GCSE · AQA · Chemistry

2 hours 23 questions

Exam Questions

Calculating Mass of Substances

The Mole / Amounts of Substances in Equations / Using Moles to Balance Equations / Limiting Reactants / Concentrations of Solutions

Easy (6 questions)	/44
Medium (10 questions)	/48
Hard (7 questions)	/48
Total Marks	**/140**

Scan here to return to the course
or visit savemyexams.com

Easy Questions

1 (a) This question is about elements in Group 2.

A teacher burns magnesium in oxygen, O_2.

Complete the word equation for the reaction.

magnesium + oxygen → _____

.....

(1 mark)

(b) Balance the equation for the reaction between magnesium and oxygen.

$$\_\_Mg + O_2 \rightarrow \_\_MgO$$

(1 mark)

(c) The teacher reacts calcium with water.

$$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$$

How many moles of reactant and product are there in this reaction?

Moles of reactant = _____

Moles of product = _____

.....

.....

(2 marks)

(d) According to the symbol equation, how many calcium atoms are present at the start of this reaction?

Tick (✓) **one** box.

6.02×10^{-23}	
6.23×10^{-23}	
6.02×10^{23}	

.....**(1 mark)**

(e) According to the symbol equation, how many hydrogen atoms are present in the hydrogen gas produced during this reaction?

Tick (✓) **one** box.

6.02×10^{-23}	
6.02×10^{23}	
1.20×10^{24}	
1.20×10^{-24}	

(1 mark)

2 (a) Ethanol, C_2H_5OH, can be formed by the hydration of ethene, C_2H_4.

Balance the equation for the hydration of ethene.

$$C_2H_4 + \_\_\_\_ \rightarrow C_2H_5OH$$

.....

(1 mark)

(b) Calculate the relative formula mass (M_r) of ethanol, C_2H_5OH.

Relative atomic masses (A_r): C = 12; H = 1; O = 16

.....

.....

(2 marks)

(c) 16.1 g of ethanol is produced in a hydration of ethene reaction.

How many moles of ethanol are in 16.1 g?

Use the equation:

$$\text{Moles} = \frac{\text{mass}}{\text{relative formula mass}}$$

.....

.....

(2 marks)

(d) Calculate the number of moles of ethene that is required to produce 16.1 g of ethanol.

.....

(1 mark)

3 (a) This question is about the reactions of metals and metal oxides.

9.6 g of magnesium is burned in oxygen to form magnesium oxide.

$$2Mg + O_2 \rightarrow 2MgO$$

How many moles are in 9.6 g of magnesium?

Relative atomic mass (A_r): Mg = 24

Use the equation:

$$\text{Moles} = \frac{\text{mass}}{M_r}$$

.....

(1 mark)

(b) How many moles of magnesium oxide are produced when 9.6 g of magnesium is burned in oxygen?

.....

(1 mark)

(c) What mass of magnesium oxide is produced when 9.6 g of magnesium is burned in oxygen?

Use the equation:

$$\text{Mass} = \text{moles} \times M_r$$

.....

(1 mark)

(d) What mass of hydrogen is needed to react with 3.18 g of copper oxide?

$$CuO + H_2 \rightarrow Cu + H_2O$$

Relative formula mass (M_r): CuO = 79.5

.....

.....

.....

(3 marks)

(e) Potassium is burned in oxygen to form potassium oxide.

$$4K + O_2 \rightarrow 2K_2O$$

What mass of potassium oxide is formed when 1.95 g of potassium is burned in oxygen?

.....

.....

..... **(3 marks)**

4 (a) 15.9 g of copper oxide reacts with 1.2 g of carbon to form 12.7 g of copper and 4.4 g of carbon dioxide.

The unbalanced equation for the reaction is:

$$CuO + C \rightarrow Cu + CO_2$$

Relative atomic masses (A_r): C = 12; Cu = 63.5; O = 16

Calculate the number of moles of each chemical in the equation.

