Revision Pack Topic 3 – Quantitative Chemistry

Quantitative Chemistry	R/A/G
Chemical measurements, conservation of mass and the quantitative interpretation of chemical equations	
Conservation of mass and balanced chemical equations	
The law of conservation of mass states that no atoms are lost or made during a chemical reaction so the mass of the products equals the mass of the reactants. This means that chemical reactions can be represented by symbol equations which are balanced in terms of the numbers of atoms of each element involved on both sides of the equation.	
Relative formula mass	
The relative formula mass (M_r) of a compound is the sum of the relative atomic masses of the atoms in the numbers shown in the formula. In a balanced chemical equation, the sum of the relative formula masses of the reactants in the quantities shown equals the sum of the relative formula masses of the products in the quantities shown.	
Mass changes when a reactant or product is a gas	
Some reactions may appear to involve a change in mass but this can usually be explained because a reactant or product is a gas and its mass has not been taken into account. For example: when a metal reacts with oxygen the mass of the oxide produced is greater than the mass of the metal or in thermal decompositions of metal carbonates, carbon dioxide is produced and escapes into the atmosphere leaving the metal oxide as the only solid product.	
Chemical measurements	
Whenever a measurement is made there is always some uncertainty about the result obtained.	
Use of amount of substance in relation of masses to pure substances	
Moles (higher tier only)	
Chemical amounts are measured in moles. The symbol for the unit mole is mol. The mass of one mole of a substance in grams is numerically equal to its relative formula mass. One mole of a substance contains the same number of the stated particles, atoms, molecules or ions as one mole of any other substance. The number of atoms, molecules or ions in a mole of a given substance is the Avogadro constant. The value of the Avogadro constant is 6.02×10^{23} per mole.	
Amounts of substances in equations (higher tier only)	
The masses of reactants and products can be calculated from balanced symbol equations. Chemical equations can be interpreted in terms of moles. For example: $Mg + 2HCl \rightarrow MgCl_2 + H_2$ shows that one mole of magnesium reacts with two moles of hydrochloric acid to produce one mole of magnesium chloride and one mole of hydrogen gas.	

Revision Pack Topic 3 – Quantitative Chemistry

Using moles to balance equations (higher tier only)	
The balancing numbers in a symbol equation can be calculated from the masses of reactants and products by converting the masses in grams to amounts in moles and converting the numbers of moles to simple whole number ratios.	
Limiting reactants (higher tier only)	
In a chemical reaction involving two reactants, it is common to use an excess of one of the reactants to ensure that all of the other reactant is used. The reactant that is completely used up is called the limiting reactant because it limits the amount of products.	
Concentration of solutions	
Many chemical reactions take place in solutions. The concentration of a solution can be measured in mass per given volume of solution, eg. grams per dm^3 (g/dm^3).	
Yield and atom economy of Chemical reactions (chemistry only)	
Percentage yield	
Even though no atoms are gained or lost in a chemical reaction, it is not always possible to obtain the calculated amount of a product because: • the reaction may not go to completion because it is reversible • some of the product may be lost when it is separated from the reaction mixture • some of the reactants may react in ways different to the expected reaction. The amount of a product obtained is known as the yield. When compared with the maximum theoretical amount as a percentage, it is called the percentage yield.	
Atom economy	
The atom economy (atom utilisation) is a measure of the amount of starting materials that end up as useful products. It is important for sustainable development and for economic reasons to use reactions with high atom economy. The percentage atom economy of a reaction is calculated using the balanced equation for the reaction as follows: (Relative formula mass of desired product from equation ÷ Sum of relative formula masses of all reactants from equation) × 100	
Using concentrations of solutions in mol/dm^3 (chemistry only) (HT only)	
The concentration of a solution can be measured in mol/dm^3. The amount in moles of solute or the mass in grams of solute in a given volume of solution can be calculated from its concentration in mol/dm^3. If the volumes of two solutions that react completely are known and the concentration of one solution is known, the concentration of the other solution can be calculated.	

