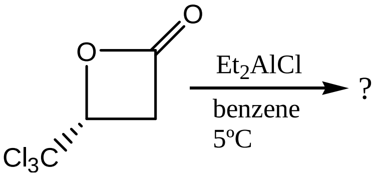
CHEMISTRY-CY

Q.1 – Q.25 : Carry ONE mark each.

1. The major product formed in the following reaction is



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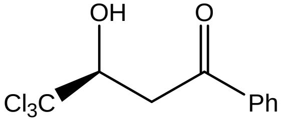

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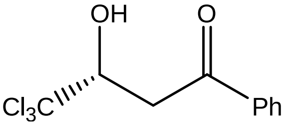
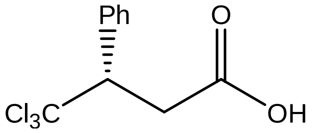


(c)


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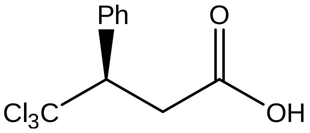
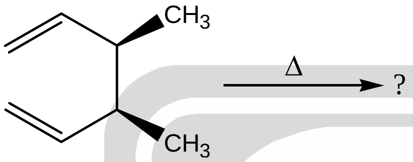
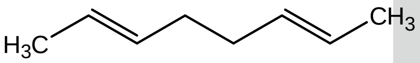


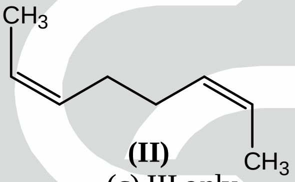
2. Among the following carbon allotropes, the one with discrete molecular structure is
(a) Diamond (b) α-Graphite (c) β-Graphite (d) Fullerene

3. The product (s) formed in the following reaction is(are)

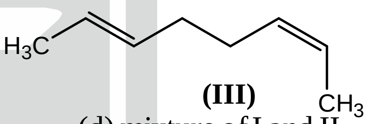




(I)



(II)



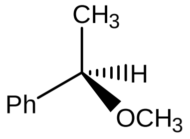
(III)

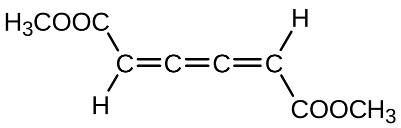
(a) I only (b) II only (c) III only (d) mixture of I and II

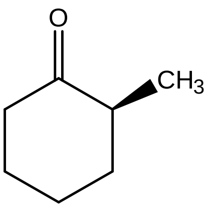
4. Micelle formation is accompanied by the
(a) decrease in overall entropy due to ordering
(b) increase in overall entropy mostly due to increase in solvent entropy
(c) increase in overall entropy mostly due to increase in solute entropy
(d) increase in overall entropy and decrease in enthalpy

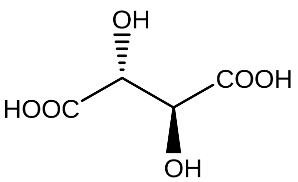
5. On heating a sample of 25 mg hydrated compound (molecular weight = 250 g/mol) in thermogravimetric analysis, 16 mg of dehydrated compound remains. The number of water molecules lost per molecule of hydrated compound is _______________
(Molecular weight of water = 18 g/mol)

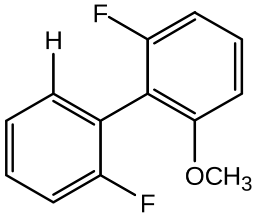
6. Among the following compounds, the number of compounds that DO NOT exhibit optical activity at room temperature is __________

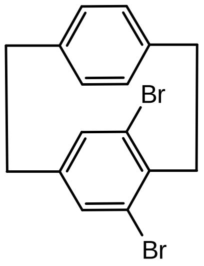




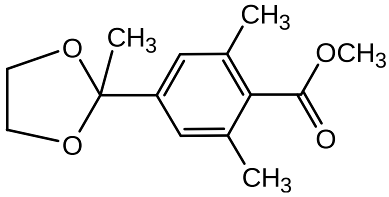








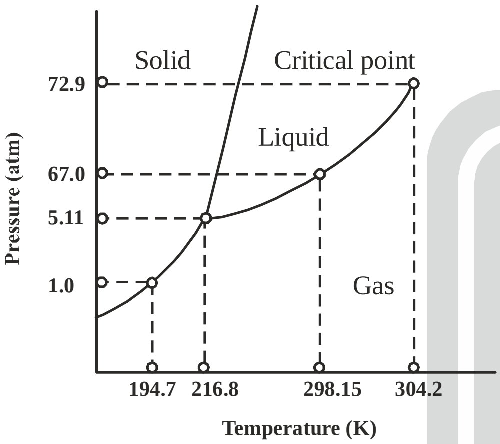
7. The number of ^1H NMR signals observed for the following compound is ______________