Use the equation:

$$\text{Moles} = \frac{\text{mass}}{M_r}$$

.....

.....

.....

..... **(4 marks)**

(b) Use your answer to part (a) to balance the equation.

$$\_\_CuO + \_\_C \rightarrow \_\_Cu + \_\_CO_2$$

(2 marks)

(c) 2.8 g of calcium oxide, CaO, reacts with 2.2 g of carbon dioxide to form 5.0 g of calcium carbonate, $CaCO_3$.

Relative atomic masses (A_r): Ca = 40; C = 12; O = 16

Use the number of moles of each chemical to write the balanced symbol equation for this reaction.

Show your working.

.....

.....

.....

..... **(4 marks)**

5 (a) This question is about limiting reagents.

Which of the following statements about limiting reagents is **not** correct?

Tick (✓) **one** box.

The limiting reagent is in excess	
The limiting reagent is used up first	
The limiting reagent controls the amount of product formed	
Doubling the amount of limiting reagent doubles the amount of product formed	

(1 mark)

(b) Magnesium reacts with sulfur to form magnesium sulfide.

Write the word equation for this reaction.

.....

(1 mark)

(c) The balanced symbol equation for the reaction of magnesium with sulfur is:

$$Mg + S \rightarrow MgS$$

1.8 g of magnesium is reacted with 1.8 g of sulfur.

Explain which chemical is the limiting reactant. Show your working.

Relative atomic masses (A_r): Mg = 24; S = 32

.....

.....

.....

.....

(4 marks)

6 (a) The concentration of a solution can be measured in different ways.

Which are the correct units for concentration in terms of the mass of a solid dissolved in a known quantity of liquid?

Circle the correct answer.

dm^3 / g	g / dm^3	mol / dm^3

(1 mark)

(b) A student is asked to make a sodium hydrogen carbonate solution, $NaHCO_3$ (aq).

The student uses 0.25 moles of sodium hydrogen carbonate.

Calculate the mass of sodium hydrogen carbonate that the student uses.

Relative atomic masses (A_r): C = 12; H = 1; Na = 23; O = 16

.....

.....

..... **(3 marks)**

(c) What is the concentration of the student's solution in g / dm^3?

..... **(1 mark)**

(d) The student takes a 25 cm^3 portion from their 1 dm^3 sodium hydrogen carbonate solution.

There are 1000 cm^3 in 1 dm^3.

Estimate the mass of sodium hydrogen carbonate in the 25 cm^3 portion.

.....

..... **(2 marks)**

Medium Questions

1 (a) The amount of substances can be described in different ways.

Complete the sentences.

One mole of a substance is the relative formula mass in _____

The relative atomic mass of an element compares the mass of an atom of an element with the mass of an atom of _____

(2 marks)

(b) Explain the meaning of the term "mole".

.....

..... **(2 marks)**

(c) Describe the link between the mole and the relative atomic mass of an element.

.....

.....

..... **(3 marks)**

2 (a) Calcium sulfate is used as a coagulant in the production of tofu and to make Plaster of Paris.

The molecular formula of calcium sulfate is $CaSO_4$.

Calculate the relative formula mass (M_r) of $CaSO_4$.

Relative atomic masses: O = 16; S = 32; Ca = 40.

Relative formula mass (M_r) = _____

.....

..... **(2 marks)**

(b) What is the mass of one mole of calcium sulfate?

..... **(1 mark)**

(c) What mass of calcium sulfate would be needed to provide 18 grams of calcium?

..... **(1 mark)**

(d) Calculate the number of moles in 320 g of Fe_2O_3.

You may need to use the periodic table to answer this question.