Revision Pack Topic 3 – Quantitative Chemistry

Amount of substance for volumes of gases (chemistry only) (HT only)	
Equal amounts in moles of gases occupy the same volume under the same conditions of temperature and pressure. The volume of one mole of any gas at room temperature and pressure (20°C and 1 atmosphere pressure) is 24 dm^3. The volumes of gaseous reactants and products can be calculated from the balanced equation for the reaction.	

Revision Pack Topic 3 – Quantitative Chemistry

Relative Formula Mass

Example Calculation:

To calculate relative formula mass (also called M_r), you add up the mass numbers (the bigger number in the Periodic Table) for each element in the compound.

E.g. what is the relative formula mass of the compound NH_3?

From the Periodic Table, the mass number of N is 14 and the mass number of H is 1.

So, the relative formula mass = 14 + (1 x 3) = 17

[There are 3 hydrogen atoms in the formula, so you must multiply the mass of H by 3).

Use the worked example to complete these relative formula mass calculations:

Compound	Workings	M_r
LiF		
C_2H_4		
$NaHCO_3$		
KNO_3		
H_2SO_4		
$Zn(CN)_2$		

Revision Pack Topic 3 – Quantitative Chemistry

Balancing Equations and Conservation of Mass:

1. How many atoms and elements are in the compound sodium aluminate, $NaAl(OH)_4$?

2. What do the following formulae tell you?
   a) 2HCl

   b) Cl_2

3. An aqueous solution of hydrogen peroxide (H_2O_2) decomposes to form water and oxygen.

   a) Write a balanced symbol equation for this reaction. Include the state symbols.

   b) Why does the water, produce during the reaction, have a lower mass than the original hydrogen peroxide?

Revision Pack Topic 3 – Quantitative Chemistry

BALANCING EQUATIONS

Balance the equations shown below. Remember that you may only write numbers in front of any of the formulae but you may not change any formulae. Some of the equations may already be balanced.

1	H_2	+	O_2	→	H_2O			
2	Al	+	Br_2	→	$AlBr_3$			
3	Ca	+	O_2	→	CaO			
4	Fe_2O_3	+	C	→	Fe	+	CO_2	
5	HNO_3	+	$Mg(OH)_2$	→	$Mg(NO_3)_2$	+	H_2O	
6	Ca	+	HCl	→	$CaCl_2$	+	H_2	
7	$MgCl_2$	+	NaOH	→	$Mg(OH)_2$	+	NaCl	
8	$BaCl_2$	+	Li_2SO_4	→	LiCl	+	$BaSO_4$	
9	H_2SO_4	+	RbOH	→	Rb_2SO_4	+	H_2O	
10	C_3H_8	+	O_2	→	CO_2	+	H_2O	

Revision Pack Topic 3 – Quantitative Chemistry

Concentration of solutions calculations:

Units: 1 dm^3 = 1000 cm^3 (= 1000 mL).

- **To convert from cm^3 into dm^3, you need to ÷ by 1000.**
- **To convert from dm^3 into cm^3, you need to x by 1000.**

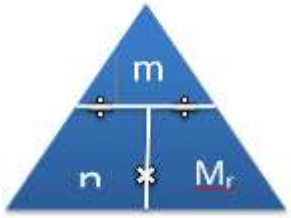
1. Calculate the concentration in g/dm^3, for 50 g of sodium chloride in 2.5 dm^3 of water.

2. Calculate the concentration, in g/dm^3, of 1.4 g of potassium carbonate in 855 cm^3 of water.

3. A teacher has a solution of lithium fluoride with a concentration of 72.6 g/dm^3. Calculate the mass of lithium fluoride dissolved in 25.0 cm^3 of solution.

Revision Pack Topic 3 – Quantitative Chemistry

Moles and Amount of Substance (HT only)



Moles are an amount of substance used in chemistry. The relative formula mass of a compound is the mass in grams of 1 mole.
Equation you need to be able to use:
number of moles = mass (in g) ÷ relative formula mass

E.g. how many moles are there in 10 g of the compound NH_3?
The relative formula mass of NH_3 is 17 (= 14 + (1x3)).
So, using the equation, the number of moles = 10 ÷ 17 = **0.6 moles**
1 mole has 6.02×10^{23} particles (ions/molecules/atoms) in it. This is Avogadro's constant.

