Sample assessment task	
Year level	10
Learning area	Science
Subject	Chemical Sciences
Title of task	Investigating rates of chemical reactions
Task details	
Description of task	Students conduct an experiment to investigate the effect of temperature on the rate of a chemical reaction, and analyse and evaluate the results.
Type of assessment	Investigation
Purpose of assessment	Used to support learning of a concept (formative assessment) and to contribute to the students mark for the purpose of grading.
Assessment strategy	Students work in pairs to determine the effect of temperature on the rate of a chemical reaction and then- individually complete questions on the activity.
Evidence to be collected	Student responses on Activity sheet.
Suggested time	2 class periods – first period to complete the planning and second period to carry out the experiment, and analyse and evaluate data.
Content description	
Content from the Western Australian Curriculum	**Science understanding** Different types of chemical reactions are used to produce a range of products and can occur at different rates. **Science inquiry skills** Formulate questions or hypotheses that can be investigated scientifically. Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies Use knowledge of scientific concepts to draw conclusions that are consistent with evidence Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data
Key concepts	Reaction rates, activation energy, hypothesis, variables
Task preparation	
Prior learning	Students have studied theory about the conditions necessary for a reaction to occur – specifically collision theory about the activation energy and the role of energy of collisions in breaking bonds in reactants
Assessment differentiation	Teachers should differentiate their teaching and assessment to meet the specific learning needs of their students, based on their level of readiness to learn and their need to be challenged. Where appropriate, teachers may either scaffold or extend the scope of the assessment tasks.
Assessment task	
Assessment conditions	Task is conducted in class with a combination of individual and group work carried out in class time.

Investigating the effect of temperature on the rate of a chemical reaction

Introduction

In this investigation you will study the effect of temperature on the rate of reaction between sodium hydrogencarbonate and hydrochloric acid. When sodium hydrogencarbonate and hydrochloric acid are mixed, they react to produce carbon dioxide gas which leaves an open reaction vessel. Thus the rate of reaction can be measured by mixing sodium hydrogencarbonate with a solution of hydrochloric acid in a beaker placed on top of an electronic balance, and measuring the loss in mass in a given time period. The word and symbol equations for the reaction are shown below.

sodium hydrogencarbonate + hydrochloric acid $\rightarrow$ sodium chloride + water + carbon dioxide

$$NaHCO_3(s) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l) + CO_2(g)$$

Planning

Working individually, answer the following questions. Submit your answers to your teacher before continuing to the *Conducting* section.

1. Identify the independent variable in this experiment. (1 mark)

2. Identify the dependent variable in this experiment. (1 mark)

3. Identify the controlled variables in this experiment. (3 marks)

4. State why these variables need to be controlled. Your answer needs to be specific to this investigation. (2 marks)

5. Write a hypothesis for the experiment. (4 marks)

Conducting

Working with a partner, complete the experimental as described below.

Marks for conduct of the experiment will be awarded on the following aspects:

- Safe working practices (2 marks)
- Competence in conduct of experiment (2 marks)
- Equipment cleaned and stored after completion of experimental work (2 marks)

Equipment and chemicals

- 100 mL beaker
- Hotplate
- Ice
- Thermometer
- 50 mL measuring cylinder
- Sodium hydrogencarbonate
- Hydrochloric acid (0.5 mol L^{-1})
- Electronic balance
- Timing device
- Safety glasses

Procedure

Note: Before starting, you will need to choose four temperatures between 10 °C and 50 °C to carry out the reaction. When carrying out the experiment it is not necessary for the reaction to be at the exact value you choose. For example, if you decide to aim for 30 °C, a temperature of 28 °C is fine to use.

Safety note: Be extremely careful when heating hydrochloric acid, HCl. Do not heat above 50 °C, and always wear your safety glasses.

1. Crush any lumps in the sodium hydrogencarbonate. Weigh out four 1 g amounts of sodium hydrogencarbonate. Try to get their masses as close to each other as possible.
2. Using the 50 mL measuring cylinder, pour 50 mL of hydrochloric acid solution into the beaker.
3. Heat the hydrochloric acid solution with the hotplate or cool with the ice to the required temperature.
4. When the acid is at the required temperature, place the beaker on an electronic balance. Record the starting mass.
5. Add the sodium hydrogencarbonate and after 30 seconds, record the weight of the beaker and its contents. Determine the loss of mass during the 30 seconds measuring time. Remember to include the mass of the sodium hydrogencarbonate when determining the mass loss. Record your results in your table.
6. Wash the solution down the sink, and clean and dry the beaker.
7. Repeat steps 2-6 for each of the other three temperatures you have selected.

