

NAMES:.....



DIOCESE OF KABGAYI

COLLEGE SAINTE MARIE REINE KABGAYI

TERM I, 2025-2026

...../ 100 MARKS

DURATION: 3 H

CLASS: ..... N<sup>0</sup> : .....

## CHEMISTRY EXAMINATION

### Instructions

- ⊕ This Paper consists of two sections: A and B

**Section A: Attempt all Questions (60marks)**

**Section B: Attempt all Questions (10marks)**

**Section C: Attempt only three Questions (30marks)**

- ⊕ Non Programmable calculators are allowed.

- ⊕ Periodic tables are not allowed.

### **SECTION A: MULTIPLE CHOICE QUESTIONS / 60 MARKS**

1. The isotope that will be deflected MOST in a mass spectrometer has:

- A. High mass and high charge      B. Low mass and high charge  
C. High mass and low charge      D. Low velocity and high mass

2. Which part of a mass spectrometer accelerates ions?

- A. Ion source      B. Electron gun      C. Magnetic field      D. Electric field

3. Ionization energy increases across a period because:

- A. Nuclear charge decreases      B. Electron shielding increases  
C. Atomic radius decreases      D. Valence electrons increase

4. Electrons fill orbitals singly before pairing due to:

- A. Pauli's principle      B. Hund's rule      C. Aufbau principle      D. Coulomb attraction

5. The lattice energy increases when:

- A. Ions are large      B. Charge on ions is small  
C. Charge on ions increases      D. Distance between ions increases

6. An ionic crystal is brittle because:

- A. Layers slide easily      B. Identical charges repel on displacement  
C. Weak IMF      D. Covalent crosslinks break

7. A coordinate bond forms when:

- A. Each atom contributes an electron      B. One atom donates both electrons  
C. Electrons are transferred      D. Nucleus donates a proton

8. The bond angle in  $\text{NH}_3$  is approximately:

- A.  $180^\circ$       B.  $120^\circ$       C.  $109.5^\circ$       D.  $107^\circ$

9. Which molecule is linear?

- A.  $\text{CO}_2$       B.  $\text{H}_2\text{O}$       C.  $\text{NH}_3$       D.  $\text{SO}_2$

10. A polar molecule is formed when:

- A. Symmetrical shape    B. No lone pairs    C. Bond dipoles cancel    D. Bond dipoles do not cancel

11. Across a period, atomic radius decreases because:

- A. More shielding    B. Greater nuclear charge    C. More energy shells    D. Fewer electrons

12. Metallic character increases:

- A. Across a period    B. Up a group    C. Down a group    D. From center outward

13. Markovnikov's rule applies to the addition of:

- A.  $\text{H}_2$  to alkenes    B.  $\text{HX}$  to alkenes    C.  $\text{Br}_2$  to alkenes    D. Steam to alkanes

14. The bond angle around the carbon in ethyne is approximately:

- A.  $120^\circ$     B.  $109.5^\circ$     C.  $180^\circ$     D.  $100^\circ$

15. Which halogenoalkane reacts fastest in  $\text{S}_{\text{N}}1$  mechanisms?

- A. Primary    B. Secondary    C. Tertiary    D. Methyl chloride

16. The test for halogenoalkanes uses:

- A.  $\text{AgNO}_3$  in ethanol    B. Fehling's solution    C. Tollens reagent    D. Bromine water

17.  $\text{S}_{\text{N}}2$  mechanism proceeds via:

- A. Carbocation    B. One-step backside attack    C. Free radical    D. Carbene intermediate

18. Tertiary alcohols on oxidation give:

- A. Ketone    B. Aldehyde    C. Carboxylic acid    D. No reaction

19. The Lucas test distinguishes alcohols based on:

- A. Combustion    B. Solubility in water    C. Rate of substitution    D. Colour change

20. Phenol differs from alcohols because it:

- A. Is saturated    B. Reacts with  $\text{NaOH}$     C. Cannot form hydrogen bonds    D. Lacks an  $-\text{OH}$  group

21. Which alcohol forms the fastest Lucas test result?

- A. Primary    B. Secondary    C. Tertiary    D. All equal

22. Boiling point of alcohols is high due to:

- A. Ionic bonding    B. Hydrogen bonding    C. Van der Waals only    D. No intermolecular forces

