# ASELL for Schools Workshop

## Laboratory Learning Activity Manual

Copperfield College

17 August 2017

# CONTENTS

## 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) 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 the team at Copperfield 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<br>Copperfield College<br>Thursday 17 August 2017** | | |
| 9:00 – 9:15 | **Arrival/Registration** ***Library*** | |
| 9:15 – 9:30 | **Welcome and Introduction** with 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>***Library*** | |
| 9:30– 10:20 | **Teachers: Learning in the Laboratory**<br>Inquiry<br>*Peta White*<br>***Library*** | ***Students: Laboratory Learning Activity 2 Building the freezer alarms***<br>*John Long*<br>***Room A9*** |
| 10:20– 10:30 | Introduction to Laboratory Learning Activity ***Library*** | |
| 10:30– 11:34 | ***Laboratory Learning Activity 1 – Corrosion: All at Sea***<br>*Carolyn Drenan and Kieran Lim*<br>***Science Labs B8 and E8*** | |
| 11:34-11:59 | **Morning Tea** ***Room A9 and Library*** | |
| 11:59-12:20 | **Teachers: Learning in the Laboratory**<br>(Continued)<br>***Library*** | **Students:** Discussion and feedback on Laboratory Learning Activity<br>*John Long*<br>***Science Lab B8*** |
| 12:20– 12:30 | | ***Students: Laboratory Learning Activity 2 Building the freezer alarms***<br>(Continued)<br>***Science Lab B8*** |
| 12:30– 12:40 | Introduction to Laboratory Learning Activity ***Library*** | |
| 12:40 – 1:12 | ***Laboratory Learning Activity 3 – Freezer Alarms***<br>*Terry Tan and John Long*<br>***Library*** | |
| 1:12-1:59 | **Lunch** ***Room A9 and Lib*** | |
| 1:59– 2:30 | ***Laboratory Learning Activity 3 – Freezer Alarms***<br>(Continued)<br>***Library*** | |
| 2:30 – 2:40 | Discussion and feedback on Laboratory Learning Activity 3 ***Library*** | |
| 2:40 – 3:10 | **Overall debrief and Evaluation for the day**<br>**Teachers:** Overall debrief and Evaluation for the day<br>*Peta White and Kieran Lim*<br>***Library*** | **Students:** Overall debrief and Evaluation for the day<br>*John Long*<br>***Science Lab B8*** |

Advancing Science & Engineering through Laboratory Learning

# *LABORATORY LEARNING ACTIVITY 1*
# *CORROSION: ALL AT SEA*

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# 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 material because of chemical reactions with the surrounding environment. Corrosion can be described as uniform (all over) or localised (at specific areas) of the material

**Metal** - A substance with high electrical conductivity, lustre and malleability, which readily loses electrons to form positive ions (cations)

**Reactivity Series** – An arrangement or series of metals from the most reactive to the least reactive

**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 a substance (the solute) is dissolved to form a solution

**Solution** - A mixture of two or more substances that are homogeneous (uniformly mixed) with a uniform appearance and composition

**Dissolve** - The process in which the solute interacts with the solvent to form a solution

**Concentration** - The ratio of the amount of a solute in a solvent or total solution, usually expressed as the 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

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

**Variable** - A factor that can be changed, kept the same or measured in an investigation

**Independent Variable** - The variable that is purposely changed in an investigation

**Controlled Variable** - A variable that is kept the same (or constant) during an investigation

**Dependant Variable** - a variable that changes in response to the change to the independent variable in an investigation

**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

**Fair Test** - An investigation where one variable (the independent variable) is changed and all other conditions (controlled variables) are kept the same; what is measured or observed is referred to as the dependent variable

## Equipment and materials

- Plastic or glass beakers
- Styrofoam cups
- Cooking salt
- Plastic spoons or glass stirring rods
- Deionised (demineralised) water
- Carbonated mineral water or soda water
- Tap water (for boiling)
- Kettle or similar
- Thermometer
- Paper clips, metal (large)
- Hair pins (or 'Bobby Pins')
- Scissors
- Plastic tweezers or tongs
- Aluminium foil cut into 1cm strips
- Iron Nails
- Galvanised nails
- Steel Wool
- Emery Paper or sandpaper
- Electronic Balance or scales
- 100 mL measuring cylinder
- Timer or stopwatch
- Sticky labels or marker pens
- Safety glasses/goggles and gloves

## Hazards

- Nails, aluminium foil pieces, emery paper and steel wool may cause cuts and/or lacerations to skin if not handled correctly.
- Water (deionised/demineralised and carbonated) may cause irritation to the stomach if consumed in excess. Salt dissolved in water may cause irritation to skin and eyes, so safety glasses and gloves must be worn.
- 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

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

**Lessons 3 and 4**: Plan and carry out the investigation

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

## Part A1: Investigation Instructions

Here, you will investigate the effect of salt in deionised (demineralised) water on metals.

