

INTERIM JOINT MATRICULATION BOARD
AHMADU BELLO UNIVERSITY
ZARIA



INTERIM JOINT MATRICULATION BOARD EXAMINATION 2016

SUBJECT: CHEMISTRY PAPER I
DATE SCHEDULED: THURSDAY 25TH FEBRUARY, 2016
TIME ALLOWED: THREE HOURS (3 HRS)

INSTRUCTIONS:

- Answer **ALL** questions in Section A and any **FOUR (4)** questions from Section B.
- Each question in Section A carries 5 marks while each question in Section B carries 25 marks.
- The use of scientific programmable calculator is **PROHIBITED**.

iv. Table of constants:

Gas constant, $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$

Molar volume of gas at STP, $V_m = 22.4 \text{ dm}^3$

Avogadro's constant, $N_A = 6.023 \times 10^{23} \text{ mol}^{-1}$

Faraday constant, $F = 96500 \text{ C mol}^{-1}$

1 atomic mass unit (a.m.u) = 931.5 MeV = $1.602 \times 10^{-13} \text{ J}$

Rydberg constant, $R_H = 109678 \text{ cm}^{-1}$

1 atmospheric pressure = 760 mm Hg = $1.013 \times 10^5 \text{ Nm}^{-2}$

Atomic masses of the following elements are: H = 1, N = 14, O = 16,

Cu = 63.5, Fe = 56, C = 12.

Atomic numbers of the following elements are: N = 7, Ca = 20, Mn = 25.

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SECTION A

1. Calculate the number of moles of copper formed when 20.50 g of Copper(II) oxide completely reacts with hydrogen gas.
2. a) Define molecular ion.
b) How many atoms are there in (i) three moles of cobalt;
(ii) 90g of water molecule; (iii) 10g of carbon?
3. State the type of force between the structural units of each of the following:
a) diamond (b) neon (c) caesium chloride (d) iron (e) carbon(IV)oxide
4. When calcium reacted with a gas A, a compound B is formed. The compound B reacts with water to form a gas C which turns red litmus paper blue. (a) Identify A and B (b) Write the equation for the reaction of: (i) calcium with A; (ii) B with water.
5. a) Suggest one reasons why B^{3+} ions are rare but Al^{3+} ions are common in compounds formation.
b) Give the names and chemical formulae of two important ores of aluminum.
6. In a Victor Meyer experiment, 0.52g of an organic liquid of molar mass 120g mol^{-1} was vaporized at temperature of 298K and pressure of $1.013 \times 10^5 \text{Nm}^{-2}$. Calculate the volume (cm^3) of the air displaced (Given that saturated vapor pressure of water at 298K = $2.32 \times 10^3 \text{Nm}^{-2}$).
7. Predict the sign of Δs° for each of the following reactions:
a) $\text{CaCO}_3(\text{s}) \longrightarrow \text{CaCO}(\text{s}) + \text{CO}_2(\text{g})$
b) $\text{CS}_2(\text{l}) \longrightarrow \text{CS}_2(\text{g})$
c) $2\text{Hg}(\text{l}) + \text{O}_2(\text{g}) \longrightarrow 2\text{HgO}(\text{s})$
d) $2\text{Na}_2\text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \longrightarrow 4\text{NaOH}(\text{aq}) + \text{O}_2(\text{g})$
e) $\text{CO}(\text{g}) + \text{H}_2\text{O}(\text{g}) \longrightarrow \text{CO}_2(\text{g}) + \text{H}_2(\text{g})$
8. Given that a certain gas is sealed up in a container, a) what happens to the average speed of the gas particles as the temperature decreases? b) Why does the pressure of a fixed volume of the gas decrease with decrease in temperature? c) What happens to the pressure of an ideal gas, if at the same temperature, its volume is doubled?
9. Consider the following elements in the second period of the periodic table: Li, Be, B, C, N, O, F and Ne.
a) Which of these elements has the highest melting point?
b) Which is the most electronegative? c) Which of these elements can form cation?

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- d) Which of these exist as mono-atomic molecule at room temperature?
10. Calculate the oxidation number of:
- a) chlorine in ClO_3^- b) chlorine in ClO^- c) chlorine in ClO_4^-
d) hydrogen in KH e) chromium in CrO_4^{2-} .

SECTION B

Answer any **FOUR (4)** questions in this section.

11. a) Explain the following observations:
- i) Nitrogen is inert at low temperature but reactive at high temperature.
- ii) The following compounds crystallized from water with the indicated number of water molecules: $\text{MgI}_2 \cdot 8\text{H}_2\text{O}$; $\text{NaI} \cdot 2\text{H}_2\text{O}$ and CsI
- iii) Lead(II) oxide is more stable than lead(IV) oxide.
- iv) Heavier members of group 16 have +4 and +6 oxidation states but oxygen (first member of the group) has -2 as the highest oxidation state).
- v) The electron affinities of group 17 members decrease down the group but fluorine does not conform to the trend.
- b) What are isoelectronic ions? Give three examples of such ions.
12. a) Define phase diagram.
b) Sketch phase diagram of each of the following:
(i) water (ii) carbon(IV) oxide.
c) Outline the essential features of diagram b(i).
d) Explain the differences between the diagrams b(i) and b(ii) above.
e) Calculate the pH of 8×10^{-3} mole dm^{-3} sodium hydroxide assuming the compound ionizes completely in water.
13. a) Differentiate between electrochemical and electrolytic cells. b) A solution of Copper(II) tetraoxosulphate(VI) was electrolyzed using inert electrodes.
- (i) Write balanced ionic equations for the reactions at the electrodes.
(ii) Give the overall equation of the reaction. (iii) Calculate the volume of gas (if any) evolved at standard temperature and pressure, when a current of 2 amperes passed through the electrolyte for 2.5 hours.

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- c) (i) What is metallic corrosion?
(ii) List 4 agents that can bring about the reaction in c (i)
(iii) Explain with relevant equation(s) the chemical processes involved in the rusting of iron.
- 14.a) What are ligands?
b) Give two IUPAC names each of (i) negatively charged ligands;
(ii) positively charged complex ions; (iii) negatively charged complex ions and (iv) polydentate ligands.
c) Outline five special features of fluorine among group 17 of the periodic table.
d) List five uses each of the following group members of the periodic table (i) group 15: (ii) group 17.
15. a) State three postulates and two limitations of Bohr's theory of atom.
b) Calculate the wavelength of the radiation corresponding to the spectra line of the lowest line in Lyman series in hydrogen atom.
c) Explain the significance of n , l , m and s quantum numbers in the orbital arrangement of electrons in atoms.
d) Arrange the following equimolar solutions in order of decreasing pH: NH_4Cl , KOH , HCl , KCl , HCOOH , and HCOOK . Give reasons for your order of arrangement.
16. a) State the major contribution of each of the following scientists to the development of Modern Chemistry (i) J.J Thompson
(ii) Mendeleev (iii) de Broglie (iv) Faraday (v) Millikan
b) Using defined rules or principles, illustrate how electrons are arranged in manganese.
c) The conversion of iron(II) to iron(III) can be carried out using acidified potassium tetraoxomanganate(VII).
(i) Write a balanced ionic equation to show how the reaction can be achieved.
(ii) What is the oxidation number of manganese in MnO_4^- ?
(iii) What species is reduced and which is oxidized?
(iv) What is the role of acid in this reaction?
d) Define the term "pollutant".
e) Differentiate between biodegradable and non-biodegradable pollutants.
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