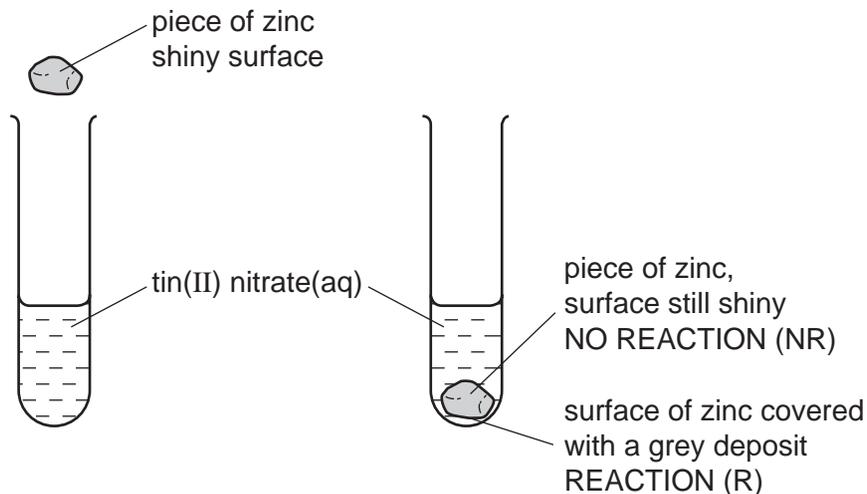


1 The reactivity series lists metals in order of reactivity.

(a) To find out which is the more reactive metal, zinc or tin, the following experiment could be carried out.



This experiment could be carried out with other metals and the results recorded in a table. Then the order of reactivity can be deduced.

(i) The order was found to be:
 manganese most reactive
 zinc
 tin
 silver least reactive

Complete the table of results from which this order was determined.

| aqueous solution | tin Sn | manganese Mn | silver Ag | zinc Zn |
|-----------------------|-----------|-----------------|--------------|------------|
| tin(II) nitrate | | R | NR | R |
| manganese(II) nitrate | | | | |
| silver(I) nitrate | | | | |
| zinc nitrate | | | | |

[3]

(ii) Write the ionic equation for the reaction between tin atoms and silver(I) ions.

.....

[2]

(iii) The following is a redox reaction.



Indicate on the equation the change which is oxidation.
Give a reason for your choice.

..... [2]

(iv) Explain why experiments of this type cannot be used to find the position of aluminium in the reactivity series.

.....
..... [2]

(b) Potassium and calcium are very reactive metals at the top of the series. Because their ions have different charges, K^+ and Ca^{2+} , their compounds behave differently when heated.

(i) Explain why the ions have different charges.

.....
..... [2]

(ii) Their hydroxides are heated.
If the compound decomposes, complete the word equation.
If it does not decompose, write "no reaction".

Potassium hydroxide \longrightarrow

Calcium hydroxide \longrightarrow [2]

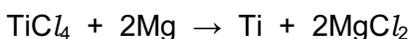
(iii) Complete the equations for the decomposition of their nitrates.

$2\text{KNO}_3 \longrightarrow$ +

$2\text{Ca}(\text{NO}_3)_2 \longrightarrow$ + + [4]

[Total: 17]

- 2 (a) Titanium is produced by the reduction of its chloride. This is heated with magnesium in an inert atmosphere of argon.



- (i) Explain why it is necessary to use argon rather than air.

..... [1]

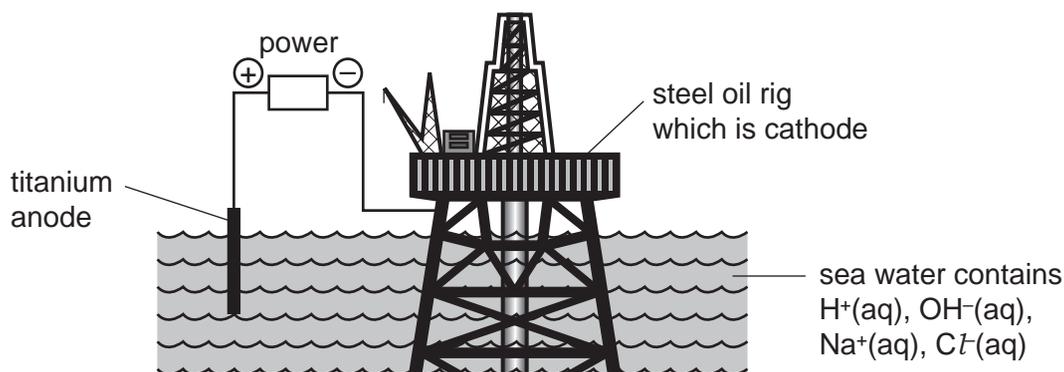
- (ii) Name another metal that would reduce titanium chloride to titanium.

