**Unit 1 Chemistry AOS 1 SAC task :** a summary report of selected practical investigations

**Title:** Reactivity of metals

**Background**

It is evident from metal items in everyday use that the reactivity of metals varies. An iron nail is more prone to the impact of rain than a copper pipe. For this task you will collect data about metal reactivity from two different experiments. You will then compare the data obtained and draw relevant conclusions.

For this task you will conduct two different experiments relating to the reactivity of metals. You will need to record your observations in your logbook.

You will then compare your findings from the two tasks under test conditions.

**Materials**

Small pieces of the following metals: lead, zinc, magnesium, iron (nails), copper, calcium, sodium

Test tubes and test tube rack

1. M HCl

3.0 M HCl

0.5 M solutions of: Pb(NO3)2, Mg(NO3)2, Ca(NO3)2, CuSO4, Fe(NO3)2, Zn(NO3)2

**MSDS:** Given the list of reagents to be used, list safety precautions that you will need to take for these experiments.

**Experiment 1: Reactivity of metals in water and acid.**

**Procedure**

* One third fill 6 test-tubes with water.
* Add small samples of a different metal to each test-tube. (Use magnesium, zinc, calcium, iron and copper).
* Record any immediate observations then leave the samples overnight to see if any further changes occur.
* Allow the samples to sit overnight. Record if any further reaction is evident.

Teacher demonstration: Your teacher might choose to demonstrate the reaction of a small sliver of sodium in water.

* Repeat the procedure using 1.0 M HCl for those metals that did not react in water.
* Repeat the procedure using 3.0 M HCl for those metals that did not react in 1.0 M HCl.

**Experiment 2**: Displacement of metal reactions.

Collect small samples of several metals and solutions containing ions of the same metals.

Add a small piece of each metal to solutions of the other metals. Record whether a reaction occurs or not.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | CuSO4 | Mg(NO3)2 | Ca(NO3)2 | Pb(NO3)2 | Zn(NO3)2 | Fe(NO3)2 |
| Cu |  |  |  |  |  |  |
| Mg |  |  |  |  |  |  |
| Ca |  |  |  |  |  |  |
| Pb |  |  |  |  |  |  |
| Zn |  |  |  |  |  |  |
| Fe |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

**Summary Report (Not shown to students until the Experiment report writing day)**

You may bring into this task your logbook and the VCAA chemistry data book.

**Before this task**: You are permitted to organise your observations from both experiments in your logbook.

Results for experiment 1 should be listed. 3 marks

A table for experiment 2 should show which reactions produced a noticeable change and which ones did not.

You will not have to rewrite your observations during the experiment report writing session.

6 marks

**Experiment report summary.**

Experiment 1

1. What conclusion can you draw from experiment 1? 2 marks

2. Rank the metals used from least reactive to most reactive. 1 mark

Experiment 2

3. Select three reactions that did occur and write balanced equations for the reactions. 3 marks

4. Rank the metals used from least reactive to most reactive. 1 mark

Comparison

5. Do the reactivity rankings obtained concur with each other? 2 marks

6. Refer to your knowledge of electron configurations to explain the different reactivities of metals. 4 marks

7. If we had tested barium, where would you expect it to appear on the reactivity rankings? Justify your answer.

2 marks

8. a. Which of the following reactions will occur spontaneously?

K(s) + Ba(NO)2(aq)

or

Ba(s) + KNO3(aq) 1 mark

b. Write a balanced equation for the reaction that proceeds. 1 mark

9. What is the significance of your results to the way in which metals are used in society? Discuss 4 marks

Total mark 30 marks

**Information for teachers**

**Title**: Reactivity of Metals

**Suited to**: Unit 1: Area of Study 2 - How are materials quantified and classified?

**Study design reference***: a summary report of selected practical investigations*

**Key knowledge**: To be selected from

* experimental determination of a reactivity series of metals based on their relative ability to undergo oxidation with water, acids and oxygen
* deduction of the formula and name of an ionic compound from its component ions, including polyatomic ions (NH4+, OH‾, NO3‾, HCO3‾, CO32‾, SO42‾ and PO43‾)
* the formation of ionic compounds through the transfer of electrons from metals to non-metals, and the writing of ionic compound formulas, including those containing polyatomic ions and transition metal ions
* the use of solubility tables to predict and identify precipitation reactions between ions in solution, represented by balanced full and ionic equations including the state symbols: (s), (l), (aq) and (g)

**Key Skill:** Analyse, evaluate and communicate scientific ideas, in particular

* Develop aims and questions, formulate hypotheses and make predictions
* Plan and conduct investigations
* Comply with safety and ethical guidelines
* Generate, collate and record data
* Analyse and evaluate data and investigation methods
* Construct evidence-based arguments and draw conclusions
* Analyse, evaluate and communicate scientific ideas

**Scope:** For this task, students

* are given an outline of expectations to complete experimental work and to then compare the results obtained.
* will conduct two experiments during the course of a week
* are expected to maintain a record of experimental observations in a logbook
* will complete a comparison summary under test conditions after experimental work is complete.

**Typical results**

Experiment 1

Reacting in water: sodium and calcium. Overnight magnesium might exhibit some change.

1. M HCl: magnesium and zinc react

3.0 M HCl; iron will react, perhaps lead slightly

Record whether a reaction occurs or not.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | CuSO4 | Mg(NO3)2 | Ca(NO3)2 | Pb(NO3)2 | Zn(NO3)2 | Fe(NO3)2 |
| Cu |  |  |  |  |  |  |
| Mg |  |  |  |  |  |  |
| Ca |  |  |  |  |  |  |
| Pb |  |  |  |  |  |  |
| Zn |  |  |  |  |  |  |
| Fe |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

*1 mark for each correct column*

**Experiment report summary.**

Experiment 1

1. Conclusions: Most metals do not react in water, but Group 1 metals do. Reactivity is predictable from position on the Periodic Table. 2 marks

2. Cu, Pb, Fe, Zn, Mg, Ca, Na 1 mark

Experiment 2

3. Ca(s) + CuSO4(aq) 🡪 CaSO4(aq) + Cu(s) 1 mark each

Mg(s) + CuSO4(aq) 🡪 MgSO4(aq) + Cu(s) 1 mark each

Ca(s) + ZnSO4(aq) 🡪 CaSO4(aq) + Zn(s) 1 mark each

4. Cu, Pb, Fe, Zn, Mg, Ca, Na 1 mark

Comparison

5. Do the reactivity rankings obtained concur with each other? They should be similar. It can be difficult to discern

the lower reactivity metals such as lead and copper. 2 marks

6. Group 1 metals are the most reactive as they have one electron only in the outer shell. They want to lose this.

Group 2 metals with two electrons in the outer shell come next, followed by the transition series. Reactivity

should also increase as you move down the group. So, reactivity reflects the outer shell electron arrangement.

4 marks

7. If we had tested barium, where would you expect it to appear on the reactivity rankings? Justify your answer.

Barium is in group 2 and it is lower down the table than calcium so should be more reactive than calcium but

less reactive than sodium

2 marks

8. a. and b.

2K(s) + Ba(NO)2(aq) 🡪 K2SO(aq) + Ba(s) 2 marks

9. Group 1 metals need to be used very carefully and in controlled ways where they are not exposed to air or

water. The unreactive metals such as copper are far more useful in exposed conditions. Metals such as iron can

be used but they need to be protected in various ways, like being painted.

It is not a good idea to have some metal combinations in use when they are in contact with each other eg iron

rivets on copper sheeting will lead to the rivets deteriorating quickly.

The reactivity of a metal can be judged by position on the periodic table.

4 marks

Total mark 30 marks