O Level Pure Chemistry Structured

The Mole Concept and Stoichiometry Test 1.0

Q1

Chlorofluorocarbons (CFCs) were widely used in refrigerants and aerosol products before the 1990s, until they were phased out by several countries due to their negative impact on the environment.

(a) Describe the negative impact CFCs have on human beings and the environment.

.....

.....[1]

(b) Applications of CFCs make use of their volatility and low reactivity.

The table shows the properties of some common CFC refrigerants.

name of CFC	formula of CFC	boiling point (°C)
Freon-11	CCl_3F	23
Freon-12	CCl_2F_2	–30
Freon-31	CH_2ClF	–9

(i) "The boiling point of the CFC increases with the size of the molecule."

Do you agree with this statement? Use the information in the table to explain your reasoning.

.....

.....

.....[2]

(ii) Freon-13, is composed of 11.5% by mass of carbon, 34% by mass of chlorine, and the remainder being fluorine.

Deduce, by calculation, the molecular formula of Freon-13.

[3]

[total = 6 marks]

Q2

Table 1.2 below lists the natural abundances for the three stable isotopes of magnesium.

Table 1.2

isotope	^{24}Mg	^{25}Mg	^{26}Mg
natural abundance (%)	78.99	10.00	

(i) Calculate and complete Table 1.2 with the natural abundance of ^{26}Mg. [1]

(ii) Using the values in the Table 1.2, calculate the average relative mass for an atom of magnesium. Leave your answer in 3 significant figures.

[2]

Q3

Aspirin is a medicine that is used as a painkiller. It is made from salicylic acid.

The student tests some aspirin tablets bought from a store.

He performs a titration using a crushed tablet and aqueous sodium hydroxide.

The formula for aspirin can be represented as  —COOH. The equation for the reaction between aspirin and aqueous sodium hydroxide is shown below.

Table 8.2 shows the results of the student's titration.

Table 8.2

concentration of aqueous NaOH used	0.10 mol/dm^3
volume of aqueous NaOH needed for neutralisation	15.90 cm^3
relative molecular mass of aspirin	180

(i) Calculate the mass of aspirin, **in mg**, in one tablet. Leave your answer in 3 significant figures. (1 g = 1000 mg)

[3]

(ii) Some tablets that contain aspirin also contain citric acid.
The student does another titration using one of these tablets.
Explain why the mass of aspirin he calculates from his titration results is incorrect.

.....

.....

.....

.....

[2]

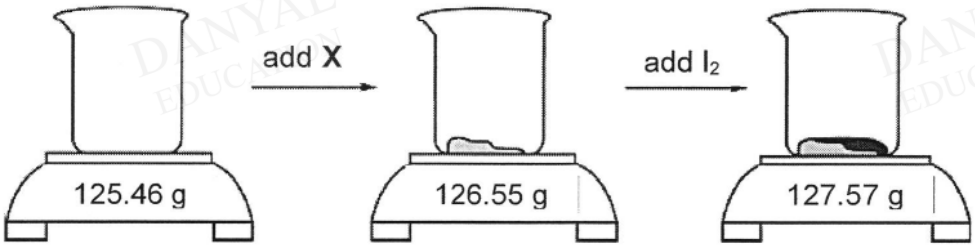
Q4

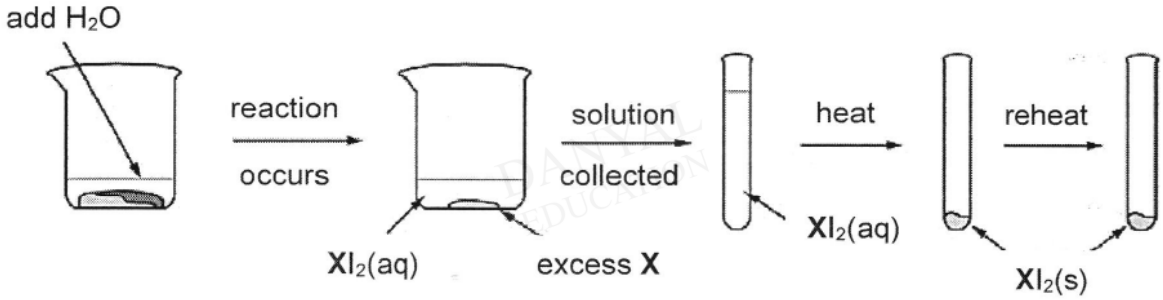
A student conducted an experiment to determine the molar mass of an unknown metal, **X**. The student reacts iodine with an **excess** of the metal to form a water-soluble compound, $\mathbf{X}I_2$.

The equation can be represented below:

$$\mathbf{X} + I_2 \rightarrow \mathbf{X}I_2$$

The reaction proceeds until all of the iodine is used up. The $\mathbf{X}I_2$ solution is collected and heated to remove the water and the product is dried and weighed to a constant mass. The experimental steps are represented and the results are tabulated below.





mass of beaker / g	125.46
mass of beaker + metal **X** / g	126.55
mass of beaker + metal **X** + I_2 / g	127.57
mass of $\mathbf{X}I_2$ (first weighing) / g	1.28
mass of $\mathbf{X}I_2$ (second weighing) / g	1.28

(a) Calculate the number of moles of I_2 used.

