Sikkim Public Service Commission

Main Written Examination for the Post of Sub Inspector

PAPER - II CHEMISTRY

Time allowed: 3.00 Hrs | Maximum Marks: 250

INSTRUCTION TO CANDIDATES

Read the instructions carefully before answering the questions: -

1. **IMMEDIATELY AFTER THE COMMENCEMENT OF THE EXAMINATION, YOU SHOULD CHECK THAT THIS BOOKLET DOES NOT HAVE ANY UNPRINTED OR TORN OR MISSING PAGES OR ITEMS ETC. IF SO, GET IT REPLACED BY A COMPLETE TEST BOOKLET.**
2. **Use only Black Ball Point Pen to fill the OMR Sheet.**
3. Do not write anything else on the OMR Answer Sheet except the required information.
4. **This Test Booklet contains 50 questions in MCQ Mode in Part I to be marked in OMR Sheet. Part II and Part III are Subjective Questions which have to be written on separate answer sheet provided to you.**
5. Before you proceed to mark in the Answer Sheet (OMR), you have to fill in some particulars in the Answer Sheet (OMR) as per given instructions.
6. After you have completed filling in all your responses on the Answer Sheet (OMR) and the examination has concluded, you should hand over the Answer Sheet (OMR) and separate answer sheet to the Invigilator only. You are permitted to take with you the Test Booklet.
7. **Marking Scheme**

   THERE WIL BE NEGATIVE MARKING FOR WRONG ANSWERS MARKED BY A CANDIDATE IN THE OBECTVE TYPE QUESTIONS

   i. There are four alternatives for the answer to every question. For each question for which a wrong answer has been given by the candidate, one-third of the marks assigned to the question will be deducted as penalty.

   ii. If a candidate gives more than one answer, it will be treated as a wrong answer even if one of the given answers happens to be correct and there will be same penalty as above to the question.

   iii. If a question is left blank. i.e., no answer is given by the candidate; there will be no penalty for that question.

DO NOT OPEN THIS TEST BOOKLET UNTIL YOU ARE ASKED TO DO SO

PART – I

Choose the correct option for the following questions: (3X50=150)

1. **Which of the following pair of 4F elements can exhibit +4 oxidation state?**

   A. La and Lu
   B. Ce and Pr
   C. C, Eu and Yb
   D. Sm and Tm

2. **What is the IUPAC nomenclature of Na $[PCl_6]$?**

   A. Sodium Hexachlorophosphine (V)
   B. Sodium Hexachlorophosphate (V)
   C. Sodium Hexachlorophosphene (V)
   D. Sodium Hexachlorophosphite (V)

3. **Select the correct order of acidity in boron trihalides.**

   A. $BBr_3 > BCl_3 > BF_3$
   B. $BBr_3 < BCl_3 < BF_3$
   C. $BCl_3 < BBr_3 < BF_3$
   D. $BCl_3 < BF_3 < BBr_3$

4. **Which of the complexes obeys the EAN rule?**

   A. $Fe(CO)_4$
   B. $Cr(CO)_5$
   C. $Ni(CO)_3(PPh_3)$
   D. $Cr(C_5H_5)$

5. **Silicates having continuous 3D frame works are:**

   A. Neso Silicates
   B. Soro Silicates
   C. Phyllo Silicates
   D. Tecto Silicates

6. **What is the magnetic moment of $[NiCl_4]^{2-}$?**

   A. 1.41 BM
   B. 1.82 BM
   C. 5.46 BM
   D. 2.82 BM

7. **The number of metal-metal bonds in $Ir_4(CO)_{12}$ is:**
   A. 4
   B. 6
   C. 10
   D. 12

8. **Which of following elements shows +7 oxidation state?**
   A. Th
   B. Pa
   C. U
   D. Np

9. **The red color of hemoglobin is because of:**
   A. LMCT
   B. MLCT
   C. Conjugated double bond present in the ligand
   D. None of the above

