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Buoyancy

Quebec - Achievements and Competencies

Learning Outcomes

Cycle 1 (Gr. 7-8)	Cycle 2 (Gr. 9-10)
Properties of matter	Characteristic physical properties
Properties of solutions	Chemical changes
Chemical changes	

The Quebec Achievements and Competencies are based on the Progression of Learning Outcomes derived from the Quebec Education Plan set by the Ministere de l'Education, du Loisir et du Sport.

Specific Expectations

GENERAL EDUCATION PATH

CYCLE 1 (Gr. 7-8) — Secondary 1 and 2

MATERIAL WORLD

A. Properties
    1. Properties of matter
        a. Mass
            i) Defines the concept of mass
        b. Volume
            i) Defines the concept of volume

Students will explore the concept of buoyancy in this investigation. They must understand the concepts of mass and volume in order to fully understand density and buoyancy. In order to calculate the gravitational force and the buoyant force, students need to know that density is mass divided by volume.

    3. Properties of solutions
        a. Solutions
            i) Describes the properties of an aqueous solution (e.g. only one visible phase, translucent)

Students will learn that density changes when various amounts of solute are added to a solvent. This concept is explored in the *Pop Floats* investigation (Station 3). Students should under why regular pop rises when salt is added to the water in the tank. When salt is added to the water, the density of the water changes. When the density of the salt water is equal to the density of the regular pop in the can, the buoyant force and the gravitational force cancel each other out. Without the two forces acting on the pop can, the can is left floating (or suspended) in the salt water.

B. Changes
3. Chemical changes
a. Chemical changes
i) Describes the indicators of a chemical change (formation of a precipitate, effervescence, colour change, heat, light)
ii) Explains a chemical change based on the changes in the properties of the substances involved

In the *Conservation of Mass* activity (Station 2), students should recognize that a chemical reaction occurs when the antacid is added to the water in the bottle. This is demonstrated by the production of a gas. The students should also recognize that when the sugar is added to the water, no chemical change occurs.

CYCLE 2 (Gr. 9-10) — Secondary 3

MATERIAL WORLD

A. Properties
2. Characteristic physical properties
c. Density
i) Explains the concept of density
ii) Determines the density of different substances

Students must understand and explain the concept of density as they investigate buoyancy. In the *Pop Floats* activity (Station 3), when the students place the regular and diet pop cans in water, salt water, and rubbing alcohol, they should recognize why the cans float or sink. If the density of the pop is greater than the density of the liquid it is placed in, the can will sink. If the density of the pop is less than the density of the liquid it is placed in, then it will sit in that fluid (float and be suspended in the liquid), depending on the net force. The net force is the difference between the buoyant force and the gravitational force acting on the pop can.

Secondary 4

MATERIAL WORLD

B. Changes
3. Chemical changes
j. Law of conservation of mass
i) Explains the law of conservation of mass during a chemical reaction
ii) Represents the conservation of mass using the particle model

During the *Conservation of Mass* investigation, students will test the law of conservation of mass at Station 2. Students will calculate whether a change in mass occurs when water is mixed with another substance (antacid or sugar).

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EST Secondary 4

MATERIAL WORLD

B. Changes
  5. Transformation of energy
    f. Effective force
      i) Defines effective force as the component of the applied force parallel to the direction of travel

Students will investigate the gravitational and buoyant forces acting on various objects. In the *Find the Hidden Message* activity (Station 1), students discover that squeezing the bottle causes the test tube to sink. The applied force (the squeezing) creates a decrease in the buoyant force, and because the gravitational force now exceeds the buoyant force, the test tube sinks to the bottom of the bottle, following the pull of gravity.

    h. Relationship between mass and weight
      i) Describes qualitatively the relationship between mass and weight
      ii) Applies the mathematical relationship between mass and weight ($F_g = mg$)

In the *Conservation of Mass* activity (Station 2), students measure the mass of the products and reactants before and after they are mixed together. Students need to understand the relationship between mass and weight. They should recognize that the gravitational force that acts on an object determines its weight, and so the weight can change depending on the gravitational force. On earth, the gravitation force is approximately 9.8 m/s^2. Students will use the mathematical relationship to calculate the gravitational force and buoyant force acting on the object (bottle and balloon) to further determine the net force acting on it.

APPLIED GENERAL EDUCATION PATH

CYCLE 1 (Gr. 7-8) — Secondary 1 and 2

MATERIAL WORLD

A. Properties
  1. Properties of matter
    a. Mass
      i) Defines the concept of mass
    b. Volume
      i) Defines the concept of volume

Students will explore the concept of buoyancy in this investigation. They must understand the concepts of mass and volume in order to fully understand density and buoyancy. In order to calculate the gravitational force and the buoyant force, students need to know that density is mass divided by volume. They will need to use this information in the calculation of the buoyant force.

B. Changes
1. Changes in matter
c. Solutions
i) Describes the properties of an aqueous solution (e.g. only one visible phase, translucent)

Students will learn that density changes when various amounts of solute are added to a solvent. This concept is explored in the *Pop Floats* investigation (Station 3). Students should under why regular pop rises when salt is added to the water in the tank. When salt is added to the water, the density of the water changes. When the density of the salt water is equal to the density of the regular pop in the can, the buoyant force and the gravitational force cancel each other out. Without the two forces acting on the pop can, the can is left floating (or suspended) in the salt water.

