ACTIVITY 5

HOW TO MAKE AN OBJECT THAT ROLLS AS FAR AS POSSIBLE?

EXPERIMENT OBJECTIVES AND CONTENT

In this activity, students design and make a rolling object and study the different forces that allow or hinder its motion.

ESSENTIAL KNOWLEDGE

Matter:
- Properties and characteristics of matter in different states (solid, liquid, gas): shape, texture, mass and weight, density

Energy:
- Forms of energy (mechanical)
- Transformation of energy: from one form to another

Forces and motion:
- Effects of a force on the direction of an object (pushing, pulling)
- Characteristics of motion (direction, speed)

Systems and interaction:
- How manufactured objects work (materials, shapes, functions)
- Transportation technology

Techniques and instrumentation:
- Manufacturing
- Use of simple measuring instruments
- Use of tools
- Design and manufacture of machines and models

Appropriate language:
- Terminology related to an understanding of the material world
- Conventions and types of representation specific to the concepts studied: drawings, sketches

SUGGESTED MATERIALS

Household materials:
- Small bottles and plastic caps
- Small cardboard boxes
- Polystyrene and wood blocks
- Wooden meat skewers
- Stir sticks, straws
- Samples of fabric
- Tissue paper, paper towels
- Balloons
- Wheels from toys
- Binder clips, clothespins
- Coins
- Blow dryer
- Hammers, screwdrivers, screws, nails, measuring tapes

School supplies:
- Pencils, scissors, rulers
- Staplers, thumbtack, elastics
- Adhesive tape, adhesive gum
- Cardboard
- Old pens
- Split-shank fasteners

School equipment:
- Chairs

CONTEXT: SITUATIONAL PROBLEM OR RESEARCH QUESTION

You and your friends decide to test which of your toy race cars can go the farthest, the one with the big wheels or the longest one. Since the results are not conclusive, you decide to check for yourself what factors affect their performance. You decide to build cars and equip them with systems that will propel them as far as possible. How will you go about it?

SUGGESTED PREPARATORY ACTIVITIES (INTRODUCTION)

Before beginning the activity, it is suggested to have a discussion with the students so they determine which parts are essential to the construction of a rolling vehicle: wheels, axles and body. The teacher could show them a sketch to help them visualize the car and discuss the different factors that influence the distance a rolling object will travel: propulsive force, aerodynamic form, reduction of friction surfaces, etc. The students can also bring materials from home to build their vehicles.

RECORD ALL YOUR IDEAS AND OBSERVATIONS IN YOUR EXPERIMENT WORKBOOK.

INITIAL IDEAS AND HYPOTHESES

Here are a few examples of hypotheses the students might formulate based on their initial ideas:

DESIGNING AND MAKING THE ROLLING OBJECT

Example 1
I predict that my car will go farther if I give it an aerodynamic shape. I predict this because real race cars have streamlined shapes.

Example 2
I predict that my car will roll in a straight line, and therefore go father, if I position the two axles perpendicular to the body of the car and parallel to each other. I predict this because my big sister once made a soapbox car and this was a very important factor.

Example 3
I predict that my car will go farther if I attach the wheels so they can turn without rubbing. I predict this because when my toy cars get damaged and the wheels rub against the chassis, they don't roll as fast or as far.

DESIGNING AND MAKING THE PROPULSION MECHANISM

Example 1
I predict that if I use a blow dryer to blow on a small sail on the roof of my car, it will go a long way. I predict this because I have seen television programs with sail cars on the beach.

Example 2
I predict that if I use an elastic to propel my car, it will roll faster and far. I predict this because I once broke one of my toy cars and it had an elastic inside.

Example 3
I predict that if I attach an inflated balloon to the roof of my car and then let it deflate, my car will go fast. I predict this because when you let the air out of a balloon, it flies around all over the place very fast.

WORK PLAN AND EXPERIMENTATION

Here are a few examples of experiments the students can carry out to verify their hypotheses:

Example A
The students build a car out of a small cardboard box and give it a shape that slopes down toward the front. They build a little sail from wooden rods and tissue paper, and use adhesive gum to attach it to the body of the car. Air from a blow dryer is directed toward the sail and the distance covered by the car is measured and recorded. It is also possible to make the sail out of straws and a piece of cloth. If the car does not seem stable enough, the students can increase its weight by sticking coins to the body.

Example B
The students build their car out of a block of wood. For wheels, they use bottle caps with holes punched in the centre. They attach the wheels to the chassis with nails, making sure to align them properly. The holes in the wheels must be larger than the diameter of the nails so they turn freely. The car is propelled with an elastic, and the distance travelled is measured and noted. The elastic can be used in several different ways: like a sling-shot, by attaching it to two chair legs, or by winding it around an axle while stapling one end to the body of the vehicle. Another option would be to hammer a nail into the front of the vehicle and stretch an elastic from it.

Example C
The students use a wooden rod inserted into a straw that is shorter than the rod. They attach a wheel to each end of the rod. Two straws prepared this way are then stuck beneath the vehicle, parallel to each other and perpendicular to the car's chassis. In this case, the axles turn along with the wheels. An inflated party balloon, with its opening held closed with a binder clip, is then attached to the top of the car. The distance travelled by the car is measured and recorded after the clip is removed. You could also use a rigid cylinder, such as a pen body with a cap.

Note: The students should work on their prototype until they have something they think will work optimally.

EXPERIMENTAL FACTORS

To ensure scientific rigor, the students should evaluate the experimental factors that might influence the experimental results.