Questions

6. Read the experimental procedure and describe any safety precautions needed for the experiment.

   Explain why the precautions are needed. (4 marks)

Note: Your teacher will need to review your safety precautions before you proceed to the experimental work.

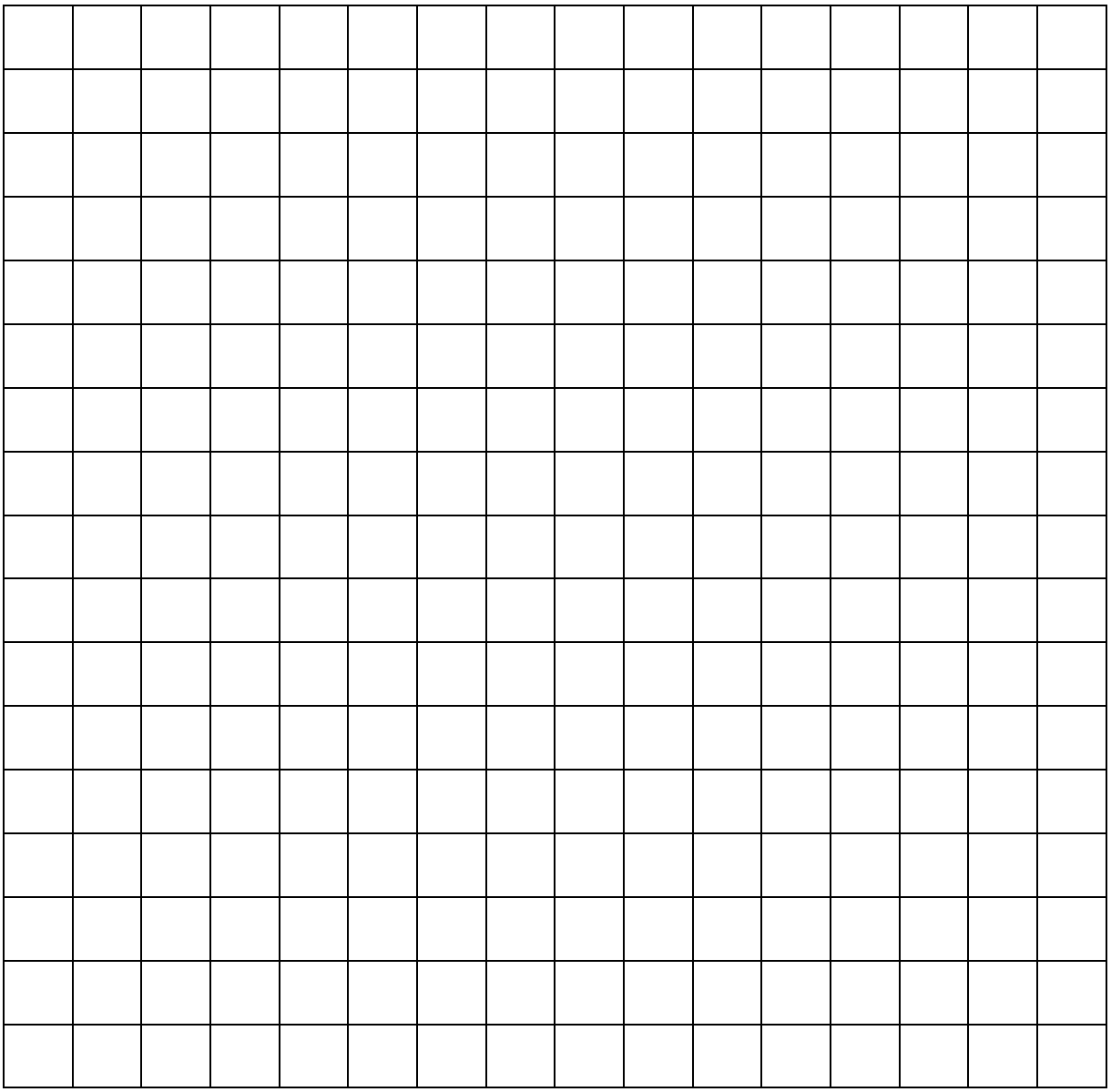
7. Design a suitable table for recording your results. Draw this table in the *Results* space provided below, or in a spreadsheet**.** (2 marks)

Results

Data analysis

Working individually, complete the following questions.