23. Fehling's solution gives a positive test for:

- A. Ketones      B. Aldehydes      C. Both      D. Neither

24. Reaction of aldehydes with Tollens reagent produces:

- A. Copper(I) oxide      B. Silver mirror      C. Black precipitate      D. No reaction

25. Which has the highest boiling point?

- A. Methanal      B. Ethanal      C. Propanone      D. Butanone

26. The reagent used to distinguish aldehydes from ketones is:

- A. Dilute H<sub>2</sub>SO<sub>4</sub>      B. Fehling's      C. HCl      D. NaCl

27. The carbonyl carbon is electrophilic because:

- A. It is highly negative    B. Oxygen withdraws electron density    C. It is a metal    D. It contains π electrons

28. 2,4-DNPH test gives a precipitate with:

- A. Alcohols      B. Aldehydes and ketones      C. Carboxylic acids      D. Alkanes

29. Addition of HCN to aldehydes is a(n):

- A. Nucleophilic substitution    B. Electrophilic addition    C. Nucleophilic addition    D. Radical substitution

30. Acyl chlorides react violently with water to form:

- A. Aldehydes      B. Alcohols      C. Carboxylic acids      D. Ethers

31. Which functional group has the highest reactivity?

- A. Ester      B. Amide      C. Acid anhydride      D. Nitrile

32. Reduction of nitriles produces:

- A. Carboxylic acids      B. Amines      C. Alcohols      D. Esters

33. Reaction of amines with strong acids produces:

- A. Alcohols      B. Ammonium salts      C. Ketones      D. Aldehydes

34. Primary amines on reaction with nitrous acid give:

- A. Alcohols      B. Alkanes      C. Nitrogen gas      D. Esters

35. Zwitterion form of amino acids exists mostly in:

- A. Strong acid      B. Strong alkali      C. Neutral pH      D. Organic solvents

36. Tertiary amines can not form hydrogen bond with themselves because:

- A. They are neutral      B. N has no lone pair      C. They lack N–H bond      D. They are weak bases

37. The isoelectric point is defined as pH at which:

- A. Net charge is zero      B. Acid form dominates      C. Base form dominates      D. No ions exist

38. Transition metals form coloured ions due to:

- A. s-orbital electrons      B. d–d electronic transitions      C. f-orbital splitting      D. Thermal vibration

39. A characteristic property of transition metals is:

- A. No variable oxidation states
- B. Forming acidic oxides
- C. Forming complex ions
- D. Not forming alloys

40. Which complex ion has octahedral shape?

- A.  $[\text{CuCl}_4]^{2-}$
- B.  $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$
- C.  $[\text{Ag}(\text{NH}_3)_2]^+$
- D.  $[\text{Zn}(\text{OH})_4]^{2-}$

41. The ability of transition metals to act as catalysts is due to:

- A. Low density
- B. Vacant d-orbitals
- C. s-orbital splitting
- D. High electronegativity

42. The method used for extraction of highly reactive metals (e.g., K, Na) is:

- A. Roasting
- B. Electrolysis of molten salts
- C. Reduction by carbon
- D. Heating with CO

43. Iron is extracted from its ore using:

- A. Electrolysis
- B. Blast furnace reduction
- C. Fractional distillation
- D. Carbonation

44. In the blast furnace, limestone acts as:

- A. Reducing agent
- B. Flux to remove impurities
- C. Catalyst
- D. Fuel

45. Aluminium is extracted by:

- A. Heating with carbon
- B. Electrolytic reduction of alumina
- C. Reduction with  $\text{H}_2$
- D. Displacement reaction

46. Which gas reduces iron(III) oxide in the blast furnace?

- A.  $\text{CO}_2$
- B.  $\text{H}_2\text{O}$
- C. CO
- D.  $\text{H}_2\text{S}$

47. The slag formed in blast furnace is:

- A.  $\text{CaCO}_3$
- B. CaO
- C.  $\text{CaSiO}_3$
- D.  $\text{SiO}_2$

48. The purpose of cryolite in extraction of aluminium is:

- A. Increase melting point
- B. Lower melting point of alumina
- C. Act as reducing agent
- D. Produce  $\text{CO}_2$

