**Mission to Mars: Space Launch System Design Challenge**

**PART 3: IMAGINE POSSIBLE SOLUTIONS – CHEMICAL ENGINEERS**

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| **PHASE 1 – INVESTIGATING FUEL INGREDIENTS** |

**Question:** Which combinations of substances will **produce a fuel (gas)** that could launch your rocket to the highest possible height?

**Available Materials:**

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| --- | --- | --- | --- |
| * Samples of ingredients – both liquid and solid | | * Pipette | * Scoop/spoon |
| * Ice cube tray | * Toothpicks | * Graduated cylinder | * Cups/beakers |

**Suggested Procedure:**

1. Choose the fuel reactants that could be used in combination to cause a chemical reaction strong enough to fuel the launch of your SLS rocket.
2. In the Data Table below, list each of your ingredients. List only one ingredient per box. ***If you would like to react two solids, one of them will need to be dissolved in water prior to reacting them and you will place this one in the liquid column.***
3. Use the data table to test the combinations of the ingredients you have selected. You will complete a total of 5 tests to recognize each possible fuel combination. **For powdered solids, a small amount on the tip of a spoon. For liquids use no more than 10-mL.**
4. Conduct your tests in one section of the ice cube tray. Record your observations in each of the boxes
5. Clean up by returning cups of ingredients to designated location, rinsing and drying ice cube tray, and returning materials.

**Data Table:**

|  |  |  |
| --- | --- | --- |
| **SOLID REACTANT** | **LIQUID REACTANT** | **REACTION OBSERVATIONS** |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
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**Analysis**

1. Which combinations of substances from your testing produce a chemical reaction?
2. Which specific combination of substances do you believe would create the strongest chemical reaction needed to launch your SLS rocket to highest possible height?

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| **CLAIM(S)** | **EVIDENCE** | **REASONING** |
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| **PHASE 2 – INVESTIGATING AMOUNTS OF DESIRED INGREDIENTS** |

**Question:** Using one combination of substances discovered in Phase 1, **how much of each ingredient** is needed to produce a chemical reaction strong enough to launch your rocket to the highest possible height?

**Available Materials:**

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| --- | --- | --- |
| * One combination of substances discovered in Phase 1 | * Ruler/meter stick | * Launch pad (bucket) |
| * RS-25 engine (film canister) | * Balance | * Graduated cylinder |

**Suggested Procedure:**

1. List the ingredients you will test because you believe they will produce the strongest chemical reaction (based on data from Phase 1):

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1. Complete the data table by deciding the amount of each ingredient you would like to test. Decide on at least 3 different amounts for each ingredient. Please note:

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| **Prototype Constraints** |
| * No more than 20 mL of a **fuel liquid** can be used to power the engine * No more than 10 g of **fuel solid** can be used to power the engine |

1. Think about/talk about the best way to add the ingredients to your film canister.
2. Measure each ingredient and add them to the film canister.
3. **QUICKLY** close the lid of the film canister and place it in the bucket (the launch pad).
4. Record observations in the data table.
   1. You can record an estimated height of launch by placing a ruler or meter stick standing upright in the bucket. One person will need to hold the ruler/meter stick to achieve this.
5. Clean up by returning all materials and wiping down any surfaces and the floor of any waste.

**Data Table:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **FUEL TESTS** | | | | | |
| Solid(s) | Liquid(s) | Solid(s) | Liquid(s) | Solid(s) | Liquid(s) |
| **Amount**  **(mL or g)** |  |  |  |  |  |  |
| **Approximate Height (cm)** |  | |  | |  | |
| **Other Observations** |  | |  | |  | |

**Analysis:**

1. About how much of each ingredient will you need to achieve the greatest possible launch height? REMINDER: You may not use more than 20 mL of liquid substances and 10 g of solid substances.
2. What evidence do you have to support your claim above?

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| **PART 3 CONCLUSIONS** |

Write a final recommendation to present to your SLS team regarding the type and amount of ingredients needed to fuel the RS-25 engine. Use data obtained in your investigations as evidence to support your claims and defend your reasoning.

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