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JAM – 2017 – CY

Attempt ALL the questions. Q.1 – Q.10 Multiple Choice Question (MCQ), carry ONE mark each (for each wrong answer: – 1/3).

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
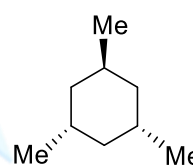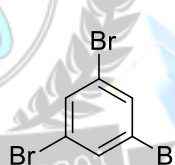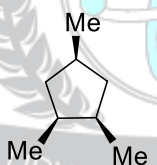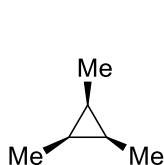
   (a) I, III and IV   (b) I, II and III   (c) I and III   (d) III and IV

5. The correct order of **rate of solvolysis** for the following compounds is
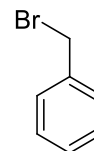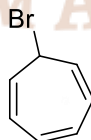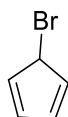
   (a) III > II > I

   (c) III > I > II

   (b) II > I > III

   (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
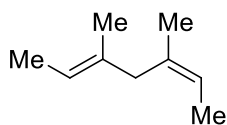
(a) 1   (b) 2   (c) 3   (d) 4

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 $-\Delta U^0/R$ is obtained in a plot between

(a) lnK_p versus T   (b) lnK_c versus T   (c) lnK_p versus 1/T   (d) lnK_c versus 1/T

> **Attempt ALL the questions. Q.11 – Q.30 Multiple Choice Question (MCQ), carry TWO mark each (for each wrong answer: – 2/3).**

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

(a)   (b)
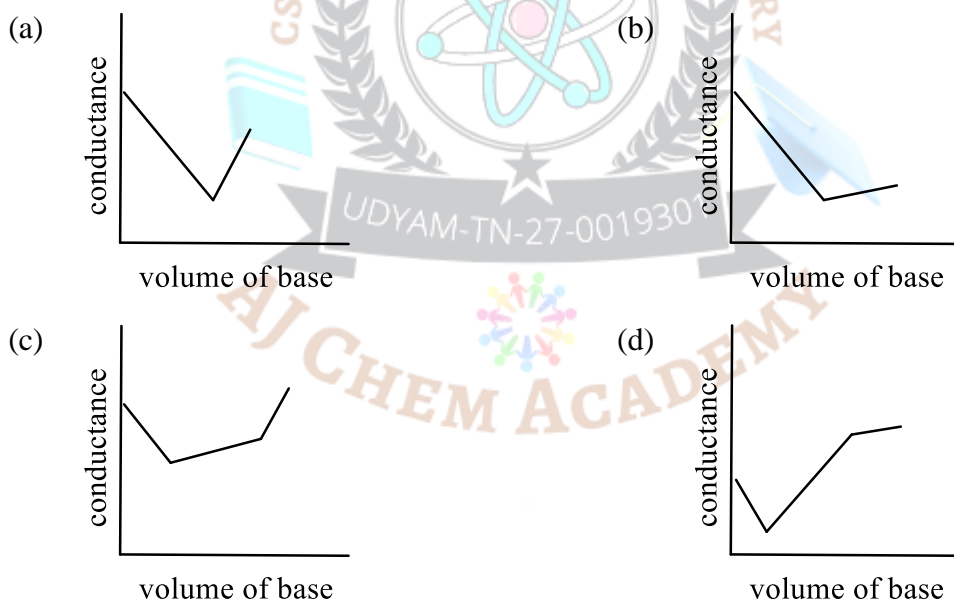
12. The **coordination number** of **Al in crystalline AlCl$_3$** and **liquid AlCl$_3$,** respectively, is

(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^+ and 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
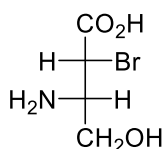
(en = ethylenediamine)

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

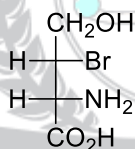(d) $[Cr(en)_3]^{3+}$ > $[Cr(CN)_6]^{3-}$ > $[Cr(H_2O)_6]^{3+}$ > $[CrF_6]^{3-}$

