ASELL SCHOOLS
Advancing Science & Engineering through Laboratory Learning

ASELL for Schools Workshop

Laboratory Learning Activity Manual

Mary MacKillop Catholic Regional College Leongatha

19 May 2017

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

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ACKNOWLEDGEMENTS

We would like to thank:

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 efforts of the submitters in presenting their experiments, as well as the assistance of technical staff and others in making this workshop possible. A very big thank you to the team at St Ignatius College Geelong, 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
ASELL for Schools Victorian Leader, on behalf of the ASELL for Schools Team

ASELL FOR SCHOOLS WORKSHOP SCHEDULE

<table>
<tr><th colspan="3">ASELL for Schools
Mary MacKillop College
Friday 19 May 2017</th></tr>
<tr><td>8:30 – 9:10</td><td colspan="2">Arrival/Registration
Venue College Chapel</td></tr>
<tr><td>9:10 – 9:25</td><td colspan="2">Welcome and Introduction with A/Prof. 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
Venue College Chapel</td></tr>
<tr><td>9:25 – 9:35</td><td colspan="2">Introduction to Laboratory Learning Activity
Venue College Chapel</td></tr>
<tr><td>9:35 – 10:45</td><td colspan="2">Laboratory learning activity 1 – Materials Testing: Adhesives
Kieran Lim and John Long
Venue Science Lab 12 and 13 (S12 and S13)</td></tr>
<tr><td>10:45 – 11:10</td><td colspan="2">Morning Tea</td></tr>
<tr><td>11:10– 11:30</td><td rowspan="2">Teachers: Teachers deconstruct LLA #1; Inquiry Scaffolding tool;
Analysis of Laboratory Learning Activity with Kieran Lim and Ian Bentley
Venue S12</td><td>Students: Discussion and feedback on Laboratory learning activity
Venue S13</td></tr>
<tr><td>11:30– 12: 45</td><td>Students: Review of how to use microscopes
Venue S13</td></tr>
<tr><td>12:45 – 12:55</td><td colspan="2">Introduction to Laboratory Learning Activity
Venue College Chapel</td></tr>
<tr><td>12:50 – 1:35</td><td colspan="2">Lunch
Venue College Chapel</td></tr>
<tr><td>1:35 – 2:40</td><td colspan="2">Laboratory learning activity 2 – Freshwater Indicator Species
Ian Bentley and Kieran Lim
Venue S12 and S13</td></tr>
<tr><td>2:40 – 3:00</td><td colspan="2">Discussion and feedback on Laboratory Learning Activity</td></tr>
<tr><td>3:00 – 3:15</td><td>Teachers: Overall debrief and Evaluation for the day with Kieran Lim
Venue S12</td><td>Students: Overall debrief and Evaluation for the day with John Long
Venue S13</td></tr>
</table>

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LABORATORY LEARNING ACTIVITY MATERIALS TESTING: ADHESIVES. PART A. UNDERSTANDING GLUES AND ADHESIVES

Contact: Ian Bentley
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Materials Testing - Adhesives: Part A. Understanding glues and adhesives

Introduction

Glues and adhesives are a common part of everyday life. We use them to stick things in a book, on a wall, or to repair a broken item.

<pixabay.com/en/repair-glue-fix-adhesive-891422/>

The desk you are sitting at probably has a plastic laminate surface glued to a particleboard plank. If you are in a room with plaster walls, the plaster board has probably been glued to the building frame.

An important component of composite materials such as carbon fibre and fibre glass use glue, usually called a resin. When the resin dries (cures), the fibres stick together making a very hard and strong material. Even particleboard is a composite material made of woodchips and a glue called formaldehyde resin.

Carbon fibre is a potential replacement for metal parts in many products. It is strong and light but currently it is expensive and slow to manufacture. Materials scientists are trying to make carbon fibre cheaper, stronger and faster to make. One of the keys to improving carbon fibre production is understanding how adhesives work.