Use the worked example calculation to calculate the numbers of moles in the compounds below (the relative formula masses/M_r values have been given to you already).

Compound	M_r	Calculate . . .
LiF	26	The number of moles in 26 g
C_2H_4	28	The mass of one mole
$NaHCO_3$	84	The number of moles in 168 g
KNO_3	101	The mass of 2 moles
H_2SO_4	98	The mass of 0.5 moles
$Zn(CN)_2$	117	The number of moles in 11.7 g
Al_2O_3	102	The number of moles in 122.4 g
$CaCl_2$	111	The mass of 0.4 moles
NH_4NO_3	80	The mass of 0.75 moles

Revision Pack Topic 3 – Quantitative Chemistry

Worked Example for Amount of Substance:

E.g. obtaining iron from iron ore in a blast furnace:

$$Fe_2O_3\ (s) + 3CO\ (g) \longrightarrow 2Fe\ (l) + 3CO_2\ (g)$$

iron ore + carbon monoxide ⟶ iron + carbon dioxide

Question: How much iron could I make from 100 g of iron oxide?

Step 1: Calculate the relative formula masses for the two species mentioned in the question

Step 2: Work out what 1 g of the reactant would give you (how much product you should get)

Step 3: Scale up to work out the amount the question asks you for

Step 1: The question mentions iron and iron oxide, so:

Fe_2O_3 ⟶ 2Fe

(56 x 2) + (16 x 3) = 160 ⟶ 2 x 56 = 112

- This means that 160 g of iron oxide, would give you 112 g of iron.

Step 2:

160 g ⟶ 112 g

÷160 (160 g → 1 g) ÷160 (112 g → (112 ÷ 160) = 0.7 g)

1 g ⟶ (112 ÷ 160) = 0.7 g

Step 3: The question asks how much iron you would get if you had 100 g of iron oxide:

So,

1 g ⟶ 0.7 g

x 100 (1 g → 100 g) x 100 (0.7 g → 0.7 x 100 = 70 g)

100 g ⟶ 0.7 x 100 = 70 g

So, the answer is **70 g of iron**.

Revision Pack Topic 3 – Quantitative Chemistry

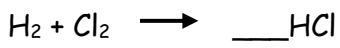
Use the worked example to answer these questions:

1. Calcium carbonate decomposes to calcium oxide in a kiln in the following reaction

$$CaCO_3 \longrightarrow CaO + CO_2$$

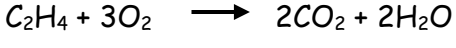
   Calculate the mass of calcium oxide that can be produced when 300 tonnes of calcium carbonate is heated.

2. 0.10g of hydrogen reacts with 3.55g of chlorine to produce 3.65g of hydrogen chloride. Use this information to work out the balancing numbers for hydrogen chloride.



$$H_2 + Cl_2 \longrightarrow \_\_\_HCl$$

3. If 4.95g of ethane (C_2H_4) are combusted with 3.25g of oxygen, what is the limiting reagent?



$$C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$$

Hint: the limiting reagent is the reactant with the smallest number of moles

Revision Pack Topic 3 – Quantitative Chemistry

Percentage Yield and Atom Economy (Chemistry only)

Percentage yield tells you how much product you actually obtained from a reaction, compared with how much product you should have obtained.

The formula you need to know is:

Percentage yield = (actual yield ÷ theoretical yield) x 100

E.g. In a chemical reaction, a student expected to obtain 25 g of her product. She actually only obtained 20 g. What was her percentage yield?

Using the equation; percentage yield = (20 ÷ 25) x 100 = 80%

Reasons why your percentage yields will always be less than 100%:

- Some products might be lost
- Not all reactants will react
- The reaction might be reversible
- The reactants may not have been pure

Atom Economy is a measure of how much of your starting materials end up as useful products.

