ASELL for Schools Workshop

Laboratory Learning Activity Manual

Kambrya College

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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

ACKNOWLEDGEMENTS

We would like to thank:

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WELCOME

Welcome to an ASELL for Schools Workshop!

ASELL (Advancing Science and Engineering through Laboratory Learning) for Schools has been implemented as a specific recomendation of the Office of the Chief Scientist of Australia. The current Schools initiative builds on a project that started in 1999.

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.

This ASELL for Schools workshop is one of a series of Victorian workshops to be run under the Australian Mathematics and Science Partnership Funding Grant, which was awarded to ASELL in 2014. This part 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 Kambrya College, 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 Kambrya College Friday 24 February 2017		
9:00 – 9:15	**Arrival/Registration**	
9:15 – 9:30	**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	
9:30 – 9:40	Introduction to Laboratory Learning Activity	
9:40 – 10:50	***Laboratory learning activity 1 – Materials Testing: Plastics*** *Mr Ian Bentley*	
10:50 – 11:15	**Morning Tea**	
11:15 – 11:35	**Teachers:** Teachers deconstruct LLA #1; Inquiry Scaffolding tool; Introduction to Laboratory Learning Activity with Dr Peta White	**Students:** Discussion and feedback on Laboratory learning activity
11:35 – 12:10		**Students:** Interview with a scientist with Dr John Long
12:10 – 12:45		**Students:** Build model electric car with Mr Ian Bentley and Dr John Long
12:45 – 12:55	Introduction to Laboratory Learning Activity	
12:55 – 1:45	**Lunch**	
1:45 – 2:50	***Laboratory learning activity 2 – Investigation - Electric cars*** ***A/Prof. Kieran Lim***	
2:50 – 3:10	Discussion and feedback on Laboratory learning activity	
3:10 – 3:25	**Teachers:** Overall debrief with A/Prof Kieran Lim and Dr Peta White Evaluation for the day	**Students:** Overall debrief with Dr John Long Evaluation for the day

LABORATORY LEARNING ACTIVITY 1
MATERIALS TESTING: PLASTICS
PART A: STRENGTH

Contact: Ian Bentley
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Materials Testing: Plastics Investigation 1: Strength

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 will have to 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?

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.

Key ideas

Force

A force is a push or a pull. When a load is applied to a material a pulling force equal to the weight of the load is applied to the material.

Strength

Strength can be thought about in many ways. In this activity, strength will be taken to mean the load that the material can hold before it breaks.

'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.

Available equipment

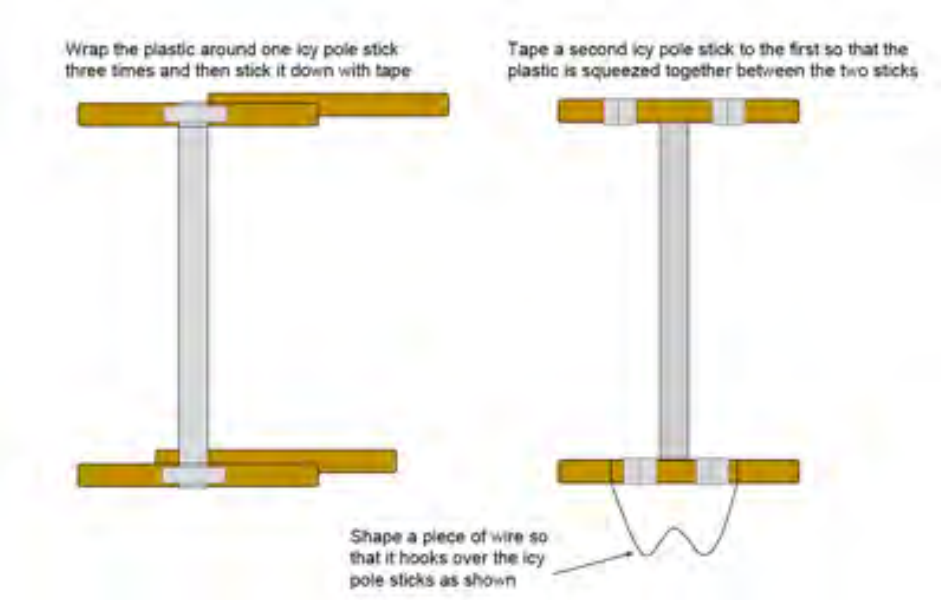
- Different plastic bags (3)
- Scissors
- Sticky tape
- Icy pole sticks
- Paper clips or wire to make hook from which to suspend weights
- Weights
- Ruler

