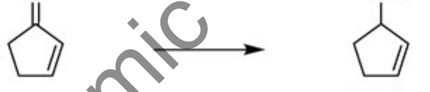
Dynamic Chemistry Point

GATE-2020-CY

Q1 - Q25 carry one mark each.

Q.No. 1 Among the following, the suitable reagents for the given transformation is:



Major

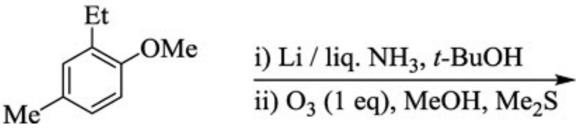
(A) H_2, Pd / C

(B) $H_2N–NH_2$ / KOH, Δ

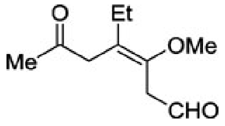
(C) $NaBH_4$ / $CeCl_3·7H_2O$

(D) Li / Liq. NH_3

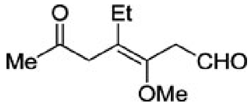
Q.No. 2 Major product formed in the following reaction sequence is:



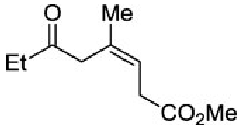
(A)



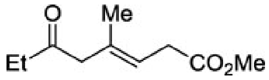
(B)



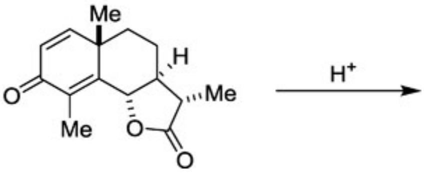
(C)



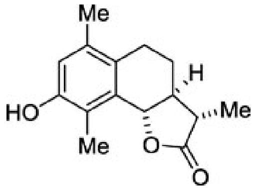
(D)



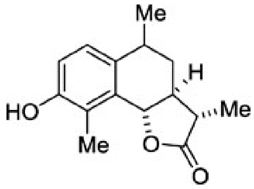
Q.No. 3 Major product formed in the following reaction is:



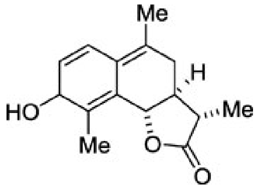
(A)



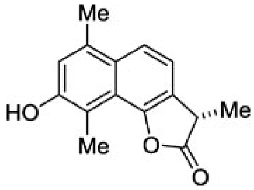
(B)



(C)

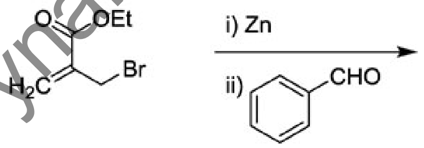


(D)

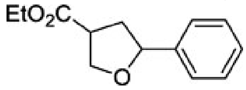


Dynamic Chemistry Point

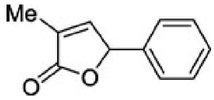
Q.No. 4 Major product formed in the following transformation is:



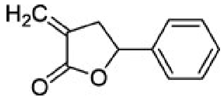
(A)



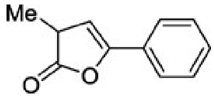
(B)



(C)

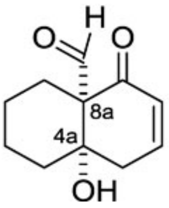


(D)



Q.No. 5

Absolute stereochemistry of the given compound is:



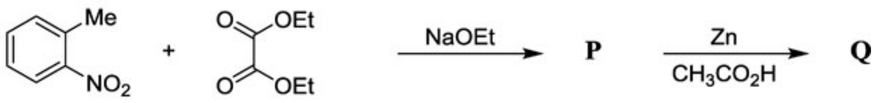
(A) 4a*R*, 8a*S*

(B) 4a*R*, 8a*R*

(C) 4a*S*, 8a*S*

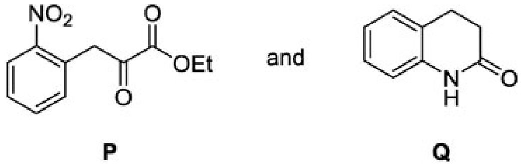
(D) 4a*S*, 8a*R*

Q.No. 6 In the following reaction sequence,

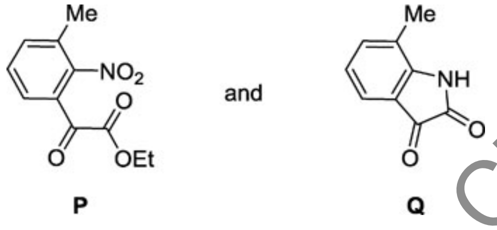


the major products **P** and **Q** are:

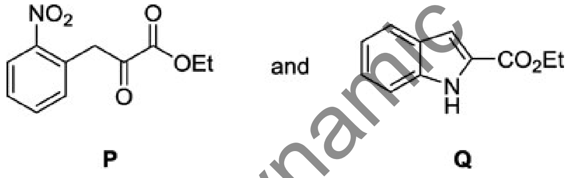
(A)



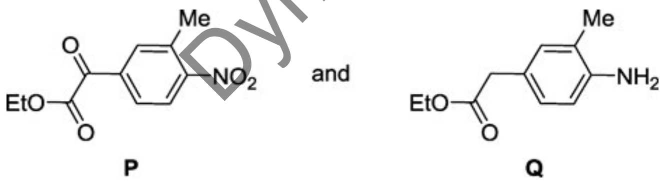
(B)



(C)

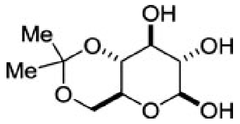


(D)

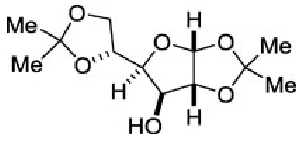


Q.No. 7 Major product formed in the given reaction is:

(A)

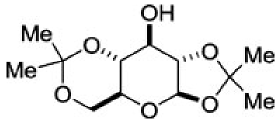


(B)

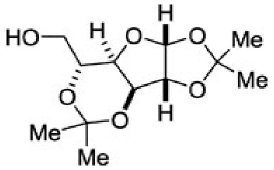


(C)

Dynamic Chemistry Point



(D)



Q.No. 8 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) $Ni(CO)_4$ and $Co(NO)(CO)_3$ follow associative and dissociative pathways, respectively.

(B) $Ni(CO)_4$ and $Co(NO)(CO)_3$ follow dissociative and associative pathways, respectively.

(C) Both $Ni(CO)_4$ and $Co(NO)(CO)_3$ follow associative pathway.

(D) Both $Ni(CO)_4$ and $Co(NO)(CO)_3$ follow dissociative pathway.

Q.No. 9 The **CORRECT** statement about hexagonal boron nitride is:

(A) It is a good electrical conductor.

(B) It has same layer stacking as that of graphite.

(C) It is reactive towards fluorine.

(D) It has lower thermal stability in air compared to that of graphite.

Q.No. 10 In oxyhemocyanin, the coordination number, mode of oxygen binding, color and the net magnetic behavior of copper ions, respectively are:

(Given: atomic number of Cu is 29)

(A) Four, μ-η^1:η^1-O_2^-, colorless and paramagnetic.

(B) Five, μ-η^2:η^2-O_2^-, colorless and paramagnetic.

(C) Five, μ-η^2:η^2-O_2^{2-}, blue and diamagnetic.

(D) Four, μ-η^1:η^1-O_2^{2-}, blue and diamagnetic.

Dynamic Chemistry Point

Q.No. 11 Among the following species, the one that has pentagonal shape is:

(Given: atomic numbers of O, F, S, I and Xe are 8, 9, 16, 53 and 54, respectively)

(A) $XeOF_4$

(B) IF_5

(C) $[SF_5]^-$

(D) $[XeF_5]^-$

Q.No. 12 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) 2.29×10^{-5}

(C) 4.59×10^{-5}

(D) 8.75×10^{-5}

Q.No. 13 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) $\Psi = 0.602\,\phi_1 + 0.372\,\phi_2 - 0.372\,\phi_3 - 0.602\,\phi_4$

