GCSE Chemistry

Gases and Solutions

Question Paper

Time available: 56 minutes
Marks available: 52 marks

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1. This question is about silicon and compounds of silicon.

(a) The reactivity series sometimes includes non-metals such as carbon, hydrogen and silicon.

Silicon can be extracted by reducing silicon dioxide with different substances.

The equation for one possible reaction is:

$$2\ C(s) + SiO_2(s) \rightarrow Si(s) + 2\ CO(g)$$

Explain what this reaction shows about the position of silicon in the reactivity series.

_____

_____

_____

_____

(2)

(b) Aluminium also reduces silicon dioxide.

Carbon is used rather than aluminium to reduce silicon dioxide because carbon is cheaper than aluminium.

Carbon can be obtained by heating coal.

Aluminium is obtained from aluminium oxide.

Explain why aluminium is more expensive than carbon.

_____

_____

_____

_____

(2)

Magnesium also reduces silicon dioxide.

The equation for the reaction is:

$$2\ Mg(s) + SiO_2(s) \rightarrow Si(s) + 2\ MgO(s)$$

(c) Give **one** reason why the products are difficult to separate if magnesium is used to reduce silicon dioxide.

_____

_____

(1)

(d) Calculate the minimum mass in grams of magnesium needed to completely reduce 1.2 kg of silicon dioxide.

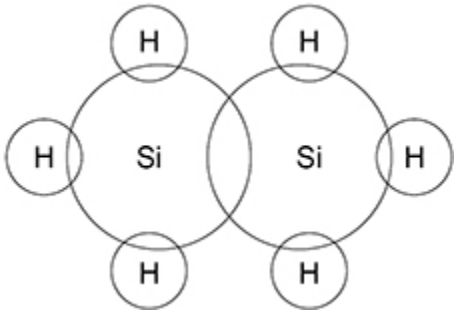
Relative atomic masses (A_r): O = 16 Mg = 24 Si = 28

Minimum mass of magnesium = _____g

(5)

Si_2H_6 is a covalent compound of silicon and hydrogen.

(e) Complete the figure below to show the outer shell electrons in a molecule of Si_2H_6



(1)

(f) Si_2H_6 reacts with oxygen.

The equation for the reaction is:

$$2\ Si_2H_6(g) + 7\ O_2(g) \rightarrow 4\ SiO_2(s) + 6\ H_2O(g)$$

30 cm^3 of Si_2H_6 is reacted with 150 cm^3 (an excess) of oxygen.

Calculate the total volume of gases present after the reaction.

All volumes of gases are measured at the same temperature and pressure.

Volume of gases = _____ cm^3

(4)

(Total 15 marks)

2. This question is about salts.

(a) Name the salt produced by the neutralisation of hydrochloric acid with potassium hydroxide.

(1)

(b) Write an ionic equation for the neutralisation of hydrochloric acid with potassium hydroxide.

_____ + _____ → _____

(1)

(c) Soluble salts can be produced by reacting dilute hydrochloric acid with an insoluble solid.

Copper, copper carbonate and copper oxide are insoluble solids.

Which of these insoluble solids can be used to make a copper salt by reacting the solid with dilute hydrochloric acid?

Tick (✓) **one** box.

Copper and copper carbonate only	☐
Copper and copper oxide only	☐
Copper carbonate and copper oxide only	☐
Copper, copper carbonate and copper oxide	☐

(1)

A student makes crystals of magnesium sulfate.

This is the method used.

1. Add sulfuric acid to a beaker.
2. Warm the sulfuric acid.
3. Add a spatula of magnesium oxide to the beaker.
4. Stir the mixture.
5. Repeat steps 3 and 4 until there is magnesium oxide remaining in the beaker.
6. Filter the mixture.
7. Evaporate the filtrate gently until crystals start to form.
8. Leave the solution to finish crystallising.

(d) Give **one** reason for:

- step 2
- step 5
- step 6.

Step 2 _____

_____

Step 5 _____

_____

Step 6 _____

_____

(3)

(e) How should the filtrate be evaporated gently in **step 7**?

_____

_____

(1)

(f) Iron chloride is produced by heating iron in chlorine gas.

The equation for the reaction is:

$$2\ Fe + 3\ Cl_2 \rightarrow 2\ FeCl_3$$

Calculate the volume of chlorine needed to react with 14 g of iron.

You should calculate:

- the number of moles of iron used
- the number of moles of chlorine that react with 14 g of iron
- the volume of chlorine needed.

