CHEMISTRY-CY

Q.1 – Q.25 : Carry ONE mark each.

1. For an enzyme catalyzed reaction, the plot of inverse of initial rate against inverse of initial substrate concentration is linear with slope 0.16 s and intercept 2.12 $mol^{-1}L$ s. The estimated value of Michaelis constant (in mol L^{-1}, rounded off to two decimal places) is _____

2. When three moles of helium is mixed with one mole of neon at constant temperature and pressure (25°C, 1 atm), the entropy of mixing (in JK^{-1}, rounded off to two decimal places) is _____

3. Fluorescence quantum yield and fluorescence lifetime of a molecule are 0.4 and 5×10^{-9} s, respectively. If the fluorescence decay rate constant is $Y\times10^{7}\ s^{-1}$, the vlaue of Y (rounded off to nearest ineger) is _____

4. In oxyhemocyanin, the coordination number, mode of oxygen binding, color and the net magnetic behaviour of copper ions, respectively are [Given: atomic number of Cu is 29)

   (a) Five, $\mu-\eta^2-O_2^-$, colorless and paramagnetic

   (b) Five, $\mu-\eta^2-\eta^2-O_2^{2-}$, blue and diamagnetic

   (c) Four, $\mu-\eta^1-\eta^1-O_2^-$, colorless and paramagnetic

   (d) Four, $\mu-\eta^1-\eta^1-O_2^{2-}$, blue and diamagnetic.

5. The maximum number of microstates for d^2 electronic configuration is _____

6. At 25°C, the emf (in volts, rounded off to three decimal places) of the cell,
   $Ag\,|\,AgBr(s)\,|\,Br^-\,(a=0.20),\ Cu^{2+}\,(a=0.48),\ Cu^+\,(a=0.24)\,|\,Pt$
   is _____
   (Given: The standard emf of the cell is 0.082 V; R = 8.314 J K^{-1} mol^{-1}; F = 96500 C mol^{-1})

7. The correct statement regarding the substitution of coordinated ligands in $Ni(CO)_4$ and $Co(NO)(CO)_3$ is
   (Given: Co–N–O bond is nearly linear; atomic numbers of Co and Ni are 27 and 28, respectively)
   (a) Both $Ni(CO)_4$ and $Co(NO)(CO)_3$ follow associative pathway.
   (b) $Ni(CO)_4$ and $Co(NO)(CO)_3$ follow dissocitive and associative pathways, respectively
   (c) $Ni(CO)_4$ and $Co(NO)(CO)_3$ follow associative and dissociative pathways, respectively
   (d) Both $Ni(CO)_4$ and $Co(NO)(CO)_3$ follow dissociative pathway.

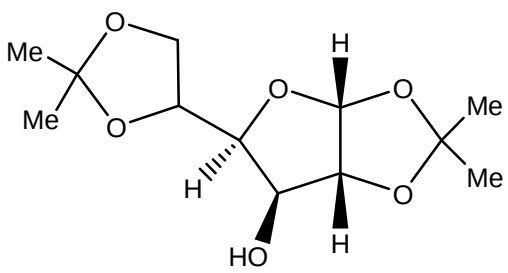
8. The activity of 'm' molal $CuSO_4$ solution can be expressed in terms of its mean activity coefficient $(\gamma_\pm)$ as

   (a) $16\,m^4\gamma_\pm^4$ (b) $4\,m^3\gamma_\pm^3$ (c) $m^2\gamma_\pm^2$ (d) $108\,m^5\gamma_\pm^5$

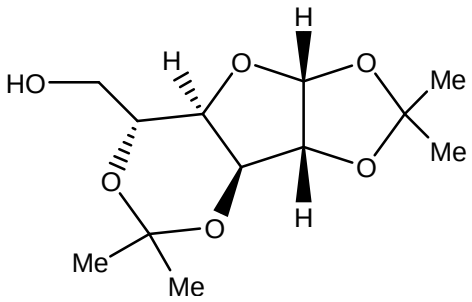
9. Major product formed in the given reaction is

$$\alpha\text{-D-glucose} \xrightarrow[H^+]{\text{acetone(excess)}}$$

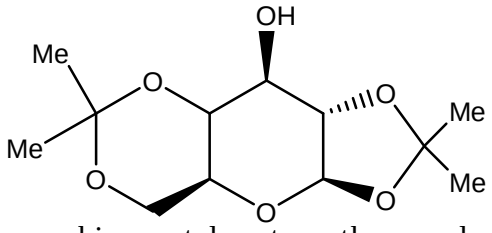
(a)

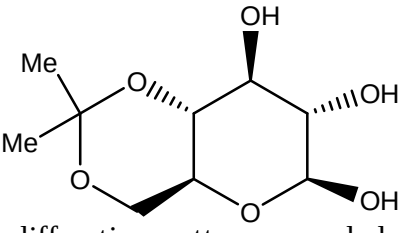


(b)



CAREER ENDEAVOUR

(c) 

(d) 

10. For a cubic crystal system, the powder X-ray diffraction pattern recorded using Cu K_α source $(\lambda = 1.54\ \text{Å})$ shows a peak at 33.60° (2θ) for (111) plane. The lattice parameter 'a' (in Å, rounded off to two decimal places) is _____

11. The character table for a pyramidal AB_3 molecule of C_{3v} point group is given below:

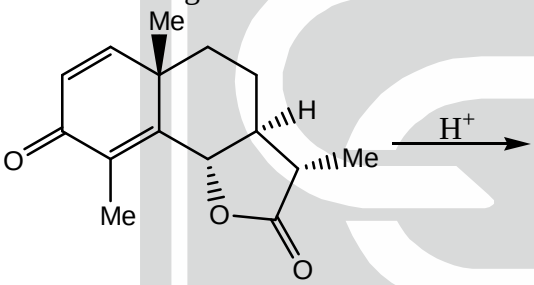
C_{3v}	E	$2C_3$	$3\sigma_v$		
A_1	1	1	1	z	x^2+y^2, z^2
A_2	1	1	−1	R_z	
E	2	−1	0	$(x, y)(R_x, R_y)$	$(x^2-y^2, xy)(xz, yz)$