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, to that will measure the amount of corrosion (change of mass) in your metals over a time interval of 15 to 30 minutes.

Suggested procedure for preparation of solutions:

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

There will be a change in the mass of the solid as the metal corrodes to form metal oxide. You might think about the percentage increase/decrease of metal mass. This might help you to plan your investigation.

## 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 B1: Investigation Instructions

Here, you will investigate the effect of salt in carbonated mineral water on metals.

To better compare your results from Parts A and B, it is suggested that you have similar hypotheses and experimental procedure in both Parts A and B. It is suggested that the only difference is the use of carbonated mineral water in Part B, instead of deionised water.

## Part B2: 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 B3: 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 C: Analysis of results

## Part D: Drawing conclusions (discussion prompts)

What was the purpose of using distilled water and carbonated mineral 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 resources from the Australian Corrosion Association (ACA) website, <https://foundation.corrosion.com.au/>, write a **word equation** for the reaction of one of the metals that you tested from this activity.

Using resources from the Australian Corrosion Association (ACA) website, <https://foundation.corrosion.com.au/>, write a **chemical equation**, described by the above word equation.

## Part E: Extension

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 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.

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

- 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, Kieran Lim, and Ian Bentley, to the refinement of this laboratory learning activity are gratefully acknowledged.

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# LABORATORY LEARNING ACTIVITY 2
# BUILDING THE FREEZER ALARMS

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**S**witch
**O**n
**T**o
**P**hysics

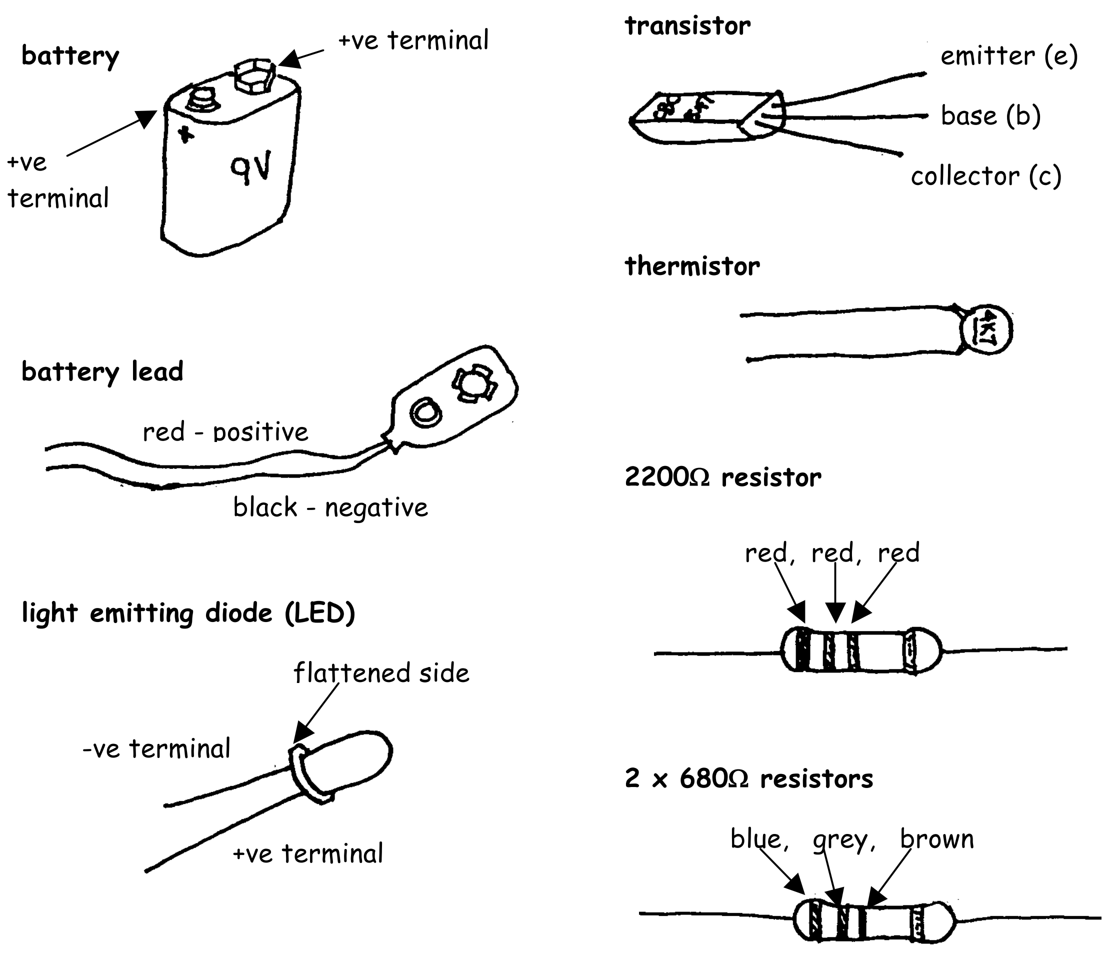
**A**ustralian
**I**nstitute of
**P**hysics
Education Sub-Committee

