**Science 10: Engineering a Race Car**

Your first Design Lab!

You will design and build a race car out of lifesavers, sticks, straws and tape. Some questions to think about are:

*What are you going to test? What are you going to measure? What causes the geyser?*

This experiment aligns with Criterion 2: Inquiring and Designing and Criterion 3: Processing and Evaluation.

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|  | **Criterion 2: Inquiring and Designing** | | | | |
|  | **(0)** | **Beginning (1-2)** | **Developing (3-4)** | **Accomplished (5-6)** | **Exemplary (7-8)** |
| **[i]**  **[ii]**  **[iii]**  **[iv]** | *I have not achieved a standard described to the right*. | *I am able to:*  **state** a problem or question to be tested by a scientific investigation  **outline** a testable hypothesis  **outline** the variables  **design** a method, **with limited success.** | *I am able to:*  **outline** a problem or question to be tested by a scientific investigation  **formulate** a testable hypothesis **using scientific reasoning**  **outline** how to manipulate the variables, and **outline** how **relevant data** will be collected  design a **safe method** in which he or she **selects materials and equipment**. | *I am able to:*  **describe** a problem or question to be tested by a scientific investigation  **formulate and explain** a testable hypothesis **using scientific reasoning**  **describe** how to manipulate the variables, and **describe** how **sufficient, relevant data** will be collected  design a **complete and safe method** in which I select **appropriate materials and equipment**. | *I am able to:*  **explain** a problem or question to be tested by a scientific investigation  **formulate and explain** a testable hypothesis **using correct scientific reasoning**  **explain** how to manipulate the variables, and **explain** how **sufficient, relevant data** will be collected  **design** a **logical, complete and safe method** in which I **select appropriate materials and equipment**. |

**TEMPLATE:**

**Problem/Question [B-i]**

* *This is the question/objective that you are trying to answer by completing your experiment. It should be specific.*

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| ***First question to determine… will you measure the distance the car has traveled OR the time it takes to get to a certain distance?***  **Choose one of the following questions for your experiment:** | |
| * How many paper clips help a car move? * What type of Life Saver works best for a car? * What distance does a car go with added weight? * What time do you save with less weight on your car? * How does adding an extra wheel help your car? * Or another one of your choice –please confirm with the teacher before proceeding.   \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |  |

**Hypothesis: [B-ii]**

* *This statement reveals the relationship you predict exists between what you’re manipulating (independent variable) and what you think will change as a result (dependent variable).*
* *What you predict will happen in your experiment, and why you think it will happen, using scientific reasoning*

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| **What do you expect will happen?**  If the is then the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  will because .  *(be affected in what way?)*  *(changed in what way?)*  *(dependent variable)*  *(independent variable)* |

**Variables[B-iii]**

* *Identify the Variables:*
  + ***Independent Variable****: Name the variable that you will change (manipulate) in the experiment and explain how it will be manipulated.*
  + ***Dependent Variable****: Name the variable that will be MEASURED and how it will be measured.*
  + ***Controlled Variables:*** *List all of the variables that you will keep the same throughout the entire   
     experiment and how you will keep them the same. (CONSTANT)*
* *Explain how sufficient (# of trials & increments) and relevant (types of measurements) data will be collected.*

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| The **independent** variable is . It will be manipulated (changed) by .  The **dependent** variable is . It will be measured by  .  The **controlled** variables are  - . It will be kept constant by .  - . It will be kept constant by .  - . It will be kept constant by .  - . It will be kept constant by .  - . It will be kept constant by . |

**Method**: **[B-iv]**

* *Steps: Step-by-step instructions that logically and concisely describe how to complete your exact experiment.* 
  + *Includes amounts (e.x. add 20mL of water) and instructions for when/where to make/record observations.*
* *Diagram: Includes a clearly labeled diagram(s) or image(s) of any apparatuses you will use “in action”.*
* *Safety: Includes important safety information/warnings.*
* *Ethical Considerations: Includes important ethical concerns of procedure or materials.*

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| **Make a list or draw diagrams to show, in order, the steps that you will take to collect data. Your method should be detailed enough so that someone in a different group could conduct your experiment.** |
| **How many times will you repeat your experiment?** |

