

Real Test

Chemistry

Q1 Ni^{2+} ion on treatment with ligand A, B and C give blue, violet, and green colour, respectively. The correct sequence of ligands with respect to colour is

- (A) H_2O , NH_3 , en
 (B) NH_3 , H_2O , en
 (C) en, H_2O , NH_3
 (D) NH_3 , en, H_2O

Q2 The correct order of decreasing ionic radii among the following isoelectronic species is

- (A) K^+
 (B) Ca^{2+}
 (C) Cl^-
 (D) S^{2-}

Choose the correct answer from the options given below:

- (A) $(A) > (B) > (C) > (D)$.
 (B) $(A) > (C) > (B) > (D)$.
 (C) $(D) > (B) > (C) > (A)$.
 (D) $(D) > (C) > (A) > (B)$.

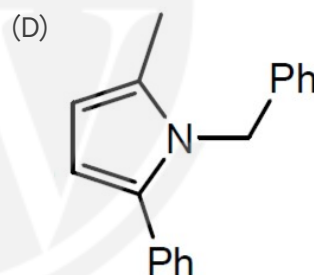
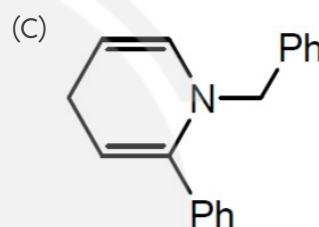
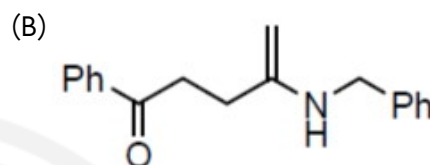
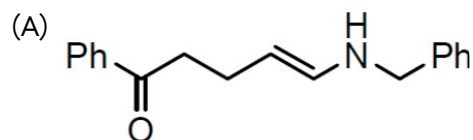
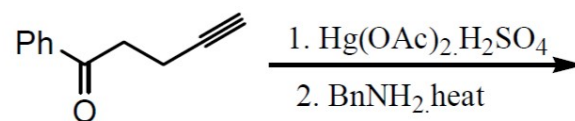
Q3 Which of the following oxides is not expected to react with sodium hydroxide?

- (A) CaO
 (B) SiO_2
 (C) BeO
 (D) B_2O_3

Q4 The atomic masses of $^1\text{H} = 1.67 \times 10^{-27}$ kg and $^{35}\text{Cl} = 58.06 \times 10^{-27}$ kg. The reduced mass of HCl is

- (A) 162.6×10^{-27} kg
 (B) 16.26×10^{-27} kg
 (C) 1.626×10^{-27} kg
 (D) 1626×10^{-27} kg

Q5 The major product formed in the following reaction sequence is



Q6 Under the same conditions, two gases have the same number of molecule. They must:

- (A) be noble gases
 (B) have equal volumes
 (C) have a volume of 22.4 dm^3 each
 (D) have an equal number of atoms

Q7 Europium (Eu) resembles Calcium (Ca) in the following ways:

- (A). Both are diamagnetic
 (B). Insolubility of their sulphates and carbonates in water



(C). Solubility of these metals in liquid NH_3
 (D). Insolubility of their dichlorides in strong HCl
 Choose the correct answer from the options given below:

- (A) (A), (B) and (D) only.
 (B) (A), (B) and (C) only.
 (C) (A), (B), (C) and (D).
 (D) (B), (C) and (D) only.

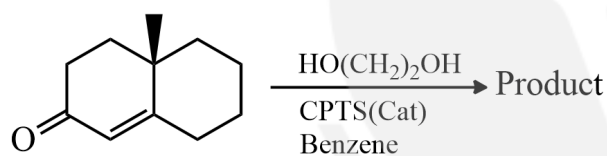
Q8 200 mL of N_2 gas maintained at 740 mm Hg pressure and 500 mL of O_2 gas at 720 mm Hg are put together in one litre flask. If temperature is kept constant, what will be the final pressure of the mixture?

- (A) 480 mm Hg (B) 500 mm Hg
 (C) 508 mm Hg (D) 520 mm Hg

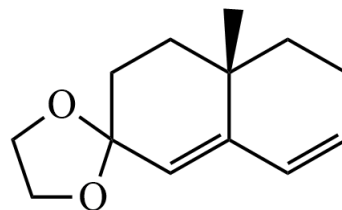
Q9 Which of the following gas molecules have maximum value of enthalpy of physisorption?

- (A) C_2H_6 (B) Ne
 (C) H_2O (D) H_2

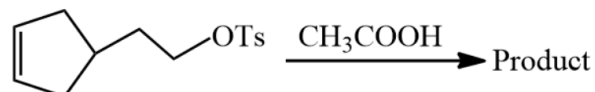
Q10 Predict the major product for the following reaction.



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

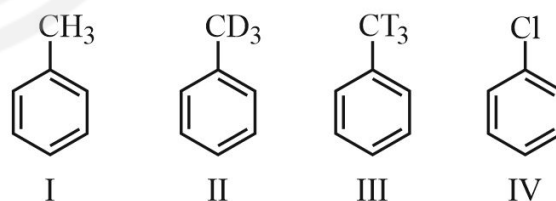


Q11 Find the major product.



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

Q12 Correct order of electron rich benzene is.



