



SCHOOL OF SCIENCE AND TECHNOLOGY

Semester 1, 2026

FINAL EXAMINATION PAPER

CHEF11: FOUNDATION CHEMISTRY I

Important Instructions to Students:

1. There are nine (9) pages in this paper. Read the questions, instructions carefully and answer the questions.
2. You are allowed an **extra 10 minutes reading time** (during this time, you are not allowed to write with pen) and **180 minutes (3 Hours) to complete this paper**.
3. Silent, non-programmable calculators are allowed but not supplied.
4. Write all your answers in the answer booklet provided. If you need extra sheets, please ask from the supervisor. Write your name, course code and student identification number in the answer booklet and in the attendance sheet.
5. This paper contains three (3) sections A, B, and C. All questions are compulsory to answer.
6. Write all your answers legibly. Ensure that all question numbers are properly written before the answer. The marker has the right to award zero for answers that are not legible.
7. This is a **Closed Book Examination**. The University views plagiarism, cheating and dishonest practice as serious offences and if found, offenders are penalized.

Examination Paper Content (Format):

<u>Section</u>	<u>Question</u>	<u>Content</u>	<u>Marks</u>	<u>Suggested Time</u>
A	1-30	Multiple Choice	30	54 minutes
B	1-5	Short Answer Questions	50	90 minutes
C	1	Long Answer Questions	20	36 minutes
		TOTAL	100	180 Minutes

There are 30 multiple choice questions. **All are compulsory.** Write the letter of the correct answer in your answer booklet.

1. Convert 0.00045 into scientific notation:
 - A. 4.5×10^{-3}
 - B. 4.5×10^{-4}
 - C. 45×10^{-5}
 - D. 0.45×10^{-3}
2. How many significant figures are in 0.00560?
 - A. 2
 - B. 3
 - C. 4
 - D. 5
3. Which of the following is correctly balanced?
 - A. $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O}$
 - B. $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
 - C. $\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
 - D. $2\text{H}_2 + 2\text{O}_2 \rightarrow 2\text{H}_2\text{O}$
4. Which of the given compounds is ionic?
 - A. CO_2
 - B. H_2O
 - C. NaCl
 - D. CH_4
5. What is the electron configuration of sodium ($Z = 11$)?
 - A. 2,8,1
 - B. 2,7,2
 - C. 2,8,2
 - D. 2,6,3
6. Which of the following is an example of qualitative measurement?
 - A. Mr. Smith is 6 feet tall.
 - B. The room is 70 degrees Fahrenheit.
 - C. Mr. Smith is tall.
 - D. 12,300,000 is scientifically notated as 1.23×10^7 .
7. Which statement best illustrates the concept of a limiting reactant in a chemical reaction?
 - A. A reaction proceeds until the limiting reactant is completely consumed.
 - B. All reactants are used up at the end of the reaction.
 - C. Reactants are present in equal amounts to ensure completeness.
 - D. The product yield is always equal to the theoretical yield.

8. What distinguishes isotopes of the same element?
- Number of electrons.
 - Chemical symbol represented on the Periodic Table.
 - Number of protons.
 - Number of neutrons.
9. Based on the naming conventions for covalent molecules, which of the following is the correct name for the compound N_2O_4 ?
- Dinitrogen tetroxide.
 - Dinitrogen dioxide.
 - Dinitrogen oxide.
 - Dinitrogen quadroxide.
10. What is the primary purpose of understanding electron configurations in atoms?
- To determine the atomic mass of an element.
 - To predict chemical and bonding behaviours.
 - To calculate the electron's speed.
 - To identify the type of chemical reactions.
11. Considering the atomic orbitals represented by quantum numbers, which of the following options best describes the number of orbitals in a subshell given $l = 2$?
- 5 orbitals.
 - 3 orbitals.
 - 7 orbitals.
 - 2 orbitals.
12. How would you correctly write the noble gas configuration for sodium (Na)?
- $[\text{Ne}] 3s^2$
 - $[\text{Ne}] 3s^1$
 - $[\text{He}] 3s^1$
 - $[\text{Ar}] 3s^1$
13. Which rule explains why electrons occupy the lowest available energy orbital in ion electron configurations?
- Aufbau Principle.
 - Pauli Exclusion Principle.
 - Hund's Rule.
 - Bohr's Theory.
14. Which of the following best explains why diffusion occurs most rapidly in gases compared to liquids and solids?
- Gases have less mass than liquids and solids.
 - Particles in gases move more freely and are farther apart compared to those in liquids and solids.
 - Gases are always positioned higher than liquids and solids in a container.
 - Diffusion in gases involves only neutral molecules, unlike liquids and solids.