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+}

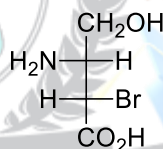(d) Cr^{2+} > Mn^{2+} > Ni^{2+} > Co^{2+}

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

I **II** **III** **IV**
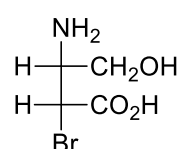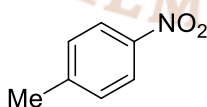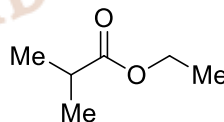
(a) I and IV (b) I and III (c) II and III (d) III and IV

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) = $NaNH_2/liq. NH_3$ (b) (i) = HNO_3/H_2SO_4

   (ii) = $NaNO_2/dil. HCl$ (ii) = Zn/HCl

   (iii) = $CuCN, \Delta$ (iii) = $NaNO_2/dil. HCl$

   (iv) = $CuCN, \Delta$

(c) (i)   = Mg/ether, H_3O^+
    (ii) = $(EtO)_2CO$
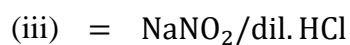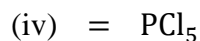   (iii) = NH_4OH
    (iv) = PCl_5
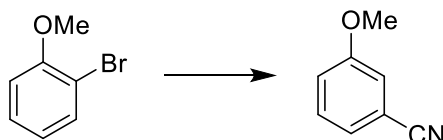
(d) (i)   = Mg/ether, H_3O^+
    (ii) = HNO_3/H_2SO_4
    (iii) = $NaNO_2/dil.\,HCl$
    (iv) = $CuCN, \Delta$
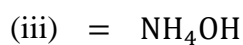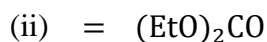
21. The **product R** in the following reaction is
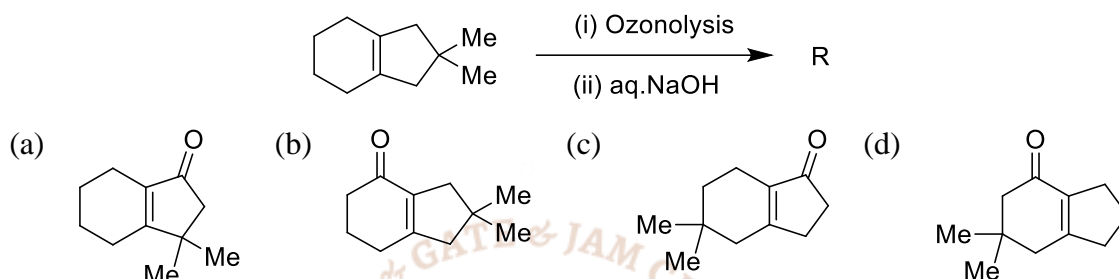
22. The major **product S** of the following reaction is
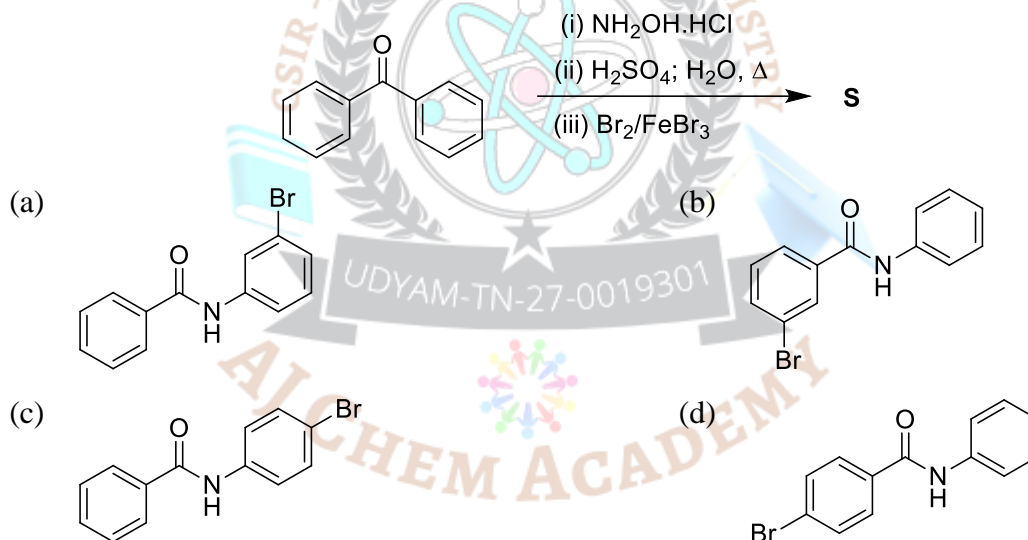
23. In the following reaction, the **major product T** is