..... **(1 mark)**

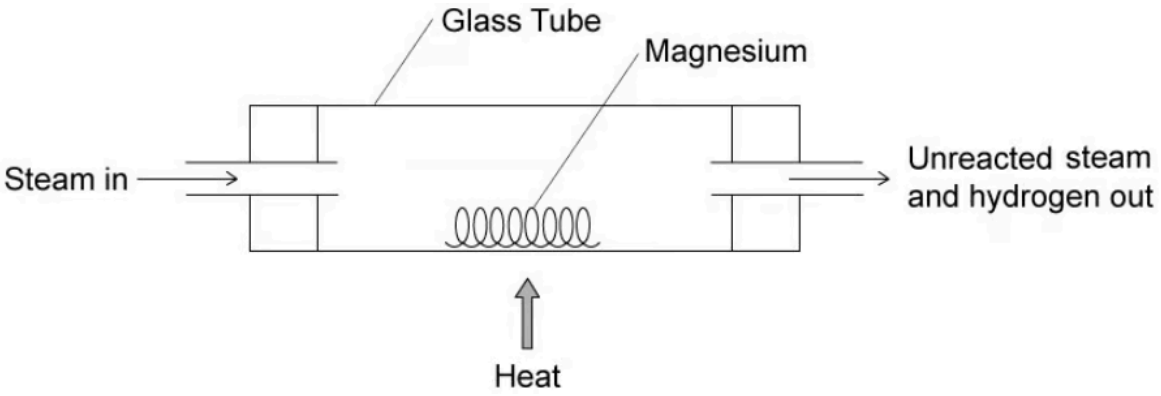
(e) Calculate the number of moles in 14 g of C_2H_4.

..... **(1 mark)**

3 (a) Magnesium and steam react to produce magnesium oxide and hydrogen gas.

A student carried out the reaction using the apparatus shown in **Figure 1** below.

Figure 1



The balanced equation for the reaction is:

$$Mg\ (s) + H_2O\ (g) \rightarrow MgO\ (s) + H_2\ (g)$$

The student used 2.00 g of Mg.

Using the equation, calculate the maximum mass of magnesium oxide produced.

Give your answer to three significant figures.

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

Maximum mass MgO = _____ g

.....

.....

..... **(3 marks)**

(b) A student uses 75 cm^3 of a copper (II) sulfate solution of 90 g / dm^3 in an experiment.

What mass of copper (II) sulfate is dissolved in 75 cm^3 of this solution?

Mass = _____ g

(2 marks)

(c) Another student uses a 0.20 mol / dm^3 solution of sodium hydroxide in an acid - base reaction.

Calculate the mass of sodium hydroxide in 250 cm^3 of a 0.20 mol / dm^3 solution.

Relative formula mass (M_r): NaOH = 40

Mass of sodium hydroxide = _____ g

(4 marks)

4 How many moles are present in 9 kg of glucose, $C_6H_{12}O_6$?

Relative formula mass (M_r): $C_6H_{12}O_6$ = 180

A. 0.02 mol

B. 0.05 mol

C. 20 mol

D. 50 mol

(1 mark)

5 What is the mass of 0.25 moles of hydrated copper(II) sulfate, $CuSO_4.5H_2O$?

Relative formula mass (M_r): H_2O = 18 $CuSO_4$ = 160

A. 40.0 g

B. 44.5 g

C. 62.5 g

D. 1000 g

(1 mark)

6 (a) This question is about Avogadro's constant.

How many grams are there in one mole of carbon?

.....

(1 mark)

(b) How many atoms are present in one mole of chlorine atoms?

Tick (✔) **one** box.

6.02×10^{23}	
6.02×10^{24}	
7.02×10^{23}	
8.02×10^{26}	

.....

(1 mark)

(c) How many atoms are present in one mole of oxygen molecules?

Tick (✔) **one** box.

1.24×10^{24}	
1.204×10^{24}	
12.04×10^{22}	
6.02×10^{46}	

(1 mark)

(d) Methanol is produced on an industrial scale by reacting carbon monoxide with hydrogen.

The equation for the reaction is:

$$CO\ (g) + 2H_2\ (g) \rightleftharpoons CH_3OH\ (g)$$

How many moles of CO react completely with 6.0×10^3 moles of H_2?