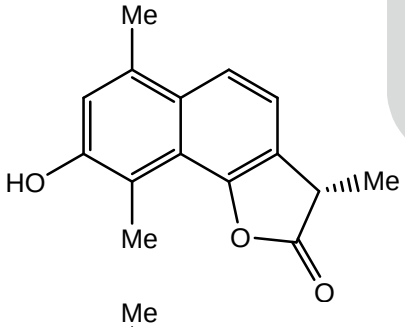
The reducible representation of pyramidal AB_3 is

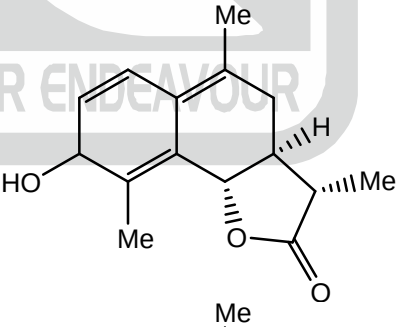
C_{3v}	E	$2C_3$	$3\sigma_v$
Γ	12	0	2

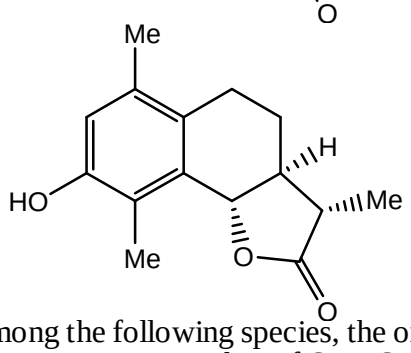
The correct option representing all the normal Raman active modes of pyramidal AB_3 is
(a) $2A_1 + 2E$ (b) $3E$ (c) $3A_1 + A_2 + E$ (d) $A_1 + A_2 + 2E$

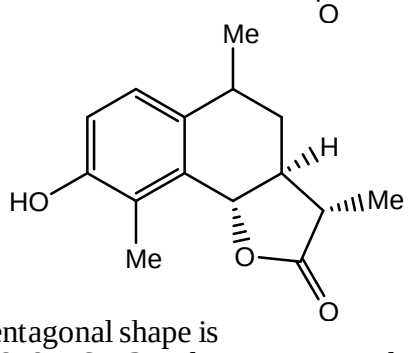
12. Major product formed in the following reaction is



(a) 

(b) 

(c) 

(d) 

13. Among the following species, the one that has pentagonal shape is
[Given: atomic number of O, F, S, I and Xe are 8, 9, 16, 53 and 54, respectively]

(a) $[XeF_5]^-$ (b) $XeOF_4$ (c) IF_5 (d) $[SF_5]^-$

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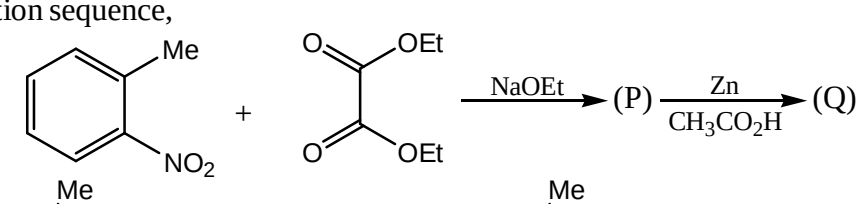
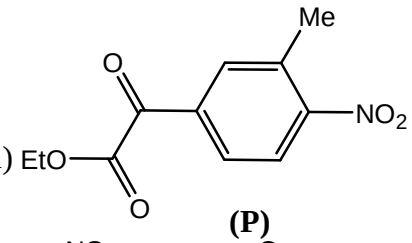
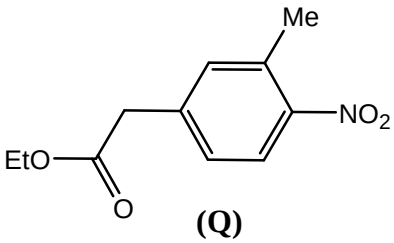
14. In the following reaction sequence,



(a)

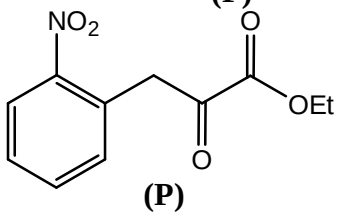


(P) and

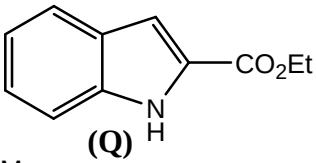


(Q)

(b)

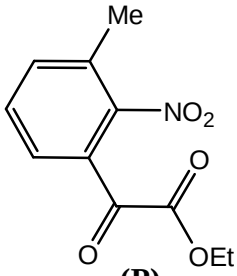


(P) and

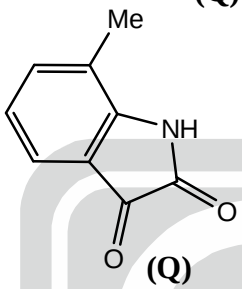


(Q)

(c)

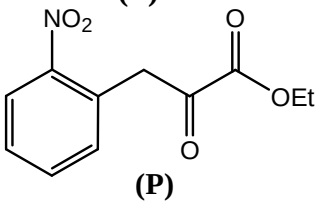


(P) and

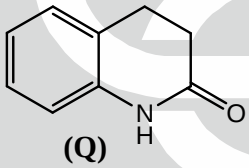


(Q)

(d)

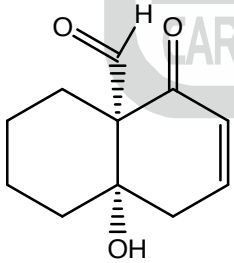


(P) and



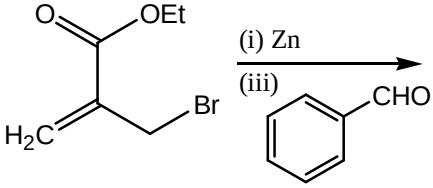
(Q)