49. During extraction of zinc, roasting converts  $\text{ZnS}$  into:

- A. Zn
- B.  $\text{ZnO}$
- C.  $\text{ZnCl}_2$
- D.  $\text{ZnCO}_3$

50. The process of concentrating ore using water flow is:

- A. Froth flotation
- B. Gravity separation
- C. Roasting
- D. Smelting

51. The macronutrient in NPK that promotes root development is:

- A. Nitrogen
- B. Phosphorus
- C. Potassium
- D. Sulphur

52. Excess nitrogen fertilizer mainly causes:

- A. Poor fruit formation
- B. Leaf yellowing
- C. Overgrowth of foliage
- D. Root deformation

53. Benzene's aromaticity requires:

- A.  $4n \pi$  electrons
- B. Non-planar structure
- C.  $4n + 2 \pi$  electrons
- D. Nitrogen substitution

54. The  $-\text{CH}_3$  group directs incoming substituents to:

- A. Meta              B. Para              C. Ortho and para              D. Meta and para

55. Which is the most activating group?

- A. -Cl                      B. -NH<sub>2</sub>                      C. -NO<sub>2</sub>                      D. -COOH

56. Halogens are unique because they:

- A. Activate and direct meta
  - B. Deactivate but direct ortho/para
  - C. Activate and direct ortho/para
  - D. Deactivate and direct meta

57. Phenol reacts faster than benzene because:

- A.  $-\text{OH}$  withdraws electrons    B.  $-\text{OH}$  donates electrons    C.  $-\text{OH}$  forms complexes    D.  $-\text{OH}$  is bulky

58. Reduction of a nitrile forms a:

- A. Amide      B. Amine      C. Alcohol      D. Aldehyde

59. According to VSEPR theory, the shape of a molecule with the formula  $\text{AB}_3\text{E}$  (where E represents a lone pair of electrons) is:

- (a) Trigonal planar      (b) Tetrahedral      (c) Trigonal pyramidal      (d) Bent

60. What is the molecular geometry of  $\text{SF}_6$  as predicted by VSEPR theory?



**SECTION B: SHORT ANSWER AND MATCHING QUESTIONS / 10 MARKS**

61. The first three ionization energies for an element X are 176, 336 and 1847 kcal/mole respectively.

a) What is meant by “first ionization energy” ? (1mark)

.....

b) Write an equation showing the third ionization energy of X. (1mark)

which group does X seem to belong? Explain.

c) In which group does X seem to belong? Explain. (1marks)

.....

**62. Fill in the blank:**

The element palladium is in the d block of the Periodic Table. Consider the following palladium compound which contains the sulfate ion.  $[Pd(NH_3)_4]SO_4$

(a) (i) Give the oxidation state of palladium in this compound.....

(1marks)

(ii) state the IUPAC name of this complex

..... (1marks)

(b) Give the names of two possible shapes for the complex of palladium ion in this compound.

.....and..... (1 marks)

63. Match the items in Column A with the correct description in Column B (4 marks)

Column A	Column B
1. Calcination	B. Concentrating sulphide ores
2. Froth flotation	C. Removal of volatile impurities
3. Electrolysis	A. Carbon reduction of iron ore
4. Blast furnace	D. Extraction of reactive metals

### SECTION C: ATTEMPT ANY THREE QUESTIONS OF YOUR CHOICE / 30 MARKS

64. There exists 3 isotopes of oxygen that occur naturally with atomic mass 16, 17 and 18 with abundance 99.1% ; 0.89% and 0.01% respectively. Given that oxygen occurs naturally as diatomic molecule,

(a) The number of peaks that will be observed on the screen of mass spectrometer is.....(1 MARKS)

(b) The molecular ions that are responsible of these peaks are

.....  
..... (5 MARKS)

(c) Describe how a dative covalent bond is formed

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..... (2MARKS)

(d) Give a specific example of your choice

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..... (2MARKS)

65. (a) Using the Rydberg formula, calculate the **wavelength** (in nm) and frequency (in Hz) of the line produced when an electron in hydrogen falls from n = 4 to n = 2. Also give the **energy** per mole (kJ·mol<sup>-1</sup>) of that photon. (6 marks)