Tick (✔) **one** box

3.0×10^3	
2.0×10^3	
2.5×10^3	
9.0×10^3	

(1 mark)

7 (a) A chemist prepares some zinc iodide (ZnI_2) to use as a catalyst in the production of some organic compounds.

The equation for the reaction is:

$$Zn + I_2 \longrightarrow ZnI_2$$

Calculate the minimum mass of zinc that should be added to 0.600 g of iodine so that the iodine fully reacts.

Relative atomic masses (A_r): Zn = 65; I = 127

Minimum mass of Zn = _____ g

(3 marks)

(b) Titanium is extracted from titanium dioxide in a two step industrial process:

Step 1 $TiO_2 + 2C + 2Cl_2 \longrightarrow TiCl_4 + 2CO$

Step 2 $TiCl_4 + 4Na \longrightarrow Ti + 4NaCl$

In step 2, 40 kg of $TiCl_4$ is added to 20 kg of Na.

The equation for the reaction is:

$$TiCl_4 + 4Na \longrightarrow Ti + 4NaCl$$

Relative atomic masses (A_r): Na = 23; Cl = 35.5; Ti = 48

Explain why titanium chloride is the limiting reactant.

You **must** show your working.

(5 marks)

8 A solution of $CuSO_4$ has a concentration of 35 g/dm^3.

What mass of $CuSO_4$ would there be in 250 cm^3 of the solution?

A. 140 g

B. 8.75 g

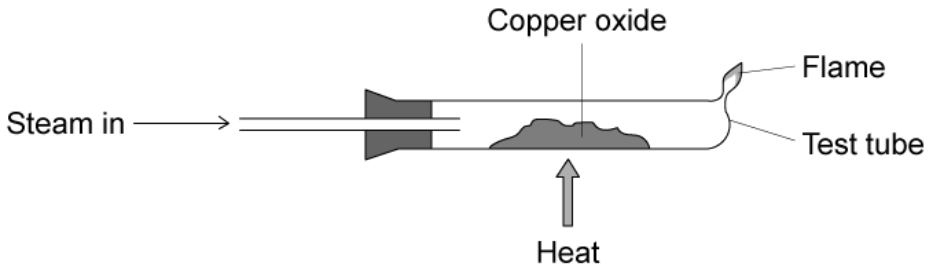
C. 7.14 g

D. 1.40 g

(1 mark)

9 (a) Copper oxide (CuO) was reacted with methane (CH_4) in the apparatus shown below in **Figure 1.**

Figure 1



Balance the equation for the reaction:

$$\_\_CuO\ (s) + \_\_CH_4\ (g) \rightarrow \_\_Cu\ (s) + \_\_H_2O\ (g) + \_\_CO_2\ (g)$$

(1 mark)

(b) Use the equation to calculate the mass of copper that could be made from 6.0 g of copper oxide.

Mass of copper = _____ g

(3 marks)

10 (a) Iron (III) chloride is used in industrial waste treatment, in water purification and in the production of electronic circuit boards.

One method of producing iron (III) chloride is reacting iron with chlorine:

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

Calculate the maximum mass of $FeCl_3$ that can be produced from 14.0 g of iron.

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

Maximum mass of $FeCl_3$ = _____ g

(3 marks)

(b) A student wanted to make 12.0 g of copper chloride by reacting copper carbonate with hydrochloric acid. The equation for the reaction is as follows:

$$CuCO_3 + 2HCl \rightarrow CuCl_2 + H_2O + CO_2$$

Relative atomic masses, A_r: H = 1; C = 12; O = 16; Cl = 35.5; Cu = 63.5

Calculate the mass of $CuCO_3$ the student needs to react with dilute hydrochloric acid to make 12.0 g of copper chloride.