(D) $\Psi = 0.372\,\phi_1 + 0.602\,\phi_2 + 0.602\,\phi_3 + 0.372\,\phi_4$

Q.No. 14 The activity of '*m*' molal $CuSO_4$ solution can be expressed in terms of its mean activity coefficient ($\gamma_{\pm}$) as:

(A) $m^2\gamma_{\pm}{}^2$

(B) $4m^3\gamma_{\pm}{}^3$

(C) $16m^4\gamma_{\pm}{}^4$

(D) $108m^5\gamma_{\pm}{}^5$

Q.No. 15 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	$(x,y)(R_x, R_y)$	$(x^2\text{-}y^2, xy)(xz, yz)$

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:

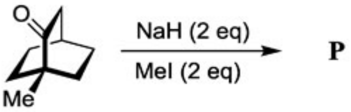
(A) $A_1 + A_2 + 2E$

(B) 3E

(C) $3A_1 + A_2 + E$

(D) $2A_1 + 2E$

Q.No. 16 In the following reaction,

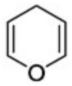
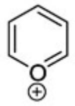
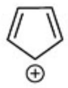


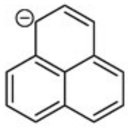
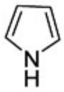
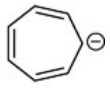
the number of peaks exhibited by the major product **P** in its broadband proton decoupled ^{13}C NMR spectrum is ________

Q.No. 17

Dynamic Chemistry Point

Among the following,

the total number of aromatic species is _______

Q.No. 18 The maximum number of microstates for d^2 electronic configuration is _______

Q.No. 19 In a uranium recovery process, an aqueous solution of uranyl ion is evaporated, dried in air at 400 °C and subsequently reduced with hydrogen at 700 °C to obtain a uranium compound (**X**). The oxidation state of uranium in **X** is _______

(Given: atomic number of U is 92)

Q.No. 20 For a cubic crystal system, the powder X-ray diffraction pattern recorded using Cu K_α source (λ = 1.54 Å) shows a peak at 33.60° (2θ) for (111) plane. The lattice parameter 'a' (in Å, *rounded off to two decimal places*) is _______

Q.No. 21 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; $\beta_N = 5.05 \times 10^{-27}$ J T^{-1}; $h = 6.626 \times 10^{-34}$ J s)

Q.No. 22 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 J K^{-1}, *rounded off to two decimal places*) is _______

(Given: R = 8.314 J K^{-1} mol^{-1})

Q.No. 23 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})

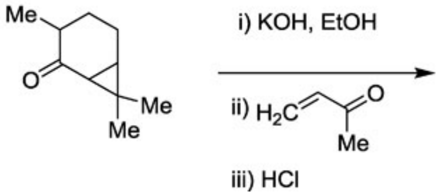
Q.No. 24 For an enzyme catalyzed reaction, the plot of inverse of initial rate against inverse of initial substrate concentration is linear with slope 0.16 s and intercept 2.12 mol^{-1} L s. The estimated value of Michaelis constant (in mol L^{-1}, *rounded off to two decimal places*) is _______

Dynamic Chemistry Point

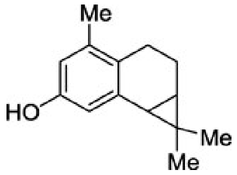
Q.No. 25 Fluorescence quantum yield and fluorescence lifetime of a molecule are 0.4 and 5×10^{-9} s, respectively. If the fluorescence decay rate constant is $\mathbf{Y} \times 10^{7}$ s^{-1}, the value of **Y** (*rounded off to nearest integer*) is _______

Q26 - Q55 carry two marks each.

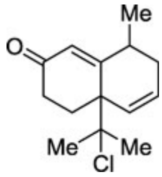
Q.No. 26 Major product formed in the following reaction sequence is:



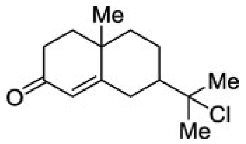
(A)



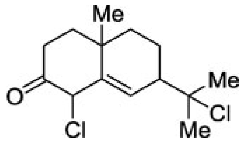
(B)



