Q.1. An alkaline (NaOH) solution of a compound produces a yellow colored solution on addition of $NaBO_3$. The compound is

1. $Mn(OH)_2$
2. $Fe(OH)_3$
3. $Pb(OH)_2$
4. $Cr(OH)_3$

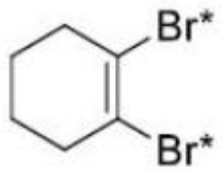
Q.2. The metal ion present in human carbonic anhydrase is

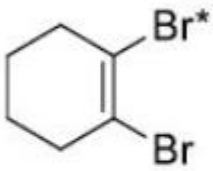
1. Cu^{2+}
2. Zn^{2+}
3. Fe^{3+}
4. Ni^{2+}

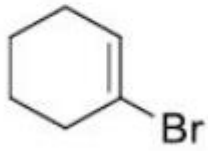
Q.3. The major product of the reaction is

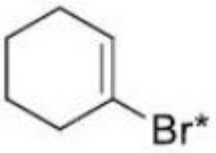


Br* = ^{82}Br

1. 

2. 

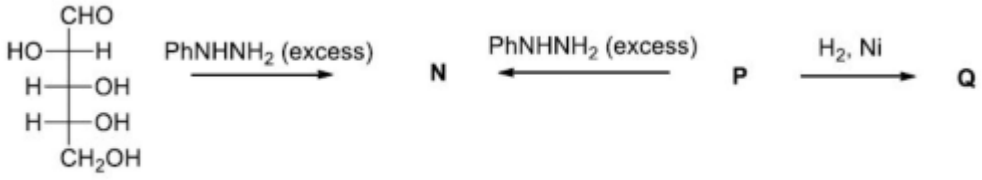
3. 

4. 

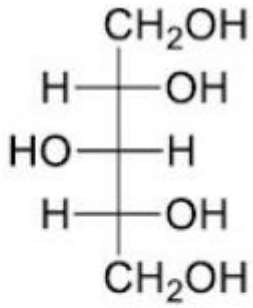
Q.4. The system with the lowest zero-point energy when it is confined to a one- dimensional box of length L is

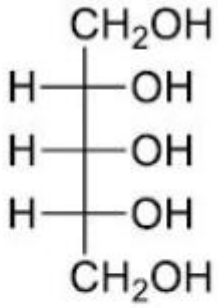
1. an electron
2. a proton
3. a helium atom
4. a hydrogen atom

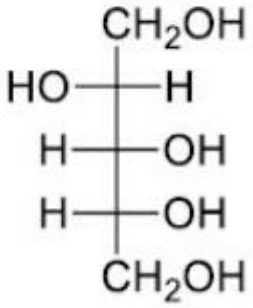
Q.5. The structure of Q in the following reaction scheme is

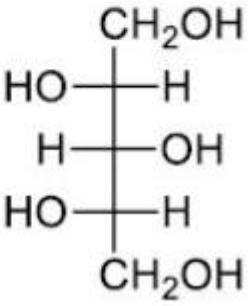


M (enantiopure)

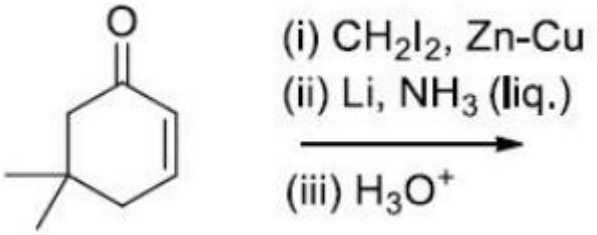
1. 

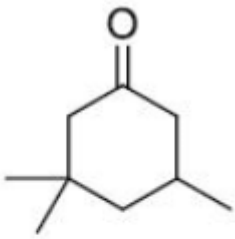
3. 

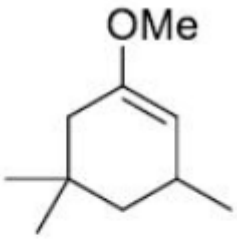
2. 