10. **Which of the following pair represents linkage isomers?**
   A. $[Pd(PPh_3)_2(NCS)_2]$ and $[Pd(PPh_3)_3(SCN)_2]$
   B. $[Co(NH_3)_5NO_3]SO_4$ and $[Co(NH_3)_5(S0_4)]NO_3$
   C. $[PtCl_2(NH_3)_4]Br_2$ and $[PtBr_2(NH_3)_5]Cl_2$
   D. $[Cu(NH_3)_4][PtCl_4$ and $[Pt(NH_3)_4][CuCl_4]$

11. **The total number of orbitals in a shell with principal quantum n is:**
   A. 2n
   B. $2n^2$
   C. n^2
   D. n+1

12. **The incorrect statement for solid sodium chloride is:**
   A. Both Na and Cl ion adopt inert gas configuration
   B. The conduction band is full
   C. The conduction band is empty
   D. The valance band is full

13. **The number of hydroxyl group/s present in phosphorus acid is:**
   A. one
   B. two
   C. three
   D. four

14. **If the criterion for the spontaneity of a process is Δ, then**
   A. $\Delta S_{sys} > 0$
   B. $\Delta S_{surr} > 0$
   C. $\Delta S_{sys} + \Delta S_{surr} > 0$
   D. $\Delta S_{sys} - \Delta S_{surr} > 0$

15. **Efficiency of a fuel cell is given by**
    A. $\Delta G/\Delta H \times 100$
    B. $\Delta S/\Delta G \times 100$
    C. $\Delta H/\Delta G \times 100$
    D. $\Delta G/\Delta S \times 100$

16. **The Langmuir adsorption isotherm is given by $\theta = KP/1+KP$, where P is pressure of adsorbed gas. The Langmuir adsorption isotherm for a diatomic gas undergoing dissociation adsorption is:**
    A. $\theta = KP/1+KP$
    B. $\theta = (KP)^2/1+(KP)^2$
    C. $\theta = 2KP/1+2KP$
    D. $\theta = (KP)^{1/2}/1+(KP)^{1/2}$

17. **Which of the following statements is correct? Galvanic cell converts**
    A. Chemical energy into electrical energy
    B. Electrical energy into Chemical energy
    C. Electrolyte into individual ions
    D. None of the above

18. **Which property can neither be created nor destroyed**
    A. Enthalpy
    B. Energy
    C. Entropy
    D. Pressure

19. **5 Mole of an ideal gas expand reversibly from a volume of $8dm^3$ to $80dm^3$ at a temperature of 27°C. Calculate the entropy change.**
    A. $95.73\ JK^{-1}$
    B. $50.23\ JK^{-1}$
    C. $105.52\ JK^{-1}$
    D. $80.37\ JK^{-1}$

20. **Calculate the EMF for the cell**
    $Zn, Zn^{+2}(1M) / Fe^{+2}(1M), Fe^{+3}$; Pt when $E^0_{Fe^{+3}/Fe^{+2}} = +0.77$ and $E^0_{Zn^{+2e}/Zn} = -0.76$
    A. 1.53V
    B. 0.59V
    C. 0.42V
    D. 4.39V

21. **Characteristic gas constant of a gas is equal to**
    A. C_P / C_V
    B. C_V / C_P
    C. $C_P - C_V$
    D. $C_P + C_V$

22. **The order of polarity of NH_3, NF_3 and BF_3 is:**
    A. $NF_3 < NH_3 < BF_3$
    B. $BF_3 < NF_3 < NH_3$
    C. $BF_3 < NH_3 < NF_3$
    D. $NF_3 < BF_3 < NH_3$

23. **The shape of the molecule XeO_2F_2 is**
    A. Distorted Oh
    B. Square planer
    C. Trigonal bipyramidal
    D. Tetrahedral

24. **The material that exhibits highest electrical conductivity among the following S-N compounds is**
    A. S_4N_4
    B. S_7NH
    C. S_2N_2
    D. (SN) x

25. **When Frenkel defects are created in an otherwise perfect crystal, the density of the ionic crystal**
    A. Increases
    B. Decreases
    C. Remains same
    D. No change