# Freezer Alarm

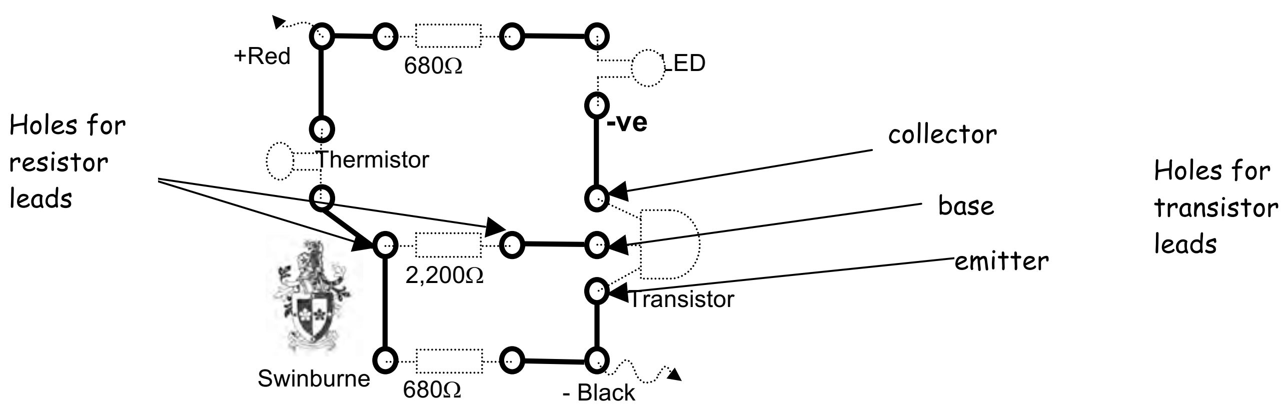
We use alarms in different ways and for many applications in our homes, factories, offices and cars. An alarm may alert you to a welcome visitor, or unwelcome intruder in your home; it may warn you that a car door is not properly shut, or your child's seat belt not fastened. In this activity you will make an alarm that could let you know if your freezer has been accidentally switched off, before the contents thaw and become spoiled. This simple circuit can be adapted in several different ways.

## Building the circuit

1. Collect and identify the components for the freezer alarm, and the card with the circuit printed on it. You also need a small nail for making holes in the card.



2. Using the nail provided, pierce small holes in the card where the round circles are marked. Place a piece of polystyrene or other suitable material under the card while you are doing this.
3. The battery, LED (light emitting diode) and transistor must be connected the right way round, otherwise they will be damaged. So before connecting anything, make sure you can recognise the terminals for these components shown in the drawings above. The negative terminal on the LED has a slightly shorter connecting wire; the negative side may also be slightly flattened.
4. Place the transistor so that the three leads goes through the three holes marked on the card. Make sure that the flat side of the transistor is facing the right way, as shown on the card. You may need to bend the leads of the transistor so that they go neatly into the holes. Don't bend the leads near where they are attached to the transistor, or they may break off.