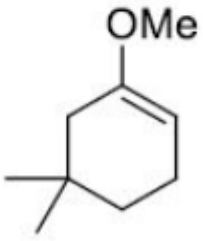
4. 

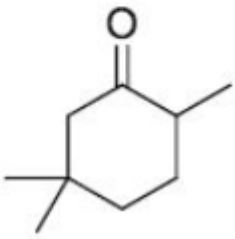
Q.6. The major product of the reaction is



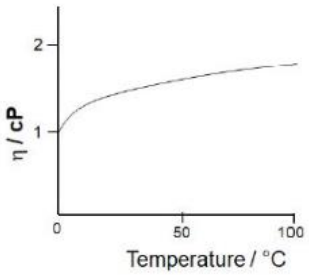
1. 

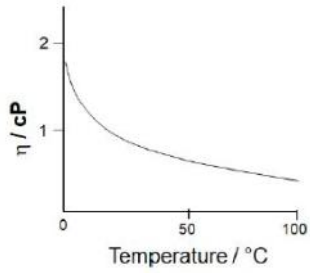
3. 

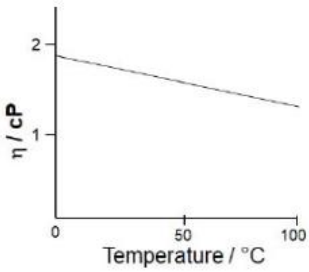
2. 

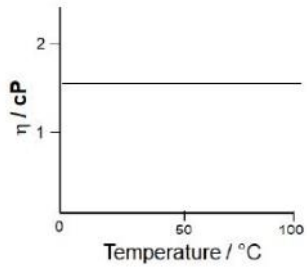
4. 

Q.7. The diagram that best describes the variation of viscosity (77) of water with temperature at 1 atm is

1.


3.


2.


4.


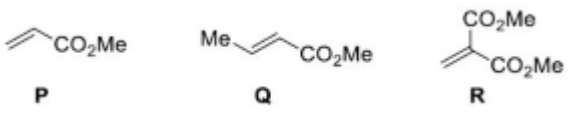
Q.8. The oxoacid of sulfur that has S-O-S bond is

1. Pyrosulfuric acid
2. Dithionous acid
3. Pyrosulfurous acid
4. Dithionic acid

Q.9. The SI unit of the molar conductivity of an electrolyte solution is

1. $Sm^{-1}\ mol^{-1}$
2. S m mol^{-1}
3. S m^2 mol^{-1}
4. S mol^{-1}

Q.10. The rate of addition of 1-hexyl radical to the given molecules follows the order

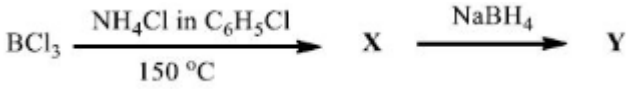


1. R > P > Q
2. P > Q > R
3. Q > P > R
4. P > R > Q

Q.11. The correct order of the energy of the d orbitals of a square planar complex is

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

Q.12. The products X and Y in the following reaction sequence, respectively, are

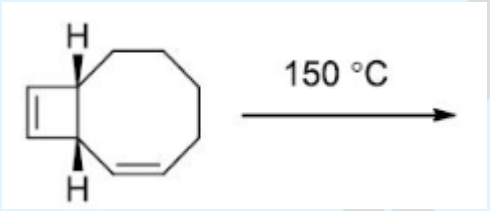


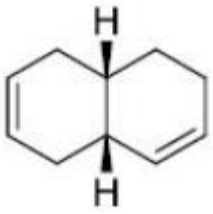
1. $B_3N_3Cl_6$ and $B_3N_3H_6$
2. $B_3N_3H3Cl_3$ and $B_3N_3H_{12}$
3. $B_3N_3H3Cl_3$ and $B_3N_3H_6$
4. $B_3N_3H9Cl_3$ and $B_3N_3H_{12}$

