# ASELL for Schools Workshop

## Laboratory Learning Activity Manual

Mercy Regional College, Camperdown

7 June 2017

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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 assistance of teachers, technical staff and others in making this workshop possible. A very big thank you to the team at Mercy Regional College, Camperdown, for hosting this Workshop. Everyone 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

## ASELL FOR SCHOOLS WORKSHOP SCHEDULE

**ASELL for Schools**
**Mercy Regional College, Camperdown**
**Wednesday 7 June 2017**

| | | |
|---|---|---|
| 9:00 – 9:15 | **Arrival/Registration** ***Venue MPA*** | |
| 9:15 – 9:30 | **Welcome and Introduction** with Jessica Niblett and Kieran Lim<br>• Introductions (of ASELL for School team and Students and Teachers)<br>• Outline ASELL for Schools<br>• Outcomes for the day<br>• How to use the booklet<br>***Venue MPA*** | |
| 9:30 – 9:40 | Introduction to Laboratory Learning Activity ***Venue MPA*** | |
| 9:40 – 10:40 | ***Laboratory learning activity 1 – Plastics***<br>*Ian Bentley and John Long*<br>***Venue Labs SCI01 and SCI03*** | |
| 10:40– 10:50 | **Teachers:** Inquiry Scaffolding tool;<br>Peta White<br>***Venue Lab SCI01*** | Discussion and feedback on Laboratory learning activity<br>Kieran Lim<br>***Venue Lab SCI03*** |
| 10:50 – 11:15 | **Morning Tea** ***Venue MPA*** | |
| 11:15– 11:25 | **Teachers:** Teachers deconstruct LLA #1; Analysis of Laboratory Learning Activity<br>Peta White<br>***Venue Lab SCI01*** | **Students:** Discussion and feedback on Laboratory learning activity<br>Kieran Lim<br>***Venue Lab SCI03*** |
| 11:25– 12:30 | | **Students:** Quantifying speed and issues to do with fair testing<br>John Long and Kieran Lim<br>***Venue Lab SCI03*** |
| 12:30 – 12:40 | Introduction to Laboratory Learning Activity<br>Kieran Lim and Jessica Niblett ***Venue Lab SCI01*** | |
| 12:40– 12:55 | ***Laboratory learning activity 2 – Bungee Barbie***<br>Kieran Lim and Jessica Niblett<br>***Venue Labs SCI01 and SCI03*** | |
| 12:55 – 1:30 | **Lunch** ***Venue MPA*** | |
| 1:30 – 2:20 | ***Laboratory learning activity 2 – Bungee Barbie*** (continued)<br>***Venue Labs SCI01 and SCI03*** | |
| 2:20 – 2:40 | Discussion and feedback on Laboratory Learning Activity<br>**Teachers:** ***Venue Lab SCI01*** | **Students:** ***Venue Lab SCI03*** |
| 2:40 – 3:00 | Overall debrief and Evaluation for the day<br>**Teachers:**<br>Kieran Lim<br>***Venue Lab SCI01*** | **Students:**<br>Peta White and<br>John Long ***Venue Lab SCI03*** |

# LABORATORY SESSION 1
# MATERIALS TESTING: PLASTICS

**Contact: Ian Bentley**
**i.bentley@deakin.edu.au**

# Materials Testing: Plastics

## Introduction

Plastics are everywhere. They have an extraordinary range of uses, from soft drink bottles and packaging to car panels and building materials. The plastic that is used for an object has been selected because of its properties including its strength, its flexibility, its durability and its cost.

Supermarket bags are extremely convenient but also environmentally damaging. Researchers and industry continue to search for cost-effective environmentally friendly biodegradable plastics. To replace traditional supermarket bags, the new bioplastics must be as strong and resilient as the plastics used currently. Just how strong will these new plastics need to be to match the plastics used in the current supermarket bags? Are the biodegradable and recyclable bags being used as good as the traditional bags?

## Key ideas

**Force** - a push or a pull.

**Strength** - can be thought about in many ways. In this activity, strength will be measured either as the **load** required to stretch and break a piece of material, or the **puncture force** to push an object into or through that material.

