PAPER : IIT-JAM 2017

CHEMISTRY-CY

1. **Section-A contains 30 Multiple Choice Questions (MCQ). Each question has 4 choices (a), (b), (c) and (d), for its answer, out of which ONLY ONE is correct. From Q.1 to Q.10 carries 1 Marks and Q.11 to Q.30 carries 2 Marks each.**
2. **Section-B contains 10 Multiple Select Questions(MSQ). Each question has 4 choices (a), (b), (c) and (d) for its answer, out of which ONE or MORE than ONE is/are correct. For each correct answer you will be awarded 2 marks.**
3. **Section-C contains 20 Numerical Answer Type (NAT) questions. From Q.41 to Q.50 carries 1 Mark each and Q.51 to Q.60 carries 2 Marks each. For each NAT type question, the value of answer in between 0 to 9.**
4. **In all sections, questions not attempted will result in zero mark. In Section–A (MCQ), wrong answer will result in negative marks. For all 1 mark questions, 1/3 marks will be deducted for each wrong answer. For all 2 marks questions, 2/3 marks will be deducted for each wrong answer. In Section–B (MSQ),there is no negative and no partial marking provisions. There is no negative marking in Section–C (NAT) as well.**

SECTION-A

Multiple Choice Questions (MCQ)

Q.1 – Q.10 carry ONE mark each.

1. The correct order of the boiling points of the compounds is

(A) $CH_4 > SiH_4 > SnH_4 > GeH_4$ (B) $SiH_4 > CH_4 > GeH_4 > SnH_4$

(C) $SnH_4 > GeH_4 > CH_4 > SiH_4$ (D) $SnH_4 > GeH_4 > SiH_4 > CH_4$

2. In the following Latimer diagram, the species that undergoes disproportionation reaction is

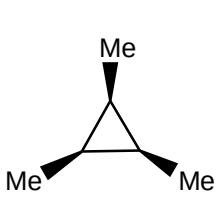
$$MnO_4^- \xrightarrow{+0.56} MnO_4^{2-} \xrightarrow{+0.27} MnO_4^{3-} \xrightarrow{+0.93} MnO_2 \xrightarrow{+0.15} Mn_2O_3 \xrightarrow{-0.25} Mn(OH)_2 \xrightarrow{-1.56} Mn$$

(A) MnO_4^{2-} (B) MnO_4^{3-} (C) Mn_2O_3 (D) $Mn(OH)_2$

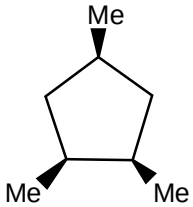
3. A yellow precipitate is formed upon addition of aqueous $AgNO_3$ to a solution of

(A) phosphite (B) pyrophosphate (C) metaphosphate (D) orthophosphate

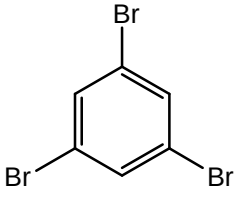
4. The compounds having C_3-axis of symmetry are



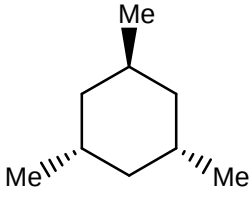
(I)



(II)



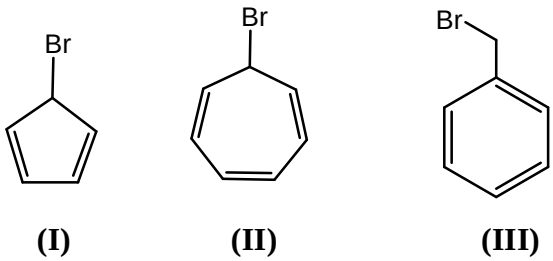
(III)



(IV)

(A) I, III and IV (B) I, II and III (C) I and III (D) III and IV

5. The correct order of rate of solvolysis for the following compounds is



(I) **(II)** **(III)**

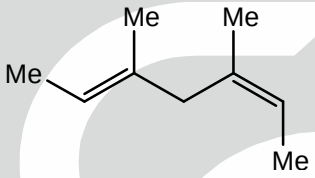
(A) III > II > I (B) II > I > III (C) III > I > II (D) II > III > I