8. The INCORRECT statement about the solid-state structure of CsCl and CaF_2 is
(a) Cations in both sides exhibit coordination number 8
(b) CsCl has bcc type structure and CaF_2 has cubic close pack structure
(c) Radius ratio for Cs/Cl and Ca/F is 0.93 and 0.73, respectively
(d) Both exhibit close pack structure

9. The number of CO stretching bands in IR spectrum of trigonal bipyramidal cis-$M(CO)_3L_2$ is ___________
(M = metal and L = monodentate ligand)

10. Consider the following phase diagram of CO_2 (not to scale). At equilibrium, the INCORRECT statement is



(a) At 200K, on increasing the pressure from 1 to 50 atm, CO_2 gas condenses to liquid
(b) It is not possible to obtain liquid CO_2 from gaseous CO_2 below 5.11 atm
(c) Both liquid and gas phase of CO_2 coexist at 298.15 K and 67 atm
(d) With increasing pressure, the melting point of solid CO_2 increases.

11. In a 400 MHz ^1H NMR spectrometer, a proton resonates at 1560 Hz higher than that of tetramethylsilane. The chemical shift value of this proton is ___________________ppm. (Round off to one decimal places). (Chemical shift of tetramethylsilane is fixed at zero ppm)

12. The Δ_0 value of $\left[Ni(H_2O)_6\right]^{2+}$ is 8500 cm^{-1}. The Δ_0 values of $\left[NiCl_6\right]^{4-}$ and $\left[Ni(NH_3)_6\right]^{2+}$ compared to $\left[Ni(H_2O)_6\right]^{2+}$ are

(a) higher and lower, respectively	(b) lower and higher, respectively
(c) higher in both complex ions	(d) lower in both complex ions

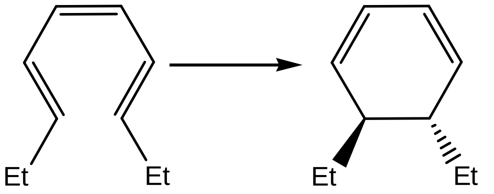
13. Consider a system of three identical and distinguishable non-interacting particles and three available non-degenerate single particle energy levels having energies 0, ε and 2ε. The system is in contact with a heat bath of temperature T(K). A total energy of 2ε is shared by these three particles. The number of ways the particles can be distributed is ______________________

14. In Freundlich isotherm, a linear relationship is obtained in the plot of $(\theta = \text{surface coverage and p} = \text{partial pressure of the gas})$

(a) θ vs p (b) $\ln(\theta)$ vs $\ln(p)$ (c) $\ln(\theta)$ vs (p) (d) θ vs $\ln(p)$

15. Consider a two-state system at thermal equilibrium having energies 0 and $2k_BT$ for which the degnerates are 1 and 2, respectively. The value of the partition function at the same absolute temperature T is ____________(Round off to two decimal places).
(k_B is the Boltzmann constant)

16. The Woodward-Hoffmann condition to bring out the following transformation is



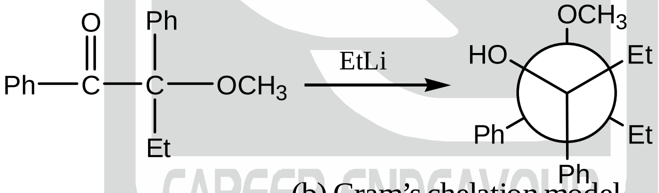
(a) Δ, conrotatory (b) Δ, disrotatory (c) hν, disrotatory (d) hν, conrotatory

17. Gas phase bond length and dipole moment of a compound (MX) is 3Å and 10.8 D, respectively. The ionic character in gas phase MX is ______________%. (Round off to one decimal place).
($1\text{D} = 3.336\times10^{-30}$ C m)

18. The INCORRECT statement about the silicones is
(a) They are thermally unstable because of the Si–C bond
(b) They are insoluble in water
(c) They are organosilicon polymers
(d) They have stable silica-like skeleton (–Si–O–Si–O–Si–)

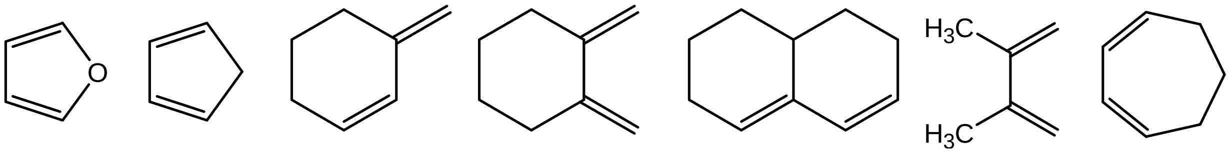
19. The entropy change for the melting of ‘x’ moles of ice (heat of fusion is 80 cal g^{-1}) at 273 K and 1 atm pressure is 28.80 cal K^{-1}. The value of ‘x’ is ____________(Round off to two decimal places)
(Molecular weight of water = 18 g/mol)

