Chemical Sciences

Paper II

Time Allowed : 75 Minutes] **[Maximum Marks : 100**

Note : This Paper contains **Fifty (50)** multiple choice questions, each question carrying **Two (2)** marks. Attempt *All* questions.

1. The de Broglie wavelength of an electron in a Bohr orbit with radius r and quantum number n is proportional to :
   (A) nr
   (B) $1/nr$
   (C) n/r
   (D) r/n

2. Which of the following conditions is *not* essential for an eigenfunction of the Hamiltonian operator to be an acceptable wavefunction ?
   (A) Continuous
   (B) Normalized
   (C) Always positive
   (D) Single valued

3. The lowest energy MO of HF is close to the energy of the :
   (A) 1*s* orbital of H
   (B) 1*s* orbital of F
   (C) 2*s* orbital of F
   (D) 2*p* orbital of F

4. The bond angles in H_2O are :
   (A) <109°
   (B) 109°
   (C) 120°
   (D) 180°

5. Under what condition is the free energy a criterion for spontaneity ?
   (A) Isolated system
   (B) Constant pressure and temperature
   (C) Constant pressure and volume
   (D) Constant volume and temperature

6. What is the unit of the thermodynamic equilibrium constant for a reaction ?
   (A) Unit of pressure
   (B) Unit of volume
   (C) It is a unitless quantity
   (D) Depends on the stoichiometry

7. The relationship from which an expression for elevation of boiling point of a solution can be derived is :

(A) $\ln\frac{K_2}{K_1} = -\frac{\Delta H^0}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

(B) $\ln\frac{K_2}{K_1} = -\frac{\Delta G^0}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

(C) $\ln\frac{K_2}{K_1} = -\frac{\Delta E^0}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

(D) $\ln\frac{K_2}{K_1} = -\frac{\Delta S^0}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$

8. Which of the following solutions will have pH close to 1 ?

(A) 100 mL of 0.1 M HCl + 100 mL of 0.1 M NaOH

(B) 75.0 mL of 0.2 M HCl + 25.0 mL of 0.1 M NaOH

(C) 55.0 mL of 0.1 M HCl + 45.0 mL of 0.1 M NaOH

(D) 10.0 mL of 0.1 M HCl + 90.0 mL of 0.1 M NaOH

9. The rate of a reaction is found to decrease with increase in temperature. Which of the following inferences can be made from this observation ?

(A) Arrhenius equation is wrong

(B) The reaction consists of multiple steps

(C) The reaction is of zeroth order

(D) There is an error in measurement

10. The unit of the rate constant for a first order reaction is :

(A) s^{-1}

(B) dm^{-3} mol s^{-1}

(C) dm^{-3} mol^{-1} s^{-1}

(D) $dm^{-3/2}$ $mol^{1/2}$ s^{-1}

11. The mean activity coefficient of 5.0×10^{-3} mol kg^{-1} aqueous KCl at 25°C is (given A = 0.509) :

(A) 0.92

(B) 0.97

(C) 0.85

(D) 0.87

12. The major axis of symmetry of a molecule is 6 and it has nC_2 axes perpendicular to this axis. The value of n is :

(A) 1

(B) 2

(C) 3

(D) 6

13. The co-ordination number of a cation, in an ionic solid in which the arrangement of the anions around it is cubic, is :

(A) 4

(B) 6

(C) 8

(D) 10

14. In the rotational spectra of diatomic molecules, the spacing between successive lines is equal to :

(A) $\frac{h}{4\pi^2 Ic}$

(B) $2\left(\frac{h}{4\pi^2 Ic}\right)$

(C) $\frac{h}{4\pi^2 Ic^2}$

(D) $\frac{4h}{\pi^2 Ic}$

15. On the basis of the following information for the reaction,

$$\frac{4}{3}Al + O_2 \rightarrow \frac{2}{3}Al_2O_3$$

$$\Delta G = -827 \text{ kJ . mol}^{-1}$$

The minimum EMF to be applied for the electrolysis of Al_2O_3 is :

(A) 8.56 V

(B) 6.42 V

(C) 4.28 V

(D) 2.14 V

16. What are the values of the mean and median of the following six burette readings ?

19.4, 19.5, 19.6, 19.8, 20.1, 20.3

(A) 19.7, 19.7

(B) 19.8, 19.6

(C) 19.8, 19.7

(D) 19.7, 19.8

17. IUPAC name of the following compound is :

(A) *Cis*-bicyclo[3.3.0]decane

(B) *Trans* bicyclo[4.4.0]decane

(C) *Cis*-bicyclo[2.2.0]decane

(D) *Cis*-bicyclo[4.4.0]decane

18. Correct IUPAC nomenclature of the following compound is :

(A) (4E)-4-methylhept-4-ene-2-yne

(B) (4Z)-4-methylhept-4-ene-2-yne

(C) (4E)-4-ene-4-methylhept-2-yne

(D) (4Z)-4-ene-4-methylhept-2-yne

19. The one isomer of 1, 2, 3, 4, 5, 6-hexachlorocyclohexane which does *not* undergo elimination with mineral base is having :

