3.2 Calculating Mass of Substances

Question Paper

Course	AQA GCSE Chemistry
Section	3. Quantitative Chemistry
Topic	3.2 Calculating Mass of Substances
Difficulty	Hard

Time Allowed 60

Score /46

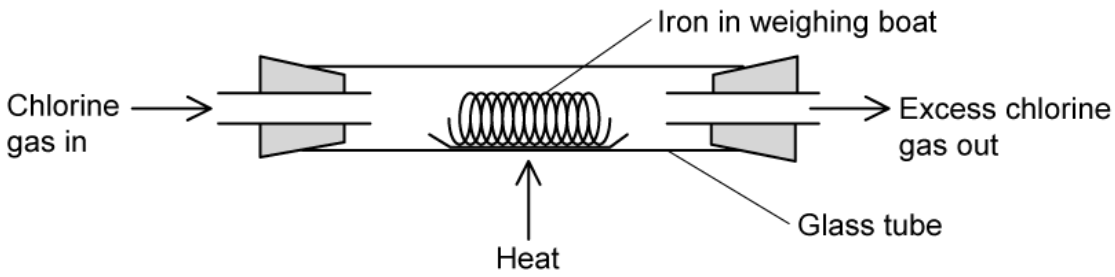
Percentage /100

Question 1a

This question is about the reaction of iron and chlorine.

A teacher uses the apparatus shown in **Figure 1** to react iron with chlorine.

Figure 1



This is the teacher's method.

- Record the mass of the weighing boat
- Add iron and record the mass again
- Heat the weighing boat and iron strongly for two minutes and then allow to cool
- Record the mass of the weighing boat and its contents

Give an addition to the method to check that the iron has fully reacted with the chlorine.

[1 mark]

Question 1b

The iron is the limiting reagent in the reaction.

Explain **one** resulting safety precaution for this reaction.

[2 marks]

Question 1c

Table 1 shows the teacher's results.

Table 1

	Mass in g
empty weighing boat	11.76
weighing boat and iron	16.24
weighing boat and iron chloride	24.76

Use the teacher's results to show that the empirical formula of iron chloride is $FeCl_3$.

Relative atomic masses (A_r): Fe = 56, Cl = 35.5

[3 marks]

Question 1d

Write the balanced symbol equation, including state symbols, for this reaction of iron and chlorine.

[2 marks]

Question 2a

This question is about the redox reaction of tungsten oxide.

The word equation for the reaction is:

tungsten oxide + hydrogen → tungsten + water

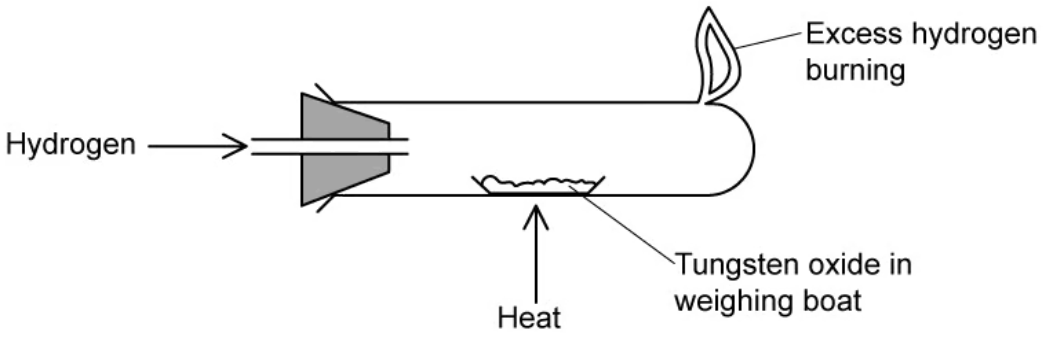
Explain, in terms of redox, the type of reaction that the tungsten oxide is undergoing.

[1 mark]

Question 2b

A teacher uses this apparatus in **Figure 1** to for the reaction of tungsten oxide with hydrogen.

Figure 1



The teacher wears appropriate eye protection and a lab coat during the demonstration.

Explain **one** other safety precaution the teacher should take.

[2 marks]

Question 2c

The teacher weighed:

- the glass tube
- the glass tube and tungsten oxide before the reaction
- the glass tube and tungsten after the reaction.

Table 1 shows the teacher's results.

Table 1

	Mass in g
empty weighing boat	12.22
weighing boat and tungsten oxide	14.54
weighing boat and tungsten	14.06

Calculate the simplest whole number ratio of:

moles of tungsten atoms : moles of oxygen atoms

Determine the balanced equation for the reaction.

Relative atomic masses (A_r): W = 184, O = 16

[6 marks]

Question 3a

This question is about the reaction of zinc with sulfuric acid.

3.75 g of zinc oxide, ZnO (s), was added to 150 cm^3 of 1.00 mol dm^{-3} of sulfuric acid (aq) producing a salt.

Write a balanced symbol equation for this reaction.

[1 mark]

Question 3b

Using the equation in part (a), calculate the limiting reactant in the reaction.

Give your answer to 2 significant figures.

Relative atomic masses (A_r): Zn = 65, O = 16, H = 1, S = 32

[3 marks]

Question 3c

Use your answer to part (b), to calculate the amount, in grams, of the salt produced.

Give your answer to 3 significant figures.

[2 marks]

Question 3d

Calculate the amount, in moles, of sulfuric acid at the end of the reaction.

Give your answer to 3 significant figures.

[1 mark]

Question 4a

This question is about aluminium.

Aluminium can be extracted from aluminium oxide by electrolysis.

The overall equation for the electrolysis of aluminium oxide is:

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

Write the balanced half-equation, including state symbols, for the process at the negative electrode.

[2 marks]

Question 4b

Calculate the mass of oxygen, in kg, produced when 5000 kg of aluminium oxide is completely electrolysed.

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

[4 marks]

Question 4c

The thermite reaction of aluminium and iron oxide is used to weld train tracks together.

The equation for this reaction is:

$$2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$$

A 5.00 kg thermite mixture contains 20% aluminium and 80% iron oxide.

Show that aluminium is the limiting reactant.

Relative atomic masses (A_r): O = 16, Al = 27, Fe = 56

[6 marks]

Question 4d

Explain why having aluminium as the limiting reactant in the thermite reaction is better for industrial applications.

[1 mark]

Question 5a

Zinc-bromine batteries are rechargeable batteries that are being developed as an alternative to lithium-ion batteries.

They are less likely to overheat and catch fire compared to lithium-ion batteries.

The zinc-bromine battery has a zinc electrode and a carbon electrode with a solution of zinc bromide as the electrolyte.

Write the balanced symbol equation for the formation of zinc bromide, $ZnBr_2$, using hydrobromic acid.

[2 marks]

Question 5b

Calculate the minimum mass of zinc that needs to be added to 5.00 cm^3 of hydrobromic acid so that the hydrobromic acid fully reacts.

The density of hydrobromic acid is 1.49 g / cm^3.

Relative atomic masses (A_r): Zn = 65, H = 1, Br = 80

[4 marks]

Question 5c

In a second experiment, 5.00 g of zinc powder was reacted with hydrobromic acid.

Calculate the number of atoms of hydrogen produced.

[3 marks]