different forces on different types of matter.

Background Information

Matter is anything that occupies space. Four properties of matter are mass, weight, volume and density. The three states of matter are solids, liquids and gases. Different types of forces act on matter. A force is a push or pull on an object. Force can be used to move an object or to change the shape of an object. Galileo discovered insights about force and motion and Sir Isaac Newton defined three laws of motion. The first law states that an object will remain still or keep moving in the same direction unless a force acts on the object. This law relates to inertia and momentum. The second law states that a force can act on an object to change the movement of the object, either by a change in speed or a change in direction. The amount of force needed to move an object or stop the movement of an object is related to the mass of the object. The third law states that as a force acts on an object, the object responds with a pull or push equal in strength but in the opposite direction (for example, the force needed to bounce a ball: the force travels in a downward movement from the hand to the ball and the ball bounces up after it hits the floor). Force and motion can be affected by many factors such as friction, air resistance, and the elasticity of an object. Gravity is a force that pulls matter downward on Earth. Energy causes things to happen and energy comes in different forms (for example: heat energy, light energy, chemical energy, electrical energy, nuclear energy, and mechanical energy). Energy can be defined as the ability to do work and energy can be stored for future work (potential energy).

Vocabulary

Matter:	Something that occupies space; what something is made of.
Gravity:	A force that pulls all matter downward; gravity holds everything down on Earth; gravity pulls on objects equally; gravity keeps the Earth in an orbit around the sun.
Weight:	The force of gravity pulling on an object.

Mass:	The amount of matter in an object; mass is measured in grams or kilograms.
Force:	The push or pull on an object; force can change the speed and direction of an object when it moves; it takes more force to move an object that has more mass compared to an object with less mass.
Energy:	The ability to do work or supply power; work is force multiplied by distance; for example, the force needed to push a box of books a specific distance.
Motion:	The act of something moving; movement.
Speed:	How fast an object travels.
Friction:	A force caused by two different objects touching each other or moving against each other; friction can slow down or stop the movement of an object.
Inertia:	A tendency of matter to remain at rest if at rest or to keep moving if movement has started unless a force stops the movement.

Materials

- Chart paper for activities and to record data
- Stand to support paper (if needed)
- Marking pens
- Large strip of paper with 5 cm markings to tape to wall
- 7 benches (11 ft x 10 in) that can be placed at different inclines
- 3 pieces of carpet and 3 pieces of window screen to cover benches
- Tape to attach carpet and screen to benches and to tape paper to walls
- 3 pieces of wood long enough to span 3 benches (for example 2cm X 2 cm X just over 1 m long).
- Pairs or triplets of identical objects to slide down benches such as:
  - Balls
  - beanbags
  - triangular blocks
  - rectangular blocks
  - wooden cars
  - empty plastic water bottles
  - plastic water bottles filled with water
- Plastic crate filled with heavy objects (such as skittles)
- Items to move the crate such as:
  - 4 wooden dowels that are 60 cm (2 ft) in length
  - platform on wheels
  - rope
  - piece of thick paper
  - piece of carpet
- Balls varying in size, mass, and ability to bounce
- Stop watch
- Whistle

In the School Gym

Introductory Discussion

1. Demonstrate and discuss different types of force and motion and ask students questions to build on their knowledge.

- Why don't we float into the air? Demonstrate gravity by dropping two different flat objects at the same time and have them land in aluminum pans (1 sugar packet and 1 Kleenex packet; 1 sugar packet and 4 sugar packets taped together in a stack; etc.). Have students watch and listen and they should discover that the objects fall at the same speed. This demonstration works best if the objects don't bounce.
- Take 2 pieces of identical paper, crumple one piece of paper into a ball and leave the other piece of paper flat. Drop both pieces of paper at the same time. Ask students why the flat piece of paper traveled more slowly through the air (the molecules in the air (air resistance) slowed the downward movement of the paper).
- At the same time, drop a piece of paper from one hand and a book with a piece of paper on top of the book from the other hand (place pillow on the floor to catch the book when it is dropped) and have students observe and discuss what happens.
- Pull and push a crate containing skittles to demonstrate force. Teachers will introduce vocabulary words prior to the lesson and the words will be reviewed during the lesson.

2. Briefly describe the four activities that will be done during the lesson.
3. Safety rules: Don't drop, bounce or throw objects in the direction of people or your feet. Have adults and older students help lift heavy objects.

Science Activity/Experiment

Four Stations are set up in the Gym. One adult is needed to help students at each station.

Divide students into four groups. The students will spend approximately 15 minutes at each station and then rotate as a group to the next station. Save a few minutes at the end of each activity to discuss student observations.

<u>Station 1– Bouncing Balls</u>

1. Students will use a variety of balls of different mass, size, and bounce characteristics to experiment with the amount of force needed to bounce each ball. Students will bounce each ball in 3 different ways:
   - Drop ball without exerting force
   - Push the ball in a downward motion with a medium amount of force from a waist high position
   - Push the ball in a downward motion with as strong a force as possible from a position above the head
2. A long strip of paper with 5 cm increment markings will be taped to the wall so that the height of the bounce can be estimated and recorded on a piece of paper. Ask students to predict which ball will bounce the highest and lowest before starting the activity. Record the approximate height that the balls bounce.
3. See Attachment 1 for an example of a table to record results of the activity.