26. **The radius of divalent cation M^{+2} is 94pm and that of divalent anion X^{-2} is 146pm. Thus $M^{+2}X^{-2}$ is**
    A. NaCl
    B. CsCl
    C. ZnS
    D. CaF_2

27. **The kinetic energy of a gas is zero at**
    A. 0℃
    B. 273℃
    C. -273℃
    D. None of the above

28. **The triple point of water is:**
    A. Unique
    B. Dependant on P but is independent of T
    C. Dependant on T but is independent of P
    D. Dependant on both P and T

29. **SI Unit of pressure is:**
    A. Torr
    B. mm of Hg
    C. Nm^{-2}
    D. Pound m^2

30. **The expression for root mean square velocity is**
    A. $\sqrt{3RT/2M}$
    B. $\sqrt{3RT/M}$
    C. 3R/M
    D. $\sqrt{3/2RTM}$

31. The rate constant for a first order reaction is 1.5×10^{-3} s^{-1}. Calculate its half-life time.

A. 200s
B. 350s
C. 450s
D. 150s

32. The $t_{1/2}$ of a reaction is halved as the initial concentration of the reactant is doubled. What is the order of reaction?

A. First order
B. Zero order
C. Second order
D. None of these

33. Which of the following set of quantum numbers is correct for an electron in $4f^1$?

	n	l	M	s
A.	3	2	-2	+1/2
B.	4	3	+1	+1/2
C.	4	4	-4	-1/2
D.	4	3	+4	+1/2

34. Which of the following ions has the maximum magnetic moment?

A. Mn^{+2}
B. Fe^{+2}
C. Ti^{+2}
D. Cr^{+2}

35. The Schrodinger wave equation is $\nabla^2 \psi + A \psi = 0$, then what is the value of A?

A. $2m/\hbar^2 [E-V] \psi$
B. $h^2/8\pi^2 m[E-V]\psi$
C. $\hbar/2m[E-V] \psi$
D. $8\pi^2 m/h^2$

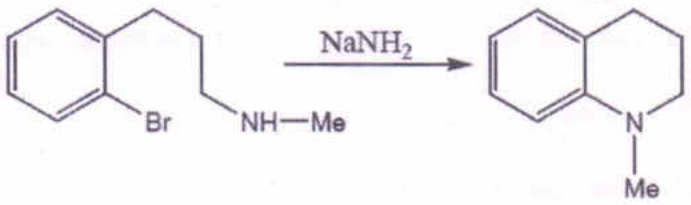
36. Which of the following statements is incorrect about aromatic compounds?

A. Are planar
B. Have 4n π-electrons
C. Are cyclic
D. Are generally less reactive than similarly substituted alkenes

37. The correct order of different types of energies is

A. $E_{el} >> E_{vib} >> E_{rot} >> E_{tr}$
B. $E_{el} >> E_{rot} >> E_{vib} >> E_{tr}$
C. $E_{el} >> E_{vib} >> E_{tr} >> E_{rot}$
D. $E_{tr} >> E_{vib} >> E_{rot} >> E_{el}$

38. The reactive intermediate involved in the following reaction is:



A. a carbocation
B. a carbanion
C. a free radical
D. an aryne

39. When considering electrophilic aromatic substitution reactions nitro group is described as:

A. *Ortho/para* directing and activating
B. *Ortho/para* directing and deactivating
C. *Meta* directing and activating
D. *Meta* directing and deactivating

40. Which intermediate carbocation is more stable in Pinacol pinacolone rearrangement?

A. 1^0
B. 2^0
C. 3^0
D. 4^0

41. What are the products of the Cannizzaro reaction?

A. A carboxylic acid and an alcohol
B. A new aldehyde (with a new 'R' group) and water
C. Two carboxylic acids
D. A carboxylic acid and an aldehyde

42. What is the other name for BUNA-S?

A. Sodium Rubber
B. Synthesized Rubber
C. Butadiene Rubber
D. Styrene Rubber

43. Which of the following are the reactions in which molecules absorbing light do not themselves react but induce other molecules to react?