(A) One chlorine is equatorial and others axial

(B) All chlorines are equatorial

(C) All chlorines are axial

(D) One chlorine is axial and others equatorial

20. Compound A has six chiral centers. The number of distereomers for compound A is :

(A) 64

(B) 63

(C) 62

(D) 60

21. The order of decreasing priority according to Cahn-Ingold-Prelog rule is :

(A) $HC\equiv C-$ > $H_2C=CH-$ > $O=CH-$ > $-CH_3$

(B) $O=CH-$ > $HC\equiv C-$ > $H_2C=CH-$ > $-CH_3$

(C) $-CH_3$ > $HC\equiv C-$ > $O=CH-$ > $H_2C=CH-$

(D) $H_2C=CH-$ > $O=CH-$ > $-CH_3$ > $HC\equiv C-$

22. In Lossen rearrangement, the reagents used are :

(A) (*i*) NaN_3 (*ii*) $CHCl_3/\Delta$ (*iii*) H_2O

(B) (*i*) HN_3 (*ii*) H_2SO_4 (*iii*) H_2O

(C) (*i*) hydrazine (*ii*) HNO_2 (*iii*) Benzene/Δ (*iv*) H_2O

(D) (*i*) NH_2OH (*ii*) NaOH/Δ (*iii*) H_2O

23. Acyl azide is the precursor in :

(A) Curtius and Schmidt rearrangement

(B) Schmidt and Lossen rearrangement

(C) Only Curtius rearrangement

(D) Curtius and Lossen rearrangement

24. $HCHO + CH_3CHO \xrightarrow[300°C]{\text{Sodium silicate}} H_2C{=}CH{-}CHO$

(A) Above reaction is an Aldol reaction in which acetaldehyde is an electrophile.

(B) Above reaction is a Perkin reaction where formaldehyde is a nucleophile.

(C) Above reaction is an Aldol reaction in which formaldehyde is an electrophile.

(D) Above reaction is a Perkin reaction where acetaldehyde is a nucleophile.

25. The following reaction is an example of :

$$\xrightarrow[\text{Isopropanol}]{Al(OCHMe_2)_3}$$

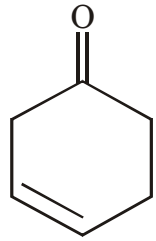
(A) Meerwein-Ponndorf-Verley reduction

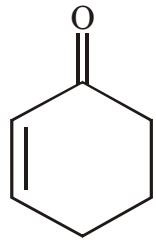
(B) Oppenauer oxidation

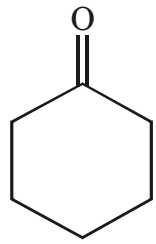
(C) Wolf-Kishner reduction

(D) Clemmenson reduction

26. Reaction of anisole with Li/liq.NH_3, followed by heating with H_3O^+ gives :

(A) 

(B) 

(C) 

(D)

27. Reaction of PhMgBr with dry ice (CO_2) followed by acid hydrolysis gives :

(A) Benzaldehyde

(B) Benzene

(C) Benzoic acid

(D) Phenol

28. Addition of HBr to 1-phenylpropene in the presence of peroxide gives :

(A) 2-Bromo-2-phenylpropane

(B) 1-Bromo-1-phenylpropane

(C) 2-Bromo-3-phenylpropane

(D) 2-Bromo-1-phenylpropane

29. The products formed in the following reaction are :

$$H_3C—CH=CH_2 \xrightarrow[(ii)\ Zn,\ H_2O]{(i)\ O_3} \ ?$$

(A) 2 moles of acetaldehyde

(B) 2 moles of formaldehyde

(C) 1 mole of acetaldehyde and 1 mole of formaldehyde

(D) 1 mole of acetone and 1 mole of formaldehyde

30. Dehydrohalogenation of erythro-1-bromo-1, 2-diphenylpropane under E_2 conditions gives :

(A) Z-1, 2-diphenyl-1-propene

(B) E-1, 2-diphenyl-1-propene

(C) *Trans*-1, 2-diphenyl-1-propene

(D) *Trans*-1, 2-diphenyl-1-butene

31. If ^1H NMR operating frequency is 500 MHz; the corresponding operating frequency for ^{13}C nuclei will be :

(A) 100 MHz

(B) 75 MHz

(C) 250 MHz

(D) 125 MHz

32. A compound shows M + 1 peak with 9.997% intensity. Therefore, the number of carbons in the molecular formula is :

(A) 10

(B) 09

(C) 08

(D) 11

33. Azurin is a copper containing electron transfer protein whose bright blue colour disappears on reduction of metal centre. The origin of blue colour of azurin is :

