ASELL for Schools Workshop

Laboratory Learning Activity Manual

St Margaret's School

22 February 2018

CONTENTS

ACKNOWLEDGEMENTS

We would like to thank:

Copyright Notice

WELCOME

Welcome to an ASELL for Schools Workshop!

ASELL (Advancing Science and Engineering through Laboratory Learning) has developed over the last 10 years. This project developed from its physical chemistry APCELL predecessor and then expanded to incorporate all of chemistry (ACELL). After successful trials of using ASELL principles at workshops in physics and biology, the project has now expanded to include biology and physics, and more recently engineering, hence the name change.

The ASELL project has been designed to help address challenges in student learning which arise in science laboratories. By bringing together diverse expertise and resources, it is possible to develop a collection of experiments, which can facilitate student learning, whilst also taking into account variations in student differences. In 2010, the first national ASELL Science Workshop was held at the University of Adelaide.

This ASELL for Schools workshop is the second Victorian workshop to be run under the Australian Mathematics and Science Partnership Funding Grant, which was awarded to ASELL in 2014. This phase of the project has been initiated by Deakin University in conjunction with the University of Sydney with support from ReMSTEP and the Australian Council of Deans of Science. With the introduction of the new Australian and Victorian Curricula now in place, an opportunity exists to address current school-based experimentation and incorporate science inquiry. ASELL for Schools will provide the following three outcomes:

- A resource, a repository of experiments with all associated documentation necessary to run them, ranging from health and safety notes, necessary equipment and resources, notes for technical staff to the science learning objectives and how the experiment achieves them.
- Authentic professional learning workshops on experimentation in schools.
- An interface and interaction between school and university staff.

Today, you will be participating in laboratory activities and discussion sessions to expand your understanding of issues surrounding learning in the laboratory environment. In particular, it is important to be able to experience the experiments as learners.

In addition to the formal program, please take the opportunity to exchange ideas about science and education and get to know each other, as an additional aim of the ASELL Schools project is to build a community of educators interested in laboratory-based education and other aspects of science education.

We would like to gratefully acknowledge the assistance of technical staff and others in making this workshop possible. A very big thank you to Deborrah Francis and the team at St Margaret's School, for hosting this Workshop. Each person has put in a lot of hard work to get this workshop set up and running. I want to thank everyone!

If you have any questions about the project, please speak with me or one of the Victorian ASELL for Schools team, who are present.

Sincerely,

Kieran Lim

Kieran Lim
ASELL for Schools Victorian Leader, on behalf of the ASELL for Schools Team

ASELL SCHOOLS Advancing Science & Engineering through Laboratory Learning · Australian Council of Deans of Science · ReMSTEP · Australian Government Department of Education and Training Office for Learning and Teaching · DEAKIN UNIVERSITY · ACA FOUNDATION LIMITED

ASELL FOR SCHOOLS WORKSHOP SCHEDULE

<table>
<tr><th colspan="3">ASELL for Schools
St Margaret's School
Thursday 22 February 2018</th></tr>
<tr><td>9:00-9:15</td><td colspan="2">Arrival/Registration tba</td></tr>
<tr><td>9:15-9:30</td><td colspan="2">Welcome and Introduction with Kieran Lim
• Introductions (of ASELL for School team and Students and Teachers)
• Outline ASELL for Schools
• Outcomes for the day
• How to use the booklet
tba</td></tr>
<tr><td>9:30-9:40</td><td colspan="2">Introduction to Laboratory Learning Activity tba</td></tr>
<tr><td>9:40-10:30</td><td colspan="2">Laboratory Learning Activity 1 – Corrosion: All at Sea
Kieran Lim
tba and tba</td></tr>
<tr><td>10:30-11:00</td><td colspan="2">Morning Tea tba</td></tr>
<tr><td>11:00-11:20</td><td rowspan="2">Teachers: Learning in the Laboratory
Peta White
tba</td><td>Students: Discussion and feedback on Laboratory Learning Activity
John Long
tba</td></tr>
<tr><td>11:20-12:20</td><td>Students: Quantifying speed and issues to do with fair testing
John Long and Kieran Lim
tba</td></tr>
<tr><td>12:20-12:30</td><td colspan="2">Introduction to Laboratory Learning Activity Library</td></tr>
<tr><td>12:30-1:15</td><td colspan="2">Lunch tba</td></tr>
<tr><td>1:15-2:05</td><td colspan="2">Laboratory Learning Activity 2 – Bungee Barbie
Kieran Lim and John Long
tba</td></tr>
<tr><td>2:05-2:25</td><td colspan="2">Discussion and feedback on Laboratory Learning Activity 3 tba</td></tr>
<tr><td rowspan="2">2:25-2:55</td><td colspan="2">Overall debrief and Evaluation for the day</td></tr>
<tr><td>Teachers: Overall debrief and Evaluation for the day
Peta White and Kieran Lim
tba</td><td>Students: Overall debrief and Evaluation for the day
John Long
tba</td></tr>
</table>