15. Absolute stereochemistry of the given compound is

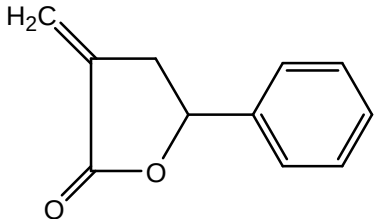


(a) 4aS, 8aR (b) 4aR, 8aS (c) 4aR, 8aR (d) 4aS, 8aS

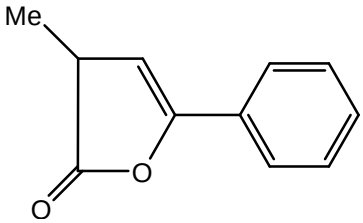
16. Major product formed in the following transformation is

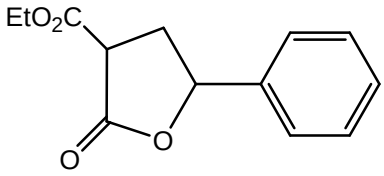


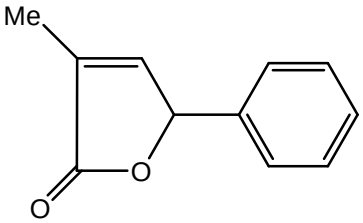
(a)



(b)



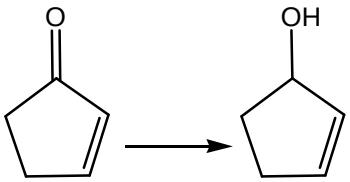
(c) 

(d) 

17. In an NMR spectrometer operating at a magnetic field strength of 16.45 T, the resonance frequency (in MHz, rounded off to one decimal place) of ^{19}F nucleus is _____

[Given: g factor of $^{19}F = 5.255$; $\beta_N = 5.05\times10^{-27}\ J\ T^{-1}$; $h = 6.626\times10^{-34}\ Js$]

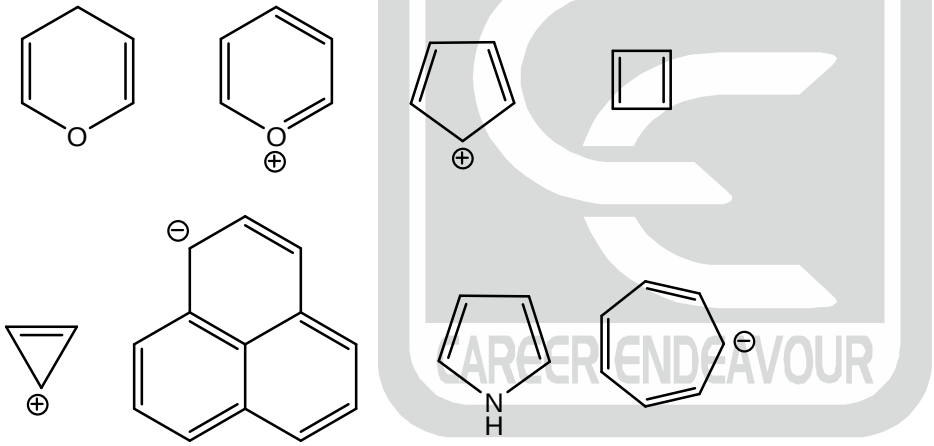
18. Among the following, the suitable reagents for the given transformation is:



Major

(a) $NaBH_4/CeCl_3.7H_2O$
(b) $H_2N–NH_2/KOH, \Delta$
(c) Li/Liq. NH_3
(d) H_2, Pd/C

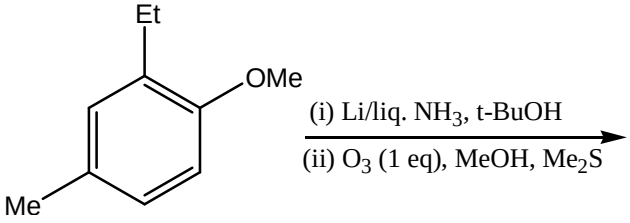
19. Among the following,

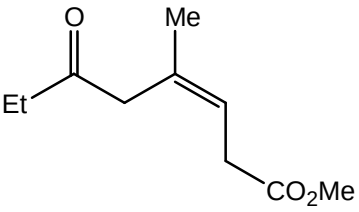


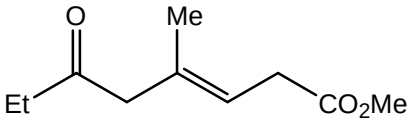
The total number of aromatic species is _____

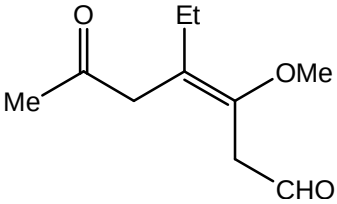
20. In a uranium recovery process, an aqueous solution of uranyl ion is evaporated, dried in air at 400ºC and subsequently reduced with hydrogen at 700ºC to obtain a uranium compound (X). The oxidation state of uranium in X is _____ [Given: atomic number of U is 92]

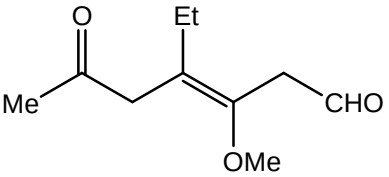
21. Major product formed in the following reaction sequence is



(a) 

(b) 

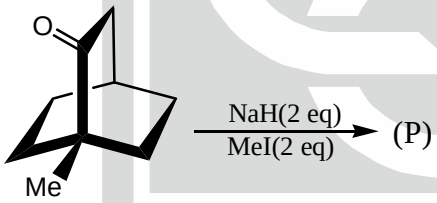
(c) 

(d) 

22. A solution containing a metal complex absorbs at 480 nm with molar extinction coefficient of 15, 000 L $mol^{-1}cm^{-1}$. If the path length of the cell is 1.0 cm and transmittance is 20.5 %, the concentration (in mol L^{-1}) of the metal complex is
(a) 1.37×10^{-5} (b) 4.59×10^{-5} (c) 8.75×10^{-5} (d) 2.29×10^{-5}