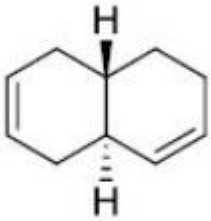
Q.13. The volume of water (in mL) required to be added to a 100 mL solution (aq. 0.1 M) of a weak acid (HA) at 25 °C to double its degree of dissociation is
[Given: K_a of HA at 25 °C = 1.8×10^{-5}]
1. 400
2. 200
3. 100
4. 300

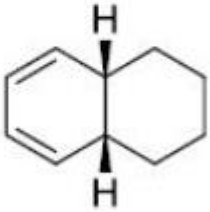
Q.14. Equal number of gas molecules A (mass m and radius r) and B (mass 2m and radius 27) are placed in two separate containers of equal volume. At a given temperature, the ratio of the collision frequency of B to that of A is
(Assume the gas molecules as hard spheres)
1. $1: 2\sqrt{2}$
2. $2\sqrt{2}: 1$
3. $1: \sqrt{2}$
4. $2\sqrt{2}: 1$

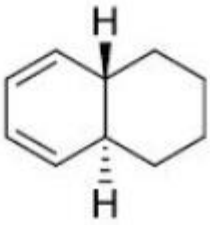
Q.15. The major product of the reaction is



1. 

2. 

3. 

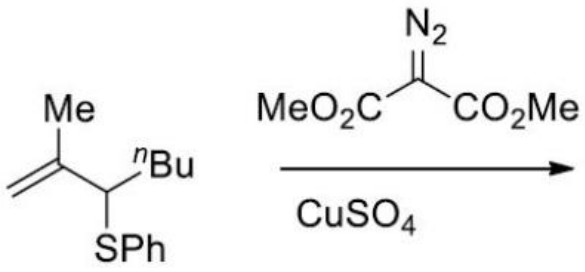
4. 

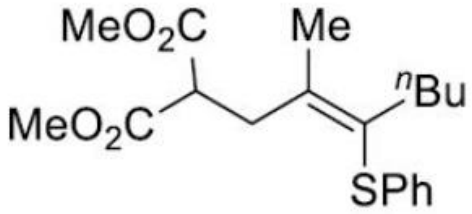
Q.16. Adsorption of a gas on a solid surface follows the Langmuir isotherm. If $\frac{k_a}{k_d} = 1.0\ bar^{-1}$, the fraction of adsorption sites occupied by the gas at equilibrium under 2.0 bar pressure of the gas at 25 °C is

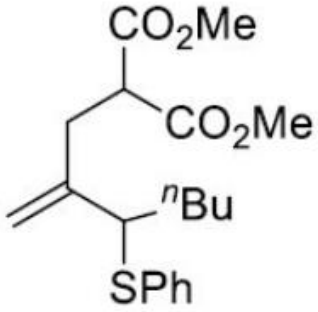
(k_a and k_d are the rate constants for adsorption and desorption processes, respectively. at 25 °C)

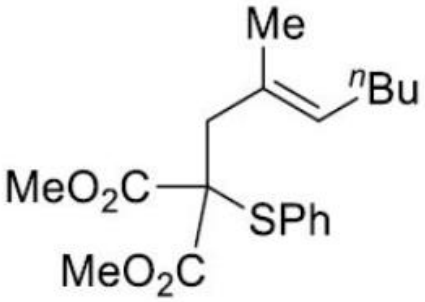
1. 1/2
2. 2/3
3. 1/3
4. 1/4

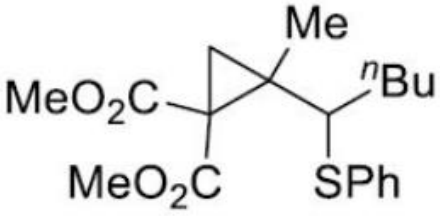
Q.17. The major product of the reaction is



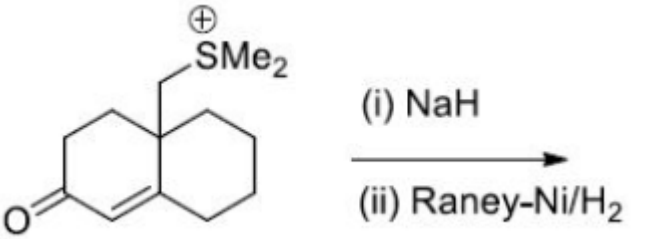
1. 

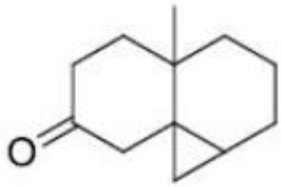
3. 

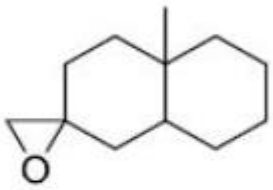
2. 

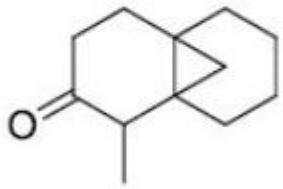
4. 

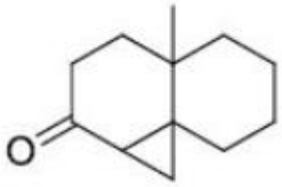
Q.18. The major product in the following reaction is



1. 

2. 

3. 

4. 

Q.19. $\boldsymbol{X}$ and $\boldsymbol{Y}$ in the following reactions, respectively, are

$EtOH+2H_2SO_4 \rightarrow X+H_3O^+ + HSO_4^-$

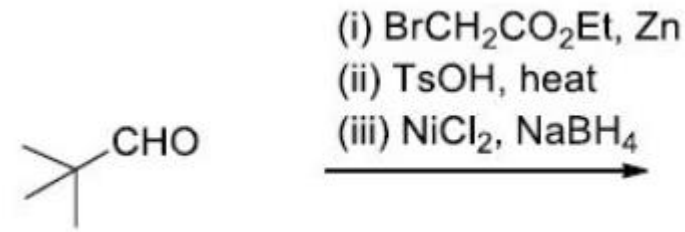
$HNO_3+2H_2SO_4 \rightarrow Y+H_3O^+ +2HSO_4^-$

1. CH_3COOH and NO^+
2. $EtOSO_3H$ and NO_2^+
3. $EtOSO_3H$ and NO^+
4. CH_3CHO and NO_2^+

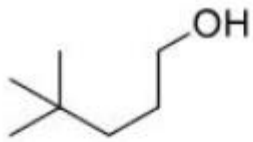
Q.20. The transition metal (M) complex that can have all isomers (geometric, linkage, and ionization) is

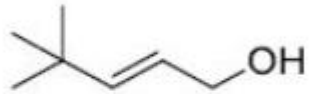
1. $[M(NH_3)_4Bl_2]SCN$
2. $[M(NH_3)_4Cl_2]Br$
3. $[M(NH_3)_4(H_2O)_2]Cl_3$
4. $[M(NH_3)_4\ (H_2O)_2]\ (SCN)_3$

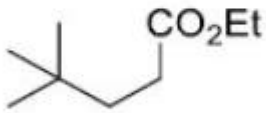
Q.21. The major product of the reaction is

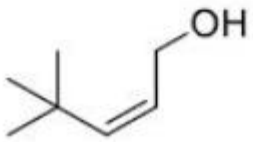


s

1. 

2. 

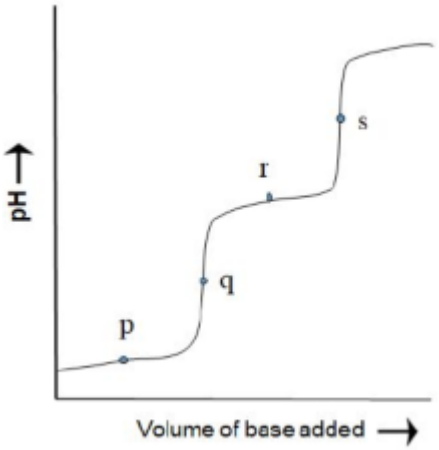
3. 

4. 