BLANK PAGE FOR NOTES

LABORATORY LEARNING ACTIVITY 1
CORROSION: ALL AT SEA

Contact: Carolyn Drenen
cardre@tpg.com.au

Contact: Kieran Lim
kieran.lim@deakin.edu.au

Corrosion: All at Sea

Introduction

The ocean is one of the most natural corrosive environments, made up of dissolved minerals (mainly sodium chloride) and carbon dioxide from the atmosphere.

Residents living near coastal areas may need to replace metal objects regularly if left outside for prolonged periods due to corrosion (e.g. cars, bikes, garden tools, BBQ's, golf clubs). Families or businesses that rely on boats and/or other leisure watercraft (e.g. jet skis, yachts, ships) with metallic parts, must deter or protect against the effects of corrosion

Photo: Dr Ian MacLeod, Heritage Conservation Solutions. Photograph used with permission

At some locations, marine archaeologists find metal artefacts and shipwrecks with severe corrosion due to the prolonged time spent submerged in the ocean, while at other sites there are artefacts and shipwrecks with almost no corrosion. Why is there a difference in the extent of corrosion?

In this activity, you will simulate and test which environmental conditions influence the rate corrosion of different metals and describe the observed changes.

Key ideas

Corrosion – The process of destruction or deterioration of a metallic material as a result of chemical reactions with the surrounding environment.

Metal - A substance that usually (1) can conduct electricity, (2) can conduct heat, (2) has shininess (lustre), and can be deformed when struck with a hammer or other hard object (malleability). When metals react, they tend to lose electrons to form positive ions (cations).

Chemical composition – The relative amounts of different elements or substances that are present in a sample.

Alloy - A solid mixture of two or more metals. Some alloys can include non-metal components. Steel is an alloy that consists of iron with small amounts of carbon. Stainless steel is an alloy that consists of iron with small amounts of carbon and about 18% chromium. 18-carat gold in jewellery is an alloy of 75% gold, 7.5% silver and 7.5% copper. Bronze and pewter are other common alloys.

Reactivity series – A ranking of listing of metals from the most reactive to the least reactive.

Solution - A mixture of two or more substances that is homogeneous. Homogeneous means that the solution is evenly mixed and has the same appearance and composition everywhere in the mixture. It is possible to have gas solutions, liquid solutions, and solid solutions. In this laboratory learning activity, **solution** will refer to water-based liquid solutions.

Concentration - The ratio of the amount of a solute in a solvent or total solution. There are many ways of measuring and expressing concentration. In this laboratory learning activity, the concentration will be expressed as the percentage mass per unit volume.

% (m/v) - Percentage mass per volume (%m/v) is one method of measuring concentration, defined as the mass of the solute per 100 mL of solution

$$\text{concentration (\%m/v)} = \frac{\text{mass of dissolved substance (g)}}{\text{volume of solution (mL)}} \times 100\%$$

Dissolve - The process in which the solute interacts with the solvent to form a solution. This only applies to mixtures in which the solute was originally in a different gas/liquid/solid states from the solvent.

Solute – A substance which is dissolved in a solvent to form a solution.

Solvent – The largest component of a liquid or a gas, in which another substance (the solute) is dissolved to form a solution.

Investigation - A scientific process of answering a question, exploring an idea or solving a problem that requires activities such as planning a course of action, collecting data, interpreting data, reaching a conclusion and communicating these activities

Variable - Something that can change.