23. Among the following linear combination of atomic orbitals, the **CORRECT** representation of the lowest unoccupied π-molecular orbital of butadiene is
(a) $\psi = 0.372\phi_1 + 0.602\,\phi_2 + 0.602\,\phi_3 + 0.372\,\phi_4$
(b) $\psi = 0.602\phi_1 - 0.372\phi_2 - 0.372\phi_3 + 0.602\phi_4$
(c) $\psi = -0.372\phi_1 + 0.602\phi_2 - 0.602\phi_3 + 0.372\phi_4$
(d) $\psi = 0.602\phi_1 + 0.372\phi_2 - 0.372\phi_3 - 0.602\phi_4$

24. In the following reaction,

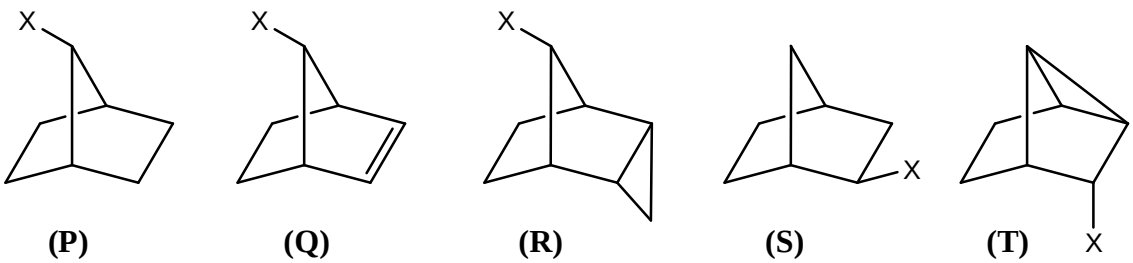


the number of peaks exhibited by the major product (P) in its broadband proton decoupled ^{13}C NMR spectrum is _____

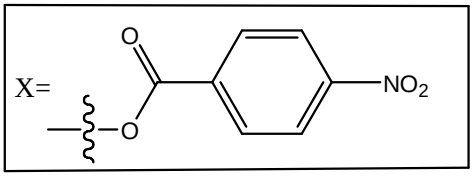
25. The CORRECT statement about hexagonal boron nitride is
(a) It is reactive towards fluorine
(b) It has same layer stacking as that of graphite
(c) It is a good electrical conductor
(d) It has lower thermal stability in air compared to that of graphite.

Q.26 – Q.55 : Carry TWO marks each.

26. The rate of solvolysis of the given compounds is in the order:



(P) **(Q)** **(R)** **(S)** **(T)**



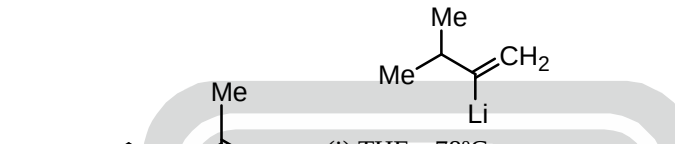
(a) R > T > Q > S > P (b) Q > T > R > P > S
(c) T > Q > R > P > S (d) T > R > Q > S > P

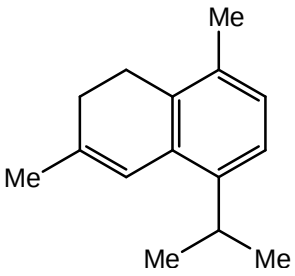
27. Assuming no interaction between vibrational and rotational energy levels in HF, the frequency (in cm^{-1}, rounded off to the nearest integer) of the R branch line originating from J = 4 in its IR spectrum is _____

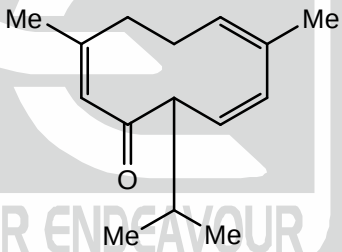
[Given: Rotational constant for HF = 19.35 cm^{-1}; $\bar{v}_0 = 4138.52\ cm^{-1}$]

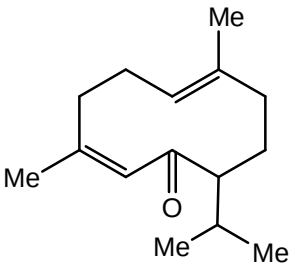
28. The total number of g|| lines expected in the EPR spectrum of a solution of bis (salicylaldimine) coppper (II) having pure ^{63}Cu and ^{14}N at 77K is _____
[Given: I values of ^{63}Cu, ^{14}N and ^{1}H are 3/2, 1 and 1/2, respectively]

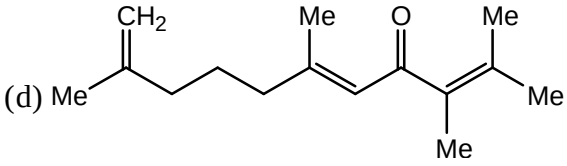
29. Major product formed in the following synthetic sequence is



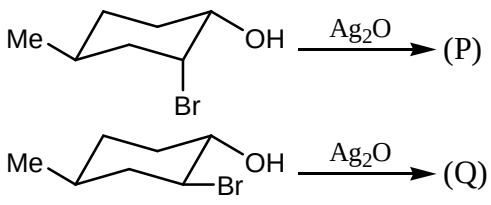
(a)


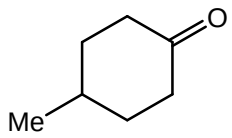
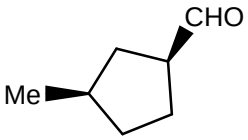
(b)


(c)


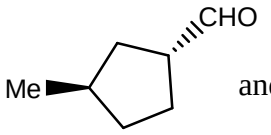
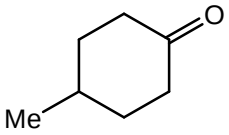
(d)


30. Major products (P) and (Q), formed in the reactions given below are

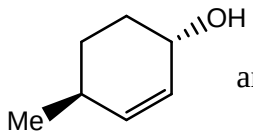
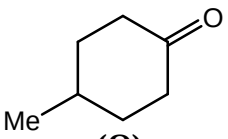


(a)  and 

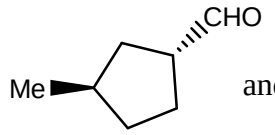
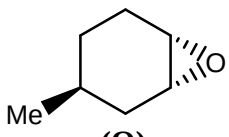
(P) **(Q)**