Q.22. The correct order of energy levels of the molecular orbitals of N_2 is

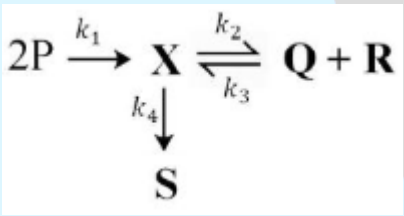
1. $1\sigma_g < 1\sigma_u < 2\sigma_g < 2\sigma_u < 1\pi_g < 3\sigma_g < 1\pi_u < 3\sigma_u$
2. $1\sigma_g < 1\sigma_u < 2\sigma_g < 2\sigma_u < 3\sigma_g < 3\sigma_u < 1\pi_u < 1\pi_g$
3. $1\sigma_g < 1\sigma_u < 2\sigma_g < 2\sigma_u < 3\sigma_g < 1\pi_u < 1\pi_g < 3\sigma_u$
4. $1\sigma_g < 1\sigma_u < 2\sigma_g < 2\sigma_u < 1\pi_u < 3\sigma_g < 1\pi_g < 3\sigma_u$

23. The following diagram is obtained in a pH-metric titration of a weak diabasic acid (H_2A) with a strong base. The point that best represents $[HA^-] = [A^{-2}]$ is



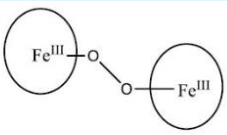
1. S
2. q
3. r
4. p

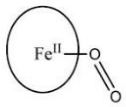
Q.24. For the given elementary reactions, the steady-state concentration of is

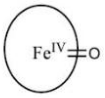


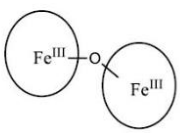
1. $\frac{k_1[P]^2+k_3[Q][R]}{-k_1+k_2-k_3+k_4}$
2. $\frac{k_1[P]+k_3[Q][R]}{k_2+k_4}$
3. $\frac{k_1[P]^2+k_3[Q][R]}{k_2+k_4}$
4. $\frac{\frac{1}{2}k_1[P]^2+k_3[Q][R]}{k_2+k_4}$

Q.25. Free heme in aqueous solution when exposed to dioxygen is finally converted to (circle around iron in the given choices represents the protoporphyrin IX)

1. 

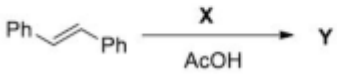
2. 

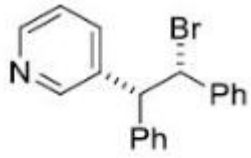
3. 

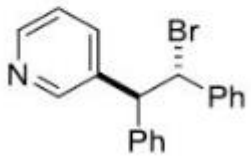
4. 

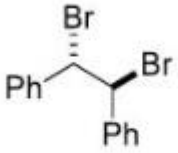
Q.26. The major product Y in the following reaction scheme is

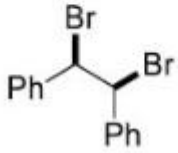




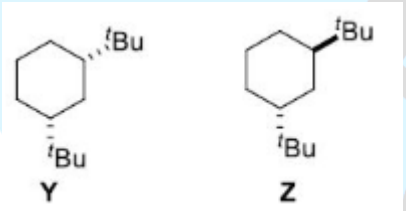
1. 

2. 

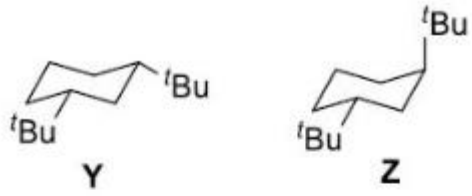
3. 

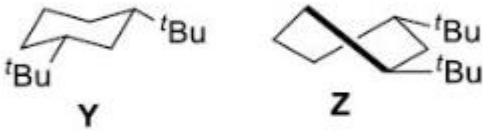
4. 

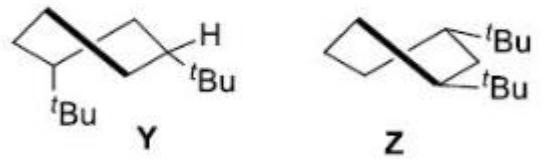
Q.27. The most stable conformation of Y and that of Z are

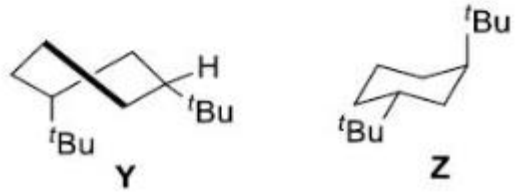


s

1. 