5. Now place the 2,200Ω (2,200ohm) resistor so that its leads go through the holes marked on each side of it. Again, you may need to bend the leads so that the resistor sits neatly.
6. On the other side of the card, twist together the resistor lead that is nearest the transistor, with the middle lead of the transistor. If you wish you can use pliers to twist the wires and make a more secure join, but **be very careful** not to twist too tightly with the pliers or the leads may break off the components.
7. Now place the LED so that its negative lead goes through the hole marked '-ve' on the diagram above, and the positive lead goes through the other hole.
8. Identify the transistor lead marked 'c' (ie collector) on the circuit diagram above. Join this to the lead from the negative lead of the LED. Again, do this by twisting these two leads together on the back of the card.
9. Work your way around the rest of the circuit joining each component in a similar way: twist together the wire in the hole at one end of a black line with the wire in the hole at the other end. In some places three wires have to be twisted together; do this under the middle hole of the three.
10. When you have assembled all the components, test your freezer alarm. Dip the thermistor in ice water – the LED should go off. Remove the thermistor from the water, and warm it by holding it between your fingers – the LED should go on.

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# *LABORATORY LEARNING ACTIVITY 3*
# *FREEZER ALARMS*

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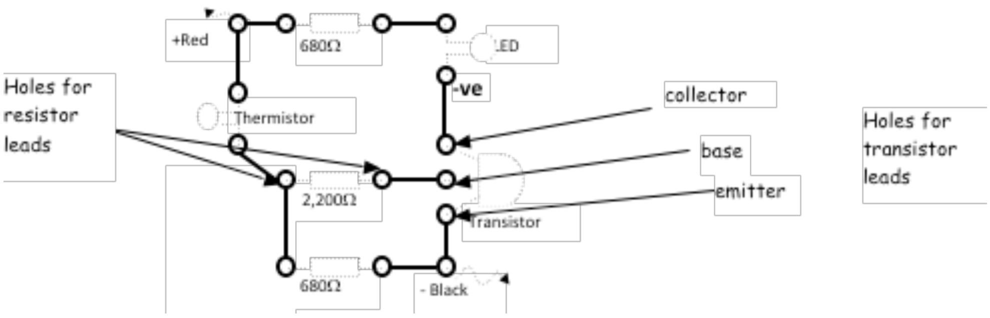
ACA FOUNDATION LIMITED

# Freezer Alarm

## Introduction

We use alarms in different ways and for many applications in our homes, factories, offices and cars. An alarm may alert you to a welcome visitor, or unwelcome intruder in your home; it may warn you that a car door is not properly shut, or your child's seat belt not fastened. In a previous activity you made an alarm that could let you know if your freezer has been accidentally switched off, before the contents thaw and become spoiled. This simple circuit can be adapted in several different ways.

Now that your freezer alarm is working, according to its original design, we will now see what happens when we change the values of the three resistors in the circuit.




## Key ideas

**Resistance** – how much an electrical element in a circuit restricts the flow of electrical current in ohms (Ω). The symbol for resistance is *R*.

**Voltage** – the height of the electrical hill in volts (V). It is a measure of electrical energy. The symbol for voltage is *V*.

**Current** – The amount of charge flowing in a wire in amperes (A). The symbol for current is *I*.

**Ohm's Law** – The relationship between voltage (*V*) across and current (*I*) in a basic electrical element that has resistance (*R*). The electrical element can be a light, a motor, a resistor, or some other element.