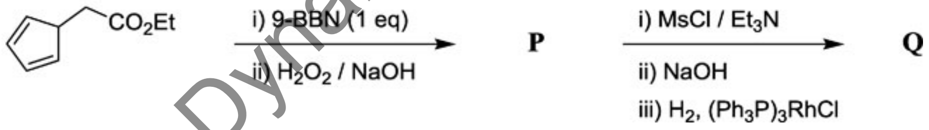
(C)



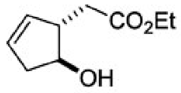
(D)



Q.No. 27 Major products **P** and **Q**, in the given reaction sequence, are:



(A)

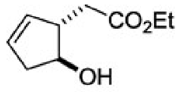


P

and

Q

(B)

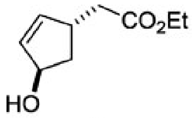


P

and

Q

(C)

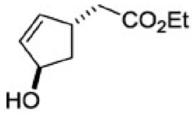


P

and

Q

(D)



P

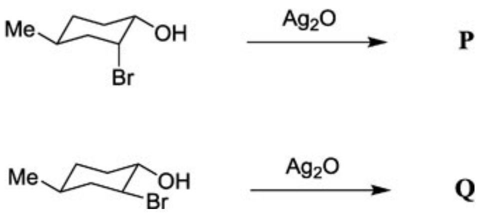
and

Q

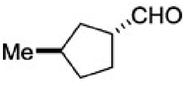
Q.No. 28

Dynamic Chemistry Point

Major products **P** and **Q**, formed in the reactions given below, are:

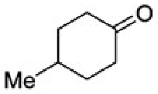


(A)



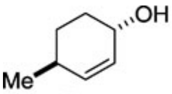
P

and



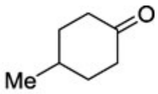
Q

(B)



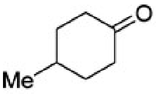
P

and



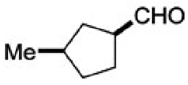
Q

(C)



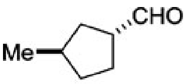
P

and



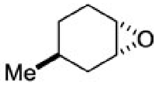
Q

(D)



P

and

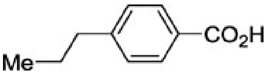


Q

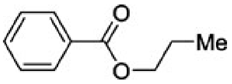
Q.No. 29 A compound with molecular formula $C_{10}H_{12}O_2$ showed a strong IR band at ~ 1720 cm^{-1}, a peak at m/z 122 in the mass spectrum and the following ^1H NMR signals: δ 8.1–8.0 (2H, m), 7.6–7.5 (1H, m), 7.5–7.3 (2H, m), 4.3 (2H, t), 1.8 (2H, sextet) and 1.0 (3H, t). The structure of the compound is:

Dynamic Chemistry Point

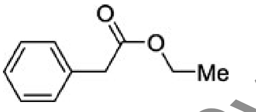
(A)



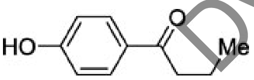
(B)



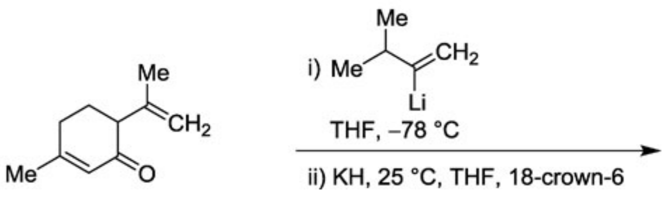
(C)



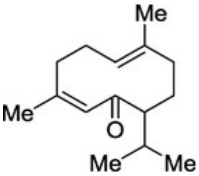
(D)



Q.No. 30 Major product formed in the following synthetic sequence is:



(A)



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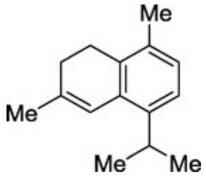
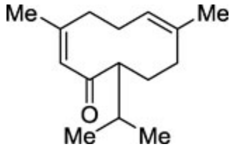
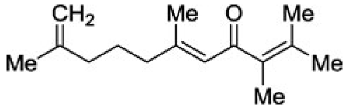


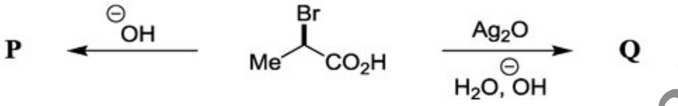
(C)



(D)



Q.No. 31 The **CORRECT** statement with respect to the stereochemistry of α–hydroxy acids **P** and **Q** formed in the following reactions is:



(A) Both **P** and **Q** are formed with retention of configuration.