8. Plot a graph of your results. If you have plotted your results using a spreadsheet, print and attach your graph to your report. (5 marks)



9. Describe the trend in your data. (2 marks)

10. Based on your chemistry understanding of the requirements for a reaction to occur, explain the trend in your data. (3 marks)

Conclusion and evaluation

Working individually, complete the following questions.

11. Write a conclusion for your experiment. State how the results support your conclusion. (3 marks)

12. Identify one way in which the validity of the results for this experiment could be improved if it were to be done again. State how this will improve validity. (2 marks)

Sample marking key

Part 1: Planning

Description	Marks
Question 1	
Temperature	1
Subtotal	**1**
Description	**Marks**
Question 2	
Mass of CO_2 lost in 30 seconds	1
Subtotal	**1**
Description	**Marks**
Question 3	
Volume of hydrochloric acid	1
Mass of sodium hydrogencarbonate	1
Time over which mass loss is measured	1
Subtotal	**3**
Description	**Marks**
Question 4	
To ensure that any differences in mass loss are due only to changes in temperature	2
To make it a fair test	1
Subtotal	**3**
Description	**Marks**
Question 5	
Hypothesis states the relationship between the dependent and independent variables	2
Hypothesis links the dependent and independent variables without indicating the relationship	1
Hypothesis relates the independent variable directly to reaction rate rather than the measured dependent variable of mass loss	1
Subtotal	**4**
• As the temperature increases, the mass of CO_2 lost from the beaker in 30 seconds will increase. • As the temperature changes, the mass of CO_2 lost from the beaker in 30 seconds will change. • As the temperature increases, the reaction gets faster.	[2] [1] [1]

Description	Marks
Question 6	
Provides at least 2 appropriate safety precautions and explains why they are required	1-2
Subtotal	**4**
Answer could include, but is not limited to: • HCl not to be heated above 50 °C as above this temperature poisonous HCl gas will be evolved • Wear personal protective equipment – safety glasses, laboratory coat. This is to prevent injury to the eyes and protect clothing • Use tongs and gloves to carry hot glassware to prevent burns to skin	[2] [2] [2]
Description	**Marks**
Question 7	
Table has columns for temperature and for masses	1
Appropriate units are shown in the column titles	1
Subtotal	**2**
Description	**Marks**
Conducting	
Safe working practices	2
Competence in conduct of experiment	2
Equipment cleaned and stored after completion of experimental work	2
Subtotal	**6**
Description	**Marks**
Results	
All required results recorded appropriately in table	1-4
Subtotal	**4**
Part 2: Data analysis	
Description	**Marks**
Question 8	
Title provided	1
Axes labelled, including units	1–2
Data correctly plotted	1
Line of best fit rather than joining the dots	1
Subtotal	**5**
Description	**Marks**
Question 9	
Accurately describes the trend in data (ideally, increase in mass of CO_2 lost as temperature increases)	1–2
Subtotal	**2**

Description	Marks
Question 10	
Clearly links higher temperature to higher energy in collisions between reactant particles	1–3
Clearly links higher energy collisions to bond breaking in reactant particles	
Links increased temperature to higher frequency of collisions	
Subtotal	**3**
Answer could include, but is not limited to: • As temperature increases, the reactant particles collide with more energy so the bonds are more likely to break allowing for new bonds in products to form. • As temperature increases, the particles are moving faster so will collide more frequently providing more opportunity for a successful collision.	[1–3]
Description	**Marks**
Conclusion and evaluation	
Question 11	
Uses evidence to make and justify conclusion that relates to the hypothesis	3
Makes conclusion that relates to the hypothesis	2
Makes simple conclusion that is not linked back to the hypothesis	1
Subtotal	**3**
Answer could include, but is not limited to: • In this experiment, the mass of CO_2 lost at 10 °C was x g and at 40 °C was x + y g. Thus as the temperature increased, the mass of CO_2 lost from the beaker increased. This supports the hypothesis that as the temperature increases, the mass of CO_2 lost will increase. From this it can be concluded that the reaction rate increases as temperature increases. • The hypothesis is supported because as temperature increased, the mass of CO_2 lost increased. Thus the reaction rate increased with temperature. • As temperature increased, more carbon dioxide was lost.	[3] [2] [1]
Description	**Marks**
Question 12	
States an appropriate way to improve validity	1
States an appropriate reason related to the method given to improve validity	1
Subtotal	**2**
Answer could include, but is not limited to: • Validity can be improved by repeating measurements at the four temperatures many times to get an average mass lost at each temperature. • Validity can be improved by increasing the number of temperatures at which the loss of CO_2 is measured. This will give more data points to show the trend more clearly.	[1] [1]
Total	**43**