2. 

3. 

4. 

Q.28. 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.

$\frac{P^*-P}{P}$ is equal to

(Assume that the vapor phase behaves as an ideal gas)

1. molality of the solution
2. weight fraction of the solute
3. mole fraction of the solvent
4. mole fraction of the solute

Q.29. The separation (in nm) of (134) planes of an orthorhombic unit cell (with cell parameters a = 0.5 nm, b= 0.6 mm, and c = 0.8 nm) is

1. 0.036
2. 0.136
3. 0.336
4. 0.236

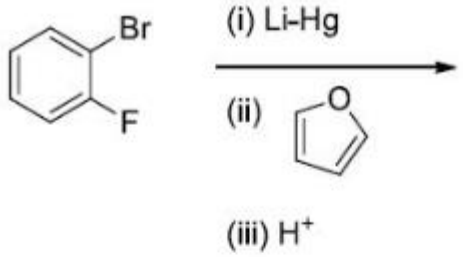
Q.30. The geometry of $[VO(acac)_2]$ is

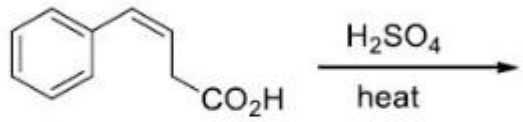
1. trigonal bipyramidal
2. pentagonal planar
3. square pyramidal
4. distorted trigonal bipyramidal

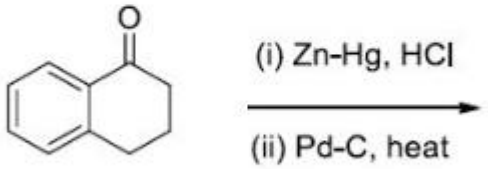
Q.31. The role(s) of fluorspar in the electrolytic reduction of Al_2O_3 is/are to

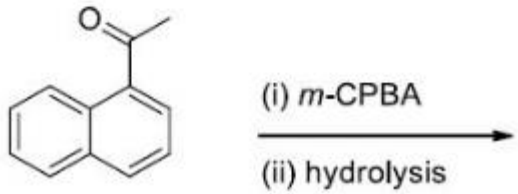
1. prevent the radiation loss of heat
2. decrease the melting point of Al_2O_3
3. prevent the corrosion of anode
4. improve the electrical conductivity of the melt

Q.32. The reaction(s) that yield(s) 1-naphthol as the major product is/are

1. 

2. 

3. 

4. 

Q.33. The correct statement(s) about the complexes I ($K_3[CoF_6]$) and II ($Ks[RhF_6]$) is/are

1. Both complexes are high spin.
2. Complex II is diamagnetic.
3. Complex I is paramagnetic.
4. The crystal field stabilization energy of complex II is more than that of complex I.

Q.34. The molecule(s) that follow(s) $I_a < I_b = I_c$ (I_a, I_b and I_c are the principal moments of inertia) is/are

1. HCN
2. C_6H_6
3. CH_3Cl
4. $CH_3C{\equiv}CH$

Q.35. The correct option(s) of the reagents required for the following reaction is/are



1. (i) Et_3B, O_2 (cat), THF; (ii) H_2O
2. (i) ^nBuLi, THF; (ii) EtI
3. (i) Et_2CuLi, Me_3SiCl; (ii) H_3O^+
4. (i) EtMgBr, Et_2O; (ii) H_2O

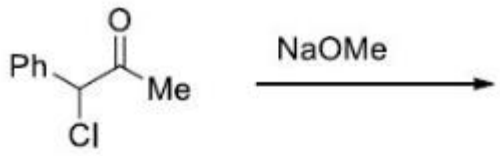
Q.36. The correct relation(s) for an ideal gas in a closed system is/are