20. In the following reaction, the stereochemistry of the major product is predicted by the

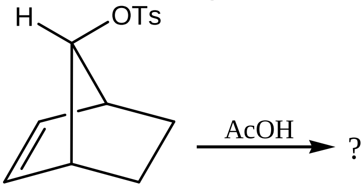


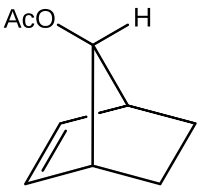
(a) Cram’s model (b) Cram’s chelation model
(c) Felkin model (d) Felkin-Anh model

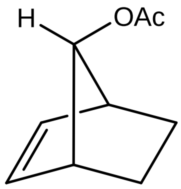
21. The number of following diene(s) that undergo Diels-Alder reaction with methyl acrylate is ______________

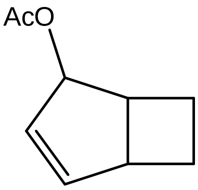


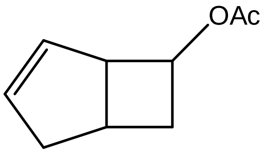
22. The major product formed in the following reaction is



(a) 

(b) 

(c) 

(d) 

23. An ideal gas occupies an unknown volume V liters (L) at a pressure of 12 atm. The gas is expanded isothermally against a constant external pressure of 2 atm so that its final volume becomes 3 L. The work involved for this expansion process is ______________cal. (Round off to two decimal places). (Gas constant R = 0.082 L atm mol^{-1} K^{-1} = 2 cal mol^{-1} K^{-1})

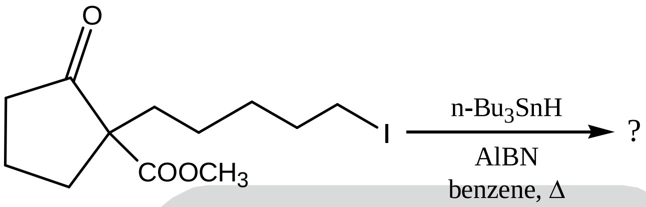
24. The total number of α and β particles emitted in the following radioactive decay is _____________

$$^{238}_{92}U \longrightarrow {}^{210}_{82}Pb$$

25. The INCORRECT statement about the interhalogen compound ICl_3 is
(a) It exists as a dimer
(b) Geometry around the iodine is tetrahedral in solid-state
(c) It decomposes as ICl and Cl_2 in gas-phase
(d) Liquid ICl_3 conducts electricity

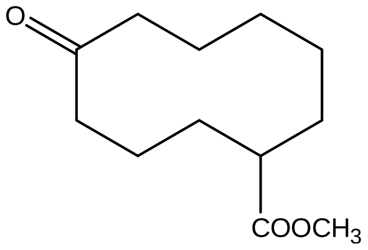
Q.26 – Q.55 : Carry TWO marks each.

26. The major product formed in the following reaction is

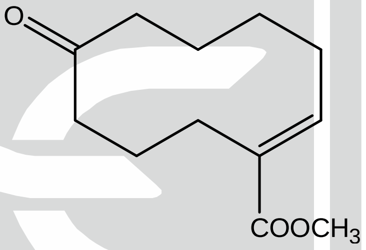


(AlBN = azobisisobutyronitrile)

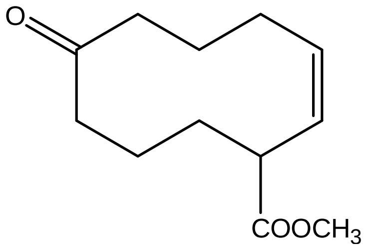
(a)



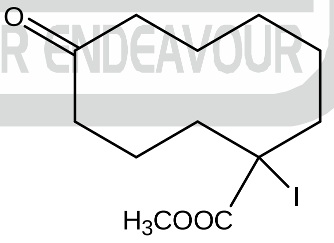
(b)



(c)



(d)



27. Match the metalloproteins with their respective functions

P	Ferritin	I	Electron transfer
Q	Rubredoxin	II	Acid – base catalysis
R	Cobalamin	III	Metal storage
S	Carbonic anhydrase	IV	Methyl transfer