Atom Economy = (M_r of desired product ÷ M_r of all reactants) x 100

(M_r = relative formula mass)

Questions to Answer:

1. Magnesium is heated in air to make magnesium oxide. Suggest why the actual yield might be less than the maximum theoretical yield.

2. In the neutralization of sulfuric acid with sodium hydroxide, the theoretical yield from 13.8g of sulfuric acid is 20g. In a synthesis, the actual yield is 17.4g. What is the percentage yield for this synthesis?

3. Calculate the atom economy for making hydrogen from methane and steam.

$$CH_4 + 2H_2O \longrightarrow CO_2 + 4H_2$$

Revision Pack Topic 3 – Quantitative Chemistry

Moles of Solution and Gases (Chemistry only)

Complete the definitions table:

Key Term	Definition
Solute	
Solvent	
Solution	

Mole Equations Summary – equations you need to know:

number of moles (mol) = $\frac{\text{mass (g)}}{\text{molar mass (g mol}^{-1}\text{)}}$ $\quad n = \frac{m}{M}$

number of moles (mol) of any gas at RTP = $\frac{\text{V (dm}^3\text{)}}{24.0}$ $\quad n = \frac{\text{V (in dm}^3\text{)}}{24.0}$

number of moles (mol) of a solution = concentration (mol dm^{-3}) x volume (dm^3)

$n = c \times V \text{ (in dm}^3\text{)}$

(RTP = room temperature and pressure)

Questions to answer:

1. What is the concentration (in g/dm^3) of a solution that has 40 g of solute in 2 dm^3 of solution?

Revision Pack Topic 3 – Quantitative Chemistry

2. Calculate the concentration, in mol/dm^3, of a solution that has 0.75 mol of an acid in 3 dm^3 of solution.

3. It takes 28.0 cm^3 of potassium hydroxide to neutralize 25.00 cm^3 of nitric acid at a concentration of 0.50 mol/dm^3

$$HNO_3 + KOH \longrightarrow KNO_3 + H_2O$$

Calculate the concentration of the potassium hydroxide.

4. What is the volume of 4.5 g of oxygen?

5. Calculate the number of moles of hydrogen that occupy 6 dm^3 at RTP.

Revision Pack Topic 3 – Quantitative Chemistry

Practice Exam Questions

Q1. Iron ore contains iron oxide.

(i) Calculate the relative formula mass of iron oxide, Fe_2O_3. Relative atomic masses: O = 16; Fe = 56.

.....

.....

Answer = ...

(2)

(ii) Calculate the percentage by mass of iron in iron oxide.

.....

Percentage of iron = ... %

(2)

(iii) Calculate the mass of iron that could be extracted from 1000 kg of iron oxide.

Use your answer to part (c) (ii) to help you with this calculation.

.....

Mass of iron = ... kg

(1)

(Total 5 marks)

Q2. (a) A chemist was asked to identify a nitrogen compound. The chemist carried out an experiment to find the relative formula mass (M_r) of the compound.

The M_r of the compound was **44**.

Relative atomic masses: N = 14, O = 16

Draw a ring around the formula of the compound.

NO **NO_2** **N_2O_4** **N_2O**

(1)

(b) Potassium nitrate is another nitrogen compound. It is used in fertilisers. It has the formula **KNO_3**. The **M_r** of potassium nitrate is **101**.

Calculate the percentage of **nitrogen** by mass in potassium nitrate. M_r: N = 14.

.....

.....

Percentage of nitrogen = ... %

(2)

(Total 3 marks)

Q3. Aqamed is a medicine for children.

(a) The medicine is a formulation.

What is meant by a formulation?

.....

.....

(1)

(b) Children often do not like taking medicine.

Suggest a substance that could be added to Aqamed to increase the desire for children to take it.

Give a reason for your suggestion.

Substance .....

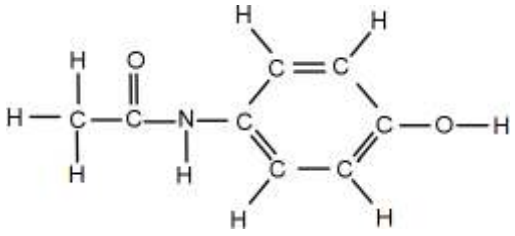
Reason .....