6. In the following sequence of reactions, the overall yield (%) of O is

$$L \xrightarrow{92\%\ \text{yield}} M \xrightarrow{78\%\ \text{yield}} N \xrightarrow{85\%\ \text{yield}} O$$

(A) 61 (B) 85 (C) 74 (D) 68

7. Catalytic hydrogenation of the following compound produces saturated hydrocarbon(s). The number of stereoisomer(s) formed is



(A) 1 (B) 2 (C) 3 (D) 4

8. The number of normal modes of vibration in naphthalene is

(A) 55 (B) 54 (C) 48 (D) 49

9. The number of degrees of freedom of liquid water in equilibrium with ice is

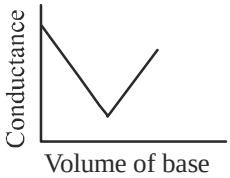
(A) 0 (B) 1 (C) 2 (D) 3

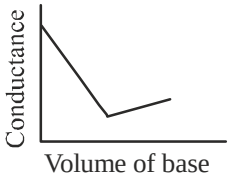
10. A straight line having a slope of $-\frac{\Delta U^0}{R}$ is obtained in a plot between

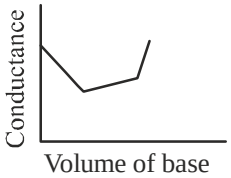
(A) $\ln(K_p)$ versus T (B) $\ln(K_c)$ versus T (C) $\ln(K_p)$ versus 1/T (D) $\ln(K_c)$ versus 1/T

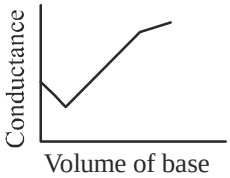
Q.11 – Q.30 carry TWO marks each.

11. In a typical conductometric titration of a strong acid with a weak base, the curve resembles

(A) 

(B) 

(C) 

(D) 

12. The coordination number of Al in crystalline $AlCl_3$ and liquid $AlCl_3$, respectively, is

(A) 4 and 4 (B) 6 and 6 (C) 6 and 4 (D) 3 and 6

13. The homogeneous catalyst used in water-gas shift reaction is

(A) $PdCl_2$ (B) Cr_2O_3

(C) $[RhCl(PPh_3)_3]$ (D) $[RuCl_2(bipyridyl)_2]$

14. Nitrosyl ligand binds to d-metal atoms in linear and bent fashion and behaves, respectively, as
(A) NO^+ anad NO^+ (B) NO^+ and NO^- (C) NO^- and NO^- (D) NO^- and NO^+

15. The metal ion (M^{2+}) in the following reaction is

$$M^{2+} + S^{2-} \longrightarrow \text{Black precipitate} \xrightarrow{\text{hot conc. } HNO_3} \text{White precipitate}$$

(A) Mn^{2+} (B) Fe^{2+} (C) Cd^{2+} (D) Cu^{2+}

16. The correct order of wavelength of absorption (λ_{max}) of the Cr-complexes is (en = ethylenediamine)

(A) $[CrF_6]^{3-} > [Cr(H_2O)_6]^{3+} > [Cr(en)_3]^{3+} > [Cr(CN)_6]^{3-}$

(B) $[Cr(H_2O)_6]^{3+} > [CrF_6]^{3-} > [Cr(en)_3]^{3+} > [Cr(CN)_6]^{3-}$

(C) $[Cr(CN)_6]^{3-} > [Cr(en)_3]^{3+} > [Cr(H_2O)_6]^{3+} > [CrF_6]^{3-}$

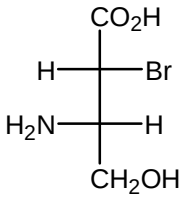
(D) $[Cr(en)_3]^{3+} > [Cr(CN)_6]^{3-} > [Cr(H_2O)_6]^{3+} > [CrF_6]^{3-}$