<u>Station 2 – Friction Caused by 3 Different Surfaces at the Same Incline</u>

1. One bench will be used without anything covering the surface, the surface of the second bench will be covered with carpet, and the surface of the third bench will be covered with window screen. The three benches will be attached to wooden climbing bars at the same incline.

2. Students will use three identical objects to observe how the friction from the 3 bench surfaces influences the travel of objects down the length of the bench. Use a piece of wood that is long enough to span the 3 benches to help release the 3 identical objects at the top of benches at the same time.
3. Ask students to predict which surface will help the objects travel fastest. Record which object reaches the end of the bench 1st, 2nd, and 3rd, or if an object couldn't travel down the bench.
4. After all objects are tested and if there is time, all benches can be placed at a steeper incline and the objects can be re-tested (use the same incline for all benches).
5. See Attachment 1 for an example of a table to record results of the activity.

Station 3 – Friction Caused by 2 Different Surfaces at 2 Different Inclines

1. Two pairs of benches will be used for this activity. The first pair of benches will be used without anything covering the bench surfaces and these benches will be placed side by side, but at different inclines. The second pair of benches will be covered with the same material (such as carpet) and these benches will be placed side by side but at different inclines.
2. Students will use pairs of identical objects to observe how the bench inclines influence the travel of objects down the length of the 2 benches (acceleration). Record which object reached the end of the bench 1st or if an object couldn't travel down the bench.
3. After all materials are tested and if there is time, objects can be re-tested using different bench inclines or a pair of benches covered with window screen and placed at different inclines.
4. See Attachment 1 for an example of a table to record results of the activity.

The teacher will observe student prediction and comments during the experiment for understanding and inclusion of vocabulary.

Station 4 – Moving a Heavy Crate

1. A plastic crate will be filled with heavy objects (such as skittles). Various materials will be placed next to the crate such as 4 wooden dowels that are 60 cm 2 ft) in length, platform on wheels, rope, piece of thick paper, and piece of carpet.
    - Students will be asked to figure out as many ways as possible to move the crate (without removing the skittles from the crate) and how much work was needed to move the crate. Students can also use their bodies to move the crate. Students can then be asked which method made it easiest to move the crate. An adult should help students lift the crate.
    - Mark a distance on the floor that the students need to move the crate. Record the different ways that were used to move the crate, how many students were needed to move the crate, and whether a lot of work or a small amount of work was needed to move the crate.
    - See Attachment 1 for an example of a table to record results of the activity.

Science Journal: Students will record discoveries that they made about force and motion and what surprised them about force and motion.

Closure Discussion

Ask questions so that students can share their discoveries and to build on their knowledge. Promote discussion about force, motion, mass, friction, gravity, inertia, and the laws of motion. Examples of questions are below.

1. Bouncing balls: What did you discover when you bounced the balls? Did balls move before you picked them up? How did force affect the movement of the balls? When you pushed down on the ball, why did it go up and then fall down?
2. Friction caused by 3 different surfaces at the same incline: How did the shape of the objects affect their movement down the incline? How did the bench surface affect the movement of objects? Which bench surface has more friction? Why did the objects stop moving when they reached the end of the bench?
3. Friction caused by 2 different surfaces at 2 different inclines: How did the slant of the bench affect the movement of objects? How did the bench surface affect movement of objects? How can you slow down the movement of objects as they travel down the bench surface? How can you speed up the movement of objects as they travel down the bench surface?
4. Moving a crate filled with wooden skittles: What did you discover when you tried to move the crate? Why did it take energy (work) to move the crate? Which way was easiest to move the crate? Were you able to reduce the friction between the crate and the floor surface when you moved the crate?

References

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Extension of Lesson Plan

1. Paper airplanes (force, motion, lift, and air pressure).
2. Spin tops on different surfaces (friction, force, motion).
3. Spin objects in a salad spinner (force, motion, centrifugal force).
4. Build a Newton's cradle (force, motion, and inertia) http://www.fi.edu/pieces/knox/automaton/newtoncradle.htm.
5. Build a boat, float the boat on water, how many ways can you move the boat, how much weight can you put on the boat before the boat sinks (force, motion, buoyancy).
6. Simple machines (wedge, lever, pulley, wheel and axle, crank, and inclined plane).

Attachment 1: Sample Tables for Recording Data

Add space below columns as needed to record data for all materials that were tested. Use a different piece of paper to record results for each group of students.

Station 1, Bouncing balls

How high did the balls bounce?

Type of ball	Drop ball using no force	Drop ball using medium force	Drop ball using strong force

Station 2, Friction caused by 3 different surfaces at the same incline

Which object reached the end of the bench 1st, 2nd or 3rd?

Object	Bench with no surface cover	Bench covered with carpet	Bench covered with window screen

Station 3, Friction caused by 2 different surfaces at 2 different inclines

Which object reached the end of the bench 1st?

	Bench with no surface cover		Bench covered with carpet	
Object	Medium incline	Steep incline	Medium incline	Steep incline

Station 4, Moving a heavy crate

How can you move the heavy crate? How much work did it take to move the crate?

Different ways I moved the crate:	Number of students that moved the crate.	A small amount of work was used.	A lot of work was used.

Name: _____

Force and Motion Experiments

I learned that:

I was surprised by:
