

FINAL
Alternative Assessment

(COVER PAGE)

Session : April 2021

Programme : Foundation in Science (CFSI)

Course : CHM1203: Chemistry 1

Date of Examination : 28 July 2021 (Wednesday)

Time : 9:00am – 11:30am Reading Time : Nil

Duration : 2 hours + 30 minutes (uploading time)

Special Instructions :

This paper consists of **FOUR (4)** questions. Answer **ALL** questions.

All questions carry equal marks.

Materials permitted :

Non-programmable calculator

Materials provided :

Nil

Examiner(s) : Ms. Gurdeep Kaur

Chief Moderator : Ms. Lim Sze Theng

This paper consists of 8 printed pages, including the cover page.

FOUNDATION IN SCIENCE (CFSI)

CHM1203: CHEMISTRY 1
FINAL ALTERNATIVE ASSESSMENT: APRIL 2021 SESSION

Instructions : This paper consists of **FOUR (4)** questions. Answer **ALL** questions. All questions carry equal marks.

Time : 2hrs

Question 1

(a) Identify the following as a physical change, chemical change, physical property or chemical property :

- (i) Distillation of sea water to obtain pure water (1 mark)
 - (ii) Water boils at below 100° C at higher altitudes (1 mark)
 - (iii) Burning of fossil fuels to produce energy for automobiles (1 mark)
 - (iv) Plants use carbon dioxide and water to produce glucose in the presence of sunlight (1 mark)
- (b) (i) The quantity of charge Q , produced in an electrolytic cell is given by the formula $Q=It$ where I is the current(A) and t is time(s). Calculate the Q to correct significant figures if $I = 2.15A$ and $t = 3315s$ (2 marks)
- (ii) A race car driver accelerates his automobile to 200km/hr. Convert this speed to miles per hour using dimensional analysis (1 mile = 1.6km) (1 mark)

(c) State the relative charge and mass of and proton, neutron and electron. In terms of particles explain the relationship between 2 isotopes. Explain why these isotopes have identical chemical properties. (3 marks)

(d) Write the electron configurations of :

- (i) Ca^{2+} (1 mark)
- (ii) Fe (1 mark)

(e) Write the electron configuration of any element with the same chemical properties with the element having electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$. Name the element that you have chosen. (2 marks)

(f) Name an element which is isoelectronic with Na^+ (1 mark)

(g) What is the definition of the Lewis Symbol of an element. Write out the Lewis symbol of any 2 elements in group IV (2 marks)

(h) Complete the table with the formula of ionic compounds containing the following polyatomic ions :

	NO_3^-	SO_4^{2-}	S^{2-}	HCO_3^-
Na^+				
Al^{3+}				

(8 marks)

[Total : 25 marks]**Question 2**

(a) Draw Lewis structures for the following covalent compounds :

- | | | |
|-------|------------------------|----------|
| (i) | SiCl_4 | (1 mark) |
| (ii) | HCN | (1 mark) |
| (iii) | CH_3OH | (1 mark) |

(b) Lithium Hydride, LiH , is an ionic compound containing the hydride ion, H^- .

The reaction between LiH and aluminium chloride, AlCl_3 , produces the ionic compound LiAlH_4

- | | | |
|-------|---|-----------|
| (i) | Balance the equation below for the reaction between LiH and AlCl_3 | |
| | $\text{LiH} + \text{AlCl}_3 \rightarrow \text{LiAlH}_4 + \text{LiCl}$ | (1 mark) |
| (ii) | Predict the shape of the AlH_4^- ion | (1 mark) |
| (iii) | Draw a diagram to show the shape of the AlH_4^- ion | (1 mark) |
| (iv) | Using the VSEPR theory explain why it has this shape | (2 marks) |
| (v) | A bond in the AlH_4^- can be represented by $\text{H} \rightarrow \text{Al}$ | |
| | Name this type of bond | (1 mark) |
| | Explain how it is formed | (2 marks) |

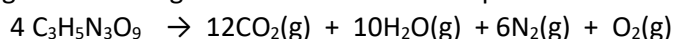
(c) Ammonia is very soluble in water due to its polarity. Draw a diagram to show how one molecule of ammonia is attracted to one molecule of water. Include all partial charges and all lone pairs of electrons in the diagram. (3 marks)