(a) P-III; Q-II; R-I; S-IV
(b) P-III; Q-I; R-IV; S-II
(c) P-IV; Q-I; R-III; S-II
(d) P-IV; Q-II; R-I; S-III

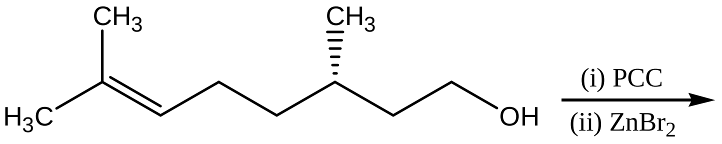
28. The correct molecular representation of $\mathrm{W(Cp)_2(CO)_2}$ is

(Cp = cyclopentadienyl)

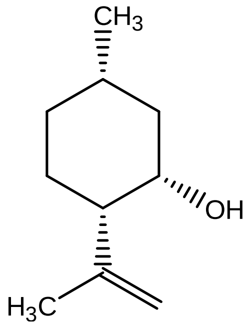
(a) $\left[\mathrm{W}(\eta^1\text{-Cp})(\eta^3\text{-Cp})(\mathrm{CO})_2\right]$ (b) $\left[\mathrm{W}(\eta^1\text{-Cp})(\eta^5\text{-Cp})(\mathrm{CO})_2\right]$

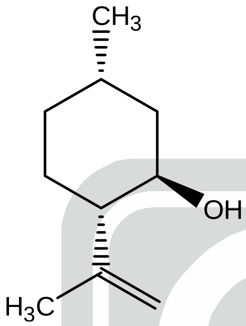
(c) $\left[\mathrm{W}(\eta^3\text{-Cp})(\eta^5\text{-Cp})(\mathrm{CO})_2\right]$ (d) $\left[\mathrm{W}(\eta^5\text{-Cp})_2(\mathrm{CO})_2\right]$

29. The major product formed in the following reaction is



(PCC = pyridinium chlorochromate)

(a)


(b)


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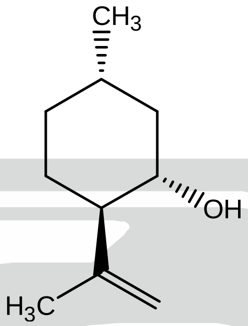
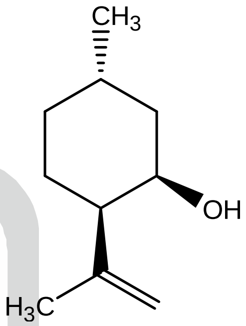


(d)


30. The rate of the following redox reaction is slowest when X is

$$\left[\mathrm{Co^{III}(NH_3)_5X}\right]^{3+/2+} + \left[\mathrm{Cr^{II}(H_2O)_6}\right]^{2+} \rightarrow \left[\mathrm{Co^{II}(NH_3)_5(H_2O)}\right]^{2+} + \left[\mathrm{Cr^{III}(H_2O)_5X}\right]^{3+/2+}$$

(a) H_2O (b) NH_3 (c) Cl^- (d) N_3^-

31. If $\left\langle \alpha \,|\, \hat{S}_x\hat{S}_y - \hat{S}_y\hat{S}_x \,|\, \alpha \right\rangle = i\hbar^2 a$, where $\hat{S}_x$ and $\hat{S}_y$ are spin angular momentum operators and $|\alpha\rangle$ is spin up eigen function, then the value of a is ____________(Round off to one decimal place)

32. Among the following compounds, a normal spinel is

(a) $MgFe_2O_4$ (b) $ZnFe_2O_4$ (c) $CoFe_2O_4$ (d) $CuFe_2O_4$

33. Following are the examples of silicate minerals

Zircon, $\underset{(\mathrm{I})}{\mathrm{ZrSiO_4}}$ Beryl, $\underset{(\mathrm{II})}{\mathrm{Be_3Al_2Si_6O_{18}}}$ Pyrophyllite, $\underset{(\mathrm{III})}{\mathrm{Al_2(OH)_2\left[(Si_2O_5)_2\right]}}$

The correct structural description of the minerals is

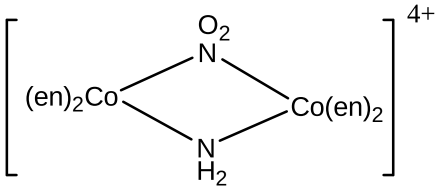
(a) **I**-Ortho silicate, **II**-Cyclic silicate and **III**-Sheet silicate