**Load** – A downwards force that is being applied to an object.

**Puncture force** is the force required to push an object into or through a material.

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

**Variable** - Something that can change.

**Independent variable** - Variable that is deliberately changed.

**Controlled variables** - Variables that are kept constant.

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

## Equipment and materials

- Different plastic bags (3)
- Scissors
- Sticky tape
- Icy pole sticks
- Paper clips or wire to make hook from which to suspend weights
- Weights
- Ruler
- Plastic cup or beaker
- Rubber bands
- Bamboo skewers
- Safety glasses/goggles

## Part 1: Strength

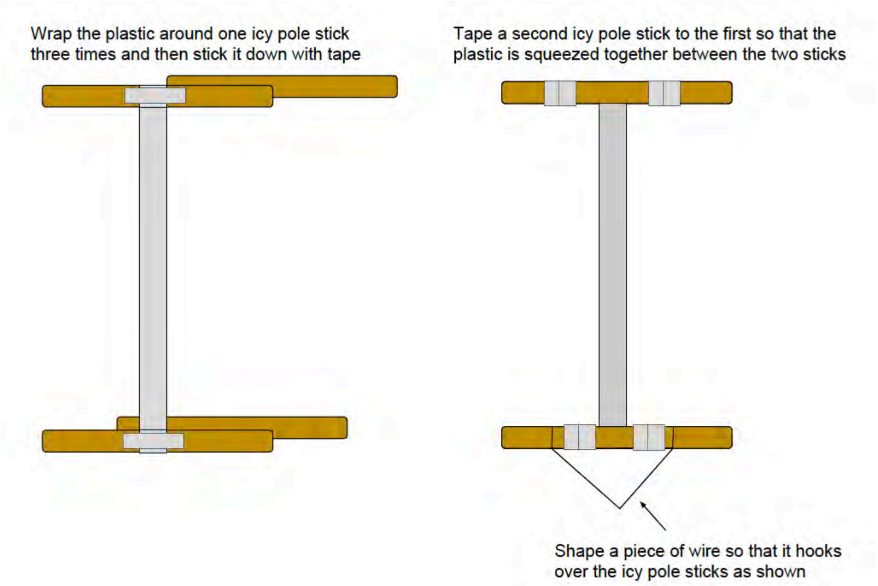
In this activity, you will work out just how strong the plastic is in different supermarket bags. The principles in the testing procedure you will use are the same as those used by materials scientists in their labs.

## Part 1: Hazards

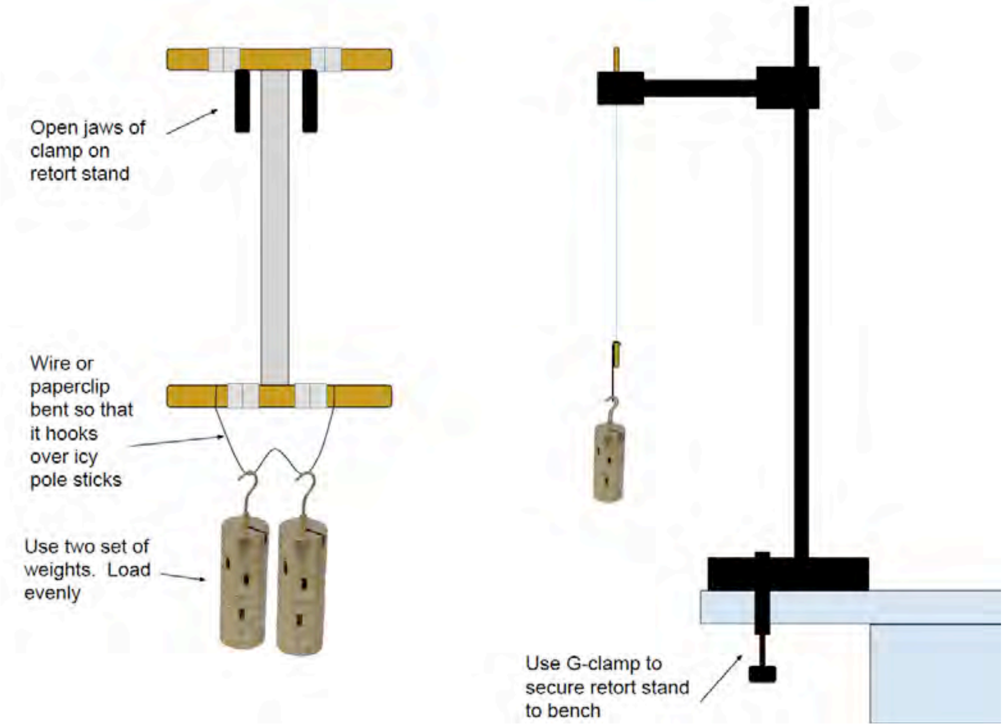
The main hazard will arise when samples of plastic give way under load. Things may fly in unpredictable directions. You must wear safety glasses/goggles, and also keep faces well away from the plastics when they are heavily loaded. Keep clear if you think the plastic is about to snap. Set up a tray with something soft in it so the weights do not crash to the floor and keep feet clear.