Hazards

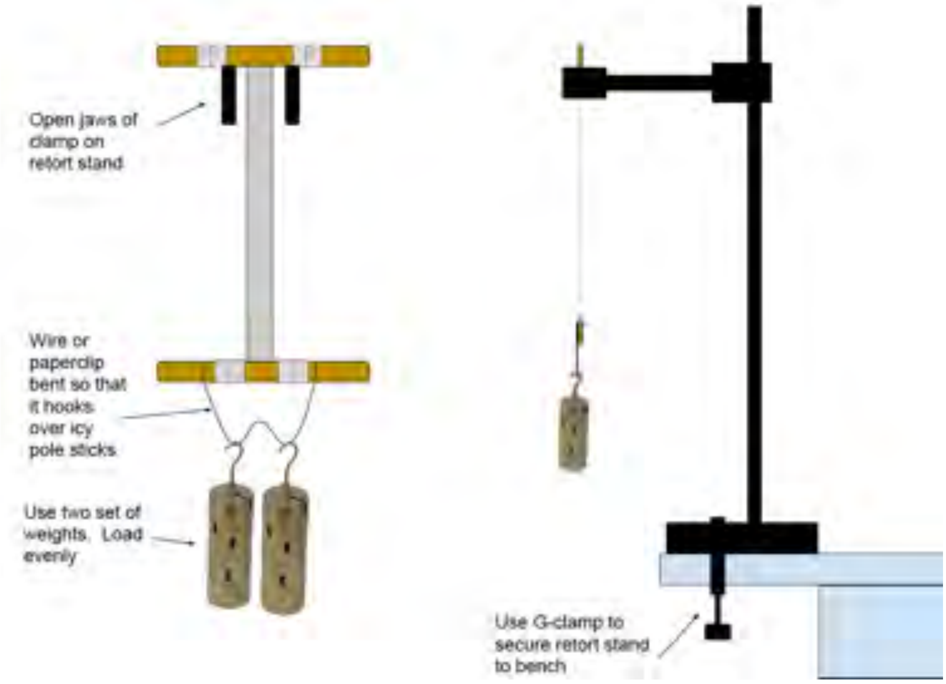
The main hazard will arise when samples of plastic give way under load. Things may fly in unpredictable directions. You must wear safety glasses/goggles, and also keep faces well away from the plastics when they are heavily loaded. Keep clear if you think the plastic is about to snap.

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



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.

Results

Record your results in the spaces below.

	Plastic Bag 1		Plastic Bag 2		Plastic Bag 3	
Source						
Load	Length	Width	Length	Width	Length	Width

Analysis

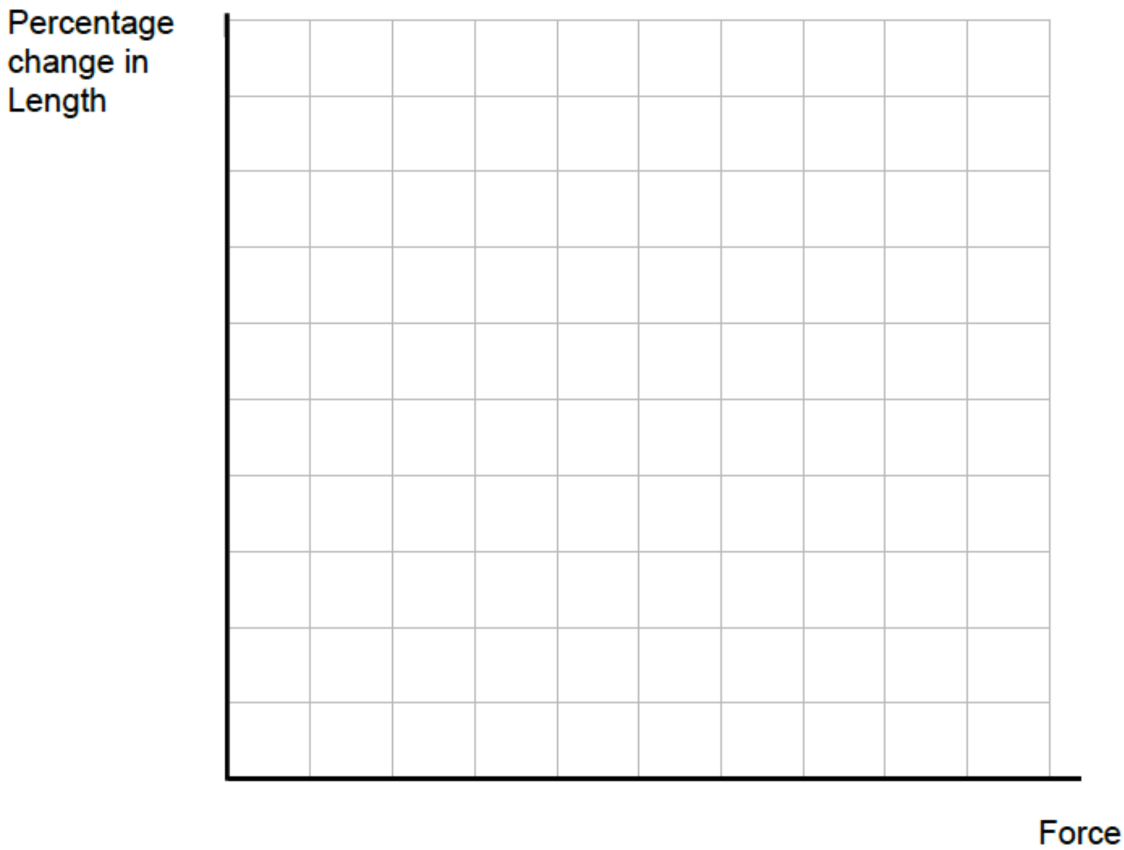
Calculate the percentage change in length versus load.

