# ASELL for Schools Workshop

## Laboratory Learning Activity Manual

Auburn High School

9 December 2016

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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 for 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 Auburn High 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 FOR SCHOOLS WORKSHOP SCHEDULE

| ASELL for Schools<br>Auburn High School<br>*Friday 9 December 2016* | | |
|---|---|---|
| 9:00–9:15 | **Arrival/Registration** | |
| 9:15–9:30 | **Welcome and Introduction** with A/Prof Kieran Lim<br>• Introductions (of ASELL for Schools team and Students and Teachers)<br>• Outline ASELL for Schools project – how to be involved? | |
| 9:30–10.00 | **Teachers: Inquiry in Science**<br>with Dr Peta White<br>• How can we incorporate more science inquiry into experiments?<br>• Introduction to the Inquiry Slider | **Students: Pre Lab Session**<br>with Ian Bentley<br>• Forces and weight |
| 10:00–10:50 | ***Laboratory learning activity 1 – "Investigating Velocity, Acceleration and Gravity"***<br>*Mr Paul van Est, Ms Louisa Phillipson,*<br>*Ms Katherine Kouloumendas, and Mr Oliver Lamb* | |
| 10:50 –11:15 | **Morning Tea** | |
| 11:15–11:35 | Discussion and feedback on Laboratory learning activity | |
| 11:35–12:15 | **Teachers: Unpacking a GREAT ASELL for Schools LLAs** with Dr Peta White<br>• What does a GREAT ASELL for Schools LLA look like? Science Inquiry skills, direct inquiry, representation construction pedagogy, and contemporary science | **Students: Car Challenges**<br>with Dr John Long |
| 12:15–12:55 | ***Laboratory learning activity 2 – Materials Testing: Adhesives***<br>*Mr Ian Bentley* | |
| 12:55–1:15 | Discussion and feedback on Laboratory learning activity | |
| 1:15–2:00 | **Lunch** | |
| 2:00–2:45 | **Teachers:** Overall debrief and Evaluation for the day with A/Prof Kieran Lim | **Students:** Overall debrief and Evaluation for the day with Dr John Long |

# LABORATORY SESSION 1
# "INVESTIGATING VELOCITY, ACCELERATION AND GRAVITY"

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LABORATORY LEARNING ACTIVITY

# Investigating Velocity, Acceleration and Gravity

## Purpose

We seldom think about or motions in everyday life, they are so second nature that they often go unnoticed. In this investigation, we will be looking at the relationship between the velocity, acceleration and mass of an object under the force of gravity.

## Understanding the apparatus:

The apparatus you will be using in this experiment is designed to measure the time it takes for an object to move particular distances and is made up of a number of parts:

1. Cart: The cart will represent or object its mass can be changed by adding or subtracting weights
2. Ramp: This is the tack the cart will run down
3. Retort stand: This can be used to adjust the angle of your ramp
4. Protractor: This is used to measure the angle of your ramp
5. Light gates: These stop the timers as the cart passes by
6. USB Port: This is where you make your connection to your computer please be gentle!
7. Computer: Your computer will run the timing software

## Before you start

1. You will be testing both the effect of the angle of the ramp and the mass of the cart!
2. Design your method to test both of these variables.
3. Write a hypothesis
4. Draw up a table that you will record your results in.

Your experiment will be conducted in groups but your report **<u>must</u>** be completed independently. This means that the only things that your report will have in common with your partner's is the data and method.

| **Identify the variables** |
|---|
| **Independent variables** |
| **Dependant variables** |
| **Controlled variables** |

## Hypothesis

| |
|---|
| |

## Procedure

**THE FOLLOWING IS NOT A PROCEDURE. WRITING THIS INTO YOUR LAB REPORTS WILL NOT MEET THE REQUIRMENTS OF THE RUBRIC! YOU MUST WRITE YOUR OWN FULL PROCEDURE FOR YOUR EXPERIMENT!**

To perform an experiment, you must place the cart at the top of the ramp with at your chosen angle and cart mass. MAKE SURE YOU LINE UP THE CART SO IT DOES NOT CRASH INTO THE SENSOR POSTS.

You're your partner will be at the computer and will count down and give a signal to release the cart they will press the star button on the timer at the same time.

The cart will stop each timer as it passes each gate.

You will need to calculate the difference in time between gate to find how long it took to pass between each gate. You will also need to measure the distance between each gate and record these values.

To start a new experiment, press stop and then reset on the timer program reposition the cart and repeat the previous steps.

## Recording your Measurements:

You will need to record all times for each experiment you do, decide how you will record these values before you begin.

## Discussion

These are suggestions of what should be addressed in the discussion of your practical report. You should be aiming to write paragraphs that include responses to these questions rather than just a list of answers. It is a good idea to think about some of these as you are conducting your experiment and write some notes.