## Part 1: Investigation Instructions

From the samples of plastic bags for testing, cut strips 30 cm long and 2 cm wide. Wind the plastic strip around the the one icy pole stick as shown leaving 20 cm between the the sticks. Use sticky tape to hold the plastic in place. Tape a second icy pole stick to the first one for extra support.




Suspend the top icy pole sticks from a clamp on a retort stand as shown below. Add weights to increase the load on 50 – 100 g at a time initially and 50 g at a time when you think the plastic is about to snap. Place something soft underneath the weights so that when the plastic breaks the weights do not crash to the ground. The supports on brass weights can be easily broken. Each time you add the load measure the distance between the top and bottom icy pole sticks i.e. the length of the plastic and also measure the width of the plastic at the midpoint of the length of plastic. Continue to add weights until the plastic test strip breaks.




As well as the measurements, note other observations you make while the weights are being added.

## Part 1: Results

Record your results in the spaces below.

| **Source of plastic** | |
|---|---|
| Plastic 1 | |
| Plastic 2 | |
| Plastic 3 | |

| | Plastic Bag 1 | | Plastic Bag 2 | | Plastic Bag 3 | |
|---|---|---|---|---|---|---|
| Load | Length | Width | Length | Width | Length | Width |
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## Part 1: Analysis

Calculate the percentage change in length versus load.

| **Plastic 1: percentage change in length versus load** | | | |
|---|---|---|---|
| Load | Length | Change in length | Percentage change in length |
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| Plastic 2: percentage change in length versus load | | | |
|---|---|---|---|
| Load | Length | Change in length | Percentage change in length |
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| Plastic 3: percentage change in length versus load | | | |
|---|---|---|---|
| Load | Length | Change in length | Percentage change in length |
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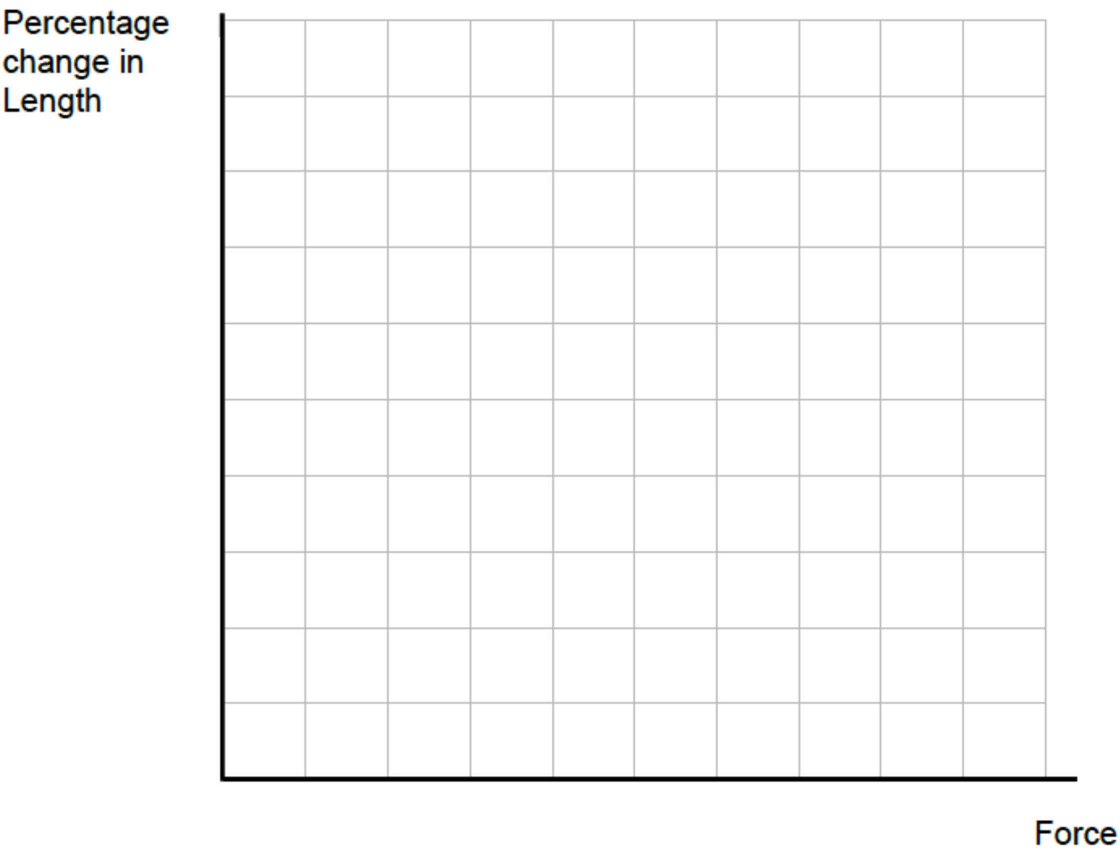
Draw graphs of the change in length versus load and percentage change in length versus load. Put your different graphs on the same set of axes.




