

JAM – 2023 – Chemistry (CY)



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5. The diagram that best describes the variation of $viscosity(\eta)$ of water with temperature at 1 atm is



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12. The major product in the following reaction is



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- 17. Adsorption of a gas on a solid surface follows the Langmuir isotherm. If $\frac{k_a}{k_d} = 1.0 \text{ bar}^{-1}$, the fraction of adsorption sites occupied by the gas at equilibrium under 2.0 bar pressure of the gas at 25 °C is (k_a and k_d are the rate constants for adsorption and desorption processes, respectively, at 25 °C)
 - (a) 1/4 (b) 1/3 (c) 1/2 (d) 2/3
- 18. The vapor pressure of a dilute solution of a non-volatile solute the vapor pressure of the pure solvent at the same temperature are P and P^{*}, respectively. $\frac{P^*-P}{P^*}$ is equal
 - to (Assume that the vapor phase behaves as an ideal gas)
 - (a) molality of the solution (b) mole fraction of the solvent

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(d) mole fraction of the solute

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- 19. The volume of water (in mL) required to be added to a 100 mL solution (aq.0.1 M) of a weak acid (HA) at 25 °C to double its degree of dissociation is
 - (a) 100 (b) 200 (c) 300 (d) 400
- 20. The following diagram is obtained in a pH-metric titration of a weak dibasic acid (H_2A) with a strong base. The point that best represents $[HA^-] = [A^{-2}]$ is



(a) p

21. Equal number of gas molecules A (mass m and radius r) and B (mass 2m and radius 2r) are placed in two separate containers of equal volume. At a given temperature, the ratio of the collision frequency of B to that of A is

(a)
$$\sqrt{2}:1$$
 (b) $2\sqrt{2}:1$ (c) $1:\sqrt{2}$ (d) $1:2\sqrt{2}$

22. For the given elementary reactions, the steady-state concentration of X is

$$2P \xrightarrow{k_1} X \xrightarrow{k_2} Q + R$$

$$k_4 \downarrow K_4 \downarrow$$
S

(a)
$$\frac{k_1[P]^2 + k_3[Q][R]}{k_2 + k_4}$$
 (b) $\frac{\frac{1}{2}k_1[P]^2 + k_3[Q][R]}{k_2 + k_4}$ (c) $\frac{k_1[P]^2 + k_3[Q][R]}{-k_1 + k_2 - k_3 + k_4}$ (d) $\frac{k_1[P] + k_3[Q][R]}{k_2 + k_4}$

23. The separation (in nm) of {134} planes of an orthorhombic unit cell is

(Cell parameters a = 0.5 nm, b = 0.6 nm and c = 0.8 nm)

- (a) 0.036 (b) 0.136 (c) 0.236 (d) 0.336
- 24. The transition metal (M) complex that can have all isomers (geometric, linkage and ionization) is

(d) s









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

(d)

Fe^{III.}

 Fe^{III}



Correct statement(s) about **Q** and **R** is/are

- (a) Both Q and R give positive Fehling's test
- (b) Q gives positive iodoform test and its ¹H-NMR spectrum shows singlets at 1.0 ppm (3H) and at 1.3 ppm (3H)
- (c) R gives positive iodoform test and its ¹H-NMR spectrum shows singlets at 1.0 ppm (3H) and at 2.2 ppm (3H)
- (d) A bright yellow precipitate is formed when Q and R treated separately with 2,4-dinitrophenyl hydrazine
- **32.** The correct statement(s) is/are^M-TN-27-001930
 - (a) The pK_{a1} of cis-cyclohexane 1,3-diol is greater than that of the trans isomer.
 - (b) The trans-4-(tert-butyl)cyclohexanamine is more basic than its cis isomer.
 - (c) 2,6-dihydroxybenzoic acid is more acidic than salicylic acid.
 - (d) 2,4,6-trinitrophenol is more acidic than 2,4,6-trinitrobenzoic acid.
- **33.** The reaction(s) that yield(s) **Ph-CH₂-CH₂-CO₂Me** as the major product is/are