15. Which description accurately explains the formation of an ionic bond?
- Metal atoms share electrons with non-metal atoms to form a stable arrangement.
 - Metal atoms donate electrons to non-metal atoms, leading to the formation of oppositely charged ions.
 - Non-metal atoms donate electrons to metal atoms to create neutrality.
 - Electrons are equally distributed among atoms, resulting in no net charge.
16. In the formation of a hydrogen molecule (H_2), what is the role of electrons shared between the hydrogen atoms?
- They create an ionic bond.
 - They stabilize the molecule by achieving a noble gas electron configuration.
 - They separate the hydrogen nuclei.
 - They repel each other, splitting the molecule.
17. Why do ionic compounds conduct electricity in their molten or aqueous states but not in solid state?
- Due to the presence of free moving ions in molten or aqueous states.
 - Due to higher heat energy in molten or aqueous states.
 - Because the ions are covalently bonded in these states.
 - Due to reduced electrostatic forces in these states.
18. How many moles are present in 44 g of carbon dioxide (CO_2)?
- 0.5 mol
 - 1 mol
 - 2 mol
 - 4 mol
19. What does the limiting reagent determine in a chemical reaction?
- The speed of the reaction.
 - The amount of product formed.
 - The colour of the product.
 - The energy change.
20. What are valence electrons?
- Electrons in the inner shell.
 - Electrons in the outermost shell.
 - Protons in the nucleus.
 - Neutrons in the nucleus.
21. What does the azimuthal/secondary quantum number (l) describe?
- Energy level.
 - Shape of orbital.
 - Spin.
 - Charge.

22. Which type of orbital has a spherical shape?
- A. p orbital.
 - B. d orbital.
 - C. s orbital.
 - D. f orbital.
23. When a chemical equation is balanced, what is equal on both sides?
- A. Mass only.
 - B. Number of atoms of each element.
 - C. Number of molecules.
 - D. Volume.
24. What information is shown in a Lewis structure?
- A. Number of neutrons.
 - B. Bonding and lone pair electrons.
 - C. Atomic mass.
 - D. Energy levels.
25. How many valence electrons does an oxygen atom have?
- A. 4
 - B. 5
 - C. 6
 - D. 7
26. What type of bond exists in a hydrogen molecule (H_2)?
- A. Ionic bond.
 - B. Covalent bond.
 - C. Metallic bond.
 - D. Polar ionic bond.
27. Which is a typical property of non-metals?
- A. Malleable.
 - B. Ductile.
 - C. Poor conductor.
 - D. Shiny.
28. Transition metals are known for:
- A. Low melting points.
 - B. Forming coloured compounds.
 - C. Being non-reactive.
 - D. Having no valence electrons.
29. What is the bond angle in a tetrahedral molecule?
- A. 90°
 - B. 104.5°
 - C. 109.5°
 - D. 120°

30. Which element has the highest electronegativity?

- A. Sodium.
- B. Carbon.
- C. Oxygen.
- D. Fluorine.

SECTION B

SHORT ANSWER QUESTIONS

50 MARKS

Answer **ALL FIVE QUESTIONS** in this section. Ensure that all necessary mechanisms, diagrams, reactions and calculations are neatly shown in your answer booklet wherever required. Each question is worth 10 marks.

Question 1

(10 marks)

- a. Calculate the number of moles in 36 g of H_2O . ($M_r \text{H}_2\text{O} = 18 \text{ g/mol}$) (2 marks)
- b. Find the empirical formula of a compound containing:
40% Carbon ($\text{C} = 12$)
6.7% Hydrogen ($\text{H} = 1$)
53.3% Oxygen ($\text{O} = 16$) (3 marks)
- c. Define the following: (2 marks)
 - i) Atomic number
 - ii) Isotope
- d. Balance the following equation: $\text{Fe} + \text{O}_2 \rightarrow \text{Fe}_2\text{O}_3$ (2 marks)
- e. Name the compound: MgO (1 mark)

Question 2

(10 marks)

An element has atomic number 17 and mass number 35.