(b) **I**-Ortho silicate, **II**-Sheet silicate and **III**-Cyclic silicate

(c) **I**-Cyclo silicate, **II**-Sheet silicate and **III**-Ortho silicate

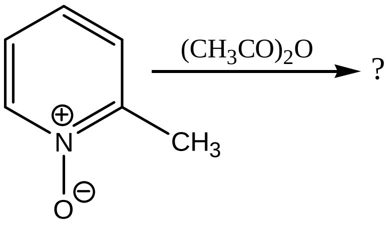
(d) **I**-Sheet silicate, **II**-Ortho silicate and **III**-Cyclic silicate

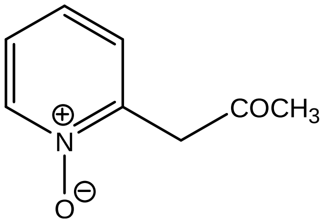
34. The number of possible optically active isomer(s) for the following complex is



en = ethylenediamine

35. The major product formed in the following reaction is



(a)


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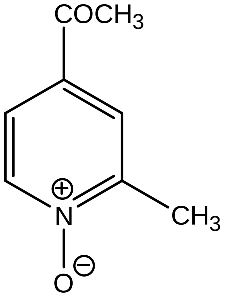

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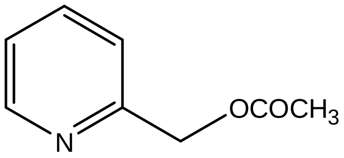

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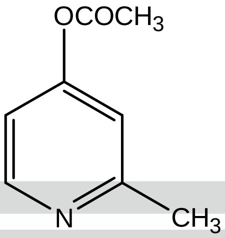
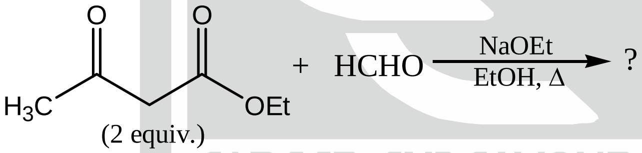


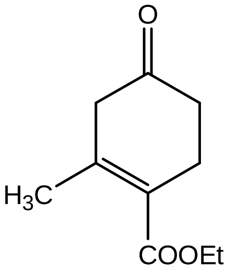
Q.36-Q.65 carry TWO marks each.

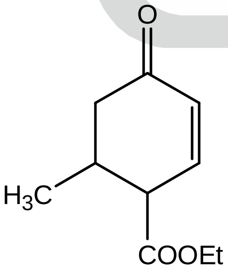
36. In the EPR spectrum of a methyl radical, the number of lines and their relative intensities, respectively are

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

37. The major product formed in the following reaction is



(a)


(b)


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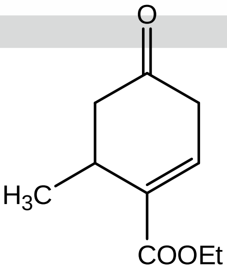

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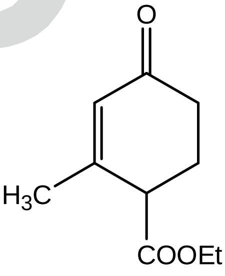
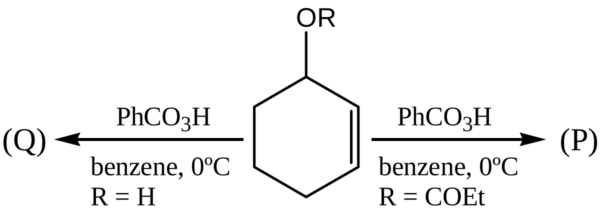
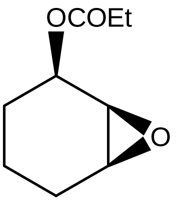
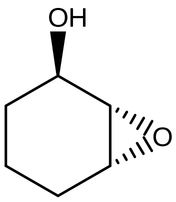
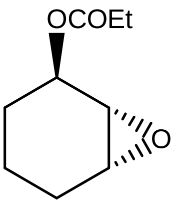


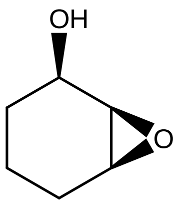
38. In the following reactions, the major product (P) and (Q) are

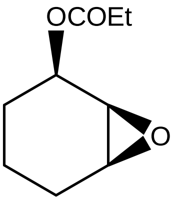


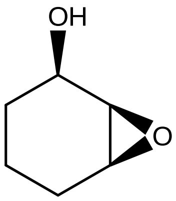
(a) P = 

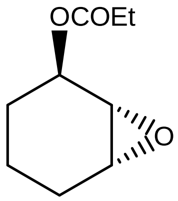
Q = 

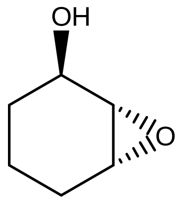
(b) P = 

Q = 

(c) P = 

Q = 

(d) P = 

Q = 

39. The normal boiling point of a compound (X) is 350 K (heat of vaporization, $\Delta_{\text{vap}}H = 30\text{ kJ mol}^{-1}$). The pressure required to boil 'X' at 300K is ____________Torr. (Round off to two decimal places)