Dependent variable - Variable that changes in response to changes in the independent variable and that is observed or measured.

Independent variable - Variable that is deliberately changed.

Controlled variables - Variables that are kept constant.

Fair test - When testing different materials all the variables except the one being tested need to be kept the same.

Equipment and materials

- Plastic or glass beakers
- Cooking salt
- Plastic spoons or glass stirring rods
- Demineralised water
- Paper clips, hair pins (or 'bobby pins'), metal washers, aluminium foil (1 cm strips), iron nails, galvanised nails, etc.
- Plastic tweezers or tongs
- 100 mL measuring cylinder
- Sticky labels or marker pens
- Safety glasses/goggles and gloves

Optional

- Metal coins
- Stainless steel cutlery
- Additional metal samples
- Carbonated mineral water or soda water
- Soft drink
- Hot water bath
- Thermometer
- Scissors
- Steel wool
- Emery paper or sandpaper
- Electronic balance or scales
- Timer or stopwatch

Hazards

- Nails, aluminium foil pieces, emery paper and steel wool may cause cuts and/or lacerations to skin if not handled correctly.
- Water that is used in corrosion experiments may contained dissolved ions, and should not be consumed.
- Use of a kettle to boil water must be situated away from wet areas and must be in good condition (i.e. no frayed chords or exposed wires). There is danger of burns from a hot appliance and/or hot water or steam.

Lesson plan organisation

Lessons 1 and 2: Recall of concepts learned from Years 7 and 8 on solutions, solvents, solutes, concentration, reactivity series of metals and chemical reactions involving formation of rust/corrosion.

% (m/v) - Percentage mass per volume (%m/v) is one method of measuring concentration, defined as the mass of the solute per 100 mL of solution

$$\text{concentration (\%m/v)} = \frac{\text{mass of dissolved substance (g)}}{\text{volume of solution (mL)}} \times 100\%$$

Lesson 3: Plan the inquiry and set up the investigation.

Lesson 4: Check the results of the investigation and analyse the results.

Lessons 5 and 6: Complete presentation of the investigation as a laboratory report, scientific poster, multimedia, or other format.

Part A1: Investigation Instructions

You will work in groups of approximately four students. Each group is assigned two metals each, so that each pair of students works with the same metal.

In your groups, design an experiment, using the provided equipment, that will determine if a metal undergoes corrosion.

Suggested procedure for preparation of solutions:

- To prepare a solution of concentration of 5%(m/v) of salt in demineralised water, weigh 5 g of salt into a dry beaker and add approximately 80-90 mL demineralised water. Dissolve the salt before topping up with demineralised water to the 100-mL mark.
- This procedure can be adapted to make solutions with other concentrations of salt in demineralised water.
- This procedure can be adapted to make solutions with other concentrations of salt in other types of water.

Part A2: Scientific questions

Suggest one or two scientific questions that you could ask using your experimental equipment and materials:

Some scientific questions will be more suitable for investigation in a classroom setting. Your teacher will lead a discussion to decide which scientific questions will be investigated. Your group will then decide how to investigate that question.

The scientific question that my group will investigate is:

Our hypothesis is:

Our **independent variable** is:

Our **dependent variable** is:

Our **controlled variables** are:

We will use the following **experimental procedure**. (If appropriate, make a drawing of your proposal.)

Are there any **safety** issues to consider?

Part A3: Testing our scientific question

Get approval from your teacher of your plans (Part A2) before starting Part A3.

Remember to take photos throughout your experiment to add to your scientific poster.

What happened? Record your observations or measurements:

Once all the groups have summarised their observations or measurements, a 'scribe' to collect all the results from each of the groups so that you can collate a summary of the entire class's results.

Part B: Analysis of results

Part C: Drawing conclusions (discussion prompts)

What was the purpose of using demineralised water instead of tap water in this experiment?

Looking at your results, which metals were the most reactive to the corrosive environment(s) simulated in this activity?

Looking at your results, which metals were the least reactive to the corrosive environment(s) simulated in this activity?

Was this a **fair test**? Are there variables that you have not controlled in your experiment? How might these variables affect your conclusions?