.....

(2)

(c) The main ingredient in Aqamed is a painkiller called paracetamol.

The figure below represents a molecule of paracetamol.



Give the molecular formula of paracetamol.

Calculate its relative formula mass (M_r).

Relative atomic masses (A_r): H = 1; C = 12; N = 14; O = 16

Molecular formula .....

Relative formula mass .....

.....

M_r = ...

(2)

(d) Aspirin is a medicine for use by adults.

An aspirin tablet contains 300 mg of acetylsalicylic acid.

Calculate the number of moles of acetylsalicylic acid in one aspirin tablet.

Give your answer in standard form to three significant figures.

Relative formula mass (M_r) of aspirin = 180

.....

.....

.....

.....

.....

.....

Number of moles = ...

(4)

(Total 9 marks)

Q4. Etching is a way of making printed circuit boards for computers. Printed circuit boards are made when copper sheets are etched using iron(III) chloride solution. Where the copper has been etched, only plastic remains.

(a) Copper is a good conductor of electricity. Explain why.

.....

.....

.....

(2)

(b) Iron(III) chloride can be produced by the reaction shown in the equation:

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

(i) Calculate the maximum mass of iron(III) chloride ($FeCl_3$) that can be produced from 11.20 g of iron.

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

.....

.....

.....

.....

.....

Maximum mass of iron(III) chloride = ... g

(3)

(ii) The actual mass of iron(III) chloride ($FeCl_3$) produced was 24.3 g.

Calculate the percentage yield.

(If you did not answer part (b)(i) assume that the maximum theoretical mass of iron(III) chloride ($FeCl_3$) is 28.0 g. This is **not** the correct answer to part (b)(i).)

.....

.....

Percentage yield = ...%

(1)

Q5. Ammonia is produced from nitrogen and hydrogen.

The equation for this reaction is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(a) (i) A company wants to make 6.8 tonnes of ammonia.

Calculate the mass of nitrogen needed.

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

.....

.....

.....

.....

.....

Mass of nitrogen = ... tonnes

(3)

(ii) The company expected to make 6.8 tonnes of ammonia.

The yield of ammonia was only 4.2 tonnes.

Calculate the percentage yield of ammonia.

.....

.....

Percentage yield of ammonia = ... %

(2)

Revision Pack Topic 3 – Quantitative Chemistry

Practice Exam Questions – MARK SCHEME

M1. (i) 160 ignore units

(2 × 56) + (3 × 16) for **1** mark

2

(ii) 70

$\frac{2 \times 56}{160}(\times 100)$ *for **1** mark*

allow ecf from part (i)

2

(iii) 700

allow ecf from part (ii)

1

[5]

M2. (a) N_2O

1

(b) 13.8 to 14

gains full marks without working

if answer incorrect

*13 gains **1** mark*

or

*14/101 × 100 gains **1** mark*

2

[3]

M3.(a) (medicine is) a mixture **and**

(designed as) a useful product

1

(b) sugar / flavouring

1

to make it taste better

or

colouring

to make it look more attractive

1

(c) $C_8H_9NO_2$

any order of elements

1

151

1

(d) mass of acetylsalicylic acid = 0.3 g

1

$= \frac{0.3}{100}$ (mol)

method mark – divide mass by M_r

1

= 0.00167 (mol)

allow 0.0016666(66)

1

1.67×10^{-3} (mol)

*correct answer with or without working scores **4** marks*

allow ecf from steps1, 2 and 3

1

[9]

M4.(a) copper has delocalised electrons

*accept copper has free electrons ignore sea of electrons **or** mobile electrons*