(Ignore the temperature variation of $\Delta_{\text{vap}}H$; Gas constant R = 8.31 J $\text{mol}^{-1}\text{K}^{-1}$ and 1 atm = 760 Torr)

40. Suppose the wave function of a one dimensional system is

$\psi = \sin(kx)\exp(3ikx)$

In an experiment measuring the momentum of the system, one of the expected outcomes is

(a) 0 (b) $\hbar k$ (c) $2\hbar k$ (d) $3\hbar k$

41. The specific rotation of optically pure (R)-2-bromobutane is –112.00. A given sample of 2-bromobutane exhibited a specific rotation of –82.88. The percentage of (S)-(+)-enantiomer present in the sample is ________________

42. The product obtained in the reaction of $Mn_2(CO)_{10}$ with Br_2 is

(a) $Mn(CO)_5Br$ (b) $Mn_2(CO)_8Br_2$ (c) $Mn(CO)_4Br_2$ (d) $Mn_2(CO)_9Br$

43. A particle in one dimensional box of length 2*a* with potential energy

$$V = \begin{cases} 0 & |x| < a \\ \infty & |x| > a \end{cases}$$

is perturbed by the potential $V' = ex\ eV$, where *c* is a constant. The first order correction to the first excited state of the system is __________________× c eV.

44. For a bimolecular gas phase reaction, $P + Q \longrightarrow R$, the pre-exponential factor is $1\times10^{13}\text{ dm}^3\text{ mol}^{-1}\text{ s}^{-1}$. The standard entropy of activation at 25°C is ___________$\text{JK}^{-1}\text{mol}^{-1}$. (Round off to two decimal points).

(The standard concentration c^0 =1 mol dm^{-3}, Planck constant h = 6.62×10^{-34} J s, Boltzmann constant k_B =$1.38\times10^{-23}\text{ JK}^{-1}$, Gas constant R = 8.31 J $\text{mol}^{-1}\text{ K}^{-1}$)

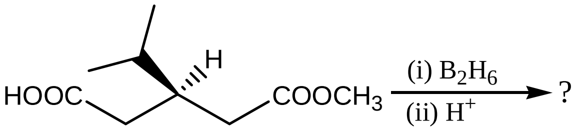
45. The experimentally observed magnetic moment values, which match well with the spin-only values for the pair of aqueous ions is

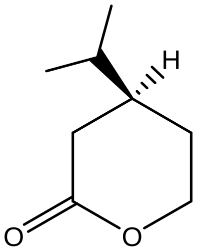
(Atomic number: Cr = 24, Co = 27, Gd = 64, Tb = 65, Dy = 66 and Lu = 71)

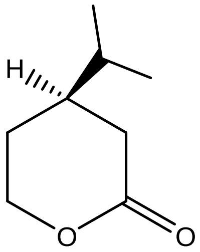
(a) Cr (III) and Gd (III) (b) Co(II) and Gd(III)

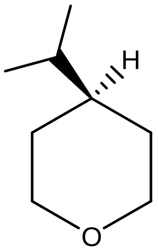
(c) Cr(III) and Dy(III) (d) Lu(III) and Tb(III)

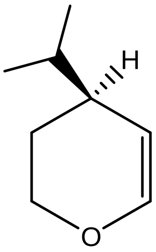
46. The major product formed in the following reaction is



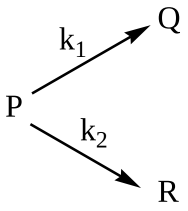
(a) 

(b) 

(c) 

(d) 

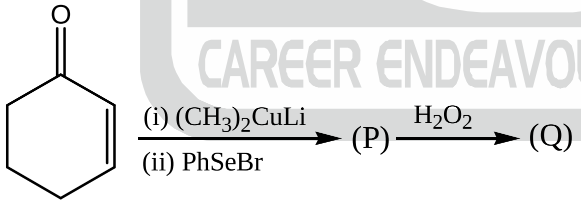
47. Consider the following two parallel irreversible first order reaction at temperature T,