<www.3domwraps.com/media/32895/aston-martin-carbon-fibre-vinyl-wrap.jpg>

In this activity, you are going to investigate how adhesives stick things together. You will be able to give a scientific explanation of the problems that the materials scientists are trying to solve in their research on carbon fibre manufacture.

Key ideas

Adhesion (force) – adhesion is the name given to the tendency of one substance to stick to another substance such as glue to paper or water to glass. A rain droplet sticks to a window by adhesive forces.

<pixabay.com/en/drops-pane-rain-rain-drops-906019/>

Cohesion (force) – cohesion is the tendency of a material to hold together and not fall apart. Cohesive forces are the pulling forces between the particles of the material that hold it together. Cohesion between water molecules holds a drop of water together.

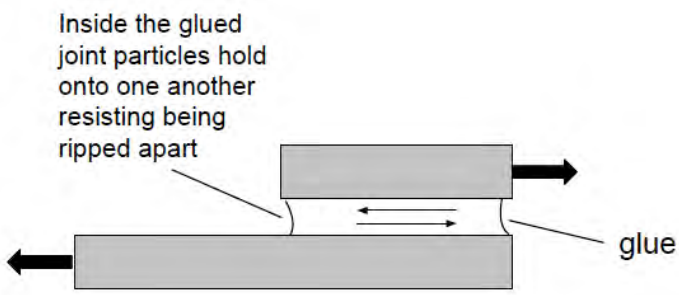
Surface – in this activity the word surface is used to refer to the part of the object or material to which the glue is applied.

Surface area – is the total area of the surface of an object. When thinking about glues we are interested in the total surface to which the glue is attached. If a surface is roughened up its surface area increases.

Force – we know that forces are pushes or pulls. Forces can be seen at the level of people's actions such as when a person pushes a trolley. But forces also operate at the level of the particles inside materials. Forces between the particles attract them to one another. The stronger the forces the stronger and harder the material.

Load – the force applied to an object.

Shear – two adjacent pushing or pulling forces, acting close together but in opposing directions, cause a shearing load.



Shear forces on glued joint

Based on <www.teachengineering.org/lessons/view/wpi_lesson_1>

Shear strength – the shear load required to break an object or joint.

Failure – the breaking of a material exposed to external force such as when a rope being used to tow a car breaks, or when you bend a stick till it breaks.

Part A1 Strength of adhesion to different surfaces

In this activity, you will investigate the question: "To which surface does Blu-Tack stick best, wood or plastic?"

Materials

- A small piece of Blu-Tack about 6 mm in diameter. [Footnote [1]]
- 2 icy pole sticks (one with a hole in one end) [Footnote [2]]
- 2 plastic strips (one with a hole in the end)
- Slotted brass weights – about 500 g
- Sand paper

Procedure

The instructions given here contain some of the things you need to do for the test. Read the instructions and try the test out before you start recording results. Identify and record what you need to do to make the test a **fair test**.

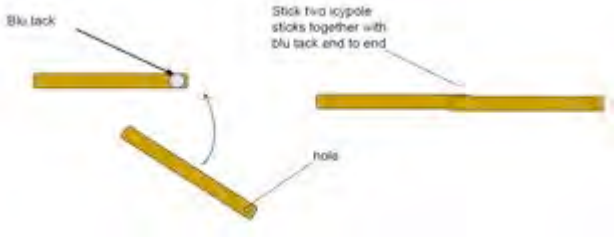
---

1 Blu-Tack is the commercial name of a "reusable" adhesive made by Bostik. Other similar products can be used.

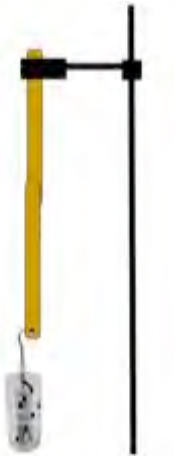
2 Icy pole stick, paddle pop stick, and popsicle stick are alternate names for flat pieces of wood about 12 cm long, 1 cm wide, and 2 mm thick. Any similar product can be used.

