SCIENCE NORTH SCIENCE NORD
SUDBURY, ONTARIO, CANADA

Edible Water Bottles for Marathons	Grade 11 Chemistry (SCH3U)

Lesson Plan

Learning Outcomes

Students will look at the impact of disposable single-use plastic bottles vs. biodegradable solution.

Students will discuss the impact of "green" solutions on the environment.

Students will perform a hands-on activity to see an actual double displacement chemical reaction.

Specific Expectations

Matter, Chemical Trends, and Chemical Bonding: B1.1 analyse, on the basis of research, the properties of a commonly used but potentially harmful chemical substance and how that substance affects the environment, and propose ways to lessen the harmfulness of the substance or identify alternative substances that could be used for the same purpose [IP, PR, AI, C]

Chemical Reactions C2.3 investigate synthesis, decomposition, single displacement, and double displacement reactions, by testing the products of each reaction [PR, AI]

C2.6 predict the products of double displacement reactions [AI]

C3.1 identify various types of chemical reactions, including synthesis, decomposition, single displacement, double displacement, and combustion.

Solutions and Solubility E1.1 analyse the origins and cumulative effects of pollutants that enter our water systems and explain how these pollutants affect water quality [AI, C]

E1.2 analyse economic, social, and environmental issues related to the distribution, purification, or use of drinking water (e.g., the impact on the environment of the use of bottled water) [AI, C]

Description

Students will use Problem-Based Learning to come up with a solution to the use of disposable water bottles in large events like marathons or festivals, perform a double displacement chemical reaction to create a polymer and figure out ways to minimize the impact on our water systems when using biodegradable polymers to deal with single-use plastics.

Materials

- Informational materials on chemical reactions, polymers, and the use of edible water containers in marathons.
- Sodium alginate solution 1% by weight (prepared)
- Calcium chloride solution 1% by weight (prepared)

- Water
- Large bowl
- Smaller bowl
- Blender or hand mixer
- Optional: Various fruit juices or flavored water (for taste)
- Spoons with rounded bottoms (size will determine the size of your water bubble)
- Safety equipment (gloves, goggles)
- Accessible measuring tools
- Digital scale
- Whiteboard and markers
- Optional:
  - Lithium Chloride solution 1% by weight (prepared)
  - Potassium Chloride solution 1% by weight (prepared)
  - Magnesium Chloride solution 1% by weight (prepared)

Introduction

Discuss the importance of hydration for athletes, specifically in the context of marathon runners. Introduce the problem: How can we create a sustainable and convenient hydration solution for marathon runners? How do we dispose of this new product?

Students will **brainstorm** some ideas they may have seen or heard of. Some students might come up with ideas that are new and innovative.

Briefly review chemical properties related to polymers and gels. Introduce the chemical reaction of sodium alginate and calcium chloride to form edible water bubbles. Ask the students what type of chemical reaction they think this might be.

Double displacement:

$2NaC_6H_7O_6 + CaCl_2 \rightarrow 2NaCl + C1_2H_{14}CaO_{12}$

sodium alginate and calcium chloride make sodium chloride and calcium alginate

Action

Hands-on Activity: Creating Edible Water Bubbles (45 minutes)
See the additional **Spherification Experiment Handout** for the chemical reaction experiment instructions.

- Divide students into groups.
- Students will need to design their own experiment with a specific question in mind. They will design their own data collection tables and plan how they might perform their experiment with the help of the handout: **Spherification Experiment Handout.**
- Before starting the experiment, ask the students to come up with what they will be testing, and what their hypothesis might be. Some suggestions of observations:
- **Quantitative Observations:**
  - Size of the spheres after a specified time in the calcium chloride solution.
  - Size of the spheres after a specified time in open air.

- Mass of spheres using different concentrations of the calcium chloride solution.

- **Qualitative Observations:**
  - Springiness of the spheres after a specified time in the calcium chloride solution.
  - Springiness of the spheres after a specified time in open air.
  - Durability of the spheres using different types of solutions. (See the lesson plan for suggested solutions.)

- Instruct students to create edible water bubbles using the chemical reaction between sodium alginate and calcium lactate.

Data Analysis (30 minutes):
- Ask students to record their experimental setup, observations, and results.
- Discuss the chemical principles behind the formation of edible water bubbles, and whether their experiment helped answer their question.

Problem-Solving (20 minutes):
- Challenge students to discuss the advantages and potential challenges of using edible water bubbles for marathon runners.
- Encourage creative thinking about packaging, convenience, and sustainability.
- Think about what happens when we dispose of biodegradable polymers into our sewer systems. What are some health and safety concerns with regards to handing out edible water bubbles?

Class Presentations (20 minutes):
- Each group presents its findings and proposed solutions.

Consolidation/Extension

Students can see if there is a difference in the resulting polymers when using different chloride solutions listed above. Does length of time in the calcium chloride solution affect the polymer "skin"? Can the quality of the polymer be modified by changing the concentrations of the solutions?

Look at how quickly the polymers degrade and breakdown/dissolve or how long they last in open air.

Students can further explore topics like biodegradable materials, waste reduction and renewable resources, efficiency and safety, consumer awareness and sustainable practices. Green chemistry involves designing products and processes that minimize the use and generation of hazardous substances.

Additional Resources

https://www.edu.gov.on.ca/eng/curriculum/secondary/2009science11_12.pdf

What is a polymer? https://www.cmu.edu/gelfand/lgc-educational-media/polymers/what-is-polymer/index.html

Alginate: https://fr.wikipedia.org/wiki/Alginate

Ooho: edible water bubble: https://www.designboom.com/technology/skipping-rocks-lab-ooho-edible-water-bottle-04-12-2017/

Ooho: la bulle d'eau comestible: https://moregreen.fr/news/ooho-la-bulle-deau-comestible/