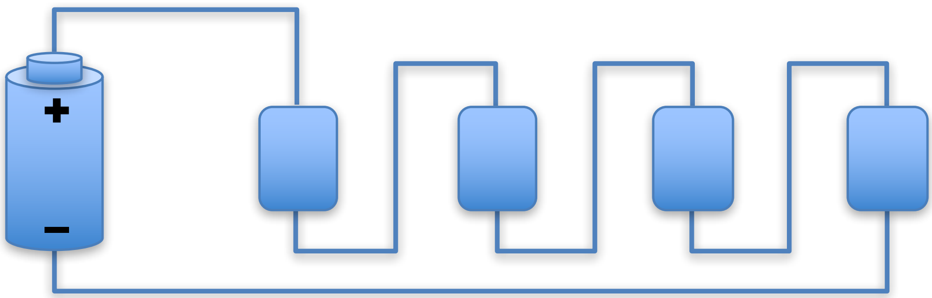
$V = IR$

**Transistor** – a type of electronic switch. This device can also be used as a simple amplifier.

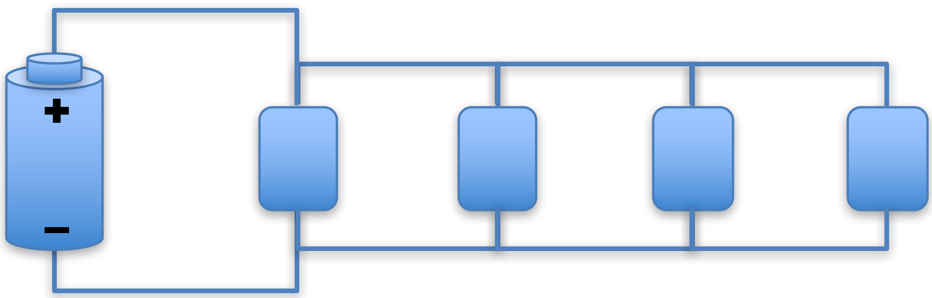
**LED** – a light-emitting diode. It is also a one-way valve for electrical current.

**Thermistor** – a resistor whose resistance changes a lot for small changes in temperature. These are often used as temperature probes.

**Series**– electrical elements are connected head-to-tail in a circuit:




**Parallel**– electrical elements are connected head-to-head and tail-to-tail in a circuit:




## Materials

- Completed freezer-alarm circuit (from previous activity)
- 9-volt battery
- one 1-MΩ 3-pin variable potentiometer.
- A cup of ice water.
- A multimeter that measures resistance.
- Jumper leads with alligator clips

## Part A: Investigating the potentiometer as a variable resistor

In this part of the experiment, you will be investigating how the potentiometer works as a variable resistor.

## Part A: Procedure

1. Turn on the multimeter and set it to measure ohms Ω.
2. Notice that the pot has three wires and a knob that you can rotate. You only use two wires at a time. There are two outside wires and a middle wire.
3. Connect the outside two wires to the multimeter and measure the resistance. Does turning the knob change anything?

4. Now investigate what happens when you connect the centre wire and one of the other wires to the multimeter. What happens when you turn the knob one way or the other?

5. What is the resistance range as you turn the knob from fully anti-clockwise to fully clockwise?

6. Now repeat the experiment for the other two-wire combination. How does it compare with your previous experiment?

## Part B: Effect of changing the 2200 Ω resistor in the alarm circuit

In this part of the experiment, you will investigate what happens when you place a variable resistor (potentiometer) in series or in parallel with the 2200 Ω (2200 ohm) resistor.

How many ohms are in 1 kΩ?

How many ohms are in 1 MΩ?

## Part B: Procedure

1. Design and perform an experiment to see what happens when you place a variable 0-1 MΩ resistor (potentiometer) in series or in parallel with the 2200 Ω resistor.

2. Draw circuit diagrams, showing what you are varying and how.

## Part B: Data Analysis

1. Have the teacher check your circuit before you continue. Describe what happens when you vary the resistance when it is in series with the 2200 Ω resistor.

2. Describe what you **think might happen** when you vary the resistance if it is in **parallel** with the 2200 Ω resistor.

## Part C: Effect of changing the top 680 Ω resistor in the alarm circuit

In this part of the experiment, you will investigate what happens when you place a variable resistor (potentiometer) in series (not in parallel) with the top 680 Ω resistor.

## Part C: Procedure

1. Design and perform an experiment to see what happens when you place a variable resistor (potentiometer) in series (not in parallel) with the top 680 Ω resistor. (Series only, not in parallel.)

2. Draw circuit diagrams, showing what you are varying and how.

## Part C: Data Analysis

1. Have the teacher check your circuit before you continue. Describe what happens when you vary the resistance when it is in series (not in parallel) with the top 680 Ω resistor.

2. Describe what you **think might happen** when you vary the resistance if it is in **parallel** with the top 680 Ω resistor. Are there any hazards in this case?

## Part D: Effect of changing the bottom 680 Ω resistor in the alarm circuit

In this part of the experiment, you will investigate what happens when you place a variable resistor (potentiometer) in series or in parallel with the bottom 680 Ω resistor.

## Part D: Procedure

1. Design and perform an experiment to see what happens when you place a variable 0-1 MΩ resistor (potentiometer) in series with the bottom 680 Ω resistor.

2. Draw circuit diagrams, showing what you are varying and how.

## Part D: Data Analysis

1. Have the teacher check your circuit before you continue. Describe what happens when you vary the resistance when it is in series with the bottom 680 Ω resistor.

2. Describe what you **think might happen** when you vary the resistance if it is in parallel with the bottom 680 Ω resistor

## Part E: Reflection

What part(s) of this activity worked well for your learning?

What improvement for this activity can you suggest so that it would work better for your learning?

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