Hint: It is important that you use only a VERY small piece of Blu-Tack otherwise it will spread around the sides gripping the edges. A sphere of about 2-3mm in diameter is enough.

1. Stick two icy pole sticks together as shown so that they overlap by a distance equal to the width of the stick.



2. Hang glued icy pole sticks from clamp on a stand as shown



3. Hang a 50-gram brass weight through hole in icy pole stick. Progressively add weight until the joint breaks. Record in the Results table the load at which the joint fails.

4. Closely observe the fractured Blu-Tack surface. Describe or draw the result in the Observations section below.

5. Repeat the tests with the icy pole sticks and record your results.

6. Repeat the tests using the plastic strips. Record your results and observations.

7. Using the sand paper roughen the surface on the end of one piece of plastic and repeat the tests. Record your results and note your observations.

Fair test

Write here what you need to do to make the test fair.

Results

Test	Suspended mass (g)		
	Wood	Smooth plastic	Rough plastic
1			
2			
3			

Observations

Your drawing or description of the broken Blu-Tack joint.

Conclusions

What conclusion can you draw about the tensile strength of Blu-Tack compared with its shear strength.

Representations

Use labelled diagrams to represent what happened in this experiment.

Hint: In your drawings represent the way the Blu-Tack stuck to the wood? Show how the Blu-Tack sticks to itself?

Draw a labelled diagram to show how the particles inside the Blu-Tack stuck the two icy pole sticks together. Use the terms adhesive forces and cohesive forces.

Draw a labelled diagram to explain the effect of roughening the surface of the plastic.

Part A2 Comparing Blu-Tack with Tuff Tacks

An office supplies chain has a produced a cheaper form of Blu-Tack. Devise and carry out a test to determine whether the new and cheaper product is as good as the original adhesive.

What variables are important in your test?

What will you measure? What will you keep the same?

Describe your Procedure.

Record your results

What is your conclusion?

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LABORATORY LEARNING ACTIVITY 2 - FRESHWATER INDICATOR SPECIES

Contact: Ian Bentley
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Freshwater Indicator Species

Introduction

In this activity, you are playing the role of a biologist in a water pollution consultancy business. You have been contracted by the Environment Protection Agency (EPA) to report on the quality of some water samples. While other scientists will be working on the physical and chemical qualities of the water, your job will be doing a biological analysis.

Small Freshwater Aquatic Organisms

Freshwater aquatic organisms vary greatly in size. Some are microscopic bacteria that are only visible with a powerful microscope, while other organisms that can be many kilograms in weight, such as fish.

In this activity, we will be concentrating organisms that can be just seen with the naked eye but seen clearly with low power microscopes. These organisms will include invertebrates, algae and some tiny plants.

Invertebrates

Animals without a backbone

- Protists - single-celled organisms
- Ciliates – rotifers and stentors
- Worms
- Crustaceans
- Insects
- Molluscs

Algae

- Simple photosynthesising aquatic organisms
- Unicellular e.g. chlorella
- Multicellualar e.g. spirogyra

Plants

Complex multicellular photosythesising organisms with cellulose cell walls

- e.g. duckweed

Indicator Species

An indicator species is an organism whose presence, absence or abundance reflects a specific environmental condition. For example, some organisms will only grow in very clean unpolluted water while others will grow abundantly in polluted water.

Equipment and materials

- Microscope – compound and stereo
- Petri dishes
- Cavity slides
- Flat glass slides
- Cover slips
- Droppers

A good reference is *A Beginners Guide to Waterbugs* produced by Melbourne Water: https://www.melbournewater.com.au/getinvolved/protecttheenvironment/Documents/Waterbug%20Guide_Online.pdf.