- What is the independent variable (things that the experimenter deliberately changes) in this experiment?
- What is the dependent variable (what is measured) in this experiment?
- Which conditions appears to be give the fastest reaction? How do you know?
- How did you make sure the experiment was fair?
- Where are places errors could have occurred? Where were places, those results could have been wrong or that the experiment was accidentally changed?
- Did you test each set of conditions more than once? Why?
- Are your conclusions reliable? Discuss the ways you made the experiment fair.
- If you were going to repeat your experiment, describe two things you would change to make your results more accurate.

Specific things to consider in your discussion:

- How did velocity/acceleration change with change in angle?
- How did Velocity/acceleration change with change in mass?
- What mathematical relationships might relate to this experiment? Do your results support these mathematical relationships?

## Conclusion

- What was the aim of your experiment?
- What was your hypothesis? Was it supported or unsupported?

- What evidence do you have to demonstrate this?
- What new questions does your research raise? What could you research next?

## Parts of a practical report – check list

Actions: Use past tense. Use passive voice to talk about the experiment, not who is doing it.

Theory: Use present continuous tense.

**TITLE**

- Make it specific, about your actions ☐

**AIM**

- State what your lab report was trying to find out ☐
- Describe why (you) chose this experiment ☐

**HYPOTHESIS**

- State your **hypothesis** ☐
- Support your hypothesis with **prior knowledge** – from books, reliable sources or your own experiences (Always say where you get information from!) ☐

**METHODOLOGY**

- Describe what you did, so that someone else could do the same thing. You get no marks for lengthy descriptions ☐
- Use a **diagram** ☐
  All diagrams should have labels and use ruled lines
- State the **Independent Variables**, and how they were **controlled** ☐
- State the **dependent variables**, and how they were **measured** ☐
- Describe your **risk assessment** ☐
- If appropriate, outline your **ethics review** ☐

## RESULTS

- Put your results in **tables** (Include units) ☐
- Present these in **graphs** ☐
  Label your graph and each axis, include units, choose a good scale
- Describe the changes in the dependent variable ☐

## DISCUSSION

- **Compare** your results to theory ☐
- Outline alternative explanations ☐
- Comment on any outliers ☐
- Describe how **errors** could affect the data ☐
- Explain how errors could be reduced by using better methods ☐

## CONCLUSION

- Evaluate the **evidence** for or against your hypothesis ☐
- Suggest **further research** ☐
- Improvements based on errors (above) ☐
- Further questions raised by your experiment, such as unexpected results ☐

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

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LABORATORY LEARNING ACTIVITY

# 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.

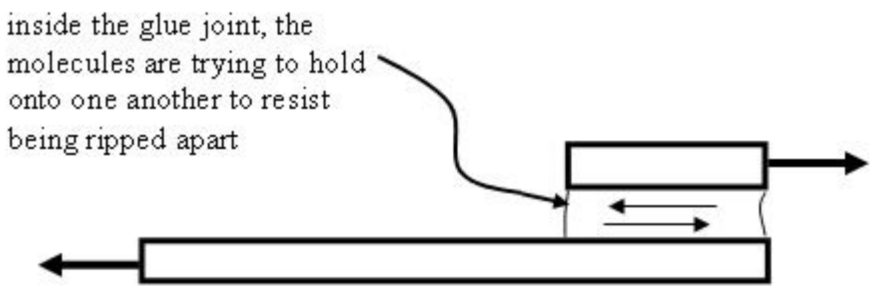
**Surface** – in this activity the word surface is used to refer to the part of the object or material to which the glue is applied.

**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.




<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

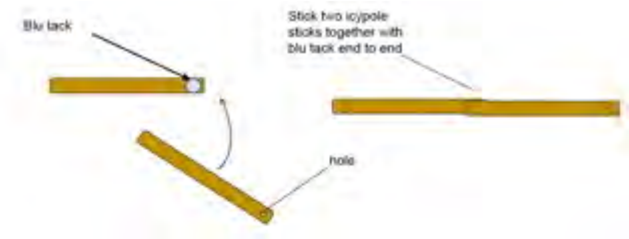
[1] Blu-Tack is the commercial name of a "reusable" adhesive made by Bostik. Other similar products can be used.

[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.

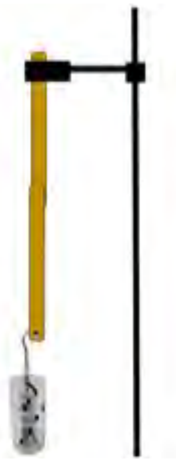
## Procedure

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




2. Suspend 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.

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. *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 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
# MATERIALS TESTING: ADHESIVES.
# PART B. MAKING AND TESTING GLUES

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L A B O R A T O R Y   L E A R N I N G   A C T I V I T Y

# Materials Testing: Adhesives.
# Part B. Making and testing glues

## Introduction

There are many types of glues for different types of jobs. Glues differ:

- in the degree to which they adhere when 'dried' to different surfaces
- in their flexibility, their strength (i.e. the strength of the cohesive forces within the 'dried' glue) and
- in their solubility in different liquids.