A. Free radical reactions
B. Chain reactions
C. Reversible reactions
D. Photosensitized reactions

44. Select the incorrect statement.

A. Resonance may sometimes cause sp^3 atoms to become sp^2 hybridized
B. Delocalizing one lone pair causes aromaticity
C. One lone pair will be counted as two pi electrons according to Huckel's equation
D. Two sigma bonds make up a double bond

45. The transition zone for Raman spectra is:

A. Between vibrational and rotational levels
B. Between electronic levels
C. Between magnetic levels of nuclei
D. Between magnetic levels of unpaired electrons

46. To check that a secondary alcohol has been completely oxidised to a ketone, which of the following statements is correct?

A. Check that the IR spectrum has absorptions at $3500cm^{-1}$ and $1650cm^{-1}$
B. Check that the IR spectrum has no absorption around $3500cm^{-1}$
C. Check that the IR spectrum has no absorption around $1650cm^{-1}$
D. Check that the IR spectrum no absorptions at $3500cm^{-1}$ and $1650cm^{-1}$

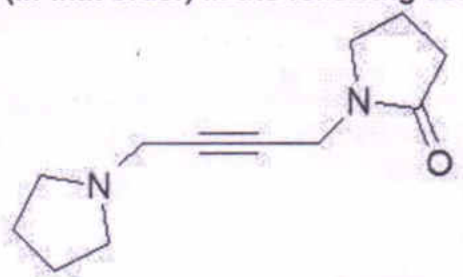
47. In NMR spectroscopy, the splitting pattern for a signal is found by:

A. Counting the number of chemically equivalent hydrogen atoms on adjacent atoms
B. Counting the number of chemically different hydrogen atoms on adjacent atoms
C. Counting the number of chemically different hydrogen atoms on adjacent atoms and adding 1
D. Counting the number of chemically different hydrogen atoms on adjacent atoms and subtracting 1

48. In mass spectrometry, the path of the ions after deflection depends on:

A. Mass of the ion
B. Charge of the ion
C. Both the charge and mass of the ion
D. Neither the charge nor the mass of the ion

49. Which of the following options gives the numbers of sp, sp^2 and sp^3 hybridised carbon atoms present (in that order) in the following compound?



A. 3, 0, 9
B. 2, 0, 10
C. 2, 1, 9
D. 9, 2, 1

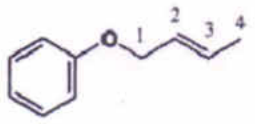
50. HCN undergoes nucleophilic addition reaction to give product:

A. Hydrogen cyanide
B. Cyanohydrin
C. Hydroxyl amine
D. All of them

PART-II

Attempt ANY TWO of the following: (25X2=50)

1. Explain the Debye-Huckel theory of strong electrolyte and derive the Debye-Huckel limiting law.
2. Draw the crystal field splitting diagrams for a Td, Oh and square planer complexes.
3. Which side-chain carbon makes a new bond to the benzene ring upon rearrangement of the following allylic phenyl ether? Giving the name of the reaction, elaborate on the mechanism.



5. Give the details of scope, mechanism and applications of Fischer Indole Synthesis.
6. Explain Woodward Hoffman Rules for the electrocyclic ring opening and closure in the conversion of cyclobutene to 1,3-butadiene using correlation diagram.

PART - III

Attempt ANY FIVE of the following : (10X5=50)

1. Describe the transition state theory.
2. Draw and discuss the phase diagram for CO_2 system.
3. Discuss the kinetics of the following photochemical reaction.

   $H_2 + Cl_2 \rightarrow 2HCl$

4. Explain the nature of metal-olefin interaction in transition metal-olefin complexes.
5. Draw the structures of
   i. $Fe_2(CO)_9$
   ii. $Mo(C_5H_5)_3NO$
7. What are the major factors affecting an E2 reaction?
8. What does lithium aluminum hydride reduce?
9. Define Isoelectric Point. Give the formula to calculate it from pK_a.