

IIT JAM 2023 CY Question Paper PDF

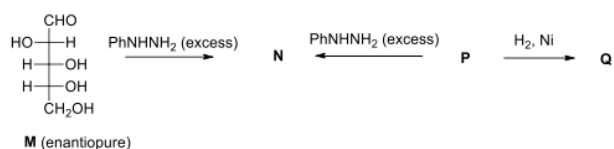
Time Allowed :1 Hour	Maximum Marks :100	Total Questions :60
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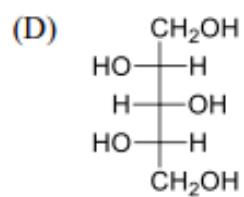
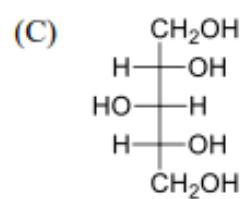
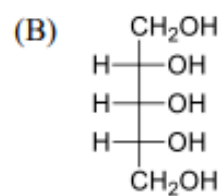
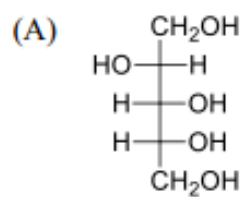
General Instructions

Read the following instructions very carefully and strictly follow them:

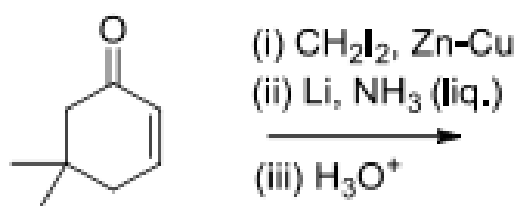
1. Please check that this question paper contains 60 questions.
2. Please write down the Serial Number of the question in the answer- book at the given place before attempting it.
3. This Question Paper has 60 questions. All questions are compulsory.
4. Adhere to the prescribed word limit while answering the questions.

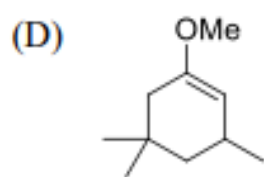
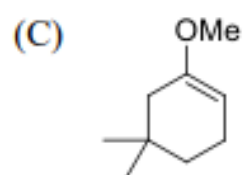
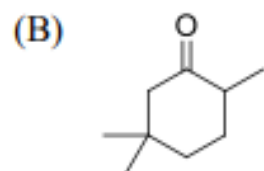
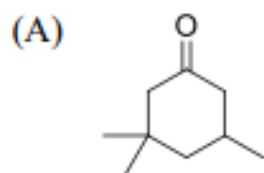
1. The structure of Q in the following reaction scheme is



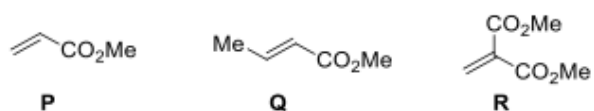


2. The major product of the reaction is



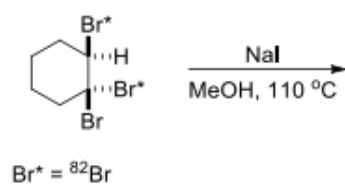


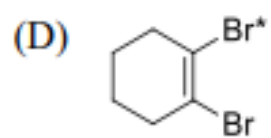
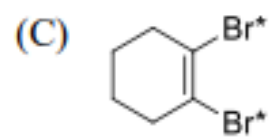
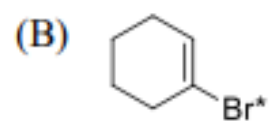
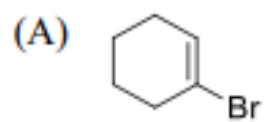
3. The rate of addition of 1-hexyl radical to the given molecules follows the order:



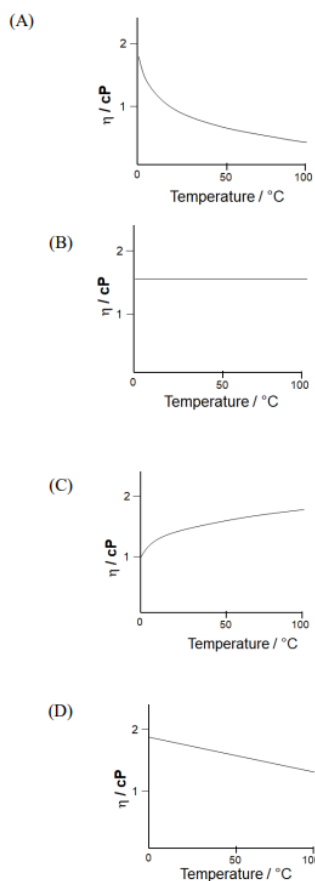
- (1) $P > R > Q$
- (2) $Q > P > R$
- (3) $R > P > Q$
- (4) $P > Q > R$

4. The major product of the reaction is





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



6. The SI unit of the molar conductivity of an electrolyte solution is

- (1) $\text{S m}^{-1} \text{mol}^{-1}$
- (2) S mol^{-1}
- (3) S m mol^{-1}
- (4) $\text{S m}^2 \text{mol}^{-1}$

7. The system with the lowest zero-point energy when it is confined to a one-dimensional box of length L is

- (1) an electron
- (2) a hydrogen atom
- (3) a helium atom
- (4) a proton

8. The metal ion present in human carbonic anhydrase is

- (1) Fe^{3+}
- (2) Cu^{2+}
- (3) Zn^{2+}

(4) Ni^{2+}

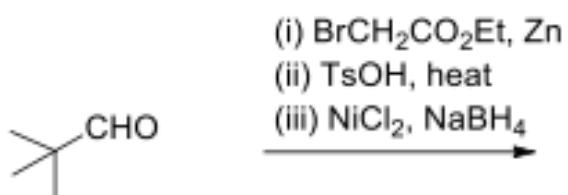
9. The oxoacid of sulfur that has $\text{S} - \text{O} - \text{S}$ bond is

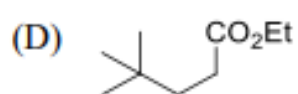
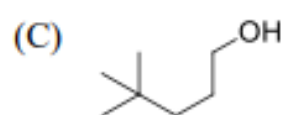
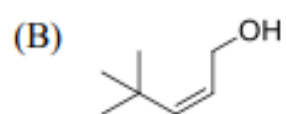
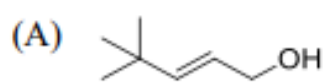
- (1) Pyrosulfuric acid
 - (2) Pyrosulfurous acid
 - (3) Dithiotic acid
 - (4) Dithionic acid
-

10. An alkaline (NaOH) solution of a compound produces a yellow colored solution on addition of NaBO . The compound is

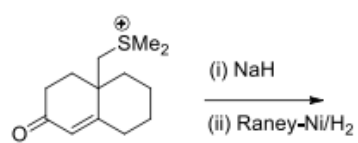
- (1) $\text{Mn}(\text{OH})_2$
 - (2) $\text{Pb}(\text{OH})_2$
 - (3) $\text{Cr}(\text{OH})_3$
 - (4) $\text{Fe}(\text{OH})_3$
-

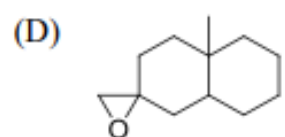
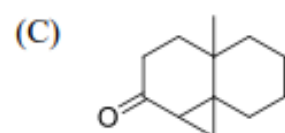
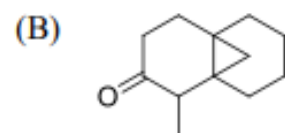
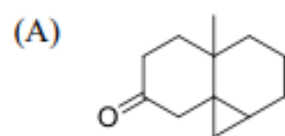
11. The major product of the reaction is



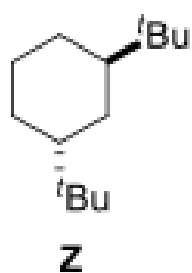
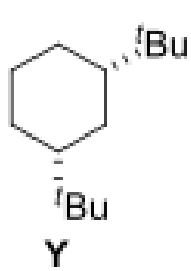


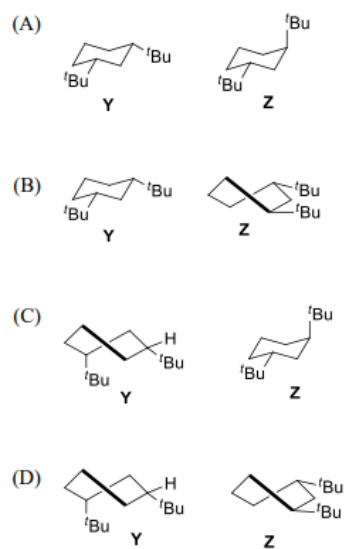
12. The major product in the following reaction is



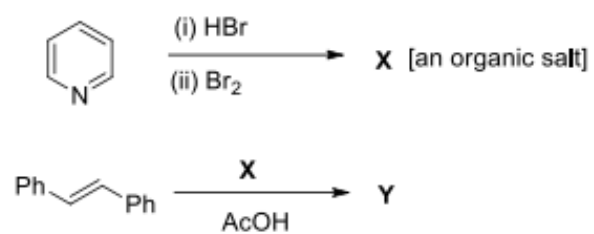


13. The most stable conformation of *Y* and that of *Z* are



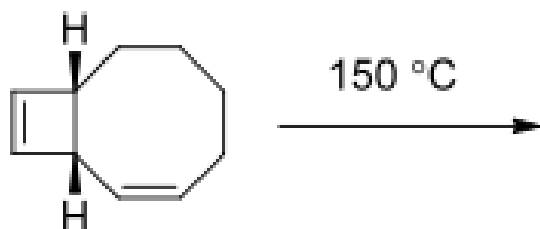


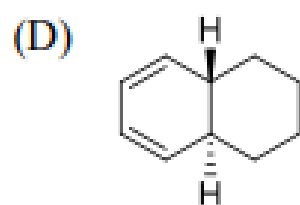
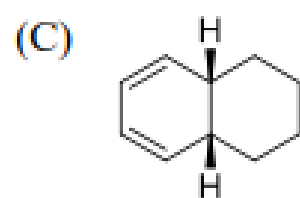
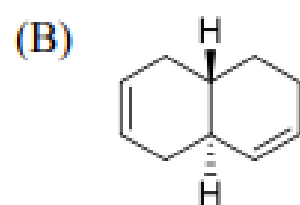
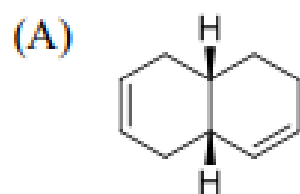
14. The major product *Y* in the following reaction scheme is



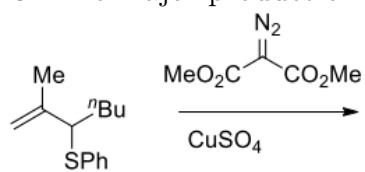
- (A)
- (B)
- (C)
- (D)

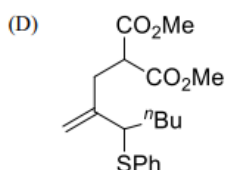
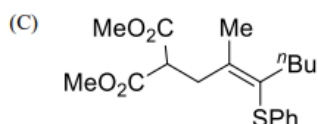
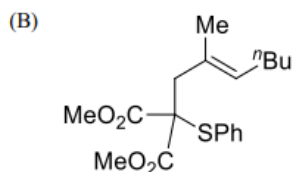
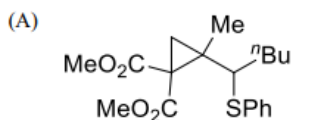
15. The major product of the reaction is





16. The major product of the reaction is





17. Adsorption of a gas on a solid surface follows the Langmuir isotherm. If $k_a/k_d = 1.0 \text{ bar}^{-1}$, the fraction of adsorption sites occupied by the gas at equilibrium under 2.0 bar of pressure of the gas at 25°C is