Instructions/directions

1. Collect samples to be analysed.

2. Look carefully at each sample of water. Note its appearance. Make sure you look very carefully at each sample and describe it as accurately as you can.

3. Put the sample into a petri dish. Use a magnifying glass and/or a stereo microscope look for small organisms. If the organisms are very small place a drop of water containing them on a flat slide. If the organism is large place it with some water on a cavity slide.

4. To observe organisms more closely, use a plastic Pasteur pipette (dropper) to suck the organism up and transfer it to a microscope slide with water. Observe at low power and if necessary at high power. In each case cover with a coverslip trying to exclude air bubbles.

5. Bring the specimen/s into focus. Use the information provided in the table below and any other resources available to identify the organism. Some things you see might be debris, that is, just bits of dead and decaying plant matter.

6. Try to estimate the abundance of the organism. That is, the number of this type of organism in your sample. If you can count them that would that is best, but you may have to make a rough guess. In your sample is there 1, 10s, 100s, 1000s of the organism?

7. If the organism has a **Signal Number** record it. This scoring system allows us to use the organisms in your samples to very roughly measure the pollution level of the water.

    - Organisms that need **unpolluted water** are given a high Signal Number;

    - Organisms that can live in **polluted waters** get a low Signal Number.

8. Calculate the **Signal Score** from each sample, by adding up all the signal numbers of the organisms you have found and then dividing the total by the number of types of organisms in the sample.

    - A Signal Score that is higher than six, indicates healthy water;

    - A Signal Score that is lower than four, indicates pollution.

Results and Analysis

Sample			
Appearance of Sample			
Organism	**Abun-dance**	**Signal Number**	**Comments**
Signal Score			

Sample			
Appearance of Sample			
Organism	**Abun-dance**	**Signal Number**	**Comments**
Signal Score			

Sample			
Appearance of Sample			
Organism	**Abun-dance**	**Signal Number**	**Comments**
Signal Score			

Sample			
Appearance of Sample			
Organism	**Abun-dance**	**Signal Number**	**Comments**
Signal Score			

Drawing conclusions

Write your conclusions for each sample of water for inclusion in a report to the EPA. Be sure to write whether you think the water is polluted, in what way it might be polluted and indicate the evidence you are using to support you claims.

Short Guide to Small Freshwater Organisms

Name	Image	Where found	Signal Number
Planaria (flat worms)	 Footnote [1]	Found in a wide range of freshwater habitats, but can tolerate polluted water. Found on the under surfaces of leaves, branches and rocks. In low oxygen conditions, they will come to the surface.	2
Ostracods	 Footnote [2]	Ostracods are found in a range of freshwater and saltwater habitats. They tend to be in abundance in warmer conditions.	5
Backswimmers	 Footnote [3]	Maybe quite large. One of several types of aquatic insects with special paddle-like legs for swimming.	1
Daphnia	 Footnote [4]	Small semi-transparent crustaceans visible under low power microscope.	5
Leeches	 Footnote [5]	Leeches are segmented worms like earthworms but they tend to be predators. There are a few parasitic species	1

[1] Image by Holger Brandl, HongKee Moon, Miquel Vila-Farré, Shang-Yun Liu, Ian Henry, and Jochen C. Rink - PlanMine - a mineable resource of planarian biology and biodiversity. Nucleic Acids Res. 2016 Jan 4; 44(Database issue): D764–D773., CC BY 4.0, https://commons.wikimedia.org/w/index.php?curid=47108231

[2] Image by Anna33 at English Wikipedia, CC BY 2.5, https://commons.wikimedia.org/w/index.php?curid=3414970

[3] Image in Public Domain, https://commons.wikimedia. org/w/index.php?curid=378120

[4] Are We Underestimating Species Extinction Risk? PLoS Biology Vol. 3/7/2005, e253 doi:10.1371/journal.pbio.0030253, CC BY 2.5, https://commons.wikimedia.org/w/index.php?curid=1430082