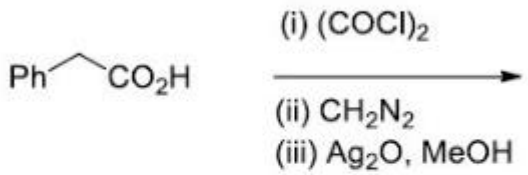
1. $\left(\frac{\partial H}{\partial T}\right)_P = 0$
2. $\left(\frac{\partial H}{\partial P}\right)_T = 0$
3. $\left(\frac{\partial T}{\partial P}\right)_H = 0$
4. $\left(\frac{\partial H}{\partial V}\right)_T = 0$

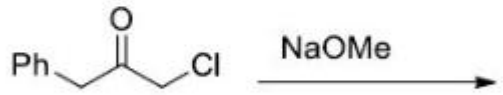
Q.37. The diatomic molecule(s) that has/have bond order of one is/are

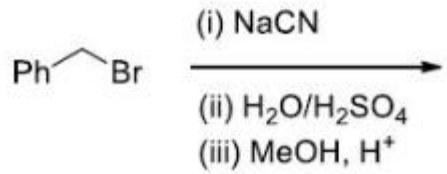
1. N_2^{2-}
2. B_2
3. O_2^{2-}
4. Li_2

Q.38. The reaction(s) that yield(s) Ph-CH_2-CH_2-CO_2Me as the major product is/are

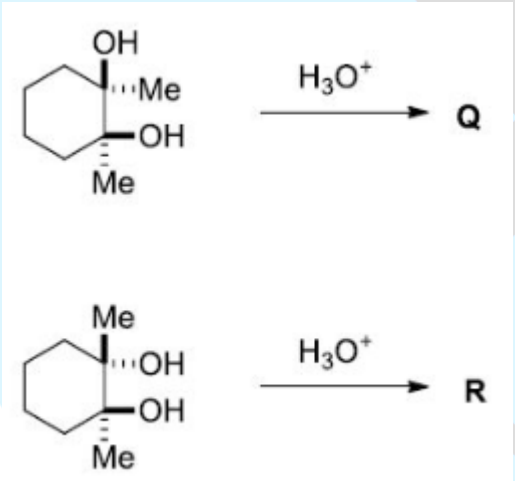
1. 

2. 

3. 

4. 

Q.39. Correct statement(s) about Q and R is/are



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

Q.40. The correct statement(s) is/are

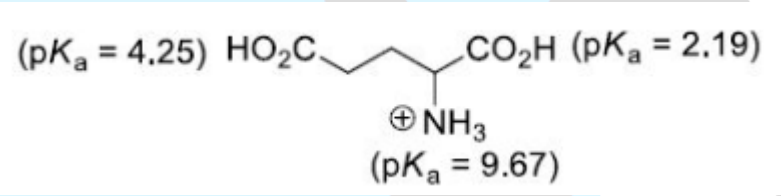
1. The trans-4-(tert-butyl)cyclohexanamine is more basic than its cis isomer.
2. The pK_{a1} of cis-cyclohexane 1,3-diol is greater than that of the trans isomer.

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.

Q.41. In the Born-Haber cycle, the heat of formation of CuCl is _____ kJ/mol.
[Given: Heat of atomization of Cu = +338 kJ/mol.
Ionization energy of Cu = +746 kJ/mol.
Heat of atomization of Cl_2 = +121 kJ/mol.
Electron affinity of Cl = -349 kJ/mol, and
Lattice energy of CuCl = -973 kJ/mol]
(round off to the nearest integer)

Q.42. For the elementary reaction $C \overset{k_2}{\leftarrow} A \overset{k_1}{\rightarrow} B, k_1 = 2k_2$. At time $t = 0$. $[A] = A_0$ and $[B] = [C] = 0$. At a later time t, the value of [B]/[C] is _____.
(round off to the nearest integer)

Q.43. The isoelectric point of glutamic acid is



(round off to two decimal places)

Q.44. The spin-only magnetic moment of B_2 molecule is _____ μ_B.
(round off to two decimal places)

Q.45. 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)