- (1) $\frac{1}{4}$
- (2) $\frac{1}{3}$
- (3) $\frac{1}{2}$
- (4) $\frac{2}{3}$

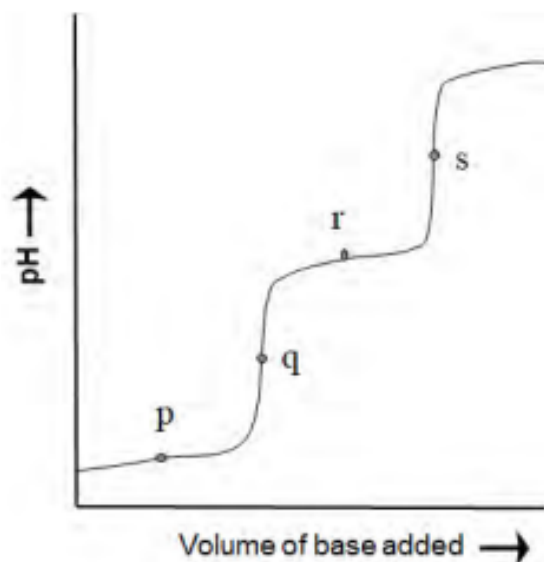
18. The vapor pressure of a dilute solution of a non-volatile solute and the vapor pressure of the pure solvent at the same temperature are P and P^* , respectively. The fraction $\frac{P^* - P}{P^*}$ is equal to

- (1) molality of the solution
- (2) mole fraction of the solvent
- (3) weight fraction of the solute
- (4) mole fraction of the solute

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 [Given: K_a of HA at $25^\circ\text{C} = 1.8 \times 10^{-5}$]

- (1) 100
- (2) 200
- (3) 300
- (4) 400

20. The following diagram is obtained in a pH-metric titration of a weak dibasic acid (HA) with a strong base. The point that best represents $[HA] = [A^{2-}]$ is



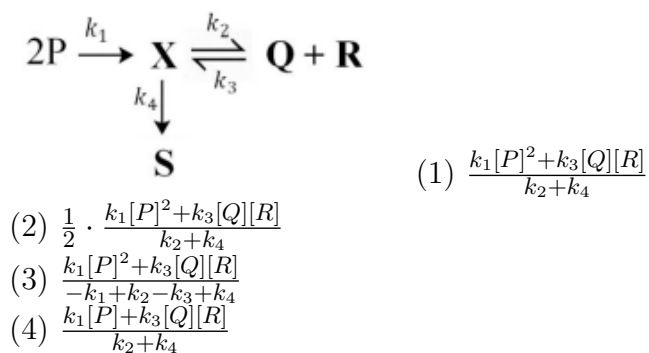
- (1) p
- (2) q
- (3) r
- (4) s

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

(Assume the gas molecules as hard spheres)

- (1) $\sqrt{2} : 1$
- (2) $2\sqrt{2} : 1$
- (3) $1 : \sqrt{2}$
- (4) $1 : 2\sqrt{2}$

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



23. The separation (in nm) of 134 planes of an orthorhombic unit cell (with cell parameters $a = 0.5 \text{ nm}$, $b = 0.6 \text{ nm}$, $c = 0.8 \text{ nm}$) is

- (1) 0.036
- (2) 0.136
- (3) 0.236
- (4) 0.336

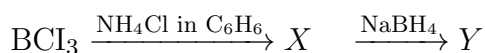
24. The transition metal (M) complex that can have all isomers (geometric, linkage, and ionization) is

- (1) $[M(NH)Br]SCN$
- (2) $[M(NH)Cl]Br$
- (3) $[M(NH)(HO)]Cl$
- (4) $[M(NH)(HO)](SCN)$

25. The geometry of $[VO(acac)]$ is

- (1) square pyramidal
- (2) trigonal bipyramidal
- (3) pentagonal planar
- (4) distorted trigonal bipyramidal

26. The products X and Y in the following reaction sequence, respectively, are

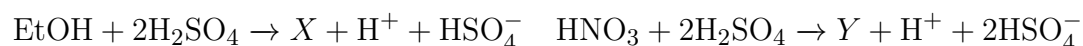


- (1) $B_3N_3Cl_6$ and $B_3N_3H_6$
- (2) $B_3N_3H_3Cl$ and $B_3N_3H_6$
- (3) $B_3N_3H_3Cl$ and $B_3N_3H_{12}$
- (4) $B_3N_3H_9Cl$ and $B_3N_3H_{12}$