3. Chemical changes
a. Chemical changes
i) Describes the indicators of a chemical change (formation of a precipitate, effervescence, colour change, heat, light)
ii) Explains a chemical change based on the changes in the properties of the substances involved

In the *Conservation of Mass* activity (Station 2), students should recognize a chemical reaction occurs when antacid is added to the water in the bottle. This is demonstrated by the production of a gas. Students should also recognize that when sugar is added to the water, no chemical change occurs.

CYCLE 2 (Gr. 9-10) — Secondary 3

MATERIAL WORLD

A. Properties
2. Characteristic physical properties
c. Density
i) Explains the concept of density
ii) Determines the density of different substances

Students must understand and explain the concept of density as they investigate buoyancy. In the *Pop Floats* activity (Station 3), when the students place the regular and diet pop cans in water, salt water, and rubbing alcohol, they should recognize why the cans float or sink. If the density of the pop is greater than the density of the liquid it is placed in, the can will sink. If the density of the pop is less than the density of the liquid it is placed in, then it will sit in that fluid (float and be suspended in the liquid), depending on the net force. The net force is the difference between the buoyant force and the gravitational force acting on the pop can.

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Secondary 4

MATERIAL WORLD

D. Fluids
- d. Archimedes' principle
  - i) Describes the relationship between the weight of the water displaced by an immersed body and the upward acting force
  - ii) Explains the buoyancy of a body in terms of Archimedes' principle

Throughout the investigation, students are learning about the gravitational and buoyant forces acting on an object. By the end of the lesson, students should understand Archimedes' principle: the buoyant force is equal to the weight of the displaced fluid. Students can test this when they investigate the law of conservation of mass (Station 2) and use this theory to discuss the actual and apparent weights of the bottle and balloon before and after the chemical reaction occurs.

G. Force and Motion
- g. Distinction between mass and weight
  - i) Qualitatively describes the relationship between mass and weight
  - ii) Applies the mathematical relationship between mass and weight ($F_g = mg$)

In the *Conservation of Mass* activity (Station 2), students measure the mass of the products and reactants before and after they are mixed together. Students need to understand the relationship between mass and weight. They should recognize that the gravitational force that acts on an object determines its weight, and so the weight can change depending on the gravitational force. On earth, the gravitation force is approximately 9.8 m/s^2. Students will use the mathematical relationship to calculate the gravitational force and buoyant force acting on the object (bottle and balloon) to further determine the net force acting on it.

SE Secondary 4

MATERIAL WORLD

B. Changes
- 3. Chemical changes
  - j. Law of conservation of mass
    - i) Explains the law of conservation of mass during a chemical reaction
    - ii) Represents the conservation of mass using the particle model

Students will test the law of conservation of mass at Station 2 during the *Conservation of Mass* investigation. Students will calculate whether a change in mass occurs when water is mixed with another substance (antacid or sugar). Furthermore, using Archimedes' principle, students will learn that the buoyant force acts in opposition to the gravitational force, therefore decreasing the "actual weight" of the object.

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G. Forces and Motion
  e. Effective force
    i) Defines effective force as the component of the applied force parallel to the direction of travel

Students will investigate the gravitational and buoyant forces acting on various objects. In the *Find the Hidden Message* activity (Station 1), students discover that squeezing the bottle causes the test tube to sink. The applied force (the squeezing) creates a decrease in the buoyant force, and because the gravitational force now exceeds the buoyant force, the test tube sinks to the bottom of the bottle, following the pull of gravity.

Techniques

B. SCIENCE
  a. Safely using laboratory materials and equipment
    i) Uses laboratory materials and equipment safely (e.g. allows hotplate to cool, uses beaker tongs)

  d. Using measuring instruments
    i) Adopts the appropriate position for reading an instrument
    ii) Measures the mass of a substance using a balance
    iii) Measures the volume of a liquid using the appropriate graduated cylinder

C. TECHNIQUES
  a. Verifying the repeatability, accuracy and sensitivity of measuring instruments
    ii) Carries out the required operations to ensure the accuracy of a measuring instrument (e.g. cleans and calibrates a balance, dries out a graduated cylinder, rinses and calibrates a pH-meter)

Strategies

A. EXPLORATION STRATEGIES
  6. Formulating questions
  7. Putting forward hypotheses (e.g. individually, in teams, as a class)
  8. Exploring various ways of solving the problem
  10. Imagining solutions to a problem in light of his or her explanations
  12. Examining his or her mistakes in order to identify their source
  13. Using different types of reasoning (e.g. induction, deduction, inference, comparison, classification)
  16. Collecting as much scientific, technological and contextual information as possible to define a problem or predict patterns

B. INSTRUMENTATION STRATEGIES
  3. Using technical design to illustrate a solution (e.g. diagrams, sketches, technical drawings)
  4. Using different tools for recording information (e.g. diagrams, notes, graphs, procedures, logbook)
  5. Using a variety of observational techniques and tools
  6. Selecting suitable techniques or tools for observation

C. ANALYTICAL STRATEGIES

1. Identifying the constraints and important elements related to the problem-solving situation
3. Using different types of reasoning (e.g. inductive and deductive reasoning, comparison, classification, prioritization) in order to process information

D. COMMUNICATION STRATEGIES

1. Using different means of communication to propose explanations or solutions (e.g. oral presentation, written presentation, procedure)
3. Exchanging information
4. Comparing different possible explanations for or solutions to a problem in order to asses their relevance (e.g. full-group discussion)
5. Using tools to display information in various formats (e.g. data tables, graphs, diagrams)