[5] Image by Karl Ragnar Gjertsen Own work, CC BY 2.5, https://commons.wikimedia.org/w/index.php?curid=1614444

Damselfly Nymphs	 Footnote [6]	An aquatic stage in the lifecycle of damselflies (like small dragon flies)	8
Paramecium	 Footnote [7]	Single-celled protists visible under low power compound microscope. Move rapidly.	N/A
Euglena	 Footnote [8]	A small single-celled prostist, which is only clearly visible at high power.	Varies
Rotifers	 Footnote [9]	Simple multicellular organism that uses beating cilia to move and to move food into its mouth	5
Stentor	 Footnote [10]	A filter feeding multicellular ciliate. Moves food into its trumpet-shaped mouth with beating cilia.	5
Amphipod	 Footnote [11]	There are many species of these small crustaceans. They feed on dead and decaying matter	5
Vinegar eel	 Footnote [12]	Found in water with a low pH (acidic)	1

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6 Image by Charlesjsharp - Own work, from Sharp Photography, sharpphotography, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=33922101

7 Image by Deuterostome - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=25530266

8 Image by Rogelio Moreno - Rogelio Moreno, CC0, https://commons.wikimedia.org/w/index.php?curid=19389802

9 Image From: https://en.wikipedia.org/wiki/Cephalodella CC-BY-SA-3.0

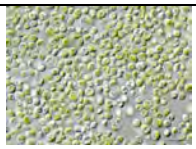
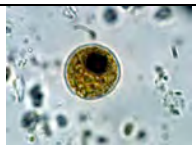
10 Image in: Public Domain, https://commons.wikimedia.org/w/index.php?curid=57073

11 Image by Uwe Kils - https://commons.wikimedia.org/wiki/File:Hyperia.jpg, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=50658752

12 Image: http://www.carolina.com/images/product/large/133266_la.jpg

Segmented worms	 Footnote [13]	Usually found in the mud and decaying debris at the bottom. Found in most locations but abundantly in polluted water. Often have a red blood vessel running the length of the body	1

Short Guide to Plants and Algae

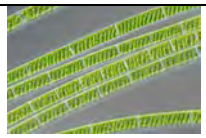
Name	Image	Where found	Signal Number
Chlorella	 Footnote [14]	When found in large numbers can indicate an algal bloom because of pollution from fertilisers. Clearly visible at high magnification.	Varies In very large numbers, 1
Chlamydomonas	 Footnote [15]	Microscopic algae with flagella found in many habitats including stagnant water. Clearly visible at high magnification.	5
Duckweed	 Footnote [16]	A flowering aquatic plants which float on or just beneath the surface of still or slow-moving bodies of fresh water and wetlands.	N/A

[13] Image by Michael Wigle http://www.yorkshiredalesriverstrust.com/river-processes-secondary-school-resources/

[14] Image: Neon CC BY-SA 3.0 https://upload.wikimedia.org/wikipedia/commons/8/83/Chlorella_vulgaris_NIES2170.jpg

[15] Image by Environmental Protection Agency - http://www.epa.gov/glnpo/image/viz_nat6.html, Public Domain, https://commons.wikimedia.org/w/index.php?curid=2776712

[16] Image by Kurt Stüber [1] - caliban.mpiz-koeln.mpg.de/mavica/index.html part of www.biolib.de, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=5225

Name	Image	Where found	Signal Number
Azolla	 Footnote [17]	A plant that floats on the surface of the water. In large amounts, it can suffocate a body of water preventing	N/A
Spirogyra	 Footnote [18]	Slimy green algae that grows near the edge of some waterways.	Varies

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[17] Image by Kurt Stüber [1] - caliban.mpiz-koeln.mpg.de/mavica/index.html part of www.biolib.de, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=6070

[18] Image by Wiedehopf20 - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=45272023

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