Your task is to be build, test and modify a self-propelled vehicle.

Follow the steps below to learn about designing accurate scientific tests.

1. **Build a self-propelled vehicle.** The vehicle must utilise energy from itself to move. It may not be pushed, or use gravity (a downhill slope) to travel. Electrical energy (battery power / a motor) is also not allowed for this project. There are many ideas on the Internet that utilise balloons, mousetraps, rubber bands, and much more.

2. **Initial testing of vehicle.** Test the vehicle at least five times. Measure the distance and time it takes to travel (enter this data into a table).

3. **Modify your vehicle and create a hypothesis.** Change ONE variable on your vehicle and make a prediction about how this will change the vehicle’s performance.

4. **Test your hypothesis by performing more tests whilst changing the selected variable.** This should be tested a number of times (to obtain an average) and all results recorded in a table. Remember each test that you undertake must include data on the distance and time. You will then need to calculate the speed of the vehicle for each test and include this in your table.

5. **Write your scientific report including your findings and conclusions.** Use the rubric and guide provided to help you write the report.

**Scientific Report: Marking Criteria**

**1. Formulate questions or hypotheses that can be investigated scientifically** [**(ACSIS198)**](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS198)

- All variables of the experiment are identified and explained in the report.

**A B C D E**

**🞎 🞎 🞎 🞎 🞎**

**2. Plan, select and use appropriate investigation types, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods** [**(ACSIS199)**](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS199)

- Reliable data is collected and presented accurately in a table (including units). A risk assessment is thoroughly completed and included in the final report.

**A B C D E**

**🞎 🞎 🞎 🞎 🞎**

**3. Select and use appropriate equipment, including digital technologies, to collect and record data systematically and accurately** [**(ACSIS200)**](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS200)

- Method is included in the report and photographs / videos are provided to demonstrate appropriate use. Data is presented using digital technologies (graphs and tables).

**A B C D E**

**🞎 🞎 🞎 🞎 🞎**

**4. Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies** [**(ACSIS203)**](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS203)

- Trends and inconsistencies in data (and possible suggestions as to WHY results occurred) are discussed in detail in the report.

**A B C D E**

**🞎 🞎 🞎 🞎 🞎**

**5. Use knowledge of scientific concepts to draw conclusions that are consistent with evidence** [(ACSIS204)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS204)

- References linking concepts and the data collected are used to support findings (in discussion). The Harvard systems should be used and at least one source should be cited.

 **A B C D E**

**🞎 🞎 🞎 🞎 🞎**

**6. Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data** [(ACSIS205)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS205)

- Detailed improvements to the experiment are suggested in the discussion.

**A B C D E**

**🞎 🞎 🞎 🞎 🞎**

**7. Critically analyse the validity of information in primary and secondary sources, and evaluate the approaches used to solve problems** [(ACSIS206)](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS206)

- Possible sources of random and systematic errors are discussed in detail.

**A B C D E**

**🞎 🞎 🞎 🞎 🞎**

**8. Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations** [**(ACSIS208)**](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSIS208)

- Scientific language is used accurately within the report and spelling and grammar is correct (minimal errors).

**A B C D E**

**🞎 🞎 🞎 🞎 🞎**

**9. Energy conservation in a system can be explained by describing energy transfers and transformations** [**(ACSSU190)**](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACSSU190)

- The transfers of energy within the vehicle are included in detail in the discussion of the report.

**A B C D E**

**🞎 🞎 🞎 🞎 🞎**

**10. Use scatter plots to investigate and comment on relationships between two numerical variables** [**(ACMSP251)**](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACMSP251)

- An accurate scatter plot is included in the practical report (results).

**A B C D E**

**🞎 🞎 🞎 🞎 🞎**

**11. Substitute values into formulas to determine an unknown** [**(ACMNA234)**](http://www.australiancurriculum.edu.au/curriculum/contentdescription/ACMNA234)

- All speed calculations are included in the report (results).

**A B C D E**

**🞎 🞎 🞎 🞎 🞎**

**Scientific Report**

Follow this guide when writing your scientific report. Use the headings in your report (and keep the order). Scientific reports are also written in third person (avoid the use of I and we) and in past tense.

**Title**: What you are specifically testing? Eg. The effect of pen size on the amount of words written in a lesson.

**Hypothesis**: What you expect to happen. Use an “If… then…” statement.

**Variables**: List the independent variable, dependent variable and controlled (constant) variables.

**Apparatus**: List the equipment that was used in your experiment.

**Method**: Write the steps taken to undertake your experiment. Can be written as: Step 1…. Step 2…. Step 3…. Like a recipe. It is a good idea to include labelled pictures of any key steps. You must also include a risk / safety assessment in this section.