Using the internet, learn about the chemical composition (makeup) of some of the metals that you have used in this activity.

Using internet or textbook resources, write a **word equation** for the reaction of one of the metals that you tested from this activity.

Using internet or textbook resources, write a **chemical equation**, described by the above word equation.

Part D: Extension 1

The ocean is not the only corrosive environment. Use the internet or a library to research other types of corrosive environments and the types of corrosion that can occur within them.

Use the internet or a library to research materials or methods used to prevent corrosion and suggest which one(s) are suitable for the environment(s) that you have described above.

In January 2003, the famous chairlift at Arthur's Seat, on the Mornington Peninsula (south of Melbourne) collapsed, injuring passengers and leaving some stranded for several hours (see footnote 1).

Use the internet or a library to research the answers to the following questions:

- What type of corrosion was blamed for this near-disaster?
- How does this type of corrosion occur?
- What types of personnel were involved in the investigation and management of this accident?
- What human factors were involved in the incident?
- How could these factors have been managed?
- What economic costs occurred as a result of the accident?

Part E1: Extension 2 - Instructions

Consult with your teacher if you should do this second extension.

Based on your results and the class results, can you propose some additional tests relating to the corrosion of metals? To better compare your results from this Part with your earlier investigations, it is suggested that you have similar hypotheses and experimental procedures.

[1] The Age (2003). 'Chairlift Collapse 18 Hurt' Retrieved 16th July 2017 from <http://www.theage.com.au/articles/2003/01/03/1041566225573.html>.

Part E2: Extension 2 - Scientific questions

Our hypothesis is:

Our **independent variable** is:

Our **dependent variable** is:

Our **controlled variables** are:

We will use the following **experimental procedure**. (If appropriate, make a drawing of your proposal.)

Are there any **safety** issues to consider?

Part E3: Extension 2 - Testing our scientific question

Remember to take photos throughout your experiment to add to your scientific poster.

What happened? Record your observations or measurements:

Once all the groups have summarised their observations or measurements, a 'scribe' to collect all the results from each of the groups so that you can collate a summary of the entire class's results.

Part E4: Extension 2 - Analysis of results

Part F: Scientific poster

1. Complete introduction:
   - One- to two-paragraph overview of the reason for completing the investigation, the scientific context and an explanation of the relevant scientific theory.
   - All sources need to be acknowledged.
2. Complete the discussion section:
   - Discuss your scientific question in this section. **POE** is often a useful guide is to help what you put in this section:
     a. Predict. Your scientific question, hypothesis and prediction of what will happen.
     b. Observe. What you observed or measured.
     c. Explain. Did your observations or measurements agree with your expectations and prediction? Can you explain why?
   - Discuss the implications of your results.

- Were there any limitations to your investigation?

3. Complete the conclusion section:
    - State your main result from your investigation.
    - State whether this supports or refutes your hypothesis.
4. Complete References and Acknowledgements.

Acknowledgements

The contributions of Linda Lawrie, Jessica Saw and Ian Bentley, to the refinement of this laboratory learning activity are gratefully acknowledged.

- Photograph of shipwreck has been used and redistributed by permission of Dr Ian MacLeod, Heritage Conservation Solutions.

Copyright and Creative Commons

LABORATORY LEARNING ACTIVITY 2 – BUNGEE BARBIE

Contact: Kieran Lim
kieran.lim@deakin.edu.au

Contact: Jessica Niblett
jniblett@mercy.vic.edu.au

Bungee Barbie

Introduction

Barbie and her friend, Ken, are enthusiastic adventurers, who would like to go bungee jumping.

In bungee jumping, a very strong and elastic rope is attached to both a support and to the bungee jumper. The bungee rope is often attached to the jumper's lower legs using a leg harness, but a chest harness can also be used.

The jumper initially stands on a platform near the support where the other end of the rope is attached. Often the adventurer jumper will ask for the rope to be adjusted so that the jumper will get as close as possible to the ground without actually hitting the ground. If the jump is made over water, the jumper might ask for the rope to be adjusted so that only the hair (or the head or the chest) gets wet.

The elasticity (stretchiness) of the rope will ensure that the jumper will keep moving up and down several times before finally stopping.