(b)  and 

(P) **(Q)**

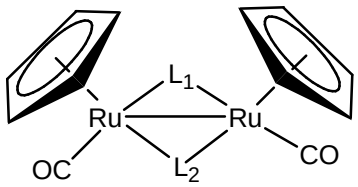
(c)  and 

(P) **(Q)**

(d)  and 

(P) **(Q)**

31. The **CORRECT** combination of L1 and L2 among H^-, NO^-, $MeCH^{2-}$ and CO, that will satisfy the 18 electron rule for both metal centers in the following neutral molecule is



(Given: atomic number of Ru is 44)

(a) $MeCH^{2-}$, CO (b) H^-, NO^- (c) $MeCH^{2-}$, NO^- (d) H^-, CO

32. In the electronic absorption spectrum of an aqueous solution of $\left[Ni\left(NH_3\right)_6\right]^{2+}$, a very weak band is observed between the bands due to the transitions $^3A_{2g} \longrightarrow {}^3T_{2g}$ and $^3A_{2g} \longrightarrow {}^3T_{1g}(F)$. The transition responsible for the very weak band is [Given: atomic number of Ni is 28)

(a) $^3A_{2g} \longrightarrow {}^1E_g$ (b) $^3A_{2g} \longrightarrow {}^1T_{2g}$ (c) $^3A_{2g} \longrightarrow {}^1T_{1g}$ (d) $^3A_{2g} \longrightarrow {}^1A_{2g}$

33. The van der Waals constants *a* and *b* for gaseous CO are given as 1.49 L_2 atm mol^{-2} and 0.0399 L mol^{-1}, respectively. The fugacity (in atm, rounded off to two decimal places) of CO at 35°C and 95 atm is _____[Given: R = 0.082 L atm K^{-1} mol^{-1}).

34. Among the following,

$\left[B_{12}H_{12}\right]^{2-}$, $\left[Ni_5(CO)_{12}\right]^{2-}$, $\left[C_2B_9H_{11}\right]^{2-}$, $Rb_6(CO)_{16}$, $Os_6(CO)_{20}$, B_5H_{11}, B_6H_{10}

the total number of species having nido structure is _____

[Given: atomic numbers of H, B, C, O, Ni, Rh and Os are 1, 5, 6, 8, 28, 45 and 76, respectively]

35. The following table lists the reaction/conversion catalyzed by metalloenzymes.

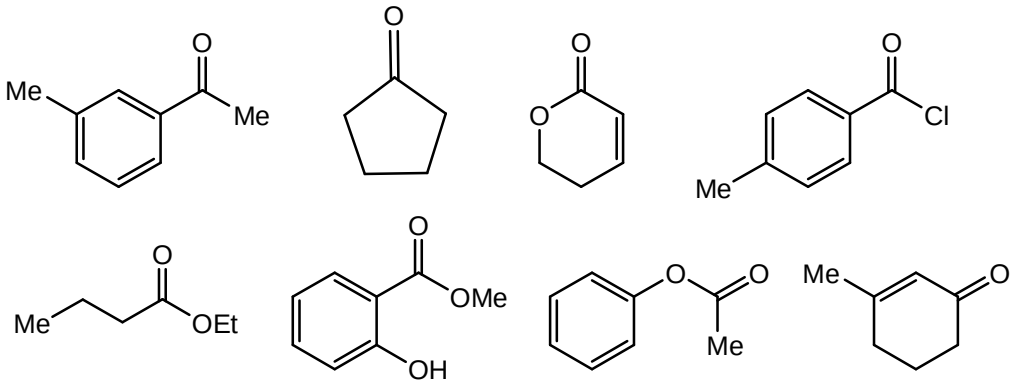
Reaction/conversion	**Metalloenzyme**
(P) $R-H+O_2+2H^-+2e^- \rightarrow R-OH+H_2O$	(I) Co-enzyme B_{12}
(Q) $O_2+4e^-+8H^+ \rightarrow 2H_2O+4H^+$	(II) Cytochrome P-450
(R) $2H_2O_2 \rightarrow 2H_2O+O_2$	(III) Cytochrome c oxidase
(S) $NH_2-CH_2-CO_2H \rightarrow NH_2-CH(CH_2OH)-CO_2H$	(IV) Catalase

The **CORRECT** combination is

(a) P-IV, Q-III, R-II, S-I (b) P-II, Q-III, R-IV, S-I

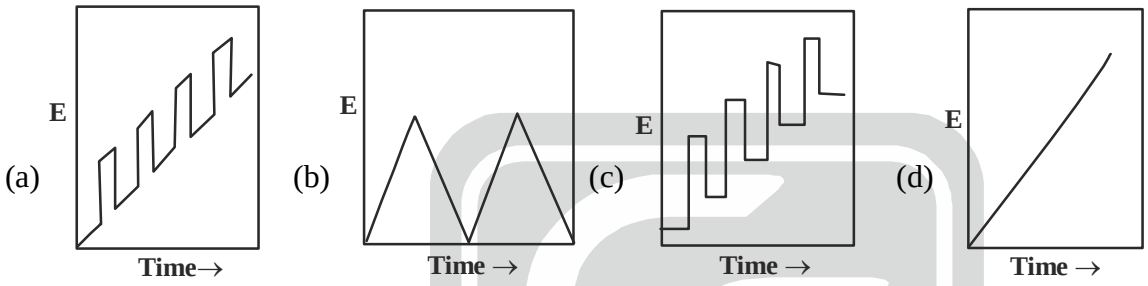
(c) P-I, Q-IV, R-III, S-II (d) P-II, Q-I, R-III, S-IV

36. Among the following,



the total number of compounds showing characteristics carbonyl stretching frequency less than 1700 cm^{-1} in their IR spectra is _____

37. The **CORRECT** 'voltage (E) versus time' excitation signal used in cyclic voltammetry is



38. ΔG_f^0 and ΔH_f^0 for Fe(g) are 370.7 kJ mol^{-1} and 416.3 kJ mol^{-1} at 298 K, respectively. Assuming ΔH_f^0 is constant in the interval 250 K to 375 K, ΔG_f^0 (rounded off to the nearest integer) for Fe(g) at 375 K is

