OCR A – A Level Chemistry Summer Task

Transition skills

0.1.2 Constructing ionic formulae

1. For each of the following ionic salts, determine the cation and anion present and use these to construct the formula of the salt. (5 marks)

a. Magnesium oxide

b. Sodium sulfate

c. Calcium hydroxide

d. Aluminium oxide

e. Copper(I) oxide

2. When an acid is added to water it dissociates to form H^+ ions (which make it acidic) and an anion. These acidic hydrogen atoms can be used to determine the charge on the anion. Deduce the charge on the anions in the following acids. The acidic H atoms, H^+, have been underlined for you. (5 marks)

a. $\underline{H}_2SO_3$

b. $\underline{H}NO_3$

c. $\underline{H}_3PO_4$

d. HCOO$\underline{H}$

e. $\underline{H}_2CO_3$

0.1.3 Writing equations from text

The following questions contain a written description of a reaction. In some cases the products may be missing as you will be expected to predict the product using your prior knowledge.

For more advanced equations you may be given some of the formulae you need.

For each one, write a balanced symbol equation for the process. (10 marks)

1. The reaction between silicon and nitrogen to form silicon nitride Si_3N_4.

.....

2. The neutralisation of sulfuric acid with sodium hydroxide.

.....

3. The preparation of boron trichloride from its elements.

.....

4. The reaction of nitrogen and oxygen to form nitrogen monoxide.

.....

5. The combustion of ethanol (C_2H_5OH) to form carbon dioxide and water only.

.....

6. The formation of silicon tetrachloride ($SiCl_4$) from SiO_2 using chlorine gas and carbon.

.....

7. The extraction of iron from iron(III) oxide (Fe_2O_3) using carbon monoxide.

.....

8. The complete combustion of methane.

.....

9. The formation of one molecule of ClF_3 from chlorine and fluorine molecules.

.....

10. The reaction of nitrogen dioxide with water and oxygen to form nitric acid.

.....

0.2.1 Rearranging equations

1. The amount of substance in moles (n) in a solution can be calculated when the concentration given in mol/dm^3 (c) and volume (v) in cm^3 are known by using the equation:

$$n = \frac{cv}{1000}$$

a. Rearrange this equation making c the subject of the equation. (1 mark)

b. Rearrange this equation making v the subject of the equation. (1 mark)

2. The density of a substance can be calculated from its mass (m) and volume (v) using the equation:

$$d = \frac{m}{v}$$

a. Rearrange this equation so that the mass of a substance can be calculated given its density and volume. (1 mark)

Chemists most commonly work with masses expressed in grams and volumes in cm^3. However, the SI unit for density is kg/m^3.

b. Write an expression for the calculation of density in the SI unit of kg/m^3 when the mass (m) of the substance is given in g and the volume (v) of the substance is given in cm^3. (2 marks)

3. The de Broglie relationship relates the wavelength of a moving particle (λ) with its momentum (p) through Planck's constant (h):

$$\lambda = \frac{h}{p}$$

a. Rearrange this equation to make momentum (p) the subject of the formula. (1 mark)

Momentum can be calculated from mass and velocity using the following equation.

$$p = mv$$

b. Using this equation and the de Broglie relationship, deduce the equation for the velocity of the particle. (2 marks)

4. The kinetic energy (KE) of a particle in a time of flight mass spectrometer can be calculated using the following equation.

$$\mathrm{KE} = \frac{1}{2}\mathrm{mv}^2$$

Rearrange this equation to make v the subject of the equation. (2 marks)

0.2.3 Quantity calculus (unit determination)

1. Determine the units of density given that

$$density = \frac{mass(g)}{volume\ (cm^3)}$$

(1 mark)

2. Determine the units of concentration given that

$$concentration = \frac{number\ of\ moles\ (mol)}{volume\ (dm^3)}$$

(1 mark)

3. Pharmacists often calculate the concentration of substances for dosages. In this case the volumes are smaller, measured in cm^3, and the amount is given as a mass in grams. Determine the units of concentration when

$$concentration = \frac{mass\ (g)}{volume\ (cm^3)}$$

(1 mark)

4. Rate of reaction is defined as the *'change in concentration per unit time'*. Determine the units for rate when concentration is measured in mol dm^{-3} and time in seconds.

(1 mark)

5. Pressure is commonly quoted in pascals (Pa) and can be calculated using the formula below. The SI unit of force is newtons (N) and area is m^2.

$$pressure = \frac{force}{area}$$

Use this formula to determine the SI unit of pressure that is equivalent to the Pascal.