Q.46. The standard reduction potential (E^0) of $Fe^{3+} \rightarrow Fe$ is _____ V.
[Given: $Fe^{3+} \rightarrow Fe^{2+}$ E^0 = 0.77 V and Fe^{2+} Fe E^0 = - 44 V]
(round off to three decimal places)

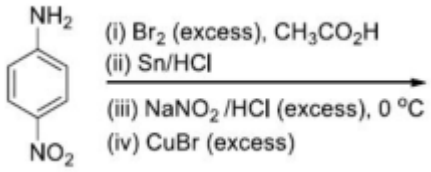
Q.47. The number of valence electrons in $Na_2[Fe(CO)_4]$ (the Colman's reagent) is _____.

Q.48. 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)

Q.49. Consider the following reaction:
$2C_6H_6 \rightarrow 12\ CO_2 + 6\ H_2\ \Delta_r\ H^0_{298} = -3120\ kJ\ mol^{-1}$.

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)

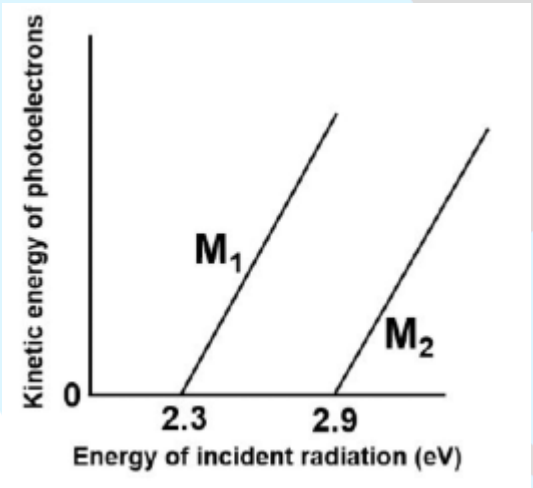
Q.50. The molecular weight of the major product of the reaction is _____ (in integer).



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

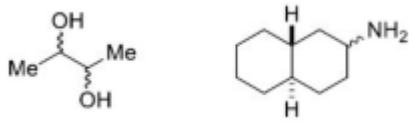
Q.51. The volume of 2.0 mol of an ideal gas is reduced to half isothermally at 300 K in a closed system. The value of ΔG is _____ kJ.
[Given: R = 8.314J $mol^{-1}K^{-1}$]
(round off to two decimal places)

Q.52. 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 M1 is equal to the work function of M_2, the de Broglie wavelength of the ejected photoelectron is nm.



[Given: Mass of electron $= 9.11 \times 10^{-31} kg$; Planck's constant $= 6.62 \times 10^{-34} J\ s$;
1 eV = 1.6×10^{-19} J.]
(round off to two decimal places)

Q.53. The sum of the total number of stereoisomers (including enantiomers) present in the following molecules is _____.



Q.54. The amount of ethane produced in the following reaction is _____ kg.

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

(round off to two decimal places)

Q.55. The number of singlets observed in the ^{1}H NMR spectrum of P is _____.



P

Q.56. The spin-only magnetic moment of $[Fe(acac)_3]$ is _____ μ_B.

(round off to two decimal places)

Q.57. 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.

[Given: Surface tension of water at 18 °C = 73.2 dyne cm^{-1}: difference in the densities of water and air at 18 °C=0.996 g cm^{-3}: gravitational acceleration constant, g = 980 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.]

(round off to two decimal places)

Q.58. An elementary reaction $2A \rightarrow P$ follows a second order rate law with rate constant $2.5 \times 10^{-3} dm^3 mol^{-1}\ s^{-1}$. 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)

Q.59. 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 is 26.98; molecular weight of $AlCl_3$ is 133.34; and molecular weight of 8-hydroxyquinoline is 145.16]

(round off to 4 decimal places)

Q.60. The harmonic vibrational frequency of a diatomic molecule is 2000 cm^{-1}. Its zero- point energy is _____ eV.

[Given: Planck's constant $= 6.62 \times 10^{-34}\ Js; 1\ eV = 1.6 \times 10^{-19} J$]

(round off to two decimal places)