(a) 325 kJ mol^{-1} (b) 338 kJ mol^{-1} (c) 310 kJ mol^{-1} (d) 359 kJ mol^{-1}

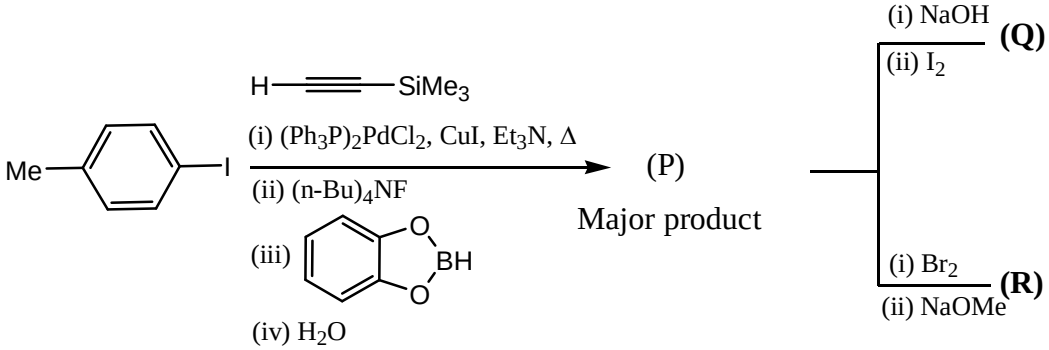
39. The frequency (in cm^{-1}, rounded off to two decimal places) for pure rotational in the spectrum of NO molecule due to change in the quantum number from J = 1 to J = 2 is _____

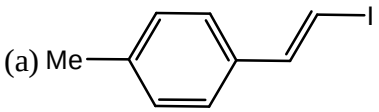
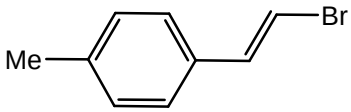
[Given: Moment of inertia of NO = 1.6427×10^{-16} kg m^2; h = 6.626×10^{-34} J s; c = 3×10^8 m/s]

40. For the ring opening reaction of cyclopropane to propene at 25°C, the pre-exponential factor is 4.3×10^{15} s^{-1}. The entropy of activation (in JK^{-1} mol^{-1}, rounded off to two decimal places) is _____

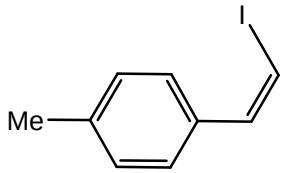
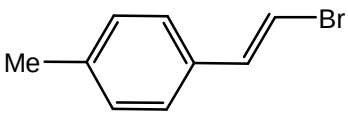
[Given: $h = 6.626 \times 10^{-34}$ Js; $k_B = 1.38 \times 10^{-23}$ JK^{-1}; $R = 8.314$ $JK^{-1}mol^{-1}$]

41. In the following reaction sequence, the major product (A) and (R) are

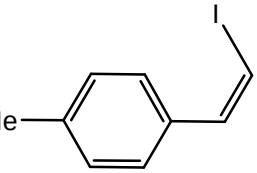
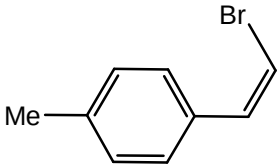


(a)  and 

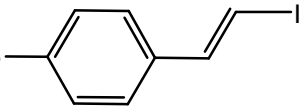
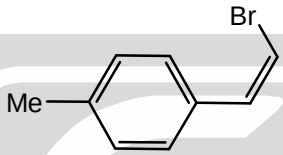
(Q) **(R)**

(b)  and 

(Q) **(R)**

(c)  and 

(Q) **(R)**

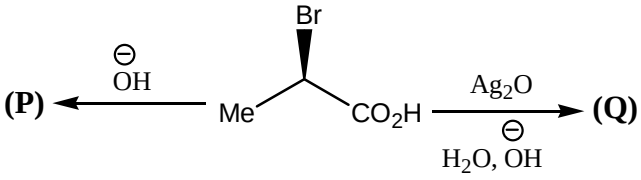
(d)  and 

(Q) **(R)**

42. The experimental magnetic moment (3.4 BM) of a hydrated salt of Eu^{3+} at 27°C is significantly different from the calculated value. The difference is due to [Given: atomic number of Eu is 63)
(a) Population of electrons at higher J level(s) via thermal excitation
(b) Pairing of electrons in f-orbitals
(c) strong ligand field splitting of f-orbitals
(d) strong spin-orbit coupling

43. Adsorption of N_2 on TiO_2 was carried out at 75 K. A plot of $\frac{z}{(1-z)V}$ versus $z\left(z = p/p^0\right)$ gives a straight line with an intercept, 4.0×10^{-6} mm^{-3} and slope, 1.0×10^{-3} mm^{-3}. The volume (rounded off to the nearest integer) corresponding to the monolayer coverage is
(a) 555 mm^3 (b) 690 mm^3 (c) 996 mm^3 (d) 785 mm^3

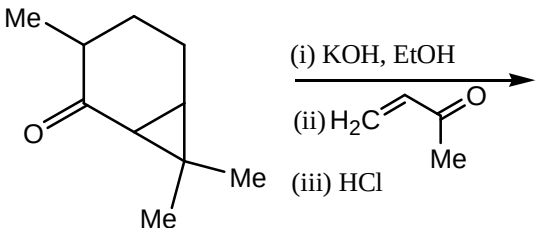
44. The CORRECT statement with respect to the stereochemistry of α-hydroxy acids P and Q formed in the following reaction is

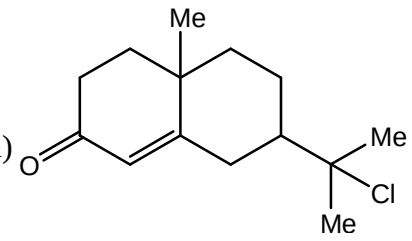


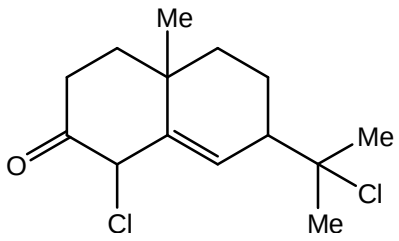
(a) P is formed with inversion of configuration and Q with retention of configuration
(b) P is formed with retention of configuration and Q with inversion of configuration
(c) Both P and Q are formed with retention of configuration
(d) Both P and Q are formed with inversion of configuration