(B) Both **P** and **Q** are formed with inversion of configuration.

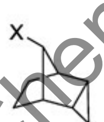
(C) **P** is formed with retention of configuration and **Q** with inversion of configuration.

(D) **P** is formed with inversion of configuration and **Q** with retention of configuration.

Q.No. 32 The rate of solvolysis of the given compounds is in the order:

P

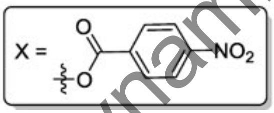
Q



R

S

T



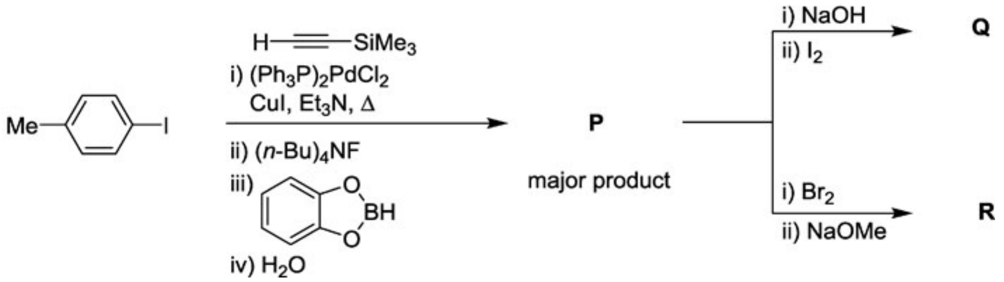
(A) **T** > **R** > **Q** > **S** > **P**

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

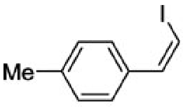
(C) **R** > **T** > **Q** > **S** > **P**

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

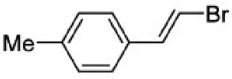
Q.No. 33 In the following reaction sequence, the major products **Q** and **R** are:



(A)



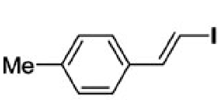
and



Q **R**

(B)

Dynamic Chemistry Point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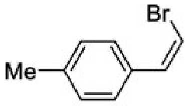
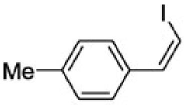
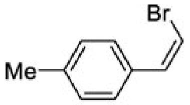
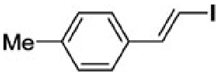
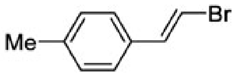


Q **R**

(C)

and


Q **R**

(D)

and


Q **R**

Q.No. 34 In the electronic absorption spectrum of an aqueous solution of $[Ni(NH_3)_6]^{2+}$, a very weak band is observed between the bands due to the transitions $^3A_{2g} \rightarrow {}^3T_{2g}$ and $^3A_{2g} \rightarrow {}^3T_{1g}(F)$. The transition responsible for the very weak band is

(Given: atomic number of Ni is 28)

(A) $^3A_{2g} \rightarrow {}^1T_{1g}$

(B) $^3A_{2g} \rightarrow {}^1T_{2g}$

(C) $^3A_{2g} \rightarrow {}^1E_g$

(D) $^3A_{2g} \rightarrow {}^1A_{2g}$

Q.No. 35 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.

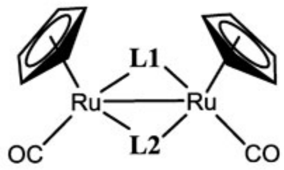
(B) strong ligand field splitting of *f*–orbitals.

(C) strong spin–orbit coupling.

(D) pairing of electrons in *f*–orbitals.