Relative atomic mass (A_r): Fe = 56

The volume of 1 mole of gas = 24 dm^3

Volume of chlorine = _____ dm^3

(3)

(Total 10 marks)

3. This question is about electrolysis.

Aluminium is produced by electrolysing a molten mixture of aluminium oxide and cryolite.

(a) Explain why a mixture is used as the electrolyte instead of using only aluminium oxide.

(2)

(b) What happens at the negative electrode during the production of aluminium?

Tick (✓) **one** box.

Aluminium atoms gain electrons. ☐

Aluminium atoms lose electrons. ☐

Aluminium ions gain electrons. ☐

Aluminium ions lose electrons. ☐

(1)

(c) Oxygen is produced at the positive electrode.

Complete the balanced half-equation for the process at the positive electrode.

$\rightarrow \quad O_2 \quad +$

(2)

(d) Explain why the positive electrode must be continually replaced.

_____

_____

_____

_____

_____

_____

(3)

(e) The overall equation for the electrolysis of aluminium oxide is:

$$2\ Al_2O_3 \rightarrow 4\ Al + 3\ O_2$$

Calculate the mass of oxygen produced when 2000 kg of aluminium oxide is completely electrolysed.

Relative atomic masses (A_r): O = 16 Al = 27

Mass of oxygen = _____ kg

(4)

Sodium metal and chlorine gas are produced by the electrolysis of molten sodium chloride.

(f) Explain why sodium chloride solution **cannot** be used as the electrolyte to produce sodium metal.

(2)

(g) Calculate the volume of 150 kg of chlorine gas at room temperature and pressure.

The volume of one mole of any gas at room temperature and pressure is 24.0 dm^3

Relative formula mass (M_r): Cl_2 = 71

Volume = _____ dm^3

(2)

(Total 16 marks)

4. Sodium carbonate reacts with dilute hydrochloric acid:

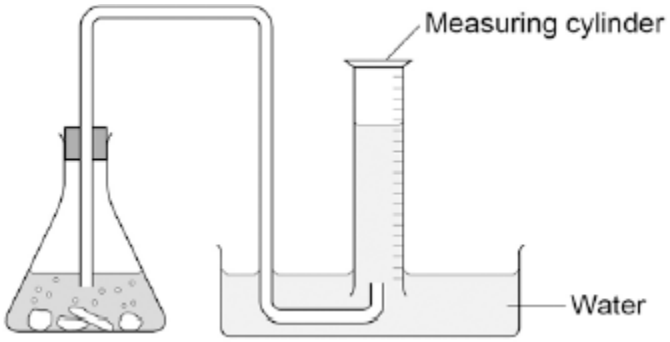
$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$

A student investigated the volume of carbon dioxide produced when different masses of sodium carbonate were reacted with dilute hydrochloric acid.

This is the method used.

1. Place a known mass of sodium carbonate in a conical flask.
2. Measure 10 cm^3 of dilute hydrochloric acid using a measuring cylinder.
3. Pour the acid into the conical flask.
4. Place a bung in the flask and collect the gas until the reaction is complete.

(a) The student set up the apparatus as shown in the figure below.



Identify the error in the way the student set up the apparatus.

Describe what would happen if the student used the apparatus shown.

_____

_____

_____

_____

(2)

(b) The student corrected the error.

The student's results are shown in the table below.

Mass of sodium carbonate in g	Volume of carbon dioxide gas in cm^3
0.07	16.0
0.12	27.5
0.23	52.0
0.29	12.5
0.34	77.0
0.54	95.0
0.59	95.0
0.65	95.0

The result for 0.29 g of sodium carbonate is anomalous.

Suggest what may have happened to cause this anomalous result.

_____

_____

(1)

(c) Why does the volume of carbon dioxide collected stop increasing at 95.0 cm^3?

_____

_____

(1)

(d) What further work could the student do to be more certain about the minimum mass of sodium carbonate needed to produce 95.0 cm^3 of carbon dioxide?

_____

_____

(1)

(e) The carbon dioxide was collected at room temperature and pressure.
The volume of one mole of any gas at room temperature and pressure is 24.0 dm^3.

How many moles of carbon dioxide is 95.0 cm^3?

Give your answer in three significant figures.

_____

_____

_____

_____

_____ mol

(2)

(f) Suggest **one** improvement that could be made to the apparatus used that would give more accurate results.

Give a reason for your answer.

_____

_____

_____

_____

(2)

(g) One student said that the results of the experiment were wrong because the first few bubbles of gas collected were air.

A second student said this would make no difference to the results.

Explain why the second student was correct.

_____

_____

_____

_____

_____

_____

(2)

(Total 11 marks)