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|  | **Criterion 3: Processing and Evaluating** | | | | |
|  | **(0)** | **Beginning (1-2)** | **Developing (3-4)** | **Accomplished (5-6)** | **Exemplary (7-8)** |
| **[i]**  **[ii]**  **[iii]**  **[iv]**  **[v]** | *I have not achieved a standard described to the right*. | *I am able to:*  **collect and present** data in numerical and/or visual forms  **interpret** data  **state** the validity of a hypothesis based on the outcome of a scientific investigation  **state** the validity of the method based on the outcome of a scientific investigation  **state** improvements or extensions to the method. | *I am able to:*  **correctly collect and present** data in numerical and/or visual forms  **accurately interpret** data and **explain** results  **outline** the validity of a hypothesis based on the outcome of a scientific investigation  **outline** the validity of the method based on the outcome of a scientific investigation  **outline** improvements or extensions to the method that would benefit the scientific investigation. | *I am able to:*  **correctly collect, organize and present** data in numerical and/or visual forms  **accurately interpret** data and **explain** results **using scientific reasoning**  **discuss** the validity of a hypothesis based on the outcome of a scientific investigation  **discuss** the validity of the method based on the outcome of a scientific investigation  **describe** improvements or extensions to the method that would benefit the scientific investigation. | *I am able to:*  **correctly collect, organize, transform and present** data in numerical and/ or visual forms  **accurately interpret** data and **explain** results **using correct scientific reasoning**  **evaluate** the validity of a hypothesis based on the outcome of a scientific investigation  **evaluate** the validity of the method based on the outcome of a scientific investigation  **explain** improvements or extensions to the method that would benefit the scientific investigation. |

**Results & Observations**:**[C-i]**

* *This is an overview of your* ***Qualitative*** *(observations) and* ***Quantitative*** *(measurement) results.*
* *Quantitative data should be well-organized in a data table(s)*
  + *Columns and rows should have headings and units of measurements, with uncertainty if applicable*
  + *Individual trials and any columns for statistical analyses should be included*
  + *Title should be descriptive and underlined (title should describe exactly the data contained in the table)*
* *Qualitative data can be included in a table, paragraphs, or in the form of images or diagrams.*

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| **Collection of Data:**  Prepare your data table by filling in the following with your independent variable and your dependent variable. Don’t forget to include units.  During the experiment, record your values.   |  |  |  | | --- | --- | --- | | Trial | ***(Independent variable)*** | ***(Dependent variable)*** | | 1 |  |  | | 2 |  |  | | 3 |  |  | |

* *“Transform” raw data by modifying in some way to reveal or emphasize trends:*
  + *Do calculations (statistical analyses like avg, % change, etc.). Include sample calculations if you do this.*
  + *Create a graph(s) that shows trends or patterns clearly. Label it clearly and include a descriptive title.*
    - *Only draw a best fit line if appropriate (to emphasize a mathematical relationship)*

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| **Transformation of Data:**  Show any calculations here. What is the average of your results? |

**Analysis & Evaluation [C-ii, iii, iv, v]**

*This should be a four to five paragraph write up that addresses the following components:*

* ***Interpret Results****:* ***[C-ii]***
* *What does your data/results mean? What have your findings revealed (refer to specific data to support your inferences), and how are they explained and supported scientifically?*
* *Comment on the reliability of the data – were there any unexpected results or outliers?*

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| **Interpretation of Results**  What are your results? |
| What does your data/results mean?  What have your findings revealed (refer to specific data to support your inferences)?  How are they explained and supported scientifically? |
| Comment on the reliability of the data – were there any unexpected results or outliers? |

* ***Assess the validity of the hypothesis:******[C-iii]***
* *Was your hypothesis valid (was it validated by your results) or not? What proof (data) supports/rejects it?*

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| **Validity of Hypothesis**  Re-state your hypothesis:  *It was predicted that:* |
| Did you get the results that you expected?  *This hypothesis was* ***supported / not supported*** *by the following results:* |

* ***Assess the validity of the method: [C-iv]***
* *Is your data precise? (Is there enough data? Is your data consistent? Are there any outliers? Why/why not? What sources of error were there in your investigation? Did you control for all extrinsic variables?)*
* *Is your data accurate? (if applicable) (does it agree with literature values?)*
* *What were sources of error in your investigation? How did they impact the validity of your test?*

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| **Validity of Method**  Is your data **precise**? Why or why not? |
| Is your data **accurate**? Why or why not? |
| What are some sources of error? Why were your results not precise or accurate? |

* ***Suggest improvements or extensions to the method:******[C-v]***
* *How could the method of the experiment be improved? Could you have obtained more accurate results? Fixed some of the invalid components from part C?*
* *What would you suggest for students doing this experiment next time; what more could you test?*

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| **Improvements or Extensions to the Method**  If you were to repeat this investigation on another day, how could your method be improved?  *(How could you improve the DESIGN of your lab? Not ‘don’t make a mistake’).* |
| How could you extend this investigation? What else could you test? |