1

(electrons) which can move through the metal / structure

allow (electrons) which can carry a charge through the metal / structure

1

(b) (i) (M_r $FeCl_3$ =) 162.5

*correct answer with or without working gains **3** marks*

*can be credited from correct substitution in step **2***

1

or

2 (moles of) $FeCl_3$ = 325

or

112 → 325

$\frac{11.20}{56} \times 162.5$

allow ecf from step 1

accept $\frac{325}{112} \times 11.2$

1

= 32.5

accept 32.48

1

(ii) 74.8
accept 74.77 - 75
accept ecf from (b)(i)
if there is no answer to part(i)
or
if candidate chooses not to use their answer then accept 86.79 - 87

1

[6]

M5.(a) (i) M_r of NH_3 = 17
*correct answer with or without working gains **3** marks*
accept correct rounding of intermediate answers
can be credited from correct substitution from step 2

1

or

2 (moles of) NH_3 = 34

or

14 → 17

or

28 → 34

(28/34) × 6.8
allow ecf from step 1

1

or

(14/17) × 6.8

= 5.6
allow ecf from step 1

1

(ii) 61.8
*accept 61.76 **or** 62 **or** 61.76…*
*correct answer with or without working gains **2** marks*
*if answer is not correct evidence of 4.2 / 6.8 × 100 gains **1** mark*
*if answer not correct 0.618 or 0.62 gains **1** mark*

2

(iii) reaction is reversible
accept reaction reaches equilibrium
allow reaction does not reach completion
ignore some is lost

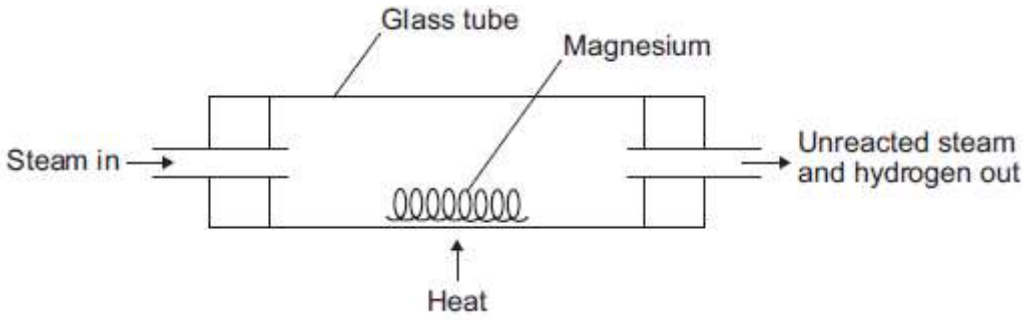
1

Revision Pack Topic 3 – Quantitative Chemistry

Practice Exam Questions – Chemistry only

Q1. Magnesium reacts with steam to produce hydrogen gas and magnesium oxide.

A teacher demonstrated the reaction to a class. The figure below shows the apparatus the teacher used.



(a) (i) The hydrogen produced was collected.

Describe how to test the gas to show that it is hydrogen.

Test .....

.....

Result .....

.....

(2)

(ii) Explain why the magnesium has to be heated to start the reaction.

.....

.....

.....

.....

(2)

(b) The equation for the reaction is:

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

(i) The teacher used 1.00 g of magnesium.

Use the equation to 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 = ... g
(3)

(ii) The teacher's demonstration produced 1.50 g of magnesium oxide.

Use your answer from part (b)(i) to calculate the percentage yield.

If you could not answer part (b)(i), use 1.82 g as the maximum mass of magnesium oxide. This is **not** the answer to part (b)(i).

.....

Percentage yield = ... %
(2)

(iii) Give **one** reason why the percentage yield is less than 100%.

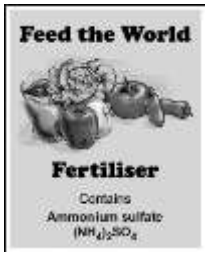
.....

.....

.....

(1)
(Total 10 marks)

Q2. Ammonium sulfate is an artificial fertiliser.



A student made some ammonium sulfate in a school laboratory.

The student carried out a titration, using a suitable indicator. The student found that 25.0 cm^3 of ammonia solution reacted completely with 32.0 cm^3 of sulfuric acid of concentration 0.050 moles per cubic decimetre.