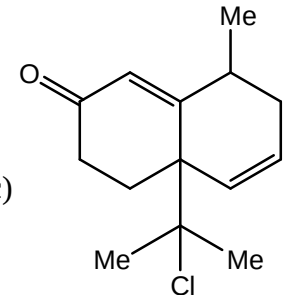
CAREER ENDEAVOUR

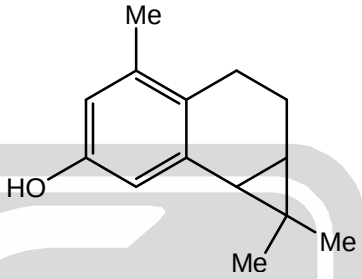
45. Major product formed in the following reaction sequence is



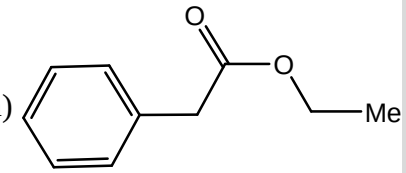
(a)


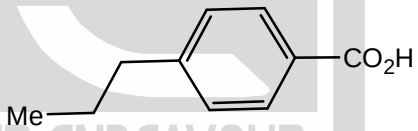
(b)


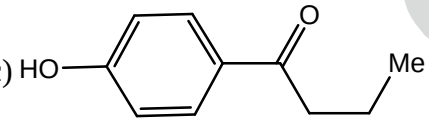
(c)


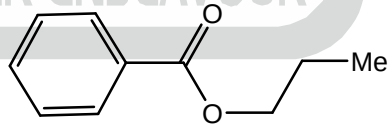
(d)


46. A compound with molecular formula $C_{10}H_{12}O_2$ showed a strong IR band at –1720 cm^{-1}, a peak at m/z 122 in the mass spectrum and the following ^1H NMR signals : δ 8.1–8.0 (2H, m), 7.6–7.5 (1H, m), 7.5–7.3 (2H, m), 4.3 (2H, t), 1.8 (2H, sextet) and 1.0 (3H, t). The structure of the compound is

(a)


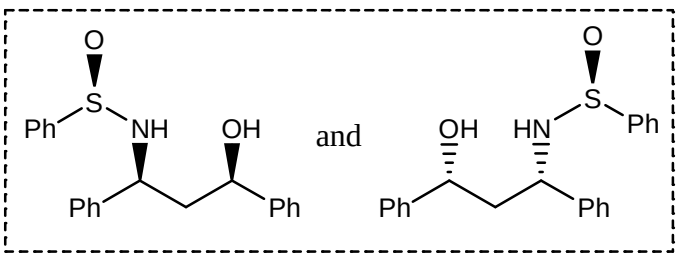
(b)


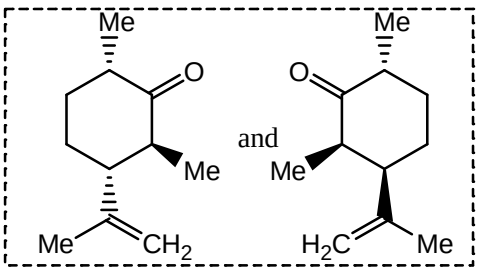
(c)


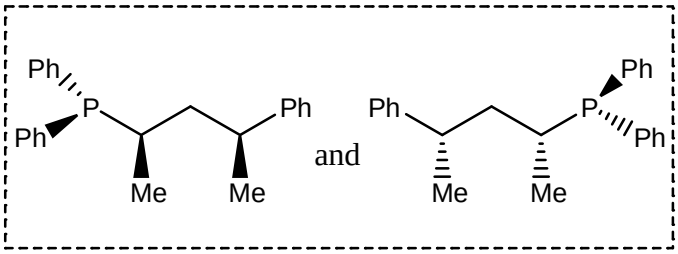
(d)


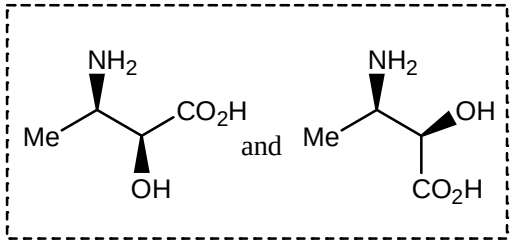
47. At 30°C, the vapor pressure and density of a 1.0 M aqueous solution of sucrose are 31.207 mm Hg and 1.1256 g/mL, respectively. If the vapor pressure of pure water at 30°C is 31.824 mm Hg, the activity coefficient (rounded off to three decimal places) of water in the given solution is _____
[Given: The molar mass of sucrose = 342.3 g mol^{-1})

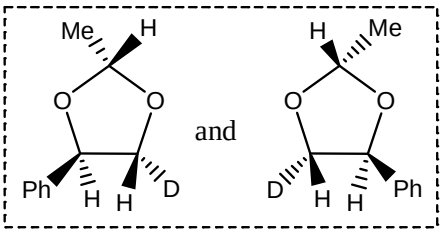
48. Among the following sets,

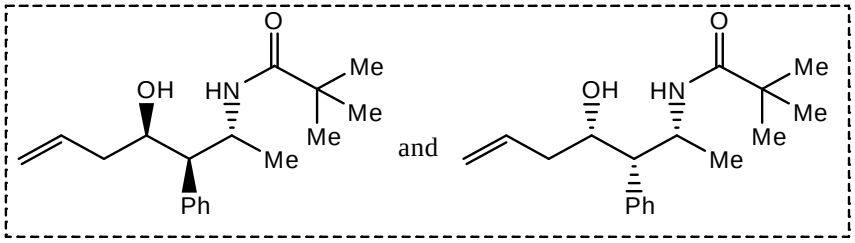










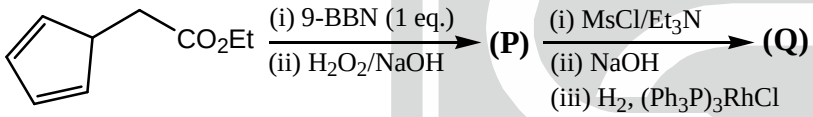


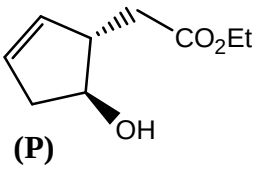
the total numberof set(s) of diastereomeric pair(s) is _____