17. The correct order of enthalpy of the hydration for the transition metal ions is

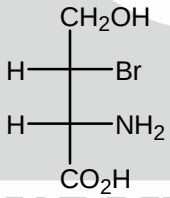
(A) $Cr^{2+} > Mn^{2+} > Co^{2+} > Ni^{2+}$ (B) $Ni^{2+} > Co^{2+} > Mn^{2+} > Cr^{2+}$

(C) $Ni^{2+} > Co^{2+} > Cr^{2+} > Mn^{2+}$ (D) $Cr^{2+} > Mn^{2+} > Ni^{2+} > Co^{2+}$

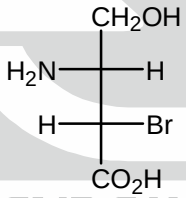
18. Among the following compounds, the pair of enantiomers is



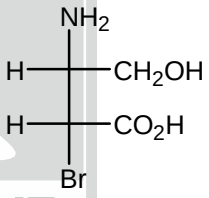
(I)



(II)



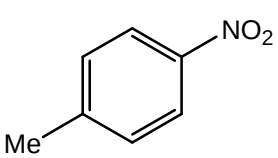
(III)



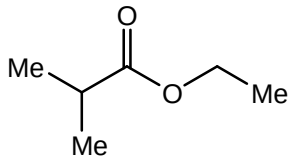
(IV)

(A) I and IV (B) I and III (C) II and III (D) III and IV

19. The number of proton NMR signals for the compounds P and Q, respectively, is



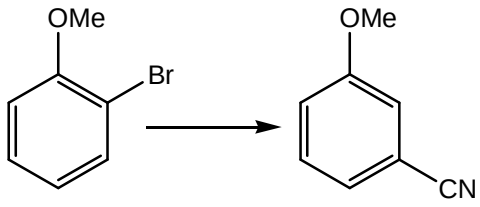
(P)



(Q)

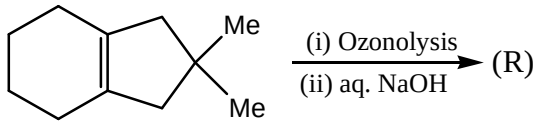
(A) 3 and 4 (B) 3 and 5 (C) 4 and 3 (D) 5 and 4

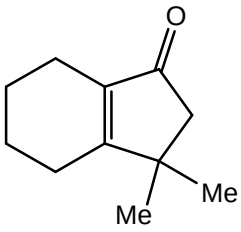
20. The correct set of reagents for the following conversion is

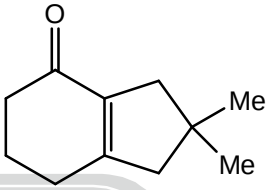


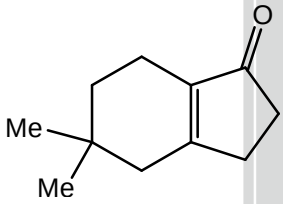
(A) (i) $NaNH_2$/liq. NH_3; (ii) $NaNO_2$/dil, HCl; (iii) CuCN, heat
(B) (i) HNO_3/H_2SO_4; (ii) Zn/HCl; (iii) $NaNO_2$/dil. HCl; (iv) CuCN, heat
(C) (i) Mg/ether, H_3O^+; (ii) $(EtO)_2CO$; (iii) NH_4OH; (iv) PCl_5
(D) (i) Mg/ether, H_3O^+; (ii) HNO_3/H_2SO_4; (iii) $NaNO_2$/dil. HCl; (iv) CuCN, heat

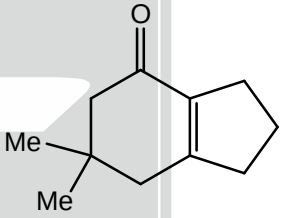
21. The product R in the following reaction is



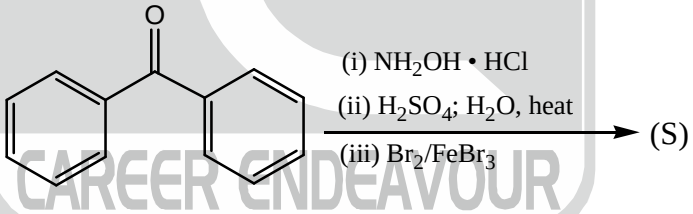
(A)