In this activity, you will investigate some of the factors that affect the bungee jump, so that Barbie and Ken can have an exciting, but safe, experience.

Key ideas

Force – a push or a pull

Tension force – a pull stretches an object to try to make it bigger or longer.

Newton's First Law – Objects at rest stay at rest. Objects in motion stay in a straight line motion unless subjected to an unbalanced force.

Newton's Second Law – The net force acting on an object is equal to the mass of the object multiplied by its acceleration:
F=ma

Newton's Third Law – When one object exerts a force on a second object, the second object exerts an equal and opposite force back on the first object.

Kinetic energy – Energy that an object has by virtue of its motion.

Potential energy – Energy that is stored in an object has by virtue of its position.

Elasticity – The ability of an object or material to resume its normal shape after being stretched or compressed; stretchiness.

Energy loss – When energy is transformed from one form to another, there is some energy loss.

Equipment and materials

- Retort stand, and clamps,
- Tape measure,
- 7 rubber bands
- string
- Weighing balance
- Barbie/Ken doll

Part 1: Bungee Barbie

1. Use two rubber bands to create a double-loop around Barbie's feet. A double loop is made by securing one rubber band to another.

Tying two rubber bands together. Diagram © "Baller14".

www.instructables.com/id/How-to-Make-a-Rubber-Band-Ball/

2. Wrap the open end of the double-loop tightly around Barbie's feet.

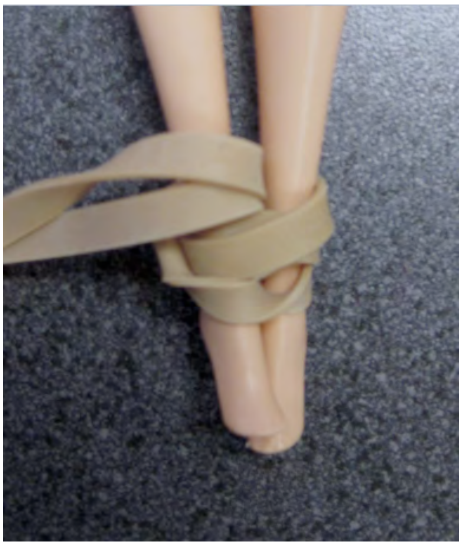

Photo: Kieran Lim

3. If desired, you can attach more rubber bands.

4. Attach the end of the last rubber band to the retort stand & clamp.

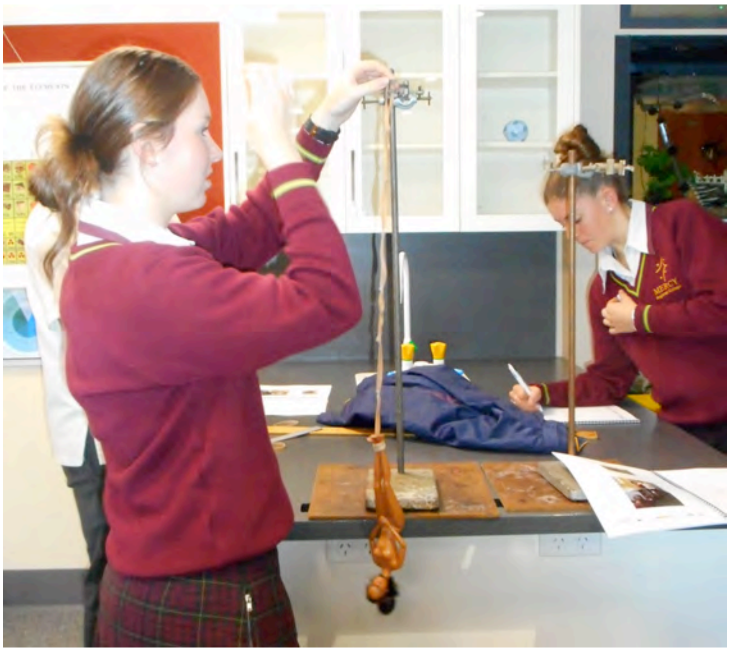

Photo: Lam Pham

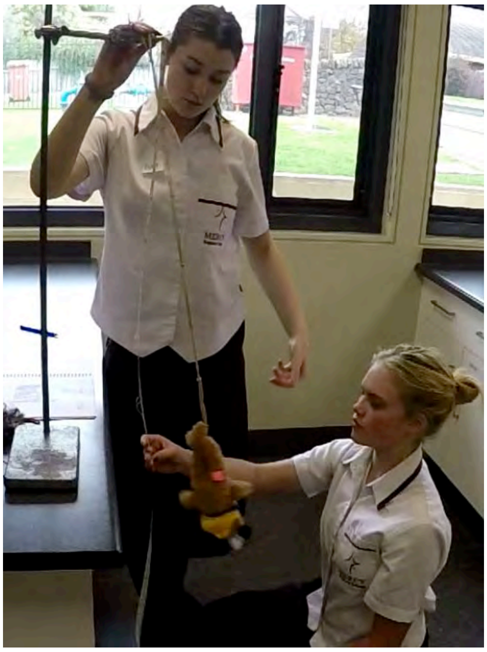

Photo: John Long

5. Hold Barbie standing upright with her feet at the end of the clamp. When your group is ready, release Barbie. She must fall head first.

Part 1: Observations

What happened? Make some notes of what you observed (saw) in the box below:

Suggest two details, about how the bungee jump is made, could you change?

Make one of those changes, repeat the bungee jump and make some observations:

Part 2: Scientific questions

When scientists and engineers ask a scientific question, they make a prediction: ***if this thing is changed, then that is expect to happen***. In testing that prediction, they try to keep all other factors unchanged.

Suggest a couple of scientific questions that you could ask using your experimental equipment and materials:

Some scientific questions will be more suitable for investigation in a classroom setting. Your teacher will lead a discussion to decide which scientific questions will be investigated. Your group will then decide how to investigate that question.