- Size, shape and weight of car
- How parallel the axles are
- Material, diameter and width of wheels
- Wheels' freedom of motion
- Size of propulsion system in relation to the car (e.g., size of balloon)
- Force of propulsion system in relation to car (e.g., force of air)

DISCUSSION: SUGGESTED INTEGRATION ACTIVITIES (CONSOLIDATION)

The students are asked to write the distance travelled by their cars in a table. The teacher reviews the activity with the class: Were all the groups able to build a car that rolled in a straight line? What propulsion system seemed the most effective? What were the main difficulties encountered? Each team can then present their vehicle to the rest of the class, explain the propulsion system used and do a demonstration.

SUGGESTED ACTIVITIES FOR APPLYING KNOWLEDGE (APPLICATION)

The teacher suggests that the students conduct research into the propulsion systems of real cars, pointing out the advantages and disadvantages of each technology. Some teams could work on conventional propulsion systems, while others explore alternative systems that are more environmentally friendly. A debate could then be set up between the two groups, each side defending the technology they studied and explaining why it has a place in the transportation industry.

SCIENTIFIC CONCEPTUAL CONTENT

Aerodynamic profile
When a body is smooth and streamlined, it is more aerodynamic. This allows it to move through the air better, since the air flows more smoothly over it.

Force
In physics, a force is an action that changes a body's speed such that it changes motion or is deformed. Force is often represented by an upper case F, above which a small arrow is placed to indicate its direction ($\vec{F}$). Force is measured in units called newtons (N).

Friction
This is the force that occurs when one surface moves over another. The science of friction, wear and lubrication is called tribology.

Opposite forces
These are forces that act in opposite directions. For example, the force that propels the car forward is opposed by the force of friction of the car against the air and the friction of the wheels on the ground. As long as the propulsive force is greater than the sum of the two other forces, the car will keep moving forward.

CULTURAL REFERENCES

History of the automobile
The term "automobile" is formed from the Greek prefix "autos," which means "self," and the Latin suffix "mobile," which means "moveable." Automobiles thus move by themselves, unlike vehicles from the past that were pulled by horses. It would appear that the very first steam-powered vehicle was invented by a Belgian Jesuit named Ferdinand Verbiest, who described his machine in the work *Astronomia Europa* in 1668. The first "steam wagon" was invented later by Joseph Cugnot in 1769 for the purpose of pulling heavy cannons. Its maximum speed was 4 km/h and it could only operate for 15 minutes before it required refueling. In 1860, Étienne Lenoir invented the combustion engine, but the first gasoline powered car was not built until 1903 by Henry Ford.

Automobiles and society
The use of cars is so widespread that it has many impacts on the organization of everyday life. Since it is now possible to travel great distances in very little time, the road network has grown and people often live far from where they work. The construction of new roads, urban sprawl and massive automobile use, which has spread worldwide, have caused numerous problems. These include increase greenhouse gas emissions, atmospheric pollution, global warming, depletion of oil reserves, destruction of plant and animal habitat, pollution of soil and water from water running off roads, etc. Since society needs its automobiles, some companies are already working on new, less environmentally harmful, models such as electric and hybrid-electric cars.

FOR MORE CULTURAL REFERENCES,
VISIT THE ÉCLAIRS DE SCIENCES WEBSITE:
www.eclairsdesciences.qc.ca

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PROCESS OF ACTIVE DISCOVERY

GENERAL LEARNING PROCESS IN SCIENCE AND TECHNOLOGY (IN ELEMENTARY SCHOOL)

Context related to everyday life

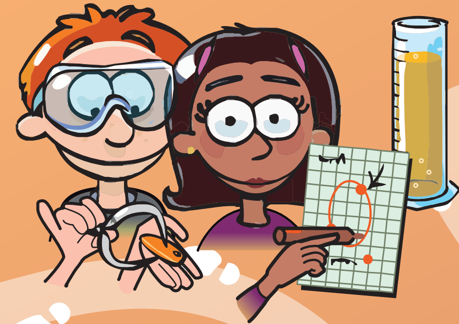
- **Situation problem** or
- **Discovery question** or
- **Need to be fulfilled**
- **Question related to the operation of an object** (how does it work?)

Initial ideas and hypothesis

My initial ideas:
- I share my own ideas.

My hypothesis:
- I predict that...
  I think that because…
- I imagine my prototype.
- I think it works like this…

Planning and carrying out



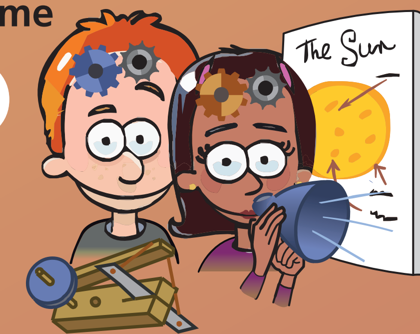
My equipment:
- I observe and handle the equipment.
- How could this equipment be useful to me?
- I choose my equipment and my materials.

Carrying out my process:
- What will the steps be?
- What precautions should I take?

My actions:
- I carry out the steps of my protocol.
- I note or draw what I observe, what I do and what I discover.

My results:
- What is my answer to the problem, question or need?

Outcome



My outcome:
- Do my results confirm my hypothesis or not?
- Are my results similar to those of the other teams?
- Can the other teams' results help me to find answers to my problem, my question or my initial need?
- What could I communicate concerning my discoveries?

New question?

What I learned:
- What do I retain from this activity?
- What could I communicate concerning my results or my discoveries?

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