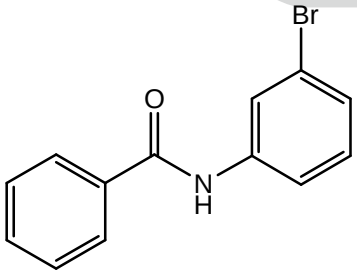
(B)


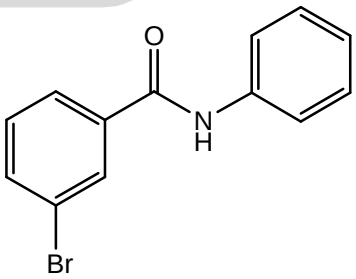
(C)


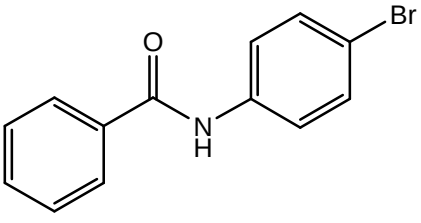
(D)


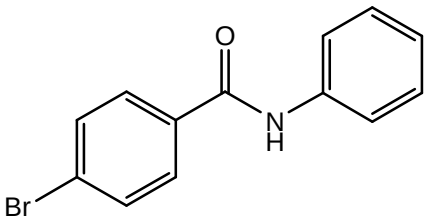
22. The major product S of the following reaction is



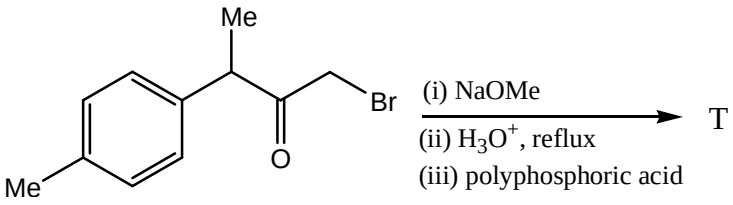
(A)


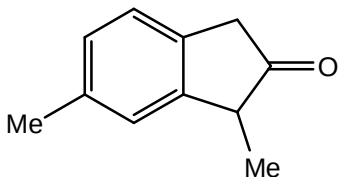
(B)


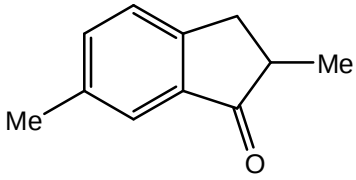
(C)


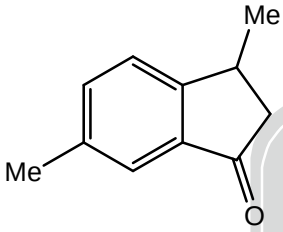
(D)


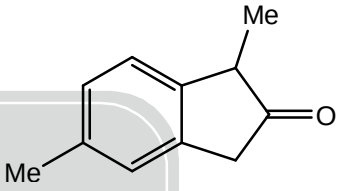
23. In the following reaction, the major product T is



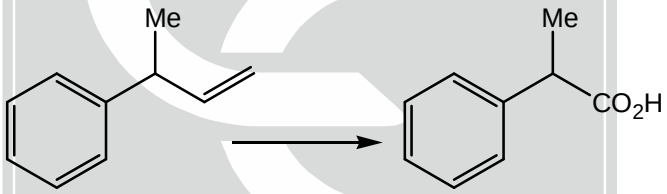
(A) 

(B) 

(C) 

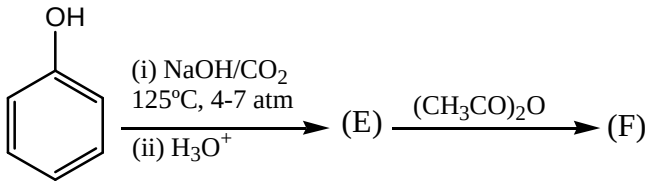
(D) 