Plastic 1: percentage change in length versus load			
Load	Length	Change in length	Percentage change in length

Plastic 2: percentage change in length versus load			
Load	Length	Change in length	Percentage change in length

Plastic 3: percentage change in length versus load			
Load	Length	Change in length	Percentage change in length

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.



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?

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.

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

Extension

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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SCHOOLS

Advancing Science & Engineering through Laboratory Learning

LABORATORY LEARNING ACTIVITY 1: MATERIALS TESTING: PLASTICS PART B: CUTTING AND TEARING

Contact: Ian Bentley
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Materials Testing: Plastics
Investigation 2: Cutting and tearing

Introduction

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.

Materials

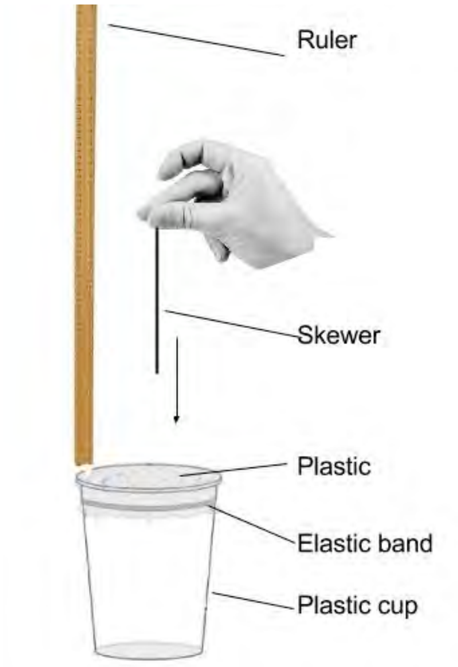
- Plastic cup or beaker
- Plastic bags from different supermarkets
- Rubber bands
- Scissors
- Bamboo skewers
- Ruler

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.

Preliminary investigation

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, from a height of about 1 cm above the plastic bag onto the plastic.



What do you observe?

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?

Investigation

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?

Results

Record your results. What units will you be using?

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?

Discussion and Conclusions

What do your results tell you about the resistance to puncture of the plastic from the different supermarket bags?

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?

How could you have improved your testing?

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STUDENT ACTIVITY – CONSTRUCTING A PROPELLER-DRIVEN ELECTRIC CAR

Contact: Ian Bentley
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Constructing a Propeller-Driven Electric Car

Introduction

Instructions for the building a propeller-driven electric car are provided here. The resulting car can be used to investigate the relationship between electrical energy input and kinetic energy output. Within the context the car provides, students can learn about and consolidate their understanding of series and parallel circuits as well as voltage and current. The design allows flexibility in the way four AA batteries are connected together to provide differences in voltage and current for driving an electric motor which is used to spin a propeller.