34. The correct option(s) of the reagents required for the following reaction is/are



- (a) (i) $Et_3B, O_2(cat), THF$; (ii) H_2O
- (b) (i) Et_2CuLi , Me_3SiCl ; (ii) H_3O^+
- (c) (i) $EtMgBr, Et_20$; (ii) H_20
- (d) (i) ⁿBuLi, THF ; (ii) EtI

35. The reaction(s) that yield(s) **1-naphthol** as the major product is/are



- (b) Complex I is paramagnetic
- (c) Complex II is diamagnetic

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(d) The crystal field stabilization energy of complex II is more than that of complex I

40. The diatomic molecule(s) that has/have bond order of one is/are

(a) B_2 (b) N_2^{2-} (c) Li_2 (d) O_2^{2-}

Attempt ALL the questions. Q.41 – Q.50 Numerical Answer Type

<u>(NAT), carry One mark each (no negative marks).</u>

41. The molecular weight of the major product of the reaction is ______ (in integer).

NH₂ (i) Br₂ (excess), CH₃CO₂H (ii) Sn/HCl (iii) NaNO₂/HCl (excess), 0 °C (iv) CuBr (excess)

[Given: atomic weight of H = 1, C = 12, N = 14 and Br = 80]

- 42. A 0.06 g/mL solution of (S)-1-phenylethanol placed in a 5 cm long polarimeter tube shows an optical rotation of 1.2°. The specific rotation is ______°. (round off to the nearest integer)
- 43. The isoelectric point of glutamic acid is _____. (round off to two decimal places)

$$(pK_a = 4.25) HO_2C$$
 $CO_2H (pK_a = 2.19)$
 $\oplus NH_3$

44. Consider the following reaction:

 $2C_6H_6 + 15O_2 \rightarrow 12CO_2 + 6H_2O$ $\Delta_r H_{298}^0 = -3120 \text{ kJ mol}^{-1}.$

A closed system initially contains 5 moles of benzene and 25 moles of oxygen under standard conditions at 298K. The reaction was stopped when 17.5 moles of oxygen is left. The amount of heat evolved during the reaction is _____ kJ. (round off to the nearest integer)

- 45. For the elementary reaction C ← A → B, k₁ = 2k₂, At time t = 0, [A] = A₀ and [B] = [C] = 0. At a later time t, the value of [B]/[C] is _____. (round off to the nearest integer)
- 46. The highest possible energy of a photon in the emission spectrum of hydrogen atom is ______ eV. (round off to two decimal places)

[Given: Rydberg constant = 13.61 eV]

47. The standard reduction potential (E^0) of $Fe^{3+} \rightarrow Fe$ is ______ V. (round off to three decimal places)



[Given: $E^0_{Fe^{2+}/Fe} = -0.44 \text{ V}$ and $E^0_{Fe^{3+}/Fe^{2+}} = 0.77 \text{ V}$]

- 48. The number of valence electrons in $Na_2[Fe(CO)_4]$ (the Colman's reagent) is _____.
- **49.** In the Born-Haber cycle, the heat of formation of CuCl is ______ kJ/mol. (round off to the nearest integer)
 - Given : Heat of atomization of Cu = +338 kJ/mol Ionization energy of Cu = +746 kJ/mol Heat of atomization of Cl₂ = +121 kJ/mol Electron affinity of Cl = -349 kJ/mol Lattice energy of CuCl = -973 kJ/mol
- 50. The spin-only magnetic moment of B_2 molecule is _____ μ_B . (round off to two decimal places)

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

51. The sum of the total number of stereoisomers (including enantiomers) present in the following molecules is _____.

52. The number of singlets observed in the ¹H-NMR spectrum of P is ______.

53. When a glass capillary tube is dipped in water, a 1.0 cm rise in the water level is observed at 18 °C. The internal radius of the capillary is _____ cm. (round off to two decimal places)

[Given: Surface tension of water at 18° C = 73.2 dyne cm⁻¹;

Difference in the densities of water and air at $18^{\circ}C = 0.996 \text{ g cm}^{-3}$;

Gravitational acceleration constant, $g = 980 \text{ cm s}^{-2}$.

Assume that water completely wets the glass capillary and the interface between the water and the air phase inside the capillary is a hemisphere.]

54. The volume of 2.0 mol of an ideal gas is reduced to half isothermally at 300 K in a





closed system. The value of ΔG is ______ kJ. (round off to two decimal places) [Given: $R = 8.314 \text{ J mol}^{-1}\text{K}^{-1}$]

55. The harmonic vibrational frequency of a diatomic molecule is 2000 cm⁻¹. Its zeropoint energy is ______ eV. (round off to two decimal places)

[Given: Planck's constant = 6.62 × 10⁻³⁴ J s; 1 eV = 1.6 × 10⁻¹⁹J]
56. An elementary reaction 2A → P follows a second order rate law with rate constant 2.5 × 10⁻³ dm³ mol⁻¹ s⁻¹. The time required for the concentration of A to change from 0.4 mol dm⁻³ to 0.2 mol dm⁻³ is _____ s. (round off to the nearest integer)

57. The following diagram shows the kinetic energy of the ejected photoelectrons against the energy of incident radiation for two metal surfaces M_1 and M_2 . If the energy of the incident radiation on M_1 is equal to the work function of M_2 , the de Broglie wavelength of the ejected photoelectron is _____ nm. (round off to two

decimal places)



Energy of incident radiation (eV)

[Given: $[1 \text{ eV} = 1.6 \times 10^{-19}]$, Mass of electron = 9.11×10^{-31} kg;

Planck's constant = 6.62×10^{-34} J s]

- 58. The spin-only magnetic moment of [Fe(acac)₃] is _____ μ_B. (round off to two decimal places)
- 59. The amount of ethane produced in the following reaction is _____kg. (round off to two decimal places)

 $C_2H_4(2kg) + H_2(2kg) \xrightarrow{Wilkinson's Catalyst} C_2H_6 (90\% catalytic conversion)$

60. In a gravimetric estimation of Al, a sample of 0. 1000 g AlCl₃ is precipitated with
8-hydroxyquinoline. The weight of the precipitate is _____ g. (round off to four

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decimal places)

[Given: atomic weight of Al = 26.98; molecular weight of $AlCl_3 = 133.34$; and molecular weight of 8-hydroxyquinoline = 145.16]

Q.No	Ans	Q.No	Ans		Q.No	Ans		Q.No	Ans
1.	b	16.	b		31.	c, d		46.	13.60 to 13.62
2.	a	17.	d		32.	b, c or b, c, d		47.	-0.037 to -0.036
3.	с	18.	d		33.	b, c, d		48.	18 to 18
4.	а	19.	с		34.	a, b		49.	-117 or -178 to -177
5.	а	20.	с	65	35.	a, c, d		50.	2.82 to 2.83
6.	d	21.	b		36.	a, b, c	1	51.	5 or 7
7.	с	22.	a		37.	a, b, c	STI	52.	3 to 3
8.	с	23.	b		38.	a, b	Y	53.	0.148 to 0.151
9.	a	24.	a	ĥ	39.	b, c, d	X	54.	3.44 to 3.46
10.	с	25.	a		40.	a, c, d		55.	0.12 to 0.13
11.	d	26.	b	יתט	41.	394 to 394		56.	500 to 500
12.	с	27.	b		42.	39 to 41		57.	1.58 to 1.59
13.	b	28.	с		43.	3.21 to 3.23		58.	5.91 to 5.92
14.	b	29.	a	.12	44.	1560 to 1560	1	59.	1.92 to 1.93
15.	d	30.	d	~	45.	2 to 2		60.	0.3440 to 0.3452

Answer Key

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)

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