27. The correct order of the energy of the d orbitals of a square planar complex is

- (1) $d_{xz} = d_{yz} < d_{z^2} < d_{xy} < d_{x^2-y^2}$
- (2) $d_{xz} = d_{yz} < d_{z^2} < d_{xy} < d_{x^2-y^2}$
- (3) $d_{xy} < d_{xz} = d_{yz} < d_{z^2} < d_{x^2-y^2}$
- (4) $d_{xy} < d_{xz} = d_{yz} < d_{z^2} < d_{x^2-y^2}$

28. X and Y in the following reactions, respectively, are

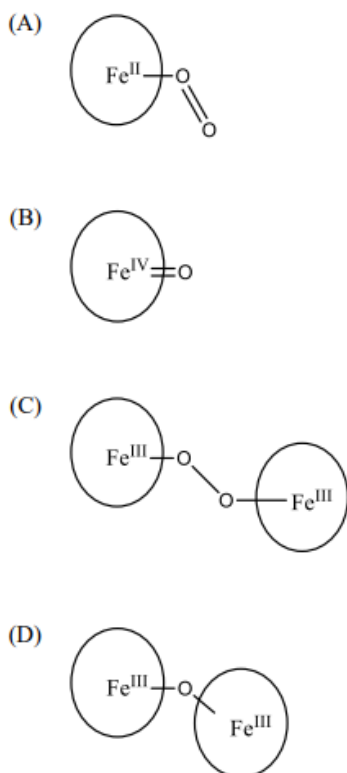


- (1) CH_3COOH and NO^+
- (2) CH_3CHO and NO_2^+
- (3) EtOSO_3H and NO_2^+
- (4) EtOSO_3H and NO^+

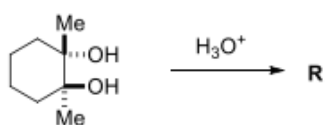
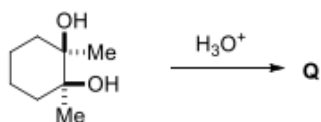
29. The correct order of energy levels of the molecular orbitals of N is

- (1) $\sigma_{1g} < \sigma_{1u} < 2\sigma_g < 2\sigma_u < 3\sigma_g < 3\sigma_u$
- (2) $\sigma_{1g} < \sigma_{1u} < 2\sigma_g < 3\sigma_u < 3\sigma_g < 1\pi_g$
- (3) $\sigma_{1g} < 2\sigma_u < \sigma_{1u} < 2\sigma_g < 3\sigma_g < 3\sigma_u$
- (4) $\sigma_{1g} < 2\sigma_g < 3\sigma_u < 1\pi_g < \sigma_{1u} < 3\sigma_g$

30. Free heme in aqueous solution when exposed to dioxygen is finally converted to (circle around iron in the given choices represents the protoporphyrin IX)



31. Correct statement(s) about Q and R is/are:

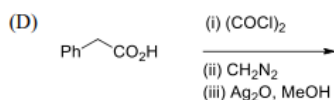
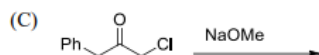
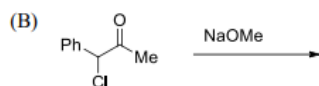
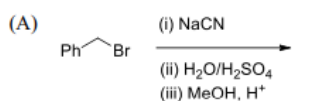


- (1) Both Q and R give positive Fehling's test
- (2) Q gives positive iodoform test and its ^1H NMR spectrum shows singlets at 1.0 ppm (3H) and at 1.3 ppm (3H)
- (3) R gives positive iodoform test and its ^1H NMR spectrum shows singlets at 1.0 ppm (3H) and at 2.2 ppm (3H)
- (4) A bright yellow precipitate is formed when Q and R treated separately with 2,4-dinitrophenyl hydrazine

32. The correct statement(s) is/are:

- (1) The pK_a of cis-cyclohexane 1,3-diol is greater than that of the trans isomer.
 - (2) The trans-4-(tert-butyl)cyclohexanamine is more basic than its cis isomer.
 - (3) 2,6-Dihydroxybenzoic acid is more acidic than salicylic acid.
 - (4) 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:

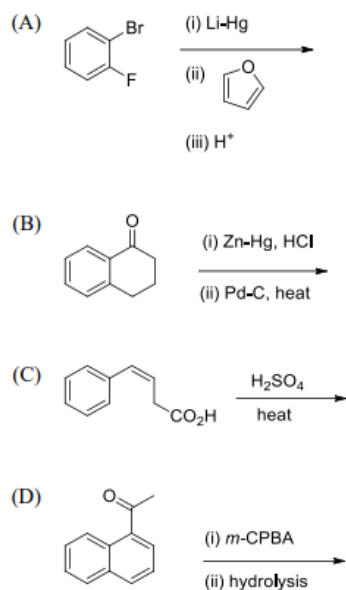


34. The correct option(s) of the reagents required for the following reaction is/are:



- (1) Et₃B, O₂(cat), THF, H₂O
 - (2) Et₂CuLi, Me₃SiCl, H₂O⁺
 - (3) EtMgBr, Et₂O, H₂O
 - (4) BuLi, THF, EtI
-

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



36. The correct relation(s) for an ideal gas in a closed system is/are:

- (1) $\left(\frac{\partial H}{\partial V}\right)_T = 0$
- (2) $\left(\frac{\partial T}{\partial P}\right)_H = 0$
- (3) $\left(\frac{\partial H}{\partial P}\right)_T = 0$
- (4) $\left(\frac{\partial H}{\partial T}\right)_P = 0$

37. The molecule(s) that follow(s) $I_a < I_b = I_c$ (where I_a , I_b , and I_c are the principal moments of inertia) is/are:

- (1) HCN
- (2) CH₃Cl
- (3) CH₃C=CH
- (4) C₆H₆

38. The role(s) of fluorspar in the electrolytic reduction of Al₂O₃ is/are to:

- (1) decrease the melting point of Al₂O₃
- (2) improve the electrical conductivity of the melt
- (3) prevent the corrosion of anode

(4) prevent the radiation loss of heat

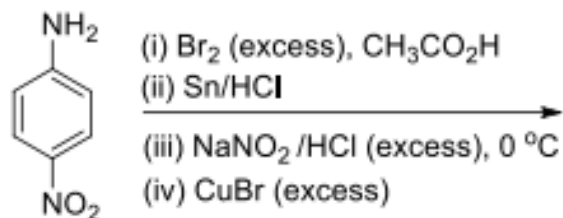
39. The correct statement(s) about the complexes I ($K_3[CoF_6]$) and II ($K_3[RhF_6]$) is/are:

- (1) Both complexes are high spin.
- (2) Complex I is paramagnetic.
- (3) Complex II is diamagnetic.
- (4) 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:

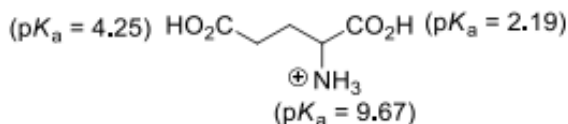
- (1) B_2
- (2) N_2^-
- (3) Li_2
- (4) O_2^-

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

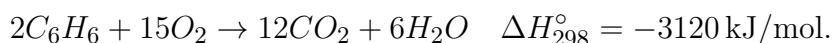


42. A 0.06 g/mL solution of (S)-1-phenylethanol placed in a 5 cm long polarimeter tube shows an optical rotation of 1.2° . The specific rotation is ____°. (round off to the nearest integer)

43. The isoelectric point of glutamic acid is ____ (round off to two decimal places).



44. Consider the following reaction:



A closed system initially contains 5 moles of benzene and 25 moles of oxygen under standard conditions at 298 K. 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 $C \xrightarrow{k_1} A \xrightarrow{k_2} B$, $k_1 = 2k_2$. At time $t = 0$, $[A] = A_0$ and $[B] = 0$. 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. [Given: Rydberg constant = 13.61 eV] (round off to two decimal places)