The scientific question that my group will investigate is:

Our hypothesis is:

Our **independent variable** is:

Our **dependent variable** is:

Our **controlled variables** are:

We will make the following changes to the **experimental procedure** of Part 1. If appropriate, make a drawing of your proposal:

Are there any **safety** issues to consider?

Part 3: Testing our scientific question

Get approval from your teacher of your plans (Part 2) before starting Part 3.

Remember to take photos throughout your experiment to add to your scientific poster.

What happened? Record your observations or measurements:

Did your observations or measurements agree with your expectations and prediction? Can you explain why?

Did you encounter any problems?

What changes could you have made to this experiment?

What did you discover for this experiment?

Part 4: Newton's Laws of Motion

Draw a diagram to illustrate the **forces** (Newton's 1st Law) acting on Barbie when she is:

a) standing on the ledge at the top of the bungee

b) Free falling on the downwards motion of the bungee.

c) At the lowest point of the bungee jump.

d) On the upward journey of the bungee.

Remember to indicate the directions and sizes of forces.

Using Newton's 2nd Law of Motion, calculate the force at which Barbie would hit the ground if the bungee failed. (Remember gravity causes an object to accelerate to Earth at a rate of 9.8 m/s^2):

What is one area in this experiment when you observed Newton's 3rd Law of Motion?

Part 5: Scientific poster

1. Complete introduction:
    - One to two paragraph overview of the reason for completing the investigation, the scientific context and an explanation of the relevant scientific theory.
    - All sources need to be acknowledged.
2. Complete the discussion section:
    - Discuss your scientific question in this section. **POE** is often a useful guide is to help what you put in this section:
        a. Predict. Your scientific question, hypothesis and prediction of what will happen.
        b. Observe. What you observed or measured.
        c. Explain. Did your observations or measurements agree with your expectations and prediction? Can you explain why?
    - Discuss the implications of your results.
    - Were there any limitations to your investigation?
3. Complete the conclusion section:
    - State your main result from your investigation.
    - State whether this supports or refutes your hypothesis.
4. Complete References and Acknowledgements.

Acknowledgement:

Diagram of "Tying two rubber bands together" © "Baller14". It has been used and redistributed under a Creative Commons 'Attribution-Non Commercial-Share Alike' Generic (CC BY-NC-SA 2.5) License.

Photographs by Kieran Lim, John Long, and Lam Pham have been used and distributed by permission of the photographers.

Copyright and Creative Commons

BLANK PAGE FOR NOTES