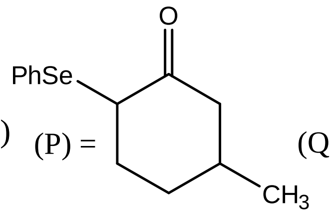


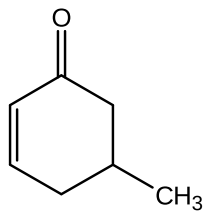
where k_1 and k_2 are the rate constants and their values are 5×10^{-2} and 15×10^{-2} min^{-1}, respectively, at temperature T. If the initial concentration of the reactant (P) is 4 mol L^{-1}, then the concentration of product (R) after 10 min of reaction is ______________mol L^{-1}. (Round off to two decimal places)
(Assume only P is present at the beginning of the reaction)

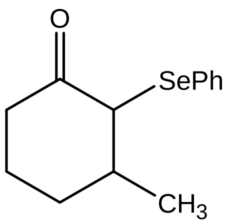
48. Consider a two dimensional harmonic oscillator with angular frequency $\omega_x = 2\omega_y = 6.5\times10^{14}\ rad\ s^{-1}$. The wavelength of x polarized light required for the excitation of a particle from its ground state to the next allowed excited state is ____________________$\times10^{-6}$ m. (Round off to one decimal places).
(Speed of light, $c = 3.0\times10^8$ m s^{-1})

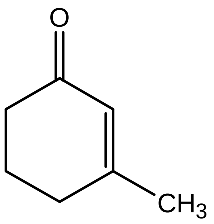
49. In the following reaction sequence, the products P and Q are

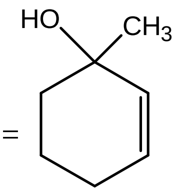


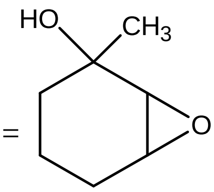
(a) (P) = 

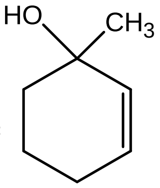
(Q) = 

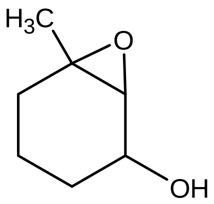
(b) (P) = 

(Q) = 

(c) (P) = 

(Q) = 

(d) (P) = 

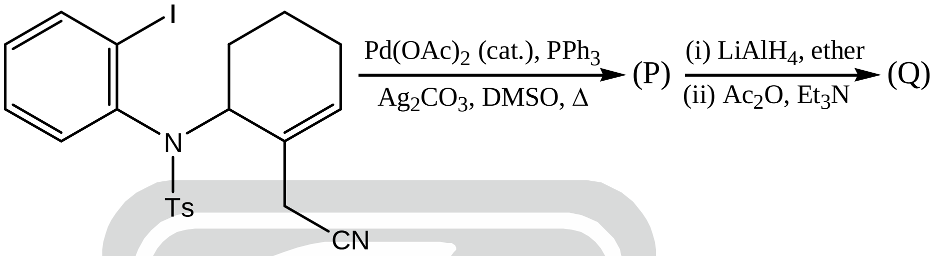
(Q) = 

50. Character table of point groups D_8 is given below

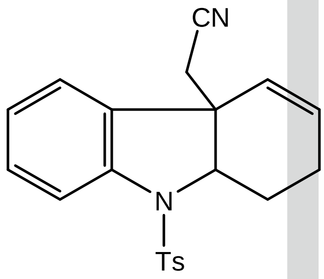
D_8	E	$2C_8$	$2C_4$	$2C_8^3$	C_2	$4C'_2$	$4C''_2$
A_1	**a**	1	1	1	1	1	1
A_2	**b**	1	1	1	1	**h**	**i**
B_1	**c**	–1	1	–1	1	1	**j**
B_2	**d**	–1	1	–1	1	–1	1
E_1	**e**	$\sqrt{2}$	0	$-\sqrt{2}$	–2	0	0
E_2	**f**	0	–2	0	**k**	0	0
E_3	**g**	$-\sqrt{2}$	0	$\sqrt{2}$	–2	0	0

The value of $(a+b+c+d+e+f+g+h+i+j+k)$ is equal to ________________

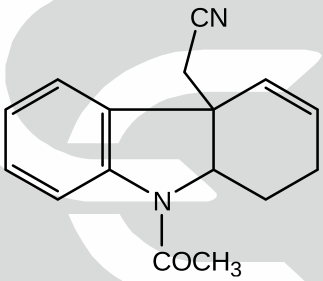
51. In the following reaction sequence, the products P and Q are