Materials

Materials	Tools
Plastic bottle – preferably square section so that it has a flat base	Ruler or measuring tape
Soft drink bottle 1.25L	Scissors
Drinking straws	Craft knife or blade
Two bamboo skewers	Hot glue gun
Light toy truck wheels or plastic screw tops from milk bottles	Sandpaper
4 AA battery holders and batteries	Candle (and matches)
An electric motor (1.5 – 6V)	Spiked tool

Procedure

Making a propeller

1. Cut the top off a soft drink bottle as shown. Keep the screw top.

2. Cut the top of the bottle to produce 8 propeller blades of the same size.

3. Warm propeller blades over candle till slightly flexible and twist as shown. Practice with a couple of pieces of plastic cut from the rest of the drink bottle. Repeat with each blade so that each blade has approximately the same slight twist. All twists must be in the same direction.

4. The length of the propeller blades may need to be trimmed. Blades of 6cm in length seem to work well

5. Remove the screw top. Using a spike tool, poke a hole in the centre of the bottle top. The drive shaft of the motor will be pushed into this hole. Be careful not to push the spike into your hand or the furniture. Use a scrap piece of wood to support lid.

Assembling Car

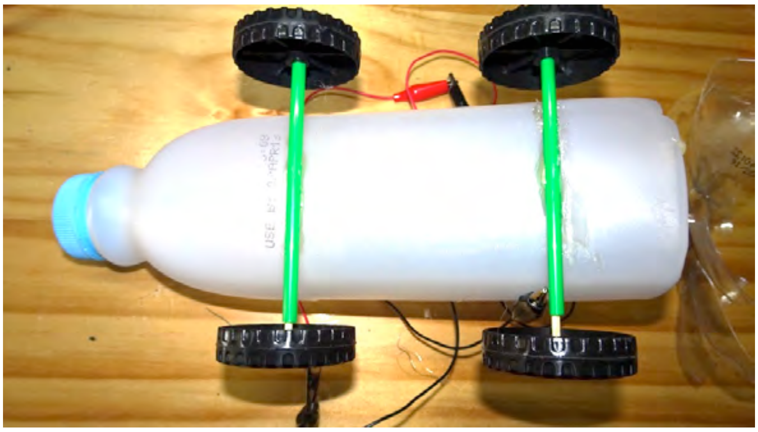
1. Layout all of the parts.

2. Cut two straws 8 cm in length and skewers to 10 cm in length with scissors or blade.

3. Shave blunt ends of skewers with sandpaper and check that the skewers push into the axel holes of the wheels.

4. Push the skewers through the straws and attach the wheels

5. Glue straws to bottle as shown.

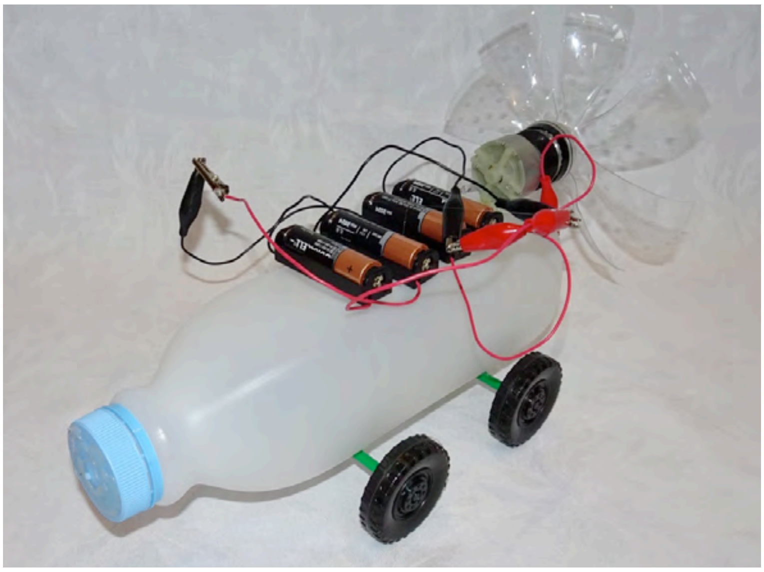


6. Glue the battery holders to the bottle. Note: Alligator clips have been soldered to the wires on the battery holder.

7. Glue the motor to the centre and as close as possible to the end of the bottle so that the propeller is clear of the end of the bottle.