Dynamic Chemistry Point

Q.No. 36 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) H^-, NO^-

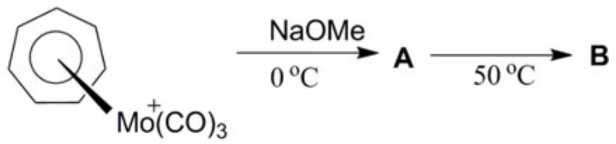
(B) $MeCH^{2-}$, NO^-

(C) $MeCH^{2-}$, CO

(D) H^-, CO

Q.No. 37

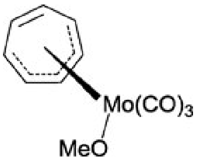
In the following reaction sequence,



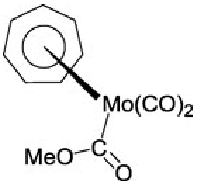
the structure of **B** is

(Given: atomic number of Mo is 42)

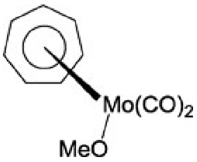
(A)



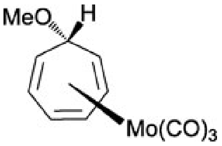
(B)



(C)



(D)



Q.No. 38 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**	Coenzyme 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-II; Q-I; R-III; S-IV**

(B) **P-IV; Q-III; R-II; S-I**

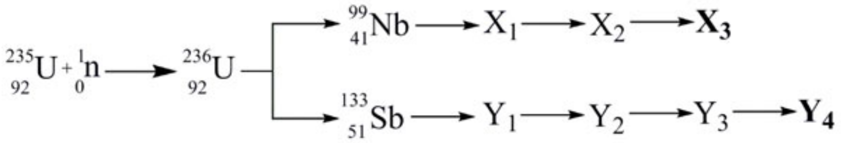
(C) **P-II; Q-III; R-IV; S-I**

(D) **P-I; Q-IV; R-III; S-II**

Q.No. 39

Dynamic Chemistry Point

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 $\mathbf{X_3}$ and $\mathbf{Y_4}$ (chain enders). The $\mathbf{X_3}$ and $\mathbf{Y_4}$, respectively are:

(A) $^{96}_{41}Nb$ and $^{130}_{51}Sb$

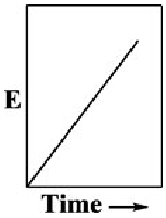
(B) $^{99}_{44}Ru$ and $^{133}_{55}Cs$

(C) $^{93}_{38}Sr$ and $^{127}_{35}Ag$

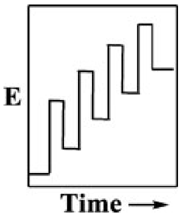
(D) $^{87}_{35}Br$ and $^{124}_{43}Tc$

Q.No. 40 The **CORRECT** 'voltage (**E**) *versus* time' excitation signal used in cyclic voltammetry is

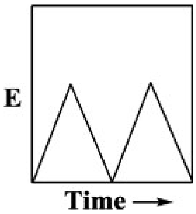
(A)



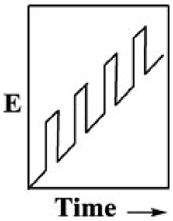
(B)



(C)



(D)



Dynamic Chemistry Point

Q.No. 41 The hydrogen-like radial wave function of the 3*s* 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 $\rho = 2Zr/a_0$; 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 3*s* orbital are at

(A) $\frac{3+\sqrt{3}}{2Z}, \frac{3-\sqrt{3}}{2Z}$

(B) $\frac{6+3\sqrt{3}}{2Z}, \frac{6-3\sqrt{3}}{2Z}$

(C)

$\frac{9+3\sqrt{3}}{2Z}, \frac{9-3\sqrt{3}}{2Z}$

(D) $\frac{3+3\sqrt{3}}{2Z}, \frac{3-3\sqrt{3}}{2Z}$

Q.No. 42 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) 359 kJ mol^{-1}

(B) 338 kJ mol^{-1}

(C) 325 kJ mol^{-1}

(D) 310 kJ mol^{-1}

Q.No. 43 Adsorption of N_2 on TiO_2 was carried out at 75 K. A plot of $\frac{z}{(1-z)V}$ *versus* z ($z = p/p^0$) 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:

