**Investigation: Exothermic and Endothermic Reactions**

**Summary**   
  
Carry out three experiments to see if the reaction is exothermic or endothermic.

Carry out a fourth experiment to determine if the reaction is endothermic or exothermic, record the temperature change over time and graph the results.

**Background**   
  
**Some reactions between substances absorb heat energy and some give off heat energy.** Exothermic reactions release lots of energy in the form of heat when they react whereas endothermic reactions absorb heat energy and therefore drop in temperature when reacting.

This practical contains four separate reactions, you are to predict and then record whether the reactions are exothermic or endothermic by using a thermometer to record the temperature of the mixtures.

For the last reaction (dilute sulfuric acid + magnesium ribbon), you are to record the temperature change every 30 seconds until the reaction finishes. Record your data in a table and then graph the change in temperature over time.

**Equipment required (per set):**

* Beakers or test tubes
* Thermometers
* 10ml sodium hydroxide solution (irritant)
* 10ml sodium hydrogen carbonate solution (irritant)
* 10ml dilute hydrochloric acid (irritant)
* 10ml copper (II) sulfate solution (irritant)
* 10ml dilute sulfuric acid (irritant)
* Four spatula measures of citric acid
* Four spatula measures of magnesium powder (highly flammable)
* 3cm magnesium ribbon (highly flammable)

The four experiments comprise two substances each and are as follows:

* Sodium hydroxide solution + dilute hydrochloric acid
* Sodium hydrogen carbonate solution + citric acid
* Copper (II) sulfate solution + magnesium powder
* Dilute sulfuric acid + magnesium ribbon

**Safety**   
  
Wear safety coat and eye protection, some of the solutions are classed as irritant.

**Procedure:**

1. **Reaction of sodium hydroxide solution and dilute hydrochloric acid**
2. Use the measuring cylinder to measure out 10 ml of sodium hydroxide solution and pour it into a beaker or test tube.
3. Measure the initial temperature of the sodium hydroxide solution and record it in the table below.
4. Measure out 10 ml of hydrochloric acid and carefully add this to the sodium hydroxide solution in the polystyrene cup. Stir with the thermometer and record the maximum or minimum temperature reached.
5. Work out the temperature change and decide if the reaction is exothermic or endothermic.
6. Discard the mixture (in the sink with plenty of water).

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| **Initial temperature** | **Final temperature** | **Temperature change** |
|  |  |  |

**Question: Is the reaction endothermic or exothermic?**

1. **Reaction of sodium hydrogen carbonate solution and citric acid**
2. Use the measuring cylinder to measure out 10 ml of sodium hydrogencarbonate solution and pour it into a beaker or test tube.
3. Measure the initial temperature of the sodium hydrogencarbonate solution and record it in the table below.
4. Add 4 small (not heaped) spatula measures of citric acid. Stir with the thermometer and record the maximum or minimum temperature reached.
5. Work out the temperature change and decide if the reaction is exothermic or endothermic.
6. Discard the mixture (in the sink with plenty of water).

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| **Initial temperature** | **Final temperature** | **Temperature change** |
|  |  |  |

**Question: Is the reaction endothermic or exothermic?**

1. **Reaction of copper(II) sulfate solution and magnesium powder**
2. Use the measuring cylinder to measure out 10 ml of copper(II) sulfate solution and pour it into a beaker or test tube.
3. Measure the initial temperature of the copper(II) sulfate solution and record it in the table below.
4. Add 1 small (not heaped) spatula measure of magnesium powder. Stir with the thermometer and record the maximum or minimum temperature reached.
5. Work out the temperature change and decide if the reaction is exothermic or endothermic.
6. Discard the mixture (in the sink with plenty of water).

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| **Initial temperature** | **Final temperature** | **Temperature change** |
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**Question: Is the reaction endothermic or exothermic?**

1. **Reaction of sulfuric acid and magnesium ribbon**
2. Use the measuring cylinder to measure out 10 ml of sulfuric acid and pour it into a beaker or test tube.
3. Measure the initial temperature of the sulfuric acid and record it in a table similar to the one below.
4. Add one 3 cm piece of magnesium ribbon. Stir with the thermometer and record the temperature after every 20 seconds until all the magnesium ribbon has reacted, about 6 or 7 minutes (record the temperatures in your table).
5. Work out the temperature change between the initial (time 0) and the final temperatures recorded and decide if the reaction is exothermic or endothermic.
6. Once all the magnesium ribbon has reacted, discard the mixture (in the sink with plenty of water).
7. Graph the change in temperature with your recorded data. Note: The independent variable (Time) will be on the x-axis and the dependent variable (Temperature) will be on the Y-axis. This will be a line graph.

**Table 1:** Time and temp for reaction

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| --- | --- |
| **Time (seconds)** | **Temperature** |
| **0** |  |
| **20** |  |
| **40** |  |
| **60** |  |

|  |  |
| --- | --- |
| **Time (seconds)** | **Temperature** |
| **80** |  |
| **100** |  |
| **120** |  |
| **140** |  |

|  |  |
| --- | --- |
| **Time (seconds)** | **Temperature** |
| **160** |  |
| **180** |  |
| **200** |  |
| **220** |  |

**Question 1: What is the temperature change from the initial to the final temperature?**

**Question 2: Is the reaction endothermic or exothermic?**

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**Graph the change in temperature (0C) versus time (secs).**

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