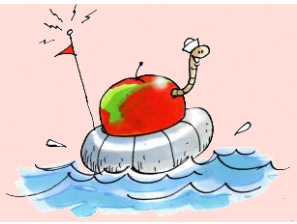

QUICK ENGINEERING CHALLENGE 2016

An Apple Flotation Device

Teacher's Guide

- **Levels:** Elementary 3 and Secondary 1
- **Recommended duration:** About 90 minutes, including setup and explanations
- **Teams:** Two or three participants per team

Knowledge to be acquired

Elementary 3

Matter

- The properties and characteristics of matter in different states (solid, liquid, gas)

  - Mass and weight
  - Density
  - Relative density and buoyancy
  - Materials of which an object is made

Forces and motion

- Effects of gravitational attraction on an object

Techniques and instrumentation

- Manufacture
- Design and manufacture of instruments, tools, machines, structures, devices, models and simple circuits

Secondary 1

Competencies to be acquired

- Seek solutions to technological problems
  - Identify a problem
  - Choose a design scenario
  - Implement the design
  - Analyze the results

Program content

- The material world

- Properties: external characteristics, mass, volume, etc.

- The technological world

- Engineering: construction drawings, raw materials, materials
- Technological systems: components of a system

Please familiarize yourself with the challenge before reading the Teacher's Guide.

Introduction

The total duration of the activity is about 80 minutes for Secondary 1 and about 90 minutes for Elementary 3. To prepare for holding the challenge during *24 Hours of Science*, you can ask your students to bring the required materials to class ahead of time, but don't tell them what they'll be used for. The day of the challenge, show them the explanatory video or read them the introduction, then let them begin.
Encourage the students to think about what they are doing and to make any necessary changes while they are designing their buoys and testing them in water.

Carrying out the challenge

We suggest dividing the class into teams of two or three students. However, the teams can be larger if necessary (for example, if you are short of space or materials).

During the final testing of the buoys, question the students about what they observe. Ask them to formulate preliminary hypotheses about the performance of each buoy. At the end of the challenge, discuss the process and the results with the students.

Questions for discussion

- Some of the buoys worked well; others, not so well. Why?
- What do the buoys that worked well have in common? What was lacking in the ones that didn't work well?
- Which materials were the most effective in this challenge? Were some components ineffective? Why?
- Which components had the best characteristics (solidity, density, rigidity, buoyancy, etc.)?

- Do you think that these buoys would really work in rougher conditions in the ocean? What improvements would be required in order for them to work effectively over a long period of time?

Conclusions

An apple can float in water all by itself—try it! But most of its volume will be under the surface of the water (like an iceberg's). That means that its relative density is lower than that of water, but not by much. The flesh of a fresh apple contains 20% to 25% air. That's why it can float.

Adding other components whose relative density is much lower than that of water (such as styrofoam or a capped, empty plastic bottle) reduces the total relative density of the buoy until it is low enough to enable the apple to float above the water.

However, making it float no matter which side is up takes some ingenuity. If all the buoyant materials are attached to the same side of the apple, the apple will be almost submerged under its ineffective "floats."

Definitions

Density: the mass of a precise volume of a material. For example, a litre of liquid water weighs almost a kilogram. Therefore, its density is 1 kg/L. (However, this value varies slightly with temperature: the colder the water, the higher its density.) Density can be expressed in grams per litre (g/L), kilograms per cubic metre (kg/m^3), grams per millilitre (g/mL), etc.

Relative density: the ratio of the density of a given material to the density of water. A material that has a relative density of 1 has the same density as water. A material that has a relative density of 2 has a density that is double that of water. Another material with a relative density of 0.5 has a density that is half that of water. For example, oil has a relative density of about 0.8, so it floats on water. Iron has a relative density of 7.87, so an iron nail will sink in water.

After May 8 2015, the deadline for the challenge, Science pour tous will send teachers photographs of devices that work. However, if you would like to receive the photos before the activity, just request them from Science pour tous.

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Illustration : Jacques Goldstyn