TEACHER NOTES

Using acids and metals to build 'batteries'

Introduction

This practical activity is a variation on the standard galvanic cell experiment found in many textbooks. Instead of using a salt bridge with two separate half-cells, a single combined cell (piece of fruit) is used.

The term Baghdad Battery is used to refer to three artifacts, which were found together: a ceramic pot, a tube of one metal, and a rod of another. The current interpretation of their purpose is as a storage vessel for sacred scrolls from nearby Seleucia on the Tigris. Those vessels do not have the outermost clay jar, but are otherwise almost identical. (Note [1])

Photographs from The Virtual Museum of Ancient Inventions (Note [2])

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1 "Baghdad Battery", Wikipedia <https://en.wikipedia.org/wiki/Baghdad_Battery> accessed on 19 November 2015.

2 D. Downs and A. Meyerhoff, "Battery, Baghdad, 250 BCE", The Virtual Museum of Ancient Inventions, Smith College, Northampton (MA) <http://www.smith.edu/hsc/museum/ancient_inventions/battery2.html> accessed on 19 November 2015.

There is some speculation that these jars were actually ancient batteries. The Museum of Ancient Inventions has asked you to investigate whether two pieces of metal immersed in fruit juice can make a battery.

Technical tip 1

HINT!

Before inserting any metal electrodes, it is best to gently squeeze the lemon (or orange). Do this gently so the skin of the lemon doesn't rupture. Rolling it on a table with a little pressure works great.

Technical tip 2

HINT!

A single lemon with copper and iron (steel) electrodes generates about 0.7 V, but only about 1 mA. Two lemon batteries in series will generate about 1.5 V, but still only about 1 mA. This is **not** enough current for an incandescent light bulb. (Note [3])

Learning outcomes

At the end of this practical activity, students should

- Be able to make accurate observations of a reaction
- Know that hydrogen gas is produced by an acid plus metal reaction
- Know that various metals have different reactivities when mixed with hydrochloric acid.

Links to the Victorian Curriculum F–10

The main learning outcome is:

- Chemical reactions, including combustion and the reactions of acids, are important in both non-living and living systems and involve energy transfer (VCSSU126)

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[3] California Energy Commission (2006), “Lemon Power”, Energy Quest, California Energy Commission <http://www.energyquest.ca.gov/projects/lemon.html> accessed on 19 November 2015.

Secondary learning outcomes are (potentially):

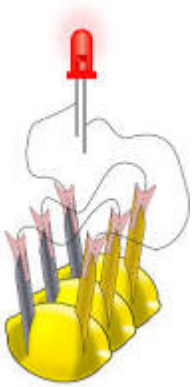
- Energy appears in different forms including movement (kinetic energy), heat, light, chemical energy and potential energy; devices can change energy from one form to another (VCSSU104)
- … chemical reactions … can occur at different rates; chemical reactions may be represented by balanced chemical equations (VCSSU125)
- Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (VCSSU115)
- Formulate questions or hypotheses that can be investigated scientifically, including identification of independent, dependent and controlled variables (VCSIS134)
- Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (VCSIS140)

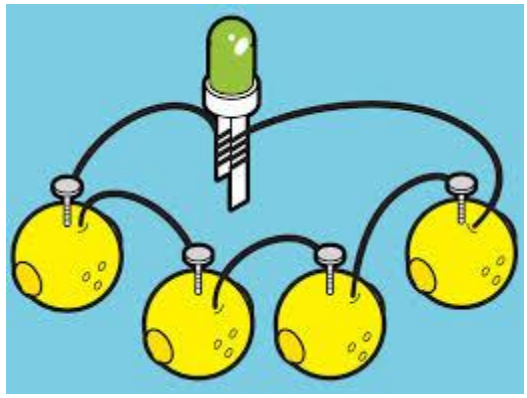
Extensions

This experiment is intended for year 9.

Once the fruit battery has been established, it is possible to add more electrodes ether in parallel or in series, which then addresses a different learning outcome:

- Electric circuits can be designed for diverse purposes using different components; the operation of circuits can be explained by the concepts of voltage and current (VCSSU130)





parallel circuit	series circuit
<https://en.wikipedia.org/wiki/Lemon_battery>	<http://makezine.com/projects/batteries-from-everyday-things/>

Further investigations can include:

1. Investigate the effect on the electric current of cutting up the fruit into pieces. If you do this, you will need to place the pieces of fruit side by side (in series).
2. Insert the (same) two different metals into each piece of cut fruit and connect the different metals using the leads. Experiment with the positioning of the two metals and terminals.
3. Which set up gives the greatest electric current or brightest LED? Draw a picture of this set up.
4. Include a drawing, explaining how you think the electricity is generated. Discuss your suggestions with the group next to you.
5. How did the cut pieces of fruit, making a series circuit, change the electric current? Why do you think this is?
6. You were advised gently squeeze the lemon (or orange) before inserting any metal electrodes. Briefly explain why this is so.
7. Where do you use batteries in everyday life?