The equation that represents this reaction is:

$2H_2SO_4(aq) + 2NH_3(aq) \rightarrow (NH_4)_2SO_4\ (aq)$

Calculate the concentration of this ammonia solution in moles per cubic decimetre.

.....

.....

.....

.....

.....

Concentration = ... moles per cubic decimetre

(3)

(iv) Use your answer to (b)(iii) to calculate the concentration of ammonia in grams per cubic decimetre.

(If you did not answer part (b)(iii), assume that the concentration of the ammonia solution is 0.15 moles per cubic decimetre. This is **not** the correct answer to part (b)(iii).)

Relative formula mass of ammonia (NH_3) = 17.

.....

.....

.....

Concentration = ... grams per cubic decimetre

(2)

Q3. An oven cleaner solution contained sodium hydroxide. A 25.0 cm^3 sample of the oven cleaner solution was placed in a flask. The sample was titrated with hydrochloric acid containing 73 g/dm^3 of hydrogen chloride, HCl.

(a) Describe how this titration is carried out.

.....

.....

.....

.....

.....

(3)

(b) Calculate the concentration of the hydrochloric acid in mol/dm^3.

Relative atomic masses: H 1; Cl 35.5

.....

Answer = ... mol/dm^3

(2)

(c) 10.0 cm^3 of hydrochloric acid were required to neutralise the 25.0 cm^3 of oven cleaner solution. (i) Calculate the number of moles of hydrochloric acid reacting.

.....

Answer = ... mol

(2)

(ii) Calculate the concentration of sodium hydroxide in the oven cleaner solution in mol/dm^3.

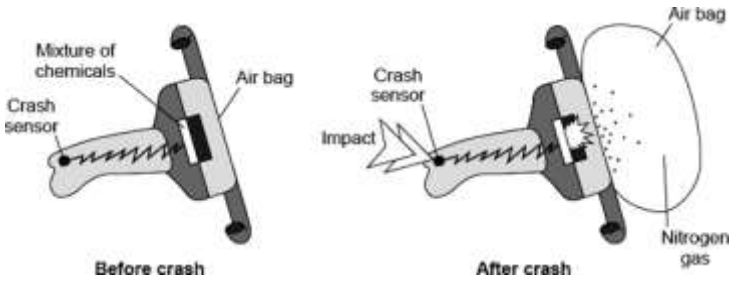
.....

Answer = ... mol/dm^3

(2)

(Total 9 marks)

Q4. Air bags are used to protect the passengers in a car during an accident. When the crash sensor detects an impact it causes a mixture of chemicals to be heated to a high temperature. Reactions take place which produce nitrogen gas. The nitrogen fills the air bag.



(a) The mixture of chemicals contains sodium azide (NaN_3) which decomposes on heating to form sodium and nitrogen.

$2NaN_3 \rightarrow 2Na + 3N_2$

A typical air bag contains 130 g of sodium azide.

(i) Calculate the mass of nitrogen that would be produced when 130 g of sodium azide decomposes.

Relative atomic masses (A_r): N = 14; Na = 23

.....

.....

.....

.....

Mass of nitrogen = ... g

(3)

(ii) 1 g of nitrogen has a volume of 0.86 litres at room temperature and pressure.

What volume of nitrogen would be produced from 130 g of sodium azide?

(If you did not answer part (a)(i), assume that the mass of nitrogen produced from 130 g of sodium azide is 80 g. This is **not** the correct answer to part (a)(i).)

.....

Volume = ... litres

(1)

(b) The sodium produced when the sodium azide decomposes is dangerous.
The mixture of chemicals contains potassium nitrate and silicon dioxide which help to make the sodium safe.

(i) Sodium reacts with potassium nitrate to make sodium oxide, potassium oxide and nitrogen. Complete the balancing of the equation for this reaction.

$10Na + ...KNO_3 \rightarrow Na_2O + K_2O + N_2$

(1)

(ii) The silicon dioxide reacts with the sodium oxide and potassium oxide to form silicates.

Suggest why sodium oxide and potassium oxide are dangerous in contact with the skin.

.....

.....