(c)

(d)
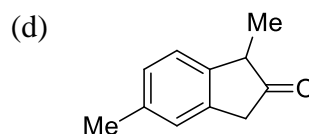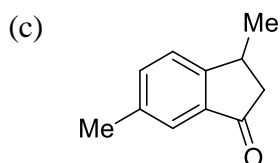
24. The following conversion is carried out using
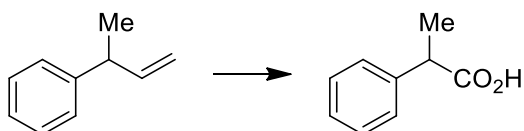
(a) hydroboration-oxidation followed by Jones oxidation

(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) and

(b) and

(c) and

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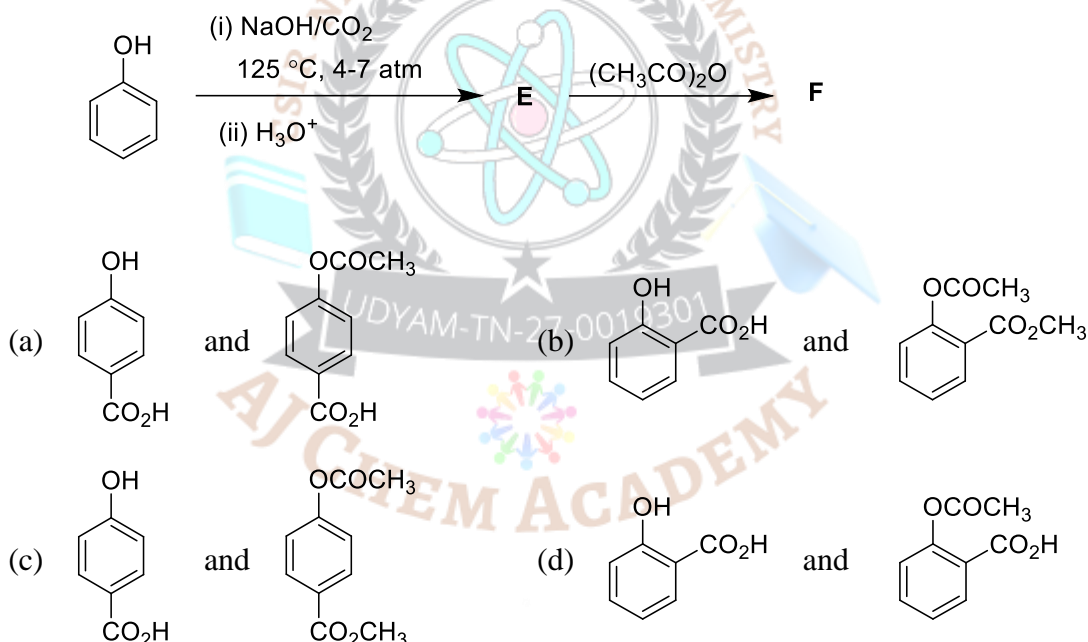
26. $\frac{dy}{dx} = -\frac{y}{x}$ is a differential equation for a/an