- (A) $\text{IV} > \text{I} > \text{II} > \text{III}$
 (B) $\text{IV} > \text{II} > \text{III} > \text{I}$
 (C) $\text{I} > \text{II} > \text{III} > \text{IV}$
 (D) $\text{IV} > \text{III} > \text{II} > \text{I}$

Q13 The density of 2.0 M solution of acetic acid in water is 1.2 g/mL. Calculate the molality of the solution. (molar mass of acetic acid = 60 g/mol).

- (A) 1.25m (B) 1.95m
 (C) 2.25m (D) 1.85m



Q14 If the electron were spin 1 particle, instead of spin $\frac{1}{2}$, then the number of electrons that can be accommodated in a level are

- (A) 1 (B) 2
(C) 3 (D) 4

Q15 For a given ionic strength, (I) rate of reaction is given by $\log(k/k_0) = -4 \times 0.51 (I)^{1/2}$.

Which of the following reactions follows the above equation?

- (A) $S_2O_8^{2-} + I^-$
(B) $[Co(NH_3)_5Br]^{2+} + OH^-$
(C) $CH_3COOC_2H_5 + OH^-$
(D) $H^+ + Br^- + H_2O_2$

Q16 Calculate the wavelength (in nanometer) associated with a proton moving at $1.0 \times 10^3 \text{ ms}^{-1}$.

- (A) 0.032 nm (B) 0.40 nm
(C) 2.5 nm (D) 14.0 nm

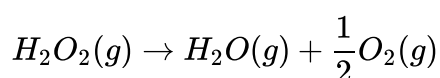
Q17 A gas sample at 27°C and 2 atm pressure occupies a volume of 10 L. If the temperature is increased to 127°C and the pressure is reduced to 1 atm, what will be the final volume?

- (A) 20 L (B) 40 L
(C) 30 L (D) 10 L

Q18 The correct order of crystal field splitting of different complexes is:

- (A) $\Delta_{sp} > \Delta_{icsh} > \Delta_0 > \Delta_t > \Delta_C$
(B) $\Delta_{sp} > \Delta_0 > \Delta_t > \Delta_C > \Delta_{icsh}$
(C) $\Delta_{sp} < \Delta_{icsh} < \Delta_0 < \Delta_t < \Delta_C$
(D) $\Delta_{sp} > \Delta_0 > \Delta_C > \Delta_t > \Delta_{icsh}$

Q19 The bond enthalpy of O=O is 498 kJ/mol, and the bond enthalpy of H-O is 463 kJ/mol. What is the enthalpy change for the reaction:

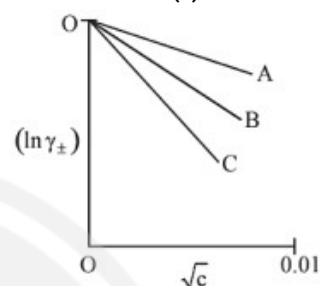


Given:

- H-O bond enthalpy = 463 kJ/mol
- O-O bond enthalpy = 146 kJ/mol
- O=O bond enthalpy = 498 kJ/mol

- (A) -103 kJ/mol (B) -202 kJ/mol
(C) 101 kJ/mol (D) 202 kJ/mol

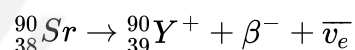
Q20 Aqueous solutions of NaCl, CaCl₂ and LaCl₃ show the following plots of logarithms of mean ionic activity coefficient ($\ln \gamma_{\pm}$) vs molar concentration (c)



The correct option is then

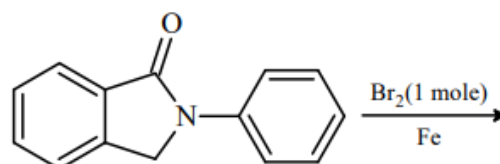
- (A) $\ln \gamma_{\pm}$
(B) A – NaCl, B – CaCl₂, C – LaCl₃
(C) A – NaCl, C – CaCl₂, B – LaCl₃
(D) C – NaCl, A – CaCl₂, B – LaCl₃

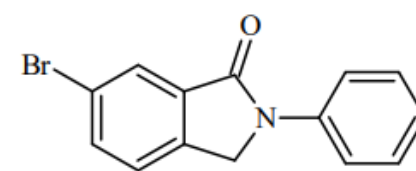

Q21 Following reaction is undergoing:



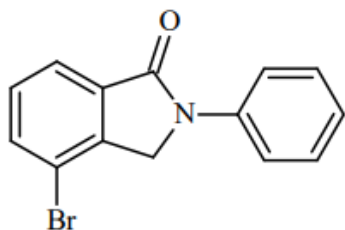
- (A) γ decay (B) β^- decay
(C) β^+ decay (D) α decay

Q22 In the reaction given below, the major product formed is:

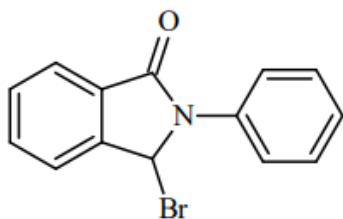


- (A) 
(B) 

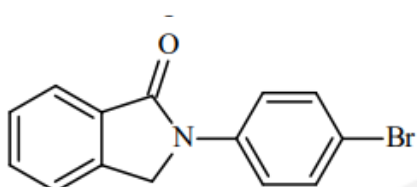