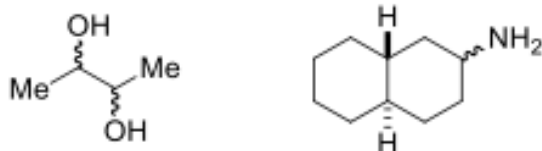
47. The standard reduction potential (E°) of $\text{Fe}^{3+} \rightarrow \text{Fe}$ is ____ V. [Given: $\text{Fe}^{3+} \rightarrow \text{Fe}^{2+}$, $E^\circ = 0.77 \text{ V}$ and $\text{Fe}^{2+} \rightarrow \text{Fe}$, $E^\circ = -0.44 \text{ V}$] (round off to three decimal places)

48. The number of valence electrons in $\text{Na}_2[\text{Fe}(\text{CO})_4]$ (the Colman's reagent) is ____.

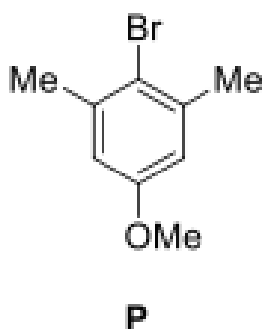
49. In the Born-Haber cycle, the heat of formation of CuCl is ____ kJ/mol. [Given: Heat of atomization of $\text{Cu} = +338 \text{ kJ/mol}$, Ionization energy of $\text{Cu} = +746 \text{ kJ/mol}$, Heat of atomization of $\text{Cl} = +121 \text{ kJ/mol}$, Electron affinity of $\text{Cl} = -349 \text{ kJ/mol}$, Lattice energy of $\text{CuCl} = -973 \text{ kJ/mol}$] (round off to the nearest integer)

50. The spin-only magnetic moment of B_2 molecule is ____ μ_B . (round off to two decimal places)

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 ____ :



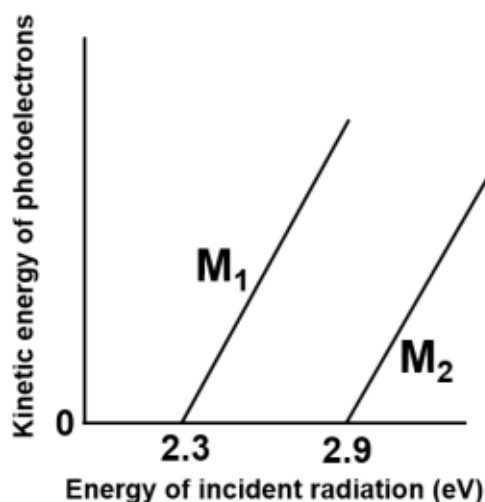
53. When a glass capillary tube is dipped in water, a 1.0 cm rise in the water level is observed at $18^\circ C$. The internal radius of the capillary is ____ cm. [Given: Surface tension of water at $18^\circ C$ = $73.2 \text{ dyne cm}^{-1}$; difference in the densities of water and air at $18^\circ C$ = 0.996 g cm^{-3} ; gravitational acceleration constant, $g = 980 \text{ cm s}^{-2}$.]

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. [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 zero-point energy is ____ eV. [Given: Planck's constant = $6.62 \times 10^{-34} \text{ J s}$; $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$]

56. An elementary reaction $2A \rightarrow P$ follows a second-order rate law with rate constant $2.5 \times 10^{-3} \text{ dm}^3 \text{ mol}^{-1} \text{ s}^{-1}$. 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 M1 and M2. If the energy of the incident radiation on M1 is equal to the work function of M2, the de Broglie wavelength of the ejected photoelectron is ____ nm.



58. The spin-only magnetic moment of $[\text{Fe}(\text{acac})_3]$ is ____ μ_B . (round off to two decimal places)

59. The amount of ethane produced in the following reaction is ____ kg. C_2H_4 (2 kg) + H_2 (2 kg) $\xrightarrow{\text{Wilkinson's Catalyst}}$ C_2H_6 (90)

60. In a gravimetric estimation of Al, a sample of 0.1000 g AlCl_3 is precipitated with 8-hydroxyquinoline. The weight of the precipitate is ____ g. [Given: atomic weight of Al = 26.98; molecular weight of AlCl_3 = 133.34; and molecular weight of 8-hydroxyquinoline = 145.16]