- a. Name the element and determine its number of protons, neutrons, and electrons. (2 marks)
- b. Write its electron configuration using shell notation. (1 mark)
- c. Draw the orbital diagram for this element and clearly show electron spins. (3 marks)
- d. Write a valid set of four quantum numbers for this element. (2 marks)
- e. Explain why two electrons in the same orbital must have opposite spins. (2 marks)

Question 3**(10 marks)**

- a. Balance the following equation:

(3 marks)

- b. Using your balanced equation, determine the limiting reagent when:

3 mol C_2H_6 reacts with 8 mol O_2

(4 marks)

- c. Calculate the number of moles of CO_2 formed.

(2 marks)

- d. Explain how you identified the limiting reagent.

(1 mark)**Question 4****(10 marks)**

- a. Arrange the following in order of increasing atomic radius:

Na, Mg, Al, Si

(2 marks)

- b. Explain your order (in a. above) using effective nuclear charge.

(2 marks)

- c. Predict which element has the highest electronegativity and justify.

(1 mark)

- d. Draw the Lewis structure of SO_2 .

(2 marks)

- e. Predict its molecular shape using VSEPR theory.

(1 mark)

- f. Explain why the molecule is not linear.

(2 marks)**Question 5****(10 marks)**

- a. Explain why transition metals often form coloured compounds.

(2 marks)

- b. State two differences between transition metals and Group 1 metals.

(2 marks)

- c. Give one example of a transition metal and its common use.

(1 mark)

- d. A student compares CO_2 and H_2O .

i) Draw both Lewis structures.

(2 marks)

ii) Explain why CO_2 is non-polar while H_2O is polar.

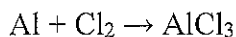
(1 mark)

iii) Predict which has a higher boiling point and justify your answer.

(2 marks)

Answer **ALL QUESTIONS** in this section. Ensure that all mechanisms, diagrams, reactions and calculations are neatly shown in your answer booklet.

- a. The following reaction occurs:



Balance the equation

(2 marks)

- b. If 5.4 g of Al reacts with excess Cl_2 :

i) Calculate moles of Al

(1 mark)

ii) Determine moles of AlCl_3 produced

(2 marks)

iii) Calculate mass of AlCl_3 formed ($M_r = 133.5 \text{ g/mol}$)

(2 marks)

- c. If the actual yield of AlCl_3 is 10.0 g, calculate the percentage yield.

(2 marks)

- d. Suggest two reasons why the actual yield is lower than expected.

(1 mark)

- e. Draw the orbital diagram of oxygen ($Z = 8$).

(2 marks)

- f. Using valence bond theory, explain how the O_2 molecule forms.

(2 marks)

- g. Identify the type of intermolecular forces present in:

i) H_2O

(1 mark)

ii) CO_2

(1 mark)

- h. Explain why H_2O has a much higher boiling point than CO_2 .

(2 marks)

- i. Compare metals and transition metals in terms of:

i) Conductivity

(1 mark)

ii) Variable oxidation states

(1 mark)

THE END

Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H 1.01																	2 He 4.00
3 Li 6.94	4 Be 9.01															9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31															17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 51.99	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.63	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc 98.91	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.6	53 I 126.90	54 Xe 131.29
55 Cs 132.91	56 Ba 137.33	57-71	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po [208.98]	85 At 209.99	86 Rn 222.02
87 Fr 223.02	88 Ra 226.03	89-103	104 Rf [261]	105 Db [262]	106 Sg [266]	107 Bh [264]	108 Hs [269]	109 Mt [278]	110 Ds [281]	111 Rg [280]	112 Cn [285]	113 Nh [286]	114 Fl [289]	115 Mc [289]	116 Lv [293]	117 Ts [294]	118 Og [294]
57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm 144.91	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.06	71 Lu 174.97			
89 Ac 227.03	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np 237.05	94 Pu 244.06	95 Am 243.06	96 Cm 247.07	97 Bk 247.07	98 Cf 251.08	99 Es [254]	100 Fm 257.10	101 Md 258.1	102 No 259.10	103 Lr [262]			