(A) LMCT transitions

(B) MLCT transitions

(C) $n - \pi^*$ transitions

(D) intra-ligand transitions

34. In biology iron-sulfur proteins are involved in :

(A) proton transfer

(B) electron transfer

(C) atom transfer

(D) oxygen transfer

35. Compound X, which is soluble in water forms a white precipitate Y on reaction with aqueous $AgNO_3$. Y is soluble in ammonia but insoluble in dilute nitric acid. On addition of K_2CrO_4 to X, a yellow precipitate is formed. Compounds X and Y are :

(A) K_3PO_4, AgCl

(B) KCl, AgCl

(C) $BaCl_2$, AgCl

(D) $BaCO_3$, AgCl

36. Which one of the following compounds is practically insoluble in water ?

(A) $CaCl_2$

(B) CaF_2

(C) MgI_2

(D) $BaCl_2$

37. The molar absorptivity of a coloured compound :

(A) decreases with increasing concentration

(B) remains constant at all wavelengths

(C) is independent of concentration

(D) changes linearly with concentration

38. The observed ^1H chemical shift for ferrocene in a 200 MHz instrument is 4.04 ppm. When the spectrum is recorded in 400 MHz instrument, the chemical shift will be :

(A) 4.04

(B) 2.02

(C) 8.08

(D) 1.01

39. The conversion of methanol to acetic acid is catalysed by :

(A) $\left[Rh(CO)_2I_2\right]^+$

(B) $\left[Rh(CO)_2I_2\right]^{2-}$

(C) $\left[Rh(CO)_2I_2\right]^-$

(D) $\left[Rh(CO)_2I_2\right]$

40. Frenkel defects are usually observed in :

(A) NaCl

(B) KCl

(C) KBr

(D) AgBr

41. Identify the series with correct order of stability of the complexes (en = ethylenediamine, trien = triethylenetetramine) :

(A) $[Cu(en)_2]Cl_2 > [Cu_2(en)_2](NO_3)_2 > [Cu(en)_2]SO_4$

(B) $[Cu(trien)]Cl_2 > [Cu(en)_2]Cl_2 > [Cu(NH_3)_4]Cl_2$

(C) $[Ag(NH_3)_2]Cl > [Au(NH_3)_4]Cl > [Cu(NH_3)_4]Cl$

(D) $[Cr(en)_2]Cl_2 > [Cu(en)_2]Cl_2 > [Zn(en)_2]Cl_2$

42. $[(NH_3)_4Rh(\mu\text{-}OH)_2Rh(NO_2)_4]$ and $[(NH_3)_2(NO_2)_2Rh(\mu\text{-}OH)_2(NH_3)_2(NO_2)_2]$ are examples of :

(A) ionization isomers

(B) coordination isomers

(C) linkage isomers

(D) hydrate isomers

43. Among the following ions which one has the highest magnetic moment ?

(A) $\left[Cr\left(H_2O\right)_6\right]^{3+}$

(B) $\left[Fe\left(H_2O\right)_6\right]^{2+}$

(C) $\left[Cu\left(H_2O\right)_6\right]^{2+}$

(D) $\left[Zn\left(H_2O\right)_6\right]^{2+}$

44. The ground state value of J for ^3F term for V^{3+} is :

(A) 0

(B) 1

(C) 2

(D) 4

45. The H-A-H bond angle in the following hydrides with general formula AH_3 follows the order :

(A) $AsH_3 > PH_3 > NH_3$

(B) $PH_3 > AsH_3 > NH_3$

(C) $NH_3 > AsH_3 > PH_3$

(D) $NH_3 > PH_3 > AsH_3$

46. Both NF_3 and NCl_3 are covalent but they do *not* undergo hydrolysis similarly because :

(A) NF_3 is more stable than NCl_3

(B) Dipole moment of NF_3 is more than NCl_3

(C) Electronegativity of F is greater than Cl

(D) Cl can expand its octet by using *d*-orbitals

47. In which of the following bonds does H carry δ-ve charge ?

(A) F-H

(B) O-H

(C) B-H

(D) N-H

48. pH of the buffer solution of 0.2M CH_3COONa and 0.1M CH_3COOH ($K_a = 10^{-5}$) is :

(A) 5.30

(B) 0.53

(C) 1.53

(D) 2.53

49. Which of the following metal ions can form bent metallocene ?

(A) Zr^{2+}

(B) Fe^{2+}

(C) Ru^{2+}

(D) Co^{2+}

50. Which of the following will form clathrates ?

(A) K

(B) He

(C) Kr

(D) Ca

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