



ZIMBABWE

**MINISTRY OF HIGHER AND TERTIARY EDUCATION,
INNOVATION, SCIENCE AND TECHNOLOGY
DEVELOPMENT**

**HIGHER EDUCATION EXAMINATIONS COUNCIL
(HEXCO)**

NATIONAL DIPLOMA

IN

APPLIED CHEMICAL TECHNOLOGY

SUBJECT: Inorganic Chemistry

PAPER NO: 501/15/S06

DURATION: 3 Hours

JUNE 2026 EXAMINATION

REQUIREMENTS

1. Non- programmable scientific calculator.
2. Chemistry data booklet.

INSTRUCTIONS TO CANDIDATE

Answer any five (5) questions.

QUESTION 1

- (a) Explain what is meant by the following terms:-
- (i) ligand (2 marks)
 - (ii) transition element (2 marks)
 - (ii) hybridisation (2 marks)
- (b) Explain using Cu^{2+} ion, the origin of colour in transition element ions or solutions. (4 marks)
- (c) Describe the extraction of gold (Au) by the Cyanide Process. (5 marks)
- (d) Sketch a graph of the trends of 1st ionisation energies of group 1 elements. (5 marks)

QUESTION 2

- (a) Technetium-99 is prepared from ^{98}Mo . Molybdenum-98 combines with a neutron to give Molybdenum-99 an unstable isotope that emits a β - particle to yield an excited form of Technetium-99, represented as $^{99}\text{Tc}^*$ by emitting a γ - ray. The ground state of ^{99}Tc then emits a β - particle.

Write equations for those nuclear reactions. (4 marks)

- (b) The mass of ^7_3Li nucleus is 7.016005 amu. Given that the mass of a proton (^1H) is 1.007276 amu and that of a neutron is 1.008665 amu, calculate the

- (i) Mass defect in kg (3 marks)
- (ii) Binding energy per nucleon in Joules. (2 marks)
- (iii) Binding energy per mole

$$c = 2.988 \times 10^8 \text{ ms}^{-1}$$

$$1 \text{ kg} = 6.022 \times 10^{26} \text{ amu}$$

$$1 \text{ J} = 1 \text{ kg} \cdot \text{m}^2 \text{ s}^{-2}$$

$$\text{Avogadro's Number} = 6.022 \times 10^{23} \text{ nuclei mol}^{-1}$$

- (c) An unstable nucleus will decompose spontaneously or decay into a more stable configuration but will do so only in a few specific ways by emitting certain particles or certain forms of electromagnetic energy. In such nuclear changes, three types of emissions are initially recognised by Rutherford

- (i) Name the three types of emissions. (3 marks)
- (ii) Arrange the three radioactive radiations in order of their penetrating strength starting with the most penetrating. (2 marks)

QUESTION 3

- (a) Sulphatopentaamine cobalt (III) bromide, $[Co(NH_3)_5SO_4]^+ Br^-$ and Bromopentaaminecobalt (III) sulphate (VI), $[Co(NH_3)_5Br]^{2+} SO_4^{2-}$ are isomers.
- (i) Explain why $[Co(NH_3)_5SO_4]^+ Br^-$ will give yellow precipitate with silver nitrate (V) solution but $[Co(NH_3)_5Br]^{2+} SO_4^{2-}$ will not. (3 marks)
- (ii) State the type of isomerism exhibited by the two transition metal complexes. (2 marks)
- (b) When aqueous solution containing $[Cr(H_2O)_6]^{3+}$ ions is warmed in the presence of Cl^- ions, $[Cr(H_2O)_5Cl]^{2+}$ changes.
- (i) name this type of reaction. (2 marks)
- (ii) explain why the colours of the complex ions are different. (3 marks)
- (c) Successive ionisation energies (IE) for the elements magnesium to Barium are shown in the table below.

Element	IE ₁ (KJmol ⁻¹)	IE ₂ (KJmol ⁻¹)	IE ₃ (KJmol ⁻¹)
Mg	736	1450	7740
Ca	590	1150	4940
Sr	548	1060	4120
Ba	502	966	3390

- (i) write the full electron configuration for Sr. (2 marks)
- (ii) Explain why the first ionisation energies (IE₁) decrease down the group. (4 marks)
- (iii) Explain why there is a large increase between second (I E₂) and third (IE₃) ionisation energies. (4 marks)

QUESTION 4

- (a) Derive the de Broglie equation using the Plank's and Einstein equations. (10 marks)
- (b) Draw diagrams to show distribution of electrons in d^6 high spin and low spin. (10 marks)

QUESTION 5

- (a) Draw a sketch diagram of Paschen, Balmer and Lyman series. (10 marks)
- (b) Explain what is meant by the following terms:-
- (i) Homogeneous catalysis (2 marks)
 - (ii) Electronegativity (2 marks)
 - (iii) allotropes (2 marks)
 - (iv) relative atomic mass (2 marks)
 - (v) isotopes (2 marks)

QUESTION 6

- (a) State:-
- (i) Hund's rule (2 marks)
 - (ii) Pauli's exclusion principle (2 marks)
- (b) Describe the four quantum numbers and give the significance of each of them. (8 marks)
- (c) Determine the energy that will be required to make an electron move from the ground state ($n=1$) of the hydrogen atom to the level with $n=5$.
($h = 6.626 \times 10^{-34} Js$ and $R = 1.098 \times 10^7 m^{-1}$) (4 marks)
($C = 299\,792\,458 m/s$)
- (d) Explain the trend in atomic radius down group 2 elements. (4 marks)

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