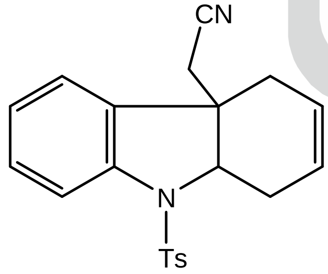
(a) **P =**



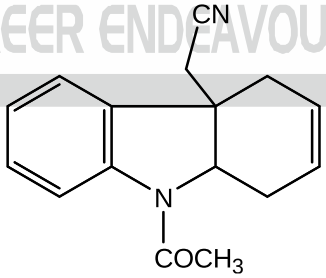
Q =



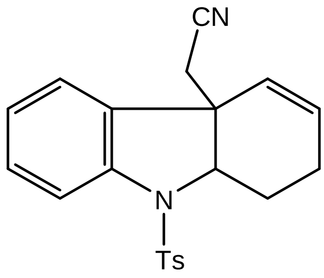
(b) **P =**



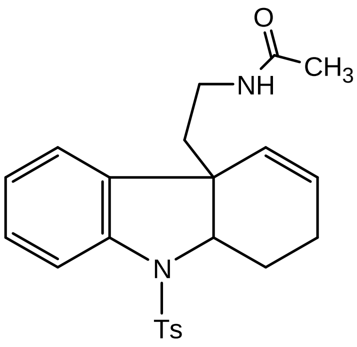
Q =



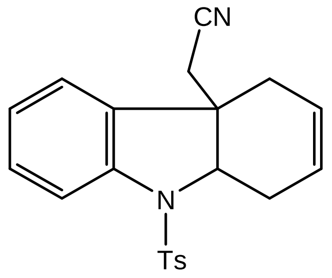
(c) **P =**



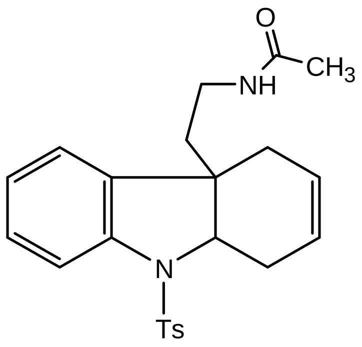
Q =



(d) **P =**



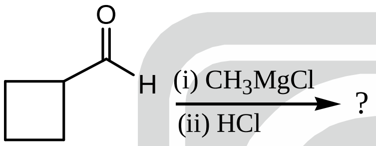
Q =



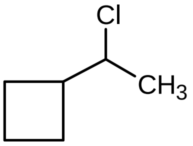
52. A complex is composed of one chromium ion, three bromides and six water molecules. Upon addition of excess $AgNO_3$, 1.0 g aqueous solution of the complex gave 0.94 g of AgBr. The molecular formula of the complex is
(Atomic weight: Cr = 52, Br = 80, Ag = 108, O = 16 and H = 1)

(a) $\left[Cr(H_2O)_6\right]Br_3$
(b) $\left[Cr(H_2O)_5 Br\right]Br_2 \bullet H_2O$
(c) $\left[Cr(H_2O)_4 Br_2\right]Br \bullet 2H_2O$
(d) $\left[Cr(H_2O)_3 Br_3\right] \bullet 3H_2O$

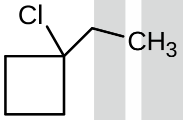
53. The major product formed in the following reaction is



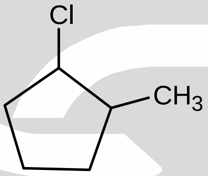
(a)



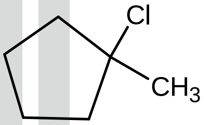
(b)



(c)



(d)



54. Consider the electrochemical cell

$$M(s)\,|\,MI_2(s)\,|\,MI_2(aq)\,|\,M(s)$$

where 'M' is a metal. At 298K, the standard reduction potentials are $E^0_{M^{2+}(aq)/M(s)} = -0.12\text{ V}$, $E^0_{MI_2(s)/M(s)} = -0.36\text{V}$ and the temperature coefficient is $\left(\frac{\partial E^0_{cell}}{\partial T}\right)_P = 1.5\times10^{-4}\,\text{VK}^{-1}$. At this temperature the standard enthalpy change for the overall cell reaction, $\Delta_r H^0$, is ____________ kJ mol^{-1}. (Round off to two decimal places)
(Faraday constant F = 96500 C mol^{-1})

55. Consider the following equilibrium,

$$SO_2(g) + \frac{1}{2}O_2 \rightleftharpoons SO_3(g)$$

At 298K, the standard molar Gibbs energies of formation, $\Delta_f G^0$, of SO_2 (g) and SO_3 (g) are –300 and –371 kJ mol^{-1}, respectively. The value of the equilibrium constant, K_p, at this temperature is ____________ $\times10^{10}$.
(Round off to the nearest integer)
(Gas constant R = 8.31 J mol^{-1} K^{-1})

***** END OF THE QUESTION PAPER *****