

ENERGY IN A BOTTLE

Teaching Guidelines

Summary: Students work in teams to carry out and present research concerning the chemistry of energy storage in fuels and batteries.

Subject: Science

Topics: Chemistry

Grades: 9 - 12

Concepts

- Energy
- Energy density

Knowledge and Skills:

- Energy storage forms (fuels and batteries) can be compared in terms of energy density, cost, weight and other factors.

Procedure

Prepare for presentation the Futures Channel movie, *The Ares Launch Vehicles*. Tell students that they will be watching a movie about rockets, and that, as they watch, you want them to think about this question:

What do rockets, cars and cell phones have in common?

Play the movie, *The Ares Launch Vehicles*, all the way through. Accept and discuss some answers to the prompt, guiding the discussion to focus on the fact that in each case the device operates on energy that it carries with it, as with fuel or in a battery.

Tell students that you want them to think for a minute about fuels, like the fuels used in rockets and in cars, using this prompt:

What do you think are the most important properties of a fuel?

Allow some time for students to think of answers, then discuss responses, making a list of properties on the board. Guide the discussion to ensure that your list includes at least these items:

- Cost of fuel
- Weight of fuel
- How much energy is in the fuel
- The chemicals that are released into the air when the fuel burns

Next, you will work out with students how the cost, weight and energy in fuel are measured.

Beginning with cost, get an estimate from students of the current cost of gasoline in your area, and point out that it is given per units of “dollars per gallon,” rather than just “dollars.” Ensure students understand what that unit means and why it wouldn’t make sense to just use the unit of “dollars” to talk about the cost of gasoline.

Next, ask students what units they would use to describe the weight of gasoline. Guide the discussion to agreement that it wouldn’t make sense to use just “pounds,” but rather you would use a unit like “pounds per gallon,” or “kilograms per liter.”

Tell students that gasoline has a weight of about 5.6 pounds per gallon, or 0.7 kilograms per liter.

With the units of “dollar per gallon” and “pound per gallon” written on the board, ask students to think about how fuel energy would be measured, if the unit used for energy is “joules.” Discuss to agreement that you would need to use a unit such as “joules per kilogram” or “joules per liter” in this case.

Tell students that fuels usually have a lot of energy per kilogram, so the unit of “kilojoules” is used, instead of joules. Explain that gasoline has an energy content of around 48,000 kilojoules per kilogram.

Ask students if they think that the energy in gasoline is more concentrated than the energy in their cell phone batteries. Accept some answers, then tell students that such batteries typically have an energy content of around 600 kilojoules per kilogram—much, much lower than gasoline.

Tell students that their task will be to work in teams to find out more about ways that energy can be stored, whether in fuels or in batteries. Each team is to research at least two forms of energy storage and present the results in a report to the class, including visual aids of some sort (slide show or poster).

Distribute the handout, review it to make sure that the task is understood and explain to students when they should work on the project and when it is due.

You may wish to use the provided rubric or (preferably) generate a rubric with the class.

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Task

You and your team are to find out about two forms of energy storage: either as fuel or in batteries. You must answer at least the questions below through your research and report your results to your class. In your report, you should use some type of visual aid to present what you have learned (a slide show, a poster or some other visual form).

Questions

Your research and report should include at least the answers to these questions:

1. What is the purpose of the form of energy storage (what is it used for)?
2. What materials (elements and compounds) are involved?
3. What is the chemical reaction that releases the energy?
4. How is the fuel (or battery) made?
5. How much energy is stored by this form of storage, in kilojoules per kilogram?
6. What is its cost?

Your report should also compare the two forms of energy that you researched.

Presentation

Your presentation should be about 4-5 minutes in length. All members of your team should participate in the presentation. Use images, diagrams and charts to communicate what you have learned in an interesting manner.

Sample Rubric

Aspect of Task	Acceptable	Excellent
Extent of research	All six questions answered.	All questions answered, and more information of interest discovered.
Sources	At least three reliable sources used, all sources cited.	At least five reliable sources used, all sources cited
Presentation	Presentation is at least 4 minutes long. Visual aids are used.	Presentation is at least 5 minutes long. Several visual aids are used, including images, diagrams and charts.
Participation	All members of the team are involved in the research and in the presentation; any member of the team can answer questions about the information presented.	