8. Attach propeller to motor drive shaft using the hole in the bottle cap.

9. Connect wires and away you go.



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LABORATORY LEARNING ACTIVITY 2: ELECTRIC CARS

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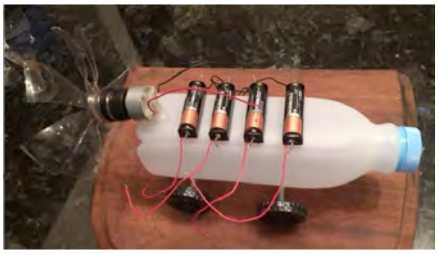
Electric Cars

Introduction

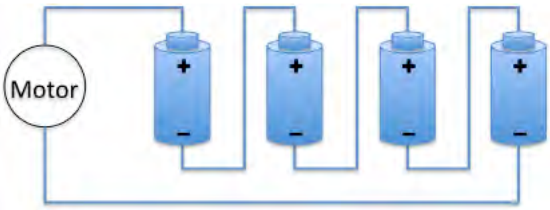
Electric devices are a part of our everyday lives. However, electric cars are widely used as because of limitations in battery technology.

A model electric car has been assembled in a previous session.

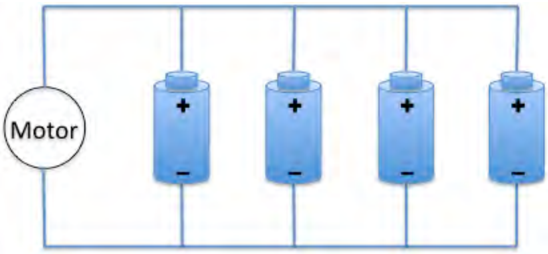


Photos by Ian Bentley (Deakin University)

In this activity, you will investigate how car performance changes if batteries are connected differently.



Batteries connected in series



Batteries connected in parallel

Your group needs to plan your investigation, conduct the investigation, record your results and make conclusions (findings) about your investigation.

In a future lesson, you will learn more about electric components connected in series and in parallel, so you should also make measures of the electric current and potential for the various ways you connect the batteries.

Available equipment

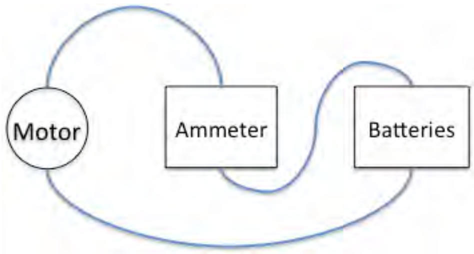
- Fan-driven vehicle;
- Rulers;
- Stopwatches;
- Measuring tapes;
- Ramps – planks of wood;
- Voltmeters (or multimeters);
- Ammeters (or multimeters);
- Leads with alligator clips;
- Safety glasses.

Hazards

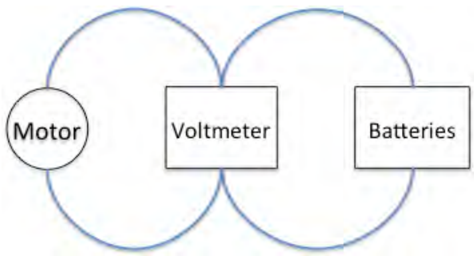
The main hazard is the spinning propeller, which may be hard to see. You must wear safety glasses/goggles, and also keep faces and hands away from the spinning propeller.

Experimental method

- You and your group members need to decide how to measure car performance. You may use all or some or none of the available equipment;
- You might investigate some or all of the following:
- how car performance changes as the number of batteries is changed;
- how car performance changes as the number of batteries in series (head to tail) is changed;
- how car performance changes as the number of batteries in parallel (all heads together and all tails together) is changed;
- Your group should measure electric current and potential for the various ways you connect the batteries. Electric current is measured by putting the ammeter *in series*. Electric potential is measured by putting the voltmeter *in parallel*.



Connecting the ammeter *in series*



Connecting the voltmeter *in parallel*

My group will measure car performance by doing the following. You can decide to use sentences in paragraph(s), picture(s), or some combination of these.

Results

My group made the following measurements. You can decide to use sentences in paragraph(s), table(s), graph(s), or some combination of these. You can include other pages if necessary.

Extension

If your group has finished this activity, then you should try drawing a **Sankey diagram** for the model electric car.

Discussion

In a scientific report, this section discusses the meaning of the results and data that have been collected. What are your conclusions? In this section, "conclusions" means deductions, inferences, interpretations, or judgements based on your results and data.

As the number of batteries was changed, the car performance:

As the number of batteries in series was changed, the car performance:

As the number of batteries in series was changed, the electric current and potential:

As the number of batteries in parallel was changed, the car performance:

As the number of batteries in parallel was changed, the electric current and potential:

Conclusions

In a scientific report, the "conclusions" section is the end or final part of the report. The "conclusions" section is a summary of your entire investigation.

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