**Results**: Present your results in a table and a graph. Ensure that all units are included and tables and graphs are labelled.

**Discussion:** This will be the longest part of the report. You will *analyse your data and suggests reasons for why these results occurred*. You will need to link and suggestions to other sources. Eg. Smith (2011) suggested that as the size of the pen increased, students were able to write faster because they could grip the pen easier. (\*NOTE: I made this reference up, but you get the point). Please avoid unreferenced claims. Eg. I think it was easier to write with a longer pen. This statement is not backed by other scientific tests and is therefore less reputable.

You will also need to include *a paragraph about the energy transfers occurring in your self-propelled vehicle*. You may want to include some diagrams or images to display the energy transfers. Again, this should be referenced with reliable resources. You should use the Harvard referencing system. Lastly, you will need to include a paragraph on the systematic and random errors of this investigation. You will also need to suggest some improvements based on your findings.

**Conclusion**: Write a sentence or two about the findings of the investigation. Was the hypothesis supported? Why / why not?

***Teacher’s help for the self-propelled vehicle***

I’m pretty keen for students to design their own results table. They will probably look like this and if anyone is having difficulty you could point them towards this…

|  |  |  |  |
| --- | --- | --- | --- |
| Attempt | Distance (m) | Time (secs) | Speed (m/sec) |
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |
| 5 |  |  |  |
| Average |  |  |  |

A good technique for creating a hypothesis is using “If… then…” statements.

For example; “If the wheel size increases, then the vehicle will travel further.”

From this example the INDEPENDENT variable is the wheel size. It is the variable that is being TESTED.

The DEPENDENT variable in this case is the distance the vehicle travels because that is the variable being MEASURED.

A good table for this experiment could be:

|  |  |
| --- | --- |
|  | Distance travelled (m) |
| Wheel diameter (cm) | Attempt 1 | Attempt 2 | Attempt 3 | Attempt 4 | Attempt 5 | Average |
| 10 | 3.5 | 3.8 | 3.2 | 1.9 | 2.8 | 3.04 |
| 20 | 3.4 | 4.1 | 4.2 | 3.3 | 3.5 | 3.7 |
| 30 | 4.3 | 4.6 | 4.1 | 3.9 | 3.2 | 4.02 |
| 40 | 1.1 | 1.4 | 2.3 | 2.1 | .9 | 1.56 |

They may need to do multiple tables (to add time and speed calculations).

I calculated the average in excel. In your table type “=average” then highlight the data you would like to average. Brilliant!

Students will need to chart their results (using excel). See the next page for an example. This is a “smooth line scatter plot”. This is the best option for this task. You can see that the independent variable is on the horizontal x-axis and the dependent variable is on the vertical y-axis. This is important. There is also a clear title and all units are displayed.

Wheel size isn’t the only variable to be tested. There are so many adaptations that could be made to their vehicle. Length of vehicle, size of balloon, position of mousetrap, size of propeller, length of axel, etc. The key is only focussing on ONE. Scientists will choose one variable to test (independent), one variable to measure (dependent) and try to keep all of the other variables CONTROLLED. Eg. same surface, same slope, same wheel type, etc.

Encourage students to go into detail in their discussion. This has the greatest amount of assessable items (linked to ACARA). They should be using data (numbers) and references to support their statements.

Eg. Graph 1 shows that as the wheel size increased the distance the vehicle travelled also increased. This trend continued until a wheel diameter of 40cm when the average distance travelled (1.56m) was less than the average distance travelled for the 30cm wheel (4.02m). It is expected that students will research (and reference) reasons for their data. Eg. Why did those results occur?

Students will also include errors (and improvements) in their discussion. There are two types of errors in scientific reports. RANDOM and SYSTEMATIC errors. Random errors are inevitable because humans cannot be 100% precise when performing and measuring investigations. To reduce the effect of random errors scientists will perform tests a number of times to receive an average. Many students confuse random errors with mistakes, but they are quite different. Random errors will occur even when undertaking all tasks to the best of our ability. We’re simply limited as humans (we’re not robots). Systematic errors are possible faults with equipment (measuring apparatus). We will not know if any systematic errors occurred unless we perform the investigation again with new equipment. We would then compare the results to see if there were similar trends or not.