## Part 1: Discussion and Conclusions

How did the plastics compare? Which one is strongest? What is the evidence?

How did each of the plastics behave as the load was increased? Were there differences?

Represent what you think is happening at the particle (molecular) level as the plastic is stretched and eventually breaks. Represent the elastic phase, the plastic phase and the point of failure.

Are there variables you have not controlled in your tests?  How might these variables affect your conclusions?

Identify two improvements to the method to ensure it is a well-controlled experiment.

Suppose you had to increase the strength of the handles of the plastic bag — what could you do?  Describe a test you could do to gain evidence for your proposal.

## Part 2: Cutting and tearing

Not only are items purchased from the supermarket heavy requiring supermarket bags to be strong but they also often come in packages with sharp edges and corners. Bags may be punctured or cut and eventually tear.

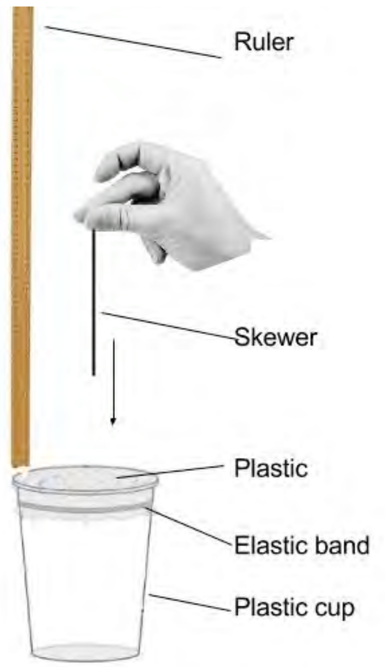
In this activity, you use the materials and your own improved version of the suggested testing technique provided to compare the resistance of the bags to puncturing.

## Part 2: Hazards

There are hazards in this activity from sharp objects. Care should be used with scissors to keep fingers clear while cutting. Both scissors and the bamboo skewers are sharp and care that they are not poked into skin or eyes. Wear eye protection.

## Part 2: Investigation Instructions

Stretch a sheet of plastic bag over the top of a plastic cup or beaker and secure it with a rubber band as shown. Drop a bamboo skewer, point down, onto the stretched plastic, from different heights.



## Part 2: Preliminary Observations and Results

What do you observe when you drop a bamboo skewer, point down, from a height of about 1 cm above the plastic bag onto the plastic?

Repeat this from 20 cm above the stretched plastic bag. What do you observe this time?

Using this technique compare three different plastic bags for their resistance to puncturing. What needs to be done to ensure that the tests are fair?

## Part 2: Planning More Detailed Investigation(s)

Your task is to use the preliminary investigation above to work out which of the plastics has the greatest resistance to puncture with the skewer. Work with your partner or your group to decide which variables you will keep the same (controlled variables) which variable/s you will change (independent variable) and which variable you will measure (dependent variable).

Controlled variables

Independent variable

Dependent variable(s)

Record your testing procedure. How many tests will you do on each plastic?

## Part 2: More Observations and Results

Record your results. What units will you be using?

## Part 2: Analysis

Summarise your results in a form that visually displays the differences in resistance to puncturing.

Why did you choose to use this particular representation? Hint: what are the advantages of using this way of visually summarising your results?

## Part 2: Discussion and Conclusions

How did the plastics compare? Which one is strongest? What is the evidence?

Do you think your results are reliable when making a judgement about which plastic bag will resist cutting by sharp objects? What are the strengths and weaknesses of the testing procedure you used?

Are there variables you have not controlled in your tests?  How might these variables affect your conclusions?

Identify two improvements to the method to ensure it is a well-controlled experiment.

## Part 3: Reflections

What other investigations could you undertake with the plastics and equipment used?

## Part 4: Extensions

### Stress vs strain

What extra measurements do you need Make the appropriate measurements and calculate the engineering stress and strain at different loads till failure. Design a table and record your measurements. Plot a stress vs strain curve for each plastic tested.

How do the shapes of the curves compare?

What do the shapes of the graphs suggest about the plastics used in supermarket bags?

### Independent investigation

What question do you intend to investigate?

Do you have a hypothesis? Briefly state it.

Outline the procedure for conducting your test.

Record your measurements.

Present data.

Analyse your data.

What conclusions can you draw? Did the experiment produce evidence to support your hypothesis? Are there improvements you would make in your experimental method?

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# *LABORATORY LEARNING ACTIVITY 2 – BUNGEE BARBIE*

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# 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,
- metre ruler,
- 7 rubber bands
- 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: 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:

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