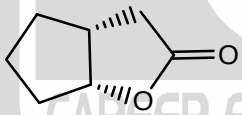
49. The % error (rounded off to two decimal places) in the ground state energy of a particle in a one dimensional box of length 'a' described by a trial variation function $\varphi = x(a-x)$, where $0 \le x \le a$, is _____

[Given: The true ground state energy of the above system is $h^2/8ma^2$; $\int_0^a \varphi^* \varphi d\tau = a^5/30$]

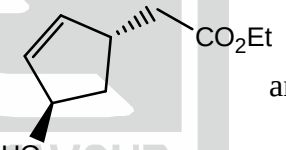
50. Major products (P) and (Q), in the given reaction sequence, are

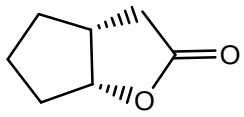


(a) 

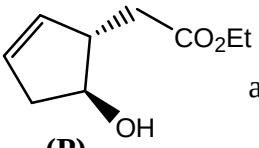
(P) and 

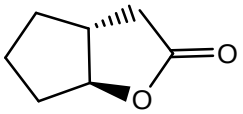
(Q)

(b) 

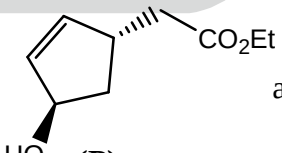
(P) and 

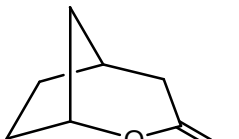
(Q)

(c) 

(P) and 

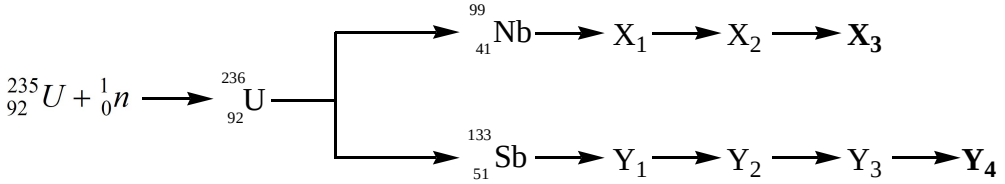
(Q)

(d) 

(P) and 

(Q)

51. The fission reaction of $^{235}_{92}U$ with thermal neutron is represented below.

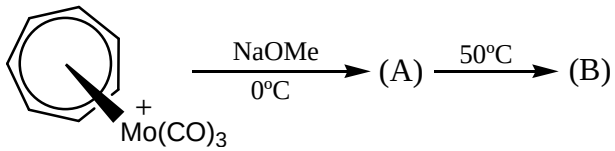


$^{99}_{41}Nb$ and $^{133}_{51}Sb$ are the primary fission fragment pair, which undergo series of radioactive decay to form stable nuclei X_3 and Y_4 (chain enders). The X_3 and X_4, respectively are

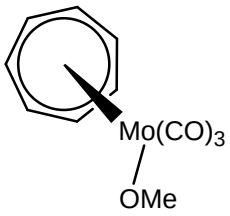
(a) $^{87}_{35}Br$ and $^{124}_{43}Tc$ (b) $^{99}_{44}Ru$ and $^{133}_{55}Cs$ (c) $^{93}_{38}Sr$ and $^{127}_{35}Ag$ (d) $^{96}_{41}Nb$ and $^{130}_{51}Sb$

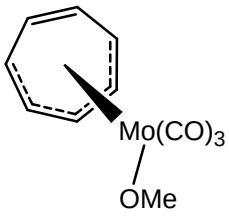
52. Consider that AgX crystallizes in rock salt structure. The density of AgX is 6477 kg/m^3 and unit cell length is 577.5 pm. Atomic weight of Ag is 107.87 g mol^{-1}. The atomic weight of X (in g mol^{-1}, rounded off to two decimal places) is _____

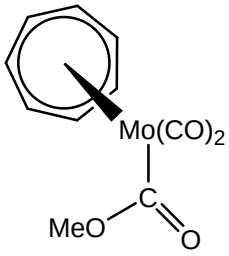
53. In the following reaction sequence,

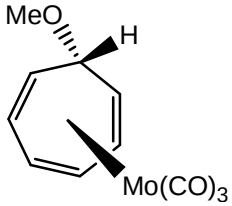


The structure of B is (Given: atomic number of Mo is 42)

(a) 

(b) 

(c) 

(d) 

54. The hydrogen-like radial wave function of the 3s orbital is given as

$$R_{3.0} = \frac{1}{9\sqrt{3}}\left(\frac{Z}{a_0}\right)^{3/2}\left(6-2\rho+\frac{\rho^2}{9}\right)e^{-\rho/6}$$

where, $\rho = \dfrac{2Zr}{a_0}$; Z = atomic number; r = distance from the nucleus and a_0 = Bohr radius

Positions of the radial nodes (in units of a_0) of the 3s orbital are at

(a) $\dfrac{3+\sqrt{3}}{2Z}, \dfrac{3-\sqrt{3}}{2Z}$ (b) $\dfrac{6+3\sqrt{3}}{2Z}, \dfrac{6-3\sqrt{3}}{2Z}$ (c) $\dfrac{3+3\sqrt{3}}{2Z}, \dfrac{3-3\sqrt{3}}{2Z}$ (d) $\dfrac{9+3\sqrt{3}}{2Z}, \dfrac{9-3\sqrt{3}}{2Z}$

55. In a reaction, reactant X is converted to products Y and Z consecutively with rate constants 6.0×10^{-2} min^{-1} and 9.0×10^{-3} min^{-1}, respectively. If the initial amount of X is 12.5 moles, the number of moles (rounded off to one decimal place) of Y formed after 10 minutes is _____

CAREER ENDEAVOUR

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