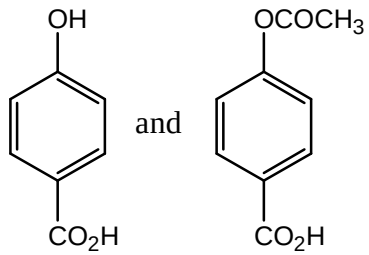
24. The following conversion is carried out using

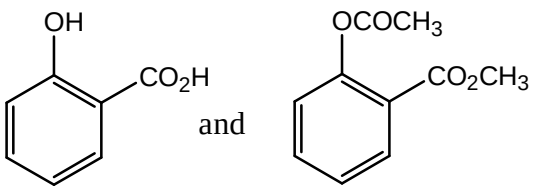


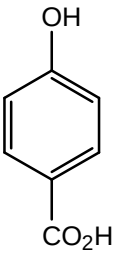
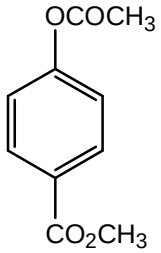
(A) hydroboration-oxidation followed by Jones oxidation
(B) Wacker oxidation followed by haloform reaction
(C) oxymercuration-demercuration followed by Jones oxidation
(D) ozonolysis followed by haloform reaction

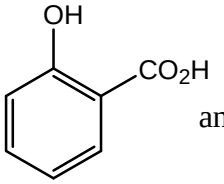
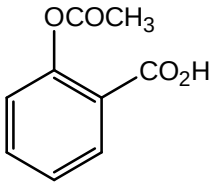
25. In the following reactions, the major product E and F, respectively, are



(A) 

(B) 

(C)  and 

(D)  and 

26. $\frac{dy}{dx} = -\frac{y}{x}$ is a differential equation for a/an

(A) circle (B) ellipse (C) bell-shaped curve (D) hyperbola

27. Value of the given determinant is

$$\begin{bmatrix} 1 & 3 & 0 \\ 2 & 6 & 4 \\ -1 & 0 & 2 \end{bmatrix}$$

(A) –12 (B) 0 (C) 6 (D) 12

28. Ionisation energy of the hydrogen atom in ground state is 13.6 eV. The energy released (in eV) for third member of Balmer series is

(A) 13.056 (B) 2.856 (C) 0.967 (D) 0.306

29. For a first order reaction $A(g) \rightarrow 2B(g) + C(g)$, the rate constant in terms of initial pressure (p_0) and pressure at time $t(p_t)$, is given by

(A) $\frac{1}{t}\ell n\frac{p_0}{p_t - p_0}$ (B) $\frac{1}{t}\ell n\frac{2p_0}{3p_0 - p_t}$ (C) $\frac{1}{t}\ell n\frac{3p_0}{p_t - p_0}$ (D) $\frac{1}{t}\ell n\frac{3p_0}{3p_t - p_0}$

30. For a particle in one-dimensional box of length L with potential energy $V(x) = 0$ for $L > x > 0$ and $V(x) = \infty$ for $x \geq L$ and $x \leq 0$, an acceptable wave function consistent with the boundary conditions is (*A*, *B*, *C* and *D* are constants)

(A) $A\cos\left(\frac{n\pi x}{L}\right)$ (B) $B\left(x + x^2\right)$ (C) $Cx^3(x - L)$ (D) $\frac{D}{\sin\left(\frac{n\pi x}{L}\right)}$

SECTION-B

Multiple Select Questions (MSQ)

Q.31 – Q.40 carry TWO marks each.

31. The 'heme' containing protein(s) is/are
(A) cytochrome C (B) hemocyanin (C) hemerythrin (D) myoglobin

32. Among the following, the species having see-saw shape is/are
(A) SF_4 (B) XeF_4 (C) ClF_4^+ (D) ClF_4^-

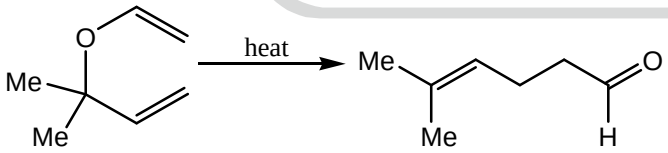
33. The indicator(s) appropriate for the determination of end point in the titration of a weak acid with a strong base is/are
(A) phenolphthalein (B) thymol blue (C) bromophenol blue (D) methyl orange

