# *Reaction rates* Student investigation sheet

## Challenge: You are the process chemist

### Introduction

The duties of a process chemist include being a troubleshooter to identify what is going wrong in a chemical reaction and to determine how the issue can be fixed. A process chemist must have theoretical knowledge about how the reaction takes place and some practical experience to enable a solution to be found.

This challenge activity requires you to be the process chemist and determine a solution to a reaction rate challenge.

### Safety

* Hydrochloric acid is corrosive and should be treated with care.
* Personal Protective Equipment must be worn.
* If exposed to a spill, wash any exposed skin or flush eyes with fresh running water.

### Materials and equipment

* 1.0 M HCl (40 mL)
* 0.1 M HCl (40 mL)
* 2.0 M HCl (40 mL)
* calcium carbonate (powder ≤1 mm diameter)
* calcium carbonate (‘sand’ 1–3 mm diameter)
* calcium carbonate (chips 4–10 mm)
* 250ml beaker (for hot or cold water)
* test tube rack
* 5 test tubes
* 5 mL measuring cylinder
* stopwatch
* electronic mass balance (± 0.01 g if possible)
* watch glass
* thermometer
* hot water
* ice
* Personal Protective Equipment

### Procedure

1. Weigh 0.1g of calcium carbonate powder then place in a test tube in the test tube rack.
2. Using the measuring cylinder measure 5 mL of 1.0 HCl.
3. Carefully pour the HCl into the test tube and observe.
4. You will see bubbling as the reaction produces carbon dioxide. Note the intensity of the bubbling.
5. Repeat steps 1–3, this time starting the stopwatch when the bubbling starts and stopping when it ceases. Record the time.
6. Repeat step 5 so you have two recorded times for the reaction.

|  |  |
| --- | --- |
| Trial | Time (in seconds) |
| 1 |  |
| 2 |  |

**Analysis of data**

* The results of the trials show the average time for the bubbles to cease is **less than/greater than** (circle the appropriate) **2 minutes.**
* A proposed change will have to **decrease/increase** (circle the appropriate) the time for the reaction to exactly meet the target time of 120 seconds or 2 minutes.

### Challenge

Your task is to manipulate the reactants to make the bubbles last for exactly 120 seconds or 2 minutes.

**Conditions**

* You must always use 0.1 gram of calcium carbonate and 5 mL of HCl.
* You may use any of the materials in the equipment list above.
* Temperatures must remain below 50°C.
* Unreacted calcium carbonate is to be placed in a waste container and NOT disposed of down the sink.

**Steps**

1. Propose a change to the reaction (not the quantity or volume) (*Hint:* recall the factors which affect reaction rates.)
2. Provide your reason/s why the change might help you achieve the desired time.
3. Predict what will happen.
4. Test your proposal and record your results.
5. Analyse the data and draw conclusions to determine whether your proposal is working and the next step towards a solution.
6. Repeat as required to work towards your solution. (Your teacher may limit your attempts.)
7. Evaluate your attempts towards reaching the solution (time or availability of sufficient materials may mean that you don’t actually achieve the target time of exactly 120 seconds or 2 minutes).

Challenge: You are the process chemist Trial \_\_\_\_\_ Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

### Proposed change

|  |
| --- |
| I will change |
|  |

### Reason/s

|  |
| --- |
| I proposed this change because |
|  |
|  |
|  |

### Prediction (hypothesis)

|  |
| --- |
| I predict that if |
| then |

### Results

|  |
| --- |
| The average time obtained was |
| Other observations include: |
|  |
|  |

### Analyse data and draw conclusions

|  |
| --- |
| The results show |
|  |
|  |
| Conclusion |

|  |
| --- |
|  |
|  |
|  |