[2]

(b) Calculate the molar mass of the unknown metal, **X**. Identify metal **X**.

Metal **X** is ..... [3]

Q5

30 cm^3 of 1 mol/dm^3 dilute hydrochloric acid is added to two different test tubes containing substances **A** and **B**. The results are recorded in the table below.

substance	appearance of substance	gas produced	colour of solution formed
A	green solid	gas formed white precipitate with limewater	pale blue
B	black solid	no gas produced	pale blue

(a) Suggest the name of substance **A** and write down a balanced chemical equation for the reaction between **A** and dilute hydrochloric acid.

.....

.....

[2]

(b) Substance **B** is impure copper(II) oxide. The mass of **B** in the test tube is 3 g. To test for the purity of substance **B**, the following is carried out. It is assumed that the impurities do not react with dilute hydrochloric acid.

(i) The excess hydrochloric acid that did not react with **B** was titrated with 1 mol/dm^3 of dilute sodium hydroxide. The average volume of sodium hydroxide required for the titration was 10.0 cm^3.

Calculate the number of moles of excess hydrochloric acid and hence, calculate the number of moles of hydrochloric acid that has reacted with substance **B**.

[3]

(ii) The reaction between copper(II) oxide and hydrochloric acid is given by the equation below.

$$CuO + 2HCl \rightarrow CuCl_2 + H_2O$$

Calculate the percentage purity of **B** in the test tube.

[2]

[Total: 7 marks]

Answers

The Mole Concept and Stoichiometry Test 1.0

Q1

(a)	CFCs cause depletion of the ozone layer, causing dangerous exposure to UV rays, skin cancer.	[1]
(b)(i)	No, I do not agree. The size of the CFC is related to its M_r, which increases from CH_2ClF (M_r = 68.5) to CCl_2F_2 (M_r = 121) to CCl_3F (M_r = 137.5). [1] However, the boiling points of the CFCs decreases from CH_2ClF (□9°C) to CCl_2F_2 (□30°C), then increases for CCl_3F (23°C). [1] *(boiling points MUST be cited, M_r is not necessary)*	[2]
(b)(ii)		[3]

	C	Cl	F
% mass	11.5	34	54.5
A_r	12	35.5	19
no. of moles	0.9583333	0.9577465	2.868421
mole ratio	1	1	2.995

The molecular formula of Freon-13 is $CClF_3$.

Q2

(b) (i) **11.01%** (exact) or **11.0%** (to 3 s.f.) [1]

(ii) $$\frac{(78.99\times24)+(10.00\times25)+(11.01\times26)}{100} \approx \mathbf{24.3} \text{ (to 3 s.f.)}$$

Award 1m for correct method.
Award 1m for answer correctly left in 3 s.f. [2]

Q3

(i) mole ratio of aspirin : NaOH = 1:1 (from equation)

Mass of aspirin = $\left(\frac{15.80}{1000} \times 0.10\right) \times \frac{1}{1} \times 180 = 0.286$ g = **286 mg**

Award 1m for calculating number of moles of aspirin using 'M = C × V'.

Award 1m for calculating mass of aspirin using 'mass = molar mass × moles'.

Award 1m for giving final answer in mg and 3 s.f. [3]

(ii) Citric acid (in the tablets) will also **react with / be neutralised** by sodium hydroxide during the titration. [1]

Hence **more** sodium hydroxide would be used / the calculated mass of aspirin will be **greater** than actual. [1]

Q4

(a)	Mass of I_2 = 127.57 – 126.55 = **1.02 g**	[1]
	Number of moles of I_2 = 1.02/ 2(127) = **0.00402** (3.s.f) *(no mark given if answer is 0.004)*	[1]
(b)	Number of moles of I_2 = number of moles of X	
	Mass of X = 1.28 – 1.02 = **0.26 g**	[1]
	0.00402 mol of X → 0.26 g 1 mole of X → 0.26/ 0.00402 = **64.7 g** (3.s.f)	[1]
	Therefore, Ar of X is 65. Identity of metal X is **zinc**	[1]

Q5

(a)		Copper(II) carbonate	1
		$CuCO_3 + 2HCl \rightarrow CuCl_2 + H_2O + CO_2$ (allow e.c.f. if candidate gives the wrong substance)	1
(b)	**(i)**	NaOH + HCl → NaCl + H2O	
		Mol of NaOH = 10/1000 x 1 = 0.01 mol Mol of excess HCl = <u>0.01 mol</u>	1
		Mol of HCl added initially = 30/1000 x 1 = 0.03 mol	1
		Mol of HCl that react with $CuCO_3$ = 0.03 – 0.01 = <u>0.02mol</u>	1
	(ii)	Mol of CuO = 0.02/2 = 0.01 mol Mass of CuO = 0.01 x 80 = 0.8 g	1
		% purity = 0.8/3*100 = 26.7%	1