(d) Complete the table to name the following ionic compounds

Formula	Name
MgCO ₃	
NaHCO ₃	
(NH ₄) ₂ SO ₄	
Ca ₃ (PO ₄) ₂	

(4 marks)

(e) Nitroglycerine, C₃H₅N₃O₉, is an explosive which, on detonation, decomposes rapidly to form a large number of gaseous molecules. The equation for this decomposition is given below :



A sample of nitroglycerine was detonated and produced 0.350g of oxygen gas

- (i) State what is meant by the term one mole of molecules (2 mark)
- (ii) Calculate the number of moles of oxygen gas produced in this reaction, and hence calculate the total number of moles of gases formed (3 marks)
- (iii) Calculate the number of moles and the mass of nitroglycerine detonated (2marks)

[TOTAL : 25 marks]

Question 3

(a) A student reacted 1.44g titanium with chlorine to form 5.70g of a chloride X

- (i) How many mols of titanium were reacted (1mark)
- (ii) How many mols of chlorine were reacted (2 mark)
- (iii) Determine the empirical formula of X (1 mark)
- (iv) Construct a balanced equation for the reaction between titanium and chlorine (1 mark)

(b) In the sixteenth century, a large deposit of graphite was discovered in the Lake District.

People at the time thought that the graphite was a form of lead. Nowadays, graphite is used in pencils but it is still referred to as 'pencil lead'.

A student decided to investigate the number of carbon atoms in a 'pencil lead'. He found that the mass of the 'pencil lead' was 0.321g

- (i) Calculate the amount, in mol, of carbon atoms in the student's pencil lead
Assume that the 'pencil lead' is pure graphite. (1 mark)
- (ii) Using the Avogadro constant, N_A, calculate the number of carbon atoms in the student's 'pencil lead'. (1 mark)

(c) When a sample of liquid, X, of mass 0.406 g was vaporised, the vapour was found to occupy a volume of $2.34 \times 10^{-4} \text{ m}^3$ at a pressure of 110 kPa and a temperature of 473 K.

- (i) Give the name of the equation $PV = nRT$ (1 mark)
- (ii) Use the equation $pV = nRT$ to calculate the number of moles of X in the sample and hence deduce the relative molecular mass of X. (The gas constant $R = 8.31 \text{ JK}^{-1}\text{mol}^{-1}$) (1 mark)

(d) An airtight container with a volume of $4.25 \times 10^4 \text{ L}$, an internal pressure of 1.00 atm, and an internal temperature of 15°C is washed off the deck of a ship and sinks to a depth where the pressure is 175 atm and the temperature is 3°C . What will the volume of the gas inside be when the container breaks under the pressure at this depth? (2 marks)

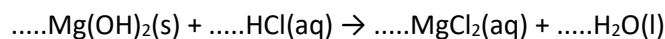
(e) Although they have the same relative molecular mass, the boiling temperatures of hexane (69°C) and 2,2-dimethylbutane (49°C) are significantly different. Explain this difference in boiling point using intermolecular forces (1 mark)

(f) The boiling temperatures of fluorine and two of its compounds are given below

Substance	F_2	CH_3F	HF
T_b/K	85	195	293

- (i) Explain why the boiling temperature of CH_3F is greater than that of F_2 , referring to the intermolecular forces present (1 mark)
- (ii) Explain why the boiling temperature of HF is the highest in the series (2 marks)
- (iii) In a HF molecule there is unequal sharing of electrons in the covalent bond. Name this type molecule. (1 mark)
- (g) A solution is a homogeneous mixture of a solvent and a solute. Give 3 general properties of a solution (3 marks)
- (h) A student had a stomach-ache and needed to take something to neutralize excess stomach acid. He decided to take some Milk of Magnesia, which is an aqueous suspension of magnesium hydroxide, $\text{Mg}(\text{OH})_2$

- (i) The main acid in the stomach is hydrochloric acid, $\text{HCl}(\text{aq})$, and the unbalanced equation for the reaction that takes place with Milk of Magnesia is shown below.