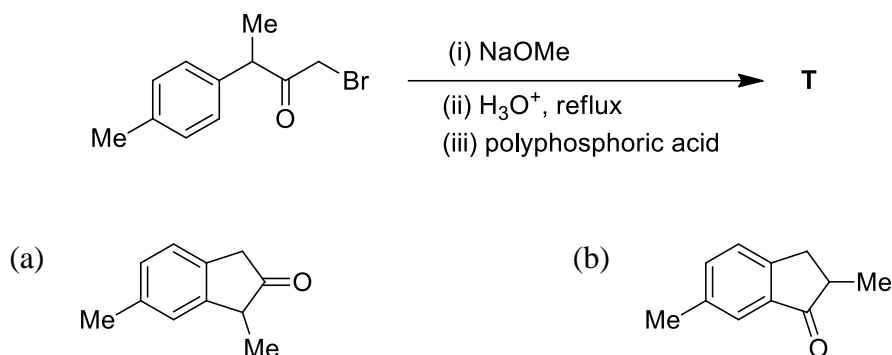(a) circle   (b) ellipse   (c) bell-shaped curve   (d) hyperbola

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) $\frac{1}{t} \ln \frac{p_0}{p_t - p_0}$ (b) $\frac{1}{t} \ln \frac{p_0}{3p_0 - p_t}$ (c) $\frac{1}{t} \ln \frac{3p_0}{p_t - p_0}$ (d) $\frac{1}{t} \ln \frac{3p_0}{3p_t - p_0}$

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

Attempt ALL the questions. Q.31 – Q.40 Multiple Select Question (MSQ), carry TWO mark each (no negative marks).

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) $[4\pi + 2\pi]$ cyclo addition reactions are carried out in presence of light

(b) $[2\pi + 2\pi]$ cyclo addition 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
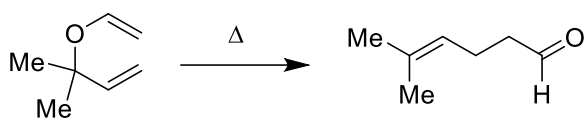
(a) oxy-Cope rearrangement   (b) sigmatropic rearrangement

(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

> **Attempt ALL the questions. Q.41 – Q.50 Numerical Answer Type (NAT), carry ONE mark each (no negative marks).**

41. The number of isomeric structures of di-substituted borazine $(B_3N_3H_4X_2)$ 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 _____
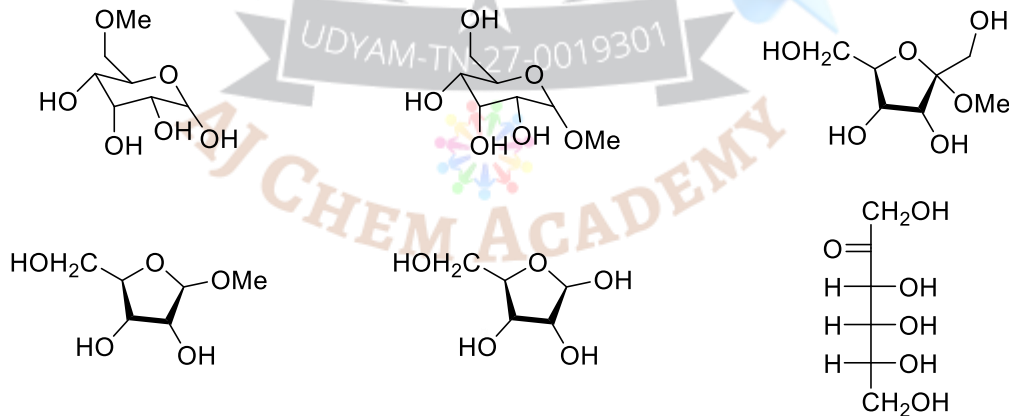
45. The maximum number of dipeptides that could be obtained by reaction of **phenylalanine** with **leucine** is _____

46. Among the following, the **number of aromatic compound(s)** is _____
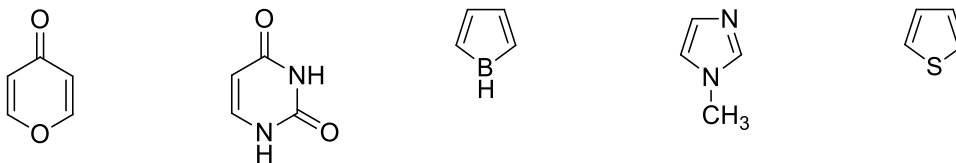
47. At an operating frequency of **350 MHz**, the shift of resonance from **TMS (tetramethylsilane)** of a proton with chemical shift of **2 ppm** is _____ **Hz**