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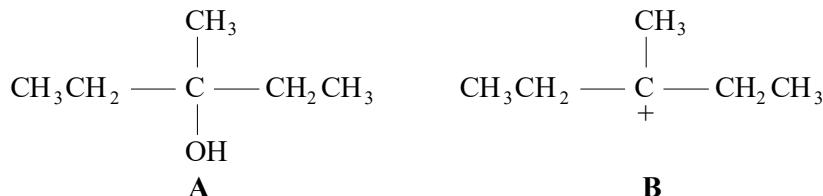
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(b) Calculate the energy (in  $\text{kJ}\cdot\text{mol}^{-1}$ ) required to ionize one mole of hydrogen atoms from the ground state, given the ground-state energy of hydrogen is  $-2.18 \times 10^{-18} \text{ J}$  per atom. **(4 marks)**

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(Answer all questions. Use  $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$ ,  $c = 3.00 \times 10^8 \text{ m/s}$ , Avogadro  $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$ , Rydberg  $R_H = 1.096776 \times 10^7 \text{ m}^{-1}$ .)

66. Protonation of alcohol A and subsequent loss of water, produces the intermediate B.



- (a) (i) Name alcohol A..... **(1mark)**
- (ii) What type of species is intermediate B? ..... **(1mark)**
- (iii) Draw the structures of the two alkenes which can be formed from species B by

removal of a proton. Label as C the alkene which shows geometrical isomerism.

.....(3marks)

- (b) The intermediate B is readily attacked by nucleophiles such as water.

What is the essential feature (characteristics) of a nucleophile?

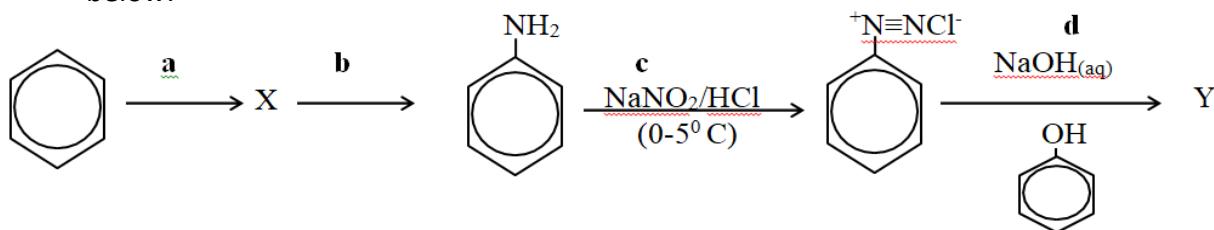
.....(1mark)

- (c) (i) State what final colour you would see if alcohol A were warmed with acidified potassium dichromate(VI). Explain your answer ..... (1mark)

- (ii) Draw two structural isomers of alcohol A which form branched chain ketones when heated with acidified potassium dichromate(VI), but which could not form alkene C on dehydration.

.....(3mark)

67. An azo dye (diazo dye) was synthesized from benzene as shown in the reaction scheme below:



- (i) Write the structural formula of compound X .....(1mark)

- (ii) What reagents and conditions are used in step(a)?

ReagentS: ..... Condition: ..... (2marks)

- (iii) What reagents are used in step(b)? .....(2marks)

- (iv) Write the structural formula of azo dye Y.: .....(1mark)

- (v) Give the stepwise mechanism for the reaction in step(a) .

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.....(4marks)

68. The two compounds V and W are isomers with the molecular formula C<sub>4</sub>H<sub>8</sub>O, and show the following properties and reactions. Both compounds react with sodium metal, and both decolorize bromine water. Compound V forms a yellow precipitate with alkaline aqueous iodine, whereas compound W does not. When reacted with cold KMnO<sub>4</sub>(aq), both V and W produce the same neutral compound X, C<sub>4</sub>H<sub>10</sub>O<sub>3</sub>. Both V and W exist as pairs of stereoisomers.

a) Suggest which functional groups are responsible for the reactions with:

i) Sodium ..... (1mark)

ii) Bromine water ..... (1mark)

iii) Alkaline aqueous iodine ..... (1mark)

b) Suggest structures for V and W.

..... (2marks)

c) State the type of stereoisomerism shown by compound V and draw the structures of the stereoisomers.

..... (3marks)

d) Suggest the structure of the neutral compound X.

..... (2marks)

\*\*\*\*\* END \*\*\*\*\*