Balance the equation by adding numbers where necessary in the unbalanced equation above (1 mark)

- (ii) The student's stomach contained 500 cm³ of stomach fluid with an acid concentration of 0.108 mol dm⁻³. The student swallowed some Milk of Magnesia containing 2.42 g Mg(OH)₂. He wondered whether this dose was sufficient to neutralise the stomach acid
Assume that all the acid in the stomach fluid was 0.108 mol dm⁻³ hydrochloric acid
Answer the following questions :

How many moles of HCl were in the 500 cm³ of stomach fluid? (1 mark)

Calculate the mass of Mg(OH)₂ necessary to neutralize this stomach fluid (3 mark)

Determine whether the student swallowed too much, too little, or just the right amount of Milk of Magnesia to neutralize the stomach acid (1 mark)

[TOTAL : 25 marks]

Question 4

- (a) The study of equilibrium constants enables chemists to calculate the composition of equilibrium mixtures.

The expression for an equilibrium constant, K_c , for a homogeneous equilibrium is given below

$$K_c = \frac{[C]^2[D]}{[E][F]^3}$$

- (i) Write an equation for the forward reaction (1 mark)
- (ii) Deduce the units for K_c (1 mark)
- (iii) State what can be deduced from the fact that the value of K_c is larger when the equilibrium is established at a lower temperature (1mark)
- (b) The reaction between hydrogen and iodine can be represented by the following equation



- (i) Write a K_c expression for the decomposition of hydrogen iodide. At a given temperature, the value of K_c for this reaction is 20.
What will be the value of K_c for the reaction between hydrogen and iodine at this temperature? (2 mark)

- (ii) The pressure of an equilibrium mixture of hydrogen iodide, hydrogen and iodine was increased. State what, if anything, would happen to:

the rates of both forward and reverse reactions (2 marks)

the position of equilibrium (1 mark)

the value of the equilibrium constant (1 mark)

- (c) Chlorine has variable oxidation states in different compounds. Complete the table below for the correct oxidation state of Chlorine in the following compounds

	HCL	KClO ₃	HClO
Oxidation state of Cl			

(3 marks)

- (d) A teacher noticed that a student had not cleared a large air bubble from below the burette tap in preparing the burette for use before starting the titration. This air bubble was ejected during the first titration of the volumetric flask mixture.

- (i) State the effect that this mistake would have on the value of the first titre (1 mark)

- (ii) State and explain the effect, if any, that this mistake would have on the average titre for this experiment (2 marks)

- (e) The dihydrogenphosphate-hydrogenphosphate ion system is an important buffer in the human body.



- (i) Identify the 2 conjugate pairs in this system (2 marks)

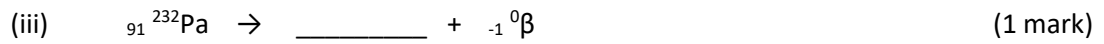
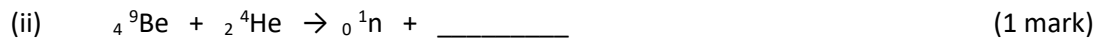
- (ii) A formula that can be used for the calculation of the pH of this buffer solution is

$$\text{pH} = \text{p}K_a + \log \left(\frac{[\text{HPO}_4^{2-}]}{[\text{H}_2\text{PO}_4^-]} \right)$$

$$\text{p}K_a = 7.20 \quad [\text{HPO}_4^{2-}] = 3.98 \times 10^{-8} \text{ mol dm}^{-3} \quad [\text{H}_2\text{PO}_4^-] = 3.89 \times 10^{-7} \text{ mol dm}^{-3}$$

Calculate the pH of this buffer system. (1 mark)

- (f) Elements with unstable nuclei will undergo radioactive decay to produce a more stable nuclei . Complete the nuclear equations for the following nuclear disintegrations :
(Use of Periodic table may be needed)



- (g) Define the half-life of a radioisotope. (1 mark)

The half-life of thorium-227 is 18.72 days. After 74.88 days how many grams remain if the initial mass is 88 grams (1 mark)

- (h) Radioisotopes are used in medicine for either diagnosis or treatment. Explain briefly why radioisotopes used for diagnosis should not emit alpha or beta radiation.

(2 marks)

[TOTAL : 25 marks]

--THE END--