Mass of copper carbonate = _____ g

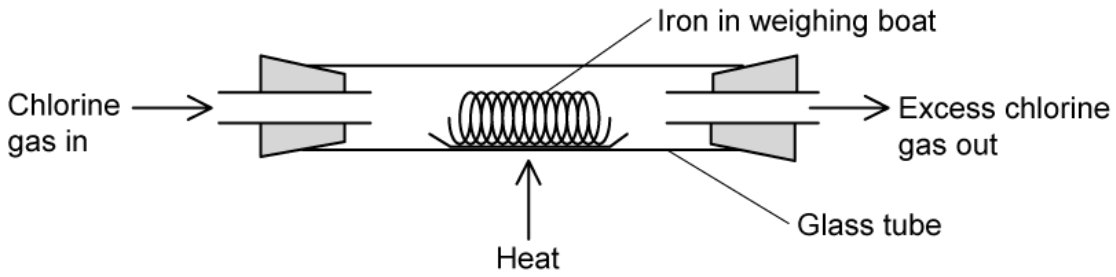
(4 marks)

Hard Questions

1 (a) 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)

(b) The iron is the limiting reagent in the reaction.

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

.....

.....

(2 marks)

(c) **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)**

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

.....

..... **(2 marks)**

2 A teacher carried out an experiment to determine the balanced equation for the reaction of tungsten oxide with hydrogen.

The word equation for this reaction is:

tungsten oxide + hydrogen → tungsten + water

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)

3 (a) 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)

(b) 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)

(c) 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)

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

Give your answer to 3 significant figures.

.....

(1 mark)

4 (a) 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)**

(b) 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)**

(c) 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)

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

(1 mark)

5 (a) 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)**

(b) 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)**

(c) 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)**

6 Nitrogen and hydrogen react together to make ammonia.

$$N_2 + 3H_2 \rightarrow 2NH_3$$

If 2.0 g of hydrogen is added to 12.0 g of nitrogen which substance is the limiting reactant and how much of the excess reactant remains?

Relative atomic masses (A_r): H = 1 N = 14

	Limiting Reactant	Mass of excess reactant
A	nitrogen	2.0 g
B	nitrogen	10.0 g
C	hydrogen	2.7 g
D	hydrogen	9.3 g

(1 mark)

7 (a) 2.7 g aluminium reacts with 38.1 g of iodine, I_2, to make 40.8 g aluminium iodide, AlI_3.

Relative atomic masses (A_r): Al = 27 I = 127

Relative formula mass (M_r): AlI_3 = 408

What coefficients would balance the equation for the reaction?

A. 1 : 3 : 2

B. 2 : 1 : 2

C. 2 : 3 : 2

D. 3 : 2 : 3

(1 mark)

(b) This question is about the redox reaction of tungsten oxide.

The word equation for the reaction is:

tungsten oxide + hydrogen → tungsten + water

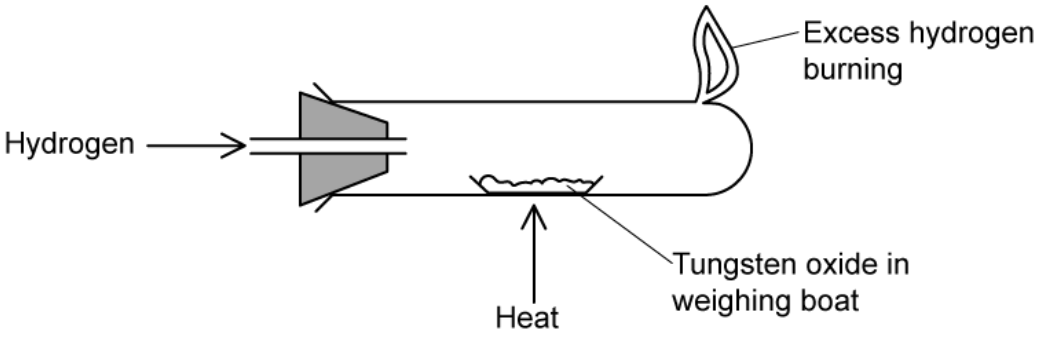
Explain, in terms of redox, the type of reaction that the tungsten oxide is undergoing.

.....

(1 mark)

(c) 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)