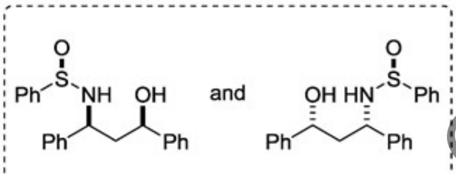
(A) 996 mm^3

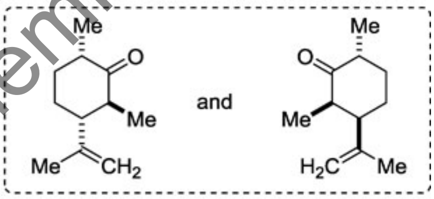
(B) 785 mm^3

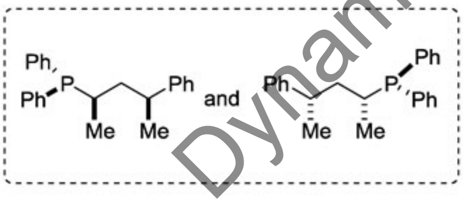
(C) 690 mm^3

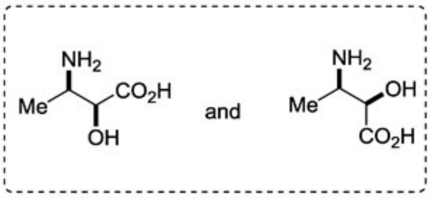
(D) 555 mm^3

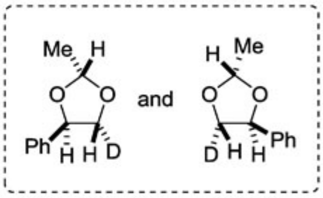
Q.No. 44 Among the following sets,

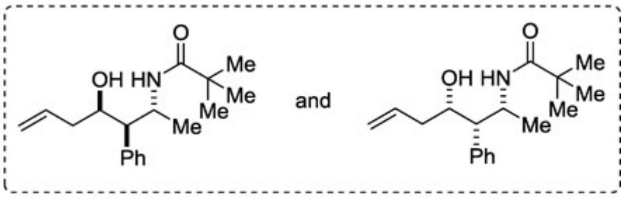










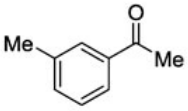
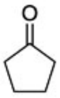
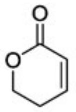
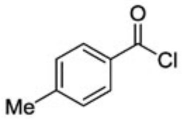
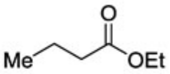
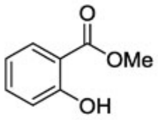
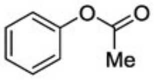
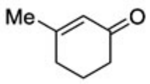


the total number of set(s) of diastereomeric pair(s) is _______

Q.No. 45

Dynamic Chemistry Point

Among the following,

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

Q.No. 46 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 _______

Q.No. 47 The total number of $g_{||}$ lines expected in the EPR spectrum of a solution of bis(salicylaldimine) copper(II) having pure ^{63}Cu and ^{14}N at 77 K is _______

(Given: I values of ^{63}Cu, ^{14}N and ^{1}H are $\frac{3}{2}$, 1 and $\frac{1}{2}$, respectively)

Q.No. 48 Among the following,

$[B_{12}H_{12}]^{2-}$, $[Ni_5(CO)_{12}]^{2-}$, $[C_2B_9H_{11}]^{2-}$, $Rh_6(CO)_{16}$, $Os_6(CO)_{20}$, 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)

Q.No. 49 The frequency (in cm^{-1}, *rounded off to two decimal places*) for pure rotational line 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^{-46} kg m^2; $h = 6.626 \times 10^{-34}$ J s; $c = 3 \times 10^8$ m/s)

Q.No. 50 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 $0 \leq x \leq a$, is _______

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

Q.No. 51 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}; $\bar{\nu}_0$ = 4138.52 cm^{-1})

Dynamic Chemistry Point

Q.No. 52 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})

Q.No. 53 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})

Q.No. 54 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 J K^{-1} mol^{-1}, *rounded off to two decimal places*) is _______

(Given: $h = 6.626 \times 10^{-34}$ J s; $k_B = 1.38 \times 10^{-23}$ J K^{-1}; R = 8.314 J K^{-1} mol^{-1})

Q.No. 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 _______

Dynamic Chemistry Point