(1 mark)

0.2.7 Unit conversions 2 – Volume

The SI unit for volume is **metre cubed, m^3**. However as volumes in chemistry are often smaller than 1 m^3, fractions of this unit are used as an alternative.

centimetre cubed, cm^3	**decimetre cubed, dm^3**
centi- *prefix* one hundredth	**deci-** *prefix* one tenth
1 cm = $\frac{1}{100}$ m so,	1 dm = $\frac{1}{10}$ m so,
1 cm^3 = $\left(\frac{1}{100}\right)^3$ m^3 = $\left(\frac{1}{1\,000\,000}\right)$ m^3	1 dm^3 = $\left(\frac{1}{10}\right)^3$ m^3 = $\left(\frac{1}{1\,000}\right)$ m^3

1. Complete the table by choosing the approximate volume from the options in bold for each of the everyday items (images not drawn to scale). (1 mark)

1 cm^3 **1 dm^3** **1 m^3**

			
	drinks bottle	sugar cube	washing machine
Approx. volume			

2. Complete the following sentences; (1 mark)

To convert a volume in **cm^3** into a volume in **dm^3**, divide by.....

To convert a volume in **cm^3** into a volume in **m^3**, divide by.....

3. a. A balloon of helium has a volume of 1600 cm^3. What is its volume in units of dm^3?

b. The technician has prepared 550 cm^3 of HCl(aq). What is its volume in units of m^3?

c. An experimental method requires 1.35 dm^3 of NaOH(aq). What volume is this in cm^3?

d. A swimming pool has a volume of 375 m^3. What volume is this in cm^3?

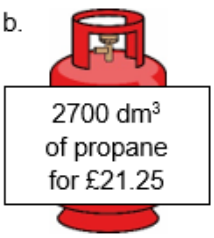
e. A 12 g cylinder of CO_2 contains 6.54 dm^3 of gas. What volume of gas is this in units of m^3?

(5 marks)

4. Which cylinder of propane gas is the best value for money? (3 marks)

a.

b.



c.

0.3.1 Laboratory equipment

Practical work is a key aspect in the work of a chemist.

To help you plan effective practical work it is important that you are familiar with the common laboratory equipment available to you.

1. For each of the pieces of glassware shown in the images below, state their name and give a possible volume(s).

a. 

Name:

.....

Possible volume(s):

.....

b. 

Name:

.....

Possible volume(s):

.....

c. 

Name:

.....

Possible volume(s):

.....

d. 

Name:

.....

Possible volume(s):

.....

e. 

Name:

.....

Possible volume(s):

.....

f. 

Name:

.....

Possible volume(s):

.....

(6 marks)

2. Name the common laboratory equipment in the images below. (4 marks)

a. 

.....

b. 

.....

c. 

.....

d. 

0.3.2 Recording results

1. A student is looking at endothermic processes. He adds 2.0 g of ammonium nitrate to 50 cm^3 of water and measures the temperature change. He repeats the experiment three times.

His results are shown in the table below.

	Temperature at start	**Temperature at end**	**Temperature change**
Run 1	21.0	–1.1	22.1
Run 2	20	–2	22
Run 3	20.2	2	18.2
Mean			**22.05**

Annotate the table to suggest **five ways** in which the table layout and the recording and analysis of his results could be improved. (5 marks)

2. For each of the experiments described below, design a table to record the results.

Experiment 1: Simon is investigating mass changes during chemical reactions. He investigates the change in mass when magnesium ribbon is oxidised to form magnesium oxide:

magnesium + oxygen $\rightarrow$ magnesium oxide

He records the mass of an empty crucible. He places a 10 cm strip of magnesium ribbon in the crucible and records the new mass of the crucible. He heats the crucible strongly until all the magnesium ribbon has reacted to form magnesium oxide. He allows the crucible to cool before recording the mass of the crucible and magnesium oxide.

Experiment 2: Nadiya is investigating how the rate of a reaction is affected by concentration. She investigates the reaction between magnesium ribbon and hydrochloric acid.

magnesium + hydrochloric acid $\rightarrow$ magnesium chloride + hydrogen

She places 25 cm^3 of hydrochloric acid with a concentration of 0.5 mol dm^{-3} into a conical flask and fits a gas syringe. She adds a 3.0 cm strip of magnesium ribbon and measures the volume of hydrogen gas produced every 20 s for 3 minutes.

She repeats the experiment with hydrochloric acid with concentrations of 1.0 mol dm^{-3} and then 1.5 mol dm^{-3}.