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 for the **conversion of one mole of propene to one mole of cyclopropane** is_____$kJ\,mol^{-1}$

49. For a cell reaction, $Pb(s) + Hg_2Cl_2(s) \longrightarrow PbCl_2(s) + 2Hg(liq)$, $\left(\frac{\partial E^0}{\partial T}\right)_p$ is $1.45 \times 10^{-4}\,V\,K^{-1}$. The entropy change for the reaction is_____ $J\,mol^{-1}\,K^{-1}$

[Given: $1F = 96500\,C\,mol^{-1}$]

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

Attempt ALL the questions. Q.51 – Q.60 Numerical Answer Type (NAT), carry TWO marks each (no negative marks).

51. The standard reduction potentials of Ce^{4+}/Ce^{3+} and $Fe^{3+}/Fe^{2+}$are 1.44 and $0.77\,V$, respectively. The $\log_{10}K$ (**K** is the equilibrium constant) value for the following reaction is _____

$$Ce^{4+} + Fe^{2+} \rightleftharpoons Ce^{3+} + Fe^{3+}$$ [Given: RT/F = 0.0257 V]

(Final answer should be rounded off to two decimal places)

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

53. Silver crystallizes in a face-centered cubic lattice. The lattice parameter of silver is_____picometer

[Given: Avogadro's number $= 6.023 \times 10^{23}\,mol^{-1}$, 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 for the estimation of $42.3\,g$ of phenol (molecular wt. $= 94\,g\,mol^{-1}$) is_____gram

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 will be _____°C   [Given: $K_f(H_2O) = 1.86\,K\,kg\,mol^{-1}$]

(final answer should be rounded off to two decimal places)

57. The adsorption of a gas follows the **Langmuir** isotherm with $K = 1.25\,k\,Pa^{-1}$ at $25\,°C$. The pressure at which surface coverage is 0.2 is_____ Pa

58. The separation of 123 planes in an orthorhombic cell with $a = 0.25$ nm, $b = 0.5$ nm and $c = 0.75$ nm is _____ nm

    (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 300 K and 1 atm. Assuming that both the gases behave ideally, the **mole fraction of N_2 (g)** in the vessel is_____

    [Given: $R = 0.082$ L atm $mol^{-1}K^{-1}$, atomic wt. of hydrogen $= 1.0$ and atomic wt. of nitrogen $= 14.0$]. **(Final answer should be rounded off to two decimal places)**

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 is_____ J K^{-1} $[R = 8.314$ J $mol^{-1}K^{-1}]$

    (final answer should be rounded off to two decimal places)

Answer Key

q.no	Ans		q.no	Ans		q.no	Ans
1.	d		21.	d		41.	4 to 4
2.	b		22.	c		42.	3 to 3
3.	d		23.	c		43.	0 to 0
4.	c		24.	b		44.	3 to 3
5.	d		25.	d		45.	2 to 2 or 4 to 4
6.	a		26.	d		46.	4 to 4
7.	c		27.	a		47.	700 to 700
8.	c		28.	b		48.	33 to 33
9.	b		29.	b		49.	27.90 to 28.10
10.	d		30.	c		50.	0.05 to 0.05
11.	b		31.	a & d		51.	11.30 to 11.38
12.	c		32.	a & c		52.	128 to 130
13.	d		33.	a & b		53.	408 to 409
14.	b		34.	b & c		54.	216 to 216
15.	d		35.	a & c & d		55.	4 to 4
16.	a		36.	a & d		56.	0.35 to 0.39
17.	c		37.	b & c & d		57.	200 to 200
18.	b		38.	a & b & c		58.	0.14 to 0.15
19.	a		39.	a & c & d		59.	0.10 to 0.12
20.	a		40.	a & b		60.	14.80 to 15.00

Q. 1 – 10	1 Mark (MCQ)				Q. 41 – 50	1 Mark (NAT)

Q. 11 – 30	2 Mark (MCQ)		Q. 31 – 40	2 Mark (MSQ)		Q. 51 – 60	2 Mark (NAT)