(1)

Revision Pack Topic 3 – Quantitative Chemistry

Practice Exam Questions – Chemistry only MARK SCHEME

M1.(a) (i) lit splint **or** ignite the gas

1

(squeaky) pop / explosion

1

(ii) because it provides energy (for the reaction)

1

to break bonds (in the reactants) **or** so the particles collide successfully

ignore reference to frequency or rate of collisions

*because it provides the activation energy gains **2** marks*

1

(b) (i) 1.67(g)

allow 1.66-1.68

*correct answer (to 3 significant figures) with or without working gains **3** marks*

*if answer incorrect allow up to **2** marks for the following steps:*

24 → 40

1.00 → 40 / 24

or

*moles magnesium = 1 / 24 **or** 0.04(17)*

multiply by 40

*allow ecf from incorrect ratio **or** incorrect number of moles*

3

(ii) **if correct answer from part (b)(i) used**

allow ecf from part (b)(i)

89.8 or 90

if 1.82 g used

82.4 or 82

*correct answer with or without working gains **2** marks*

*if answer incorrect, allow the following for **1** mark:*

1.50 / 1.67 (or their answer from part (b)(i))

if 1.82 g used: 1.50 / 1.82

2

(iii) any **one** from:

ignore measurement errors

- not all the magnesium reacted

allow the reaction may be reversible

- some of the magnesium oxide / product may have been left in the tube **or** may have been lost

ignore magnesium lost

- different / unexpected reaction
- magnesium not pure

1

[10]

M2.

(iii) 32 × 0.05/1000 **or** 0.0016 (mole H_2SO_4)
*accept (0.05 x 32) = (V x 25) **or** 0.05 x 32 / 25*

1

(reacts with) 2 × 0.0016 **or** 0.0032 (mole NH_3 in 25 cm^3)
*accept dividing rhs by 2 **or** multiplying lhs by 2*

1

(0.0032 × 1000/25 =) 0.128
allow ecf from previous stage
*correct answer 0.128 **or** 0.13 with or without working gains all **3** marks*

1

(iv) 2.176 **or** 2.18
correct answer with or without working

or ecf from candidate's answer to (b)(iii)

or 2.55 if 0.15 moles used
if answer incorrect or no answer
*0.128 × 17 **or** 0.13 x 17*
***or** their (b)(iii) × 17*
***or** 0.15 × 17 gains **1** mark*

2

M3. (a) hydrochloric acid in burette

1

indicator

1

note volume at end / neutralisation point
titre must be HC1

1

(b) 1 mole HCl = 36.5g /36.5

1

$\therefore \frac{73}{36.5}$ = 2 moles / dm^3
2 for correct answer

1

(c) (i) $\frac{10 \times 2}{1000}$

allow e.c.f. ie their (b) × $\frac{10}{1000}$

2 for correct answer

1

= 0.02 moles

1

(ii) $0.02 \times \frac{1000}{25}$ = 0.8 mol / dm^3

1

allow e.c.f. ie their (c)(i) × $\frac{1000}{25}$

1

[9]

M4. (a) (i) 84 / 84.5 / 83.98

*correct answer with or without working gains **3** marks*

(moles of NaN_3 =) 130/65 (1)

moles of nitrogen = 3 (1)

mass of nitrogen = 3 x 28 = 84 (1)

or

2 x (23 + (3 x 14)) (1)

3 x (2 x14) (1)

or

$2NaN_3$ = 130 (1)

$3N_2$ = 84 (1)

if answer is incorrect then look for evidence of correct working.

allow ecf from previous stage

***1** mark lost for each mistake in the working if they do not have the correct answer.*

3

(ii) 72 / 72.24 / 72.2

allow ecf from part (i) × 0.86

or

ignore working

69 **or** 68.8

1

(b) (i) 2 **and** 5

1

(ii) any **one** from:

- corrosive / burns
- alkaline / basic

*do **not** accept acidic*

- attacks / destroys / damages living tissue / cells

allow irritant
ignore reference to reactivity
ignore reference to silicates
ignore harmful / toxic

1
[6]