## Key ideas

Glues are usually liquid when they are applied but become solid when they dry or cure. The process of becoming solid or more solid can occur in several different ways. The glue dries or sets when:

1. the solvent or liquid part of the glue evaporates. This happens with the traditional glue called clag that is made of starch and water. Modelling glues also work in this way but the solvent is usually something other than water that evaporates very quickly.
2. a chemical reaction (polymerisation) occurs. The molecules of the glue form chemical bonds with one another. This is what happens in 'two part' glues. These glues have one part called the resin and another called the hardener.
3. the glue cools, such as when the hot glue from a hot glue gun cools.

Different glues work better on different surfaces, so in this activity we will compare how well the glues work on wood, plastic and paper.

**Curing** – the name given to the hardening of a glue where a chemical reaction causes bonds (strong attractive forces) to form between the particles

**Drying** – some glues harden because the solvent (liquid part) evaporates.

## Hazards

Wear gloves and eye protection.

**Temperature hazard** – When making glues they will be hot and sticky.

**Dropping weights** – be careful when testing your glues that weights don't drop on your hands or feet

## Activity B1 Making Glues

Recipes for four different glues you can make at home or in the laboratory.

## Materials

- Strips of paper and cardboard.
- Icy pole sticks.
- Ingredients for making the glues.
- Heat source.
- Stirring rods or spoons.
- Beakers or glass jars or cups.

Your group will be assigned one of the following glues to make. Use the ingredients provided and follow the instructions

**Corn syrup glue**

- Corn syrup

- White vinegar
- Corn-starch

1. In a small saucepan, mix 180 mL water with 35mL corn syrup and 15mL tablespoon white vinegar.
2. Bring the mixture to a rolling boil.
3. In bowl, mix 20g corn-starch with 180 mL cold water.
4. Slowly add the cold mixture into the hot mixture. Stir constantly for one minute.
5. Remove from heat.

Once it has cooled, pour the mixture into a labelled glass jar or beaker or cup.

(Let it stand overnight at room temperature before using.)

**Casein glue**

- gelatine [Footnote [1]]
- skim milk
- clove oil (optional)

This glue can stick glass together, use it in its gelled (room temperature) state.

1. Pour two tablespoons of cold water into a small bowl.
2. Sprinkle 2 packets of unflavoured gelatine over the water and set aside for about an hour.
3. Heat 40 g skim milk to just below boiling and pour it into the gelatine and water.
4. Stir the mixture until the gelatine is completely dissolved.

Optionally, add a few drops of clove oil as preservative if you're not going to use all the glue immediately. (With clove

[1] Gelatine and gelatin are alternate spellings for the same substance.

oil, the glue will keep for a day or so – when it starts smelling like spoiled milk, throw it out.)

**Gum Arabic glue**

- 45 mL gum arabic
- 15 mL glycerol [Footnote [2]]
- 8 mL water

1. Mix 45 mL gum arabic, 15 mL glycerol and 8mL water thoroughly in a bowl or beaker.

2. To use this glue, apply a thin coat to each surface and hold the pieces firmly together until the glue dries. (up to an hour)

**Gelatine glue**

- 1 packet gelatine (10 g)
- 15 mL glycerol
- 15 mL white vinegar
- 60 mL water

1. Add the gelatine to 15 mL cold water in a beaker, stir gently, let stand until it 'blooms'

2. Mix 45 mL boiling water, the white vinegar, and glycerol to the gelatine and stir until it all dissolves.

The resultant glue may become solid and will need to be warmed to soften before each use.

## Activity B2 Testing Glues

Which is the best for gluing wood, plastic?

In designing your fair test, you need to identify the important variables.

[2] Glycerol, glycerin, glycerine, 1,2,3-propanetriol, propan-1,2,3-triol and propane-1,2,3-triol are all alternate names and spellings for the same chemical substance. Glycerol is the official IUPAC (International Union of Pure and Applied Chemistry) name. Propan-1,2,3-triol is the systematic IUPAC name. Glycerin is a commonly used commercial name.

What variable will you change? (independent variable)

What variables will you keep constant? (controlled variables)

What variable will you measure?

Record the load needed to break the glue joint and record it in your table

Examine the surface of the break. Has the glue separated from itself or has it come away from the surface of the glued object?

Repeat this procedure using strips of rigid plastic.

## Results

| | Failure load (g) | |
|---|---|---|
| Glue name | Wood | Plastic |
| | | |
| | | |
| | | |
| | | |

## Analysis

Draw a graph or chart using the data from your results table

## Discussion and Conclusions

Which of the glues is best for gluing each of the materials, wood and plastic?

What evidence are you have for your claim?

How confident are you in your conclusions? Is there any doubt in your mind? Why?

How could you improve your testing procedure to achieve more reliable results?

## Extension

Devise a test to measure the effectives of the different glues on paper.

Design an investigation to test whether the glues are waterproof.

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