..... [1]

- (iii) Suggest how you could separate the metal, titanium, from the soluble salt magnesium chloride.

.....
 [2]

- (b) Titanium is very resistant to corrosion. One of its uses is as an electrode in the cathodic protection of large steel structures from rusting.



- (i) Define oxidation in terms of electron transfer.

..... [1]

- (ii) The steel oil rig is the cathode. Name the gas formed at this electrode.

..... [1]

- (iii) Name the **two** gases formed at the titanium anode.

..... and [2]

- (iv) Explain why the oil rig does not rust.

.....
 [2]

- (v) Another way of protecting steel from corrosion is sacrificial protection.
Give **two** differences between sacrificial protection and cathodic protection.

.....
..... [2]

[Total: 12]

3 Zinc is extracted from zinc blende, ZnS.

(a) Zinc blende is heated in air to give zinc oxide and sulphur dioxide. Most of the sulphur dioxide is used to make sulphur trioxide. This is used to manufacture sulphuric acid. Some of the acid is used in the plant, but most of it is used to make fertilisers.

(i) Give another use of sulphur dioxide.

..... [1]

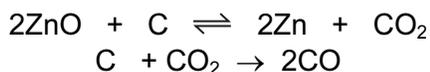
(ii) Describe how sulphur dioxide is converted into sulphur trioxide.

.....
.....
..... [3]

(iii) Name a fertiliser made from sulphuric acid.

..... [1]

(b) Some of the zinc oxide was mixed with an excess of carbon and heated to 1000 °C. Zinc distils out of the furnace.



(i) Name the **two** changes of state involved in the process of distillation.

..... [2]

(ii) Why is it necessary to use an excess of carbon?

.....
..... [2]

(c) The remaining zinc oxide reacts with sulphuric acid to give aqueous zinc sulphate. This is electrolysed with inert electrodes (the electrolysis is the same as that of copper(II) sulphate with inert electrodes).

ions present: $\text{Zn}^{2+}(\text{aq})$ $\text{SO}_4^{2-}(\text{aq})$ $\text{H}^+(\text{aq})$ $\text{OH}^-(\text{aq})$

(i) Zinc forms at the negative electrode (cathode). Write the equation for this reaction.

..... [1]

(ii) Write the equation for the reaction at the positive electrode (anode).

..... [2]

(iii) The electrolyte changes from aqueous zinc sulphate to

..... [1]

(d) Give two uses of zinc.

1.

2. [2]

[Total: 15]

4 Some reactions of metals **W**, **X**, **Y** and **Z** are given below.

| metal | reaction with water | reaction with dilute hydrochloric acid |
|----------|--|--|
| W | A few bubbles form slowly in cold water. | Vigorous reaction. Gas given off. |
| X | Vigorous reaction. Metal melts. Gas given off. | Explosive reaction. Should not be attempted. |
| Y | No reaction. | No reaction. |
| Z | Does not react with cold water. Hot metal reacts with steam. | Steady fizzing. |

(a) Arrange these metals in order of reactivity.

most reactive

.....

.....

least reactive [2]

(b) Which of these metals could be

(i) magnesium,
..... [1]

(ii) copper?
..... [1]

(c) The equation for the reaction of **X** with cold water is given below.



(i) Describe the test you would use to show that the gas evolved is hydrogen.

.....
..... [1]

(ii) How could you show that the water contained a compound of the type **XOH**?

.....
..... [2]

(iii) In which group of the Periodic Table does metal **X** belong?

..... [1]

(iv) The ore of **X** is its chloride. Suggest how metal **X** could be extracted from its chloride.

..... [2]

5 The first three elements in Group IV are
carbon,
silicon,
germanium.

(a) The element germanium has a diamond-type structure. Describe the structure of germanium. A diagram is acceptable.

[2]

(b) Unlike diamond, graphite is soft and is a good conductor of electricity.

(i) Explain why graphite has these properties.

.....
.....
..... [3]

(ii) Give a use of graphite that depends on one of these properties.

property

use [1]

(c) Carbon dioxide and silicon(IV) oxide have similar formulae but different types of structure.

(i) Give the formulae of these oxides.

..... [1]

(ii) How are their structures different?

.....
..... [2]

(d) All these elements form compounds with hydrogen called hydrides. The saturated hydrides of carbon are the alkanes. Predict the formula of the hydride of germanium which contains two germanium atoms.

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