34. Jahn-Teller distortion is/are observed in octahedral complexes with d-electron configuration of
(A) d^5-high spin (B) d^5-low spin (C) d^6-high spin (D) d^6-low spin

35. Among the following, the correct statement(s) is/are
(A) Guanine is a purine nucleobase
(B) Glycine and proline are achiral amino acids
(C) DNA contains glycosidic bonds and pentose sugars
(D) Sucrose is a non-reducing sugar

36. The INCORRECT statement(s) among the following is/are
(A) $[4\pi+2\pi]$ cycloaddition reactions are carried out in presence of light
(B) $[2\pi+2\pi]$ cycloaddition reaction between a keto group and an alkene is photochemically allowed
(C) $[4\pi+2\pi]$ cycloaddition reactions are thermally allowed
(D) Transoid dienes undergo Diels-Alder reactions

37. The following conversion(s) is/are example(s) of



(A) oxy-Cope rearrangement (B) sigmatropic rearrangement
(C) Claisen rearrangement (D) pericyclic reaction

38. IR active molecules(s) is/are
(A) CO_2 (B) CS_2 (C) OCS (D) N_2

39. Intensive variable(s) is/are
(A) temperature (B) Volume (C) Pressure (D) Density

40. Wave nature of electromagnetic radiation is observed in
(A) diffraction (B) interference
(C) photoelectric effect (D) Compton scattering

SECTION-C

Numerical Answer Type (NAT)

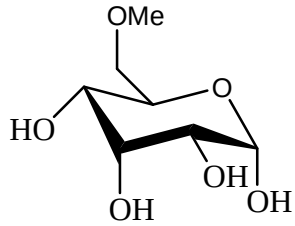
Q.41 – Q.50 carry ONE mark each.

41. The number of isomeric structures of di-substituted borazine $\left[B_3N_3H_4X_2\right]$ is _____

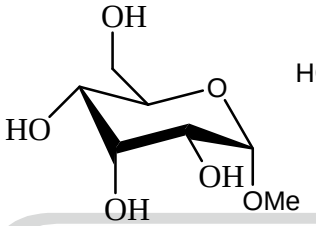
42. The number of S-S bond(s) in tetrathionate ion is _____

43. The number of unpaired electron(s) in K_2NiF_6 is _____

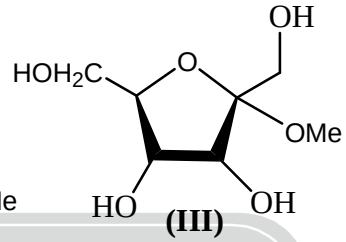
44. The number of reducing sugars among the following is _____



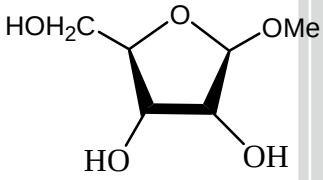
(I)



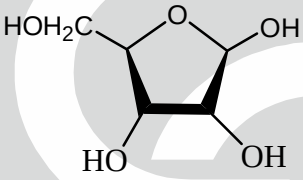
(II)



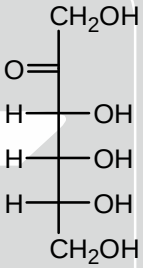
(III)



(IV)



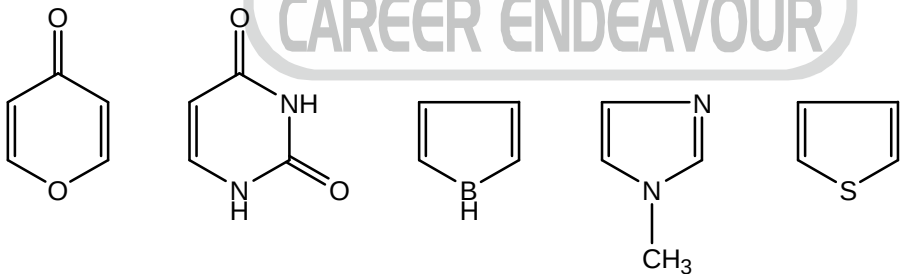
(V)



(VI)

45. The maximum number of dipeptides that could be obtained by reaction of phenylalanine with leucine is _____

46. Among the following, the number of aromatic compound(s) is _____



47. At an operating frequency of 350 MHz, the shift (in Hz) of resonance from TMS (tetramethylsilane) of a proton with chemical shift of 2 ppm is _____

48. At 298K and 1 atm, the molar enthalpies of combustion of cyclopropane and propene are –2091 kJ mol^{-1} and –2058 kJ mol^{-1}, respectively. The enthalpy change (in kJ mol^{-1}) for the conversion of one mole of propene to one mole of cyclopropane is _____

49. For a cell reaction, $Pb(s)+Hg_2Cl_2(s)\rightarrow PbCl_2(s)+2Hg(\ell)$, $\left(\frac{\partial E^0}{\partial T}\right)_P$ is 1.45×10^{-4} VK^{-1}. The entropy change (in J $mol^{-1}K^{-1}$) for the reaction is _____
[**Given** : 1F = 96500 C mol^{-1}]

50. For a reaction $2A + B \rightarrow C + D$, if rate of consumption of A is 0.1 mol L^{-1} s^{-1}, the rate of production of C (in mol $L^{-1}s^{-1}$) is _____

Q.51 – Q.60 carry TWO marks each.

51. The standard reduction potentials of Ce^{4+}/Ce^{3+} and Fe^{3+}/Fe^{2+} are 1.44 and 0.77V, respectively. The $\log_{10} K$ (K is the equilibrium constant) value for the following reaction is _____ (Final answer should be rounded off to two decimal places)

$$Ce^{4+} + Fe^{2+} \rightleftharpoons Ce^{3+} + Fe^{3+}$$

[Given : RT/F = 0.0257 V]

52. A radioactive element undergoes 80% radiaoctive decay in 300 min. The half-life for this species in minutes is _____

53. Silver crystallizes in a face-centered cubic lattice. The lattice parameter of silver (in picometer) is _____
[**Given :** Avogadro's number = 6.023×10^{23} mol^{-1}, molar mass of silver = 107.87 g mol^{-1} and density of crystal = 10.5 g cm^{-3}]

54. The amount of bromine (atomic wt. = 80) required (in gram) for the estimation of 42.3 g of phenol (molecular wt. = 94 g mol^{-1}) is _____

55. The total number of pair of enantiomers possible with molecular formula $C_5H_{12}O$ is _____

56. In 200 g of water, 0.01 mole of NaCl and 0.02 mole of sucrose are dissolved. Assuming solution to be ideal, the depression in freezing point of water (in ºC) will be _____
(final answer should be rounded off to two decimal places)

[Given : $K_f(H_2O) = 1.86$ K kg mol^{-1}**]**

57. The adsorption of a gas follows the Langmuir isotherm with K = 1.25 kPa^{-1} at 25ºC. The pressure (in Pa) at which surface coverage is 0.2 is _____

58. The separation of 123 planes (in nm) in an orthorhombic cell with a = 0.25 nm and b = 0.5 nm and c = 0.75 nm is _____
(final answer should be rounded off two decimal places)

59. A vessel contains a mixture of H_2 and N_2 gas. The density of this gas mixture is 0.2 g L^{-1} at 300K and 1 atm. Assuming that both the gases behave ideally, the mole fraction of N_2 (g) in the vessel is _____
(Final answer should be rounded off to two decimal places)
[**Given :** R = 0.082 L atm mol^{-1} K^{-1}, atomic wt. of hydrogen = 1.0 and atomic wt. of nitrogen = 14.0]

60. Consider an isothermal reversible compression of one mole of an ideal gas in which the pressure of the system is increased from 5 atm to 30 atm at 300K. The entropy change of the surroundings (in J K^{-1}) is _____ (final answer should be rounded off to two decimal places)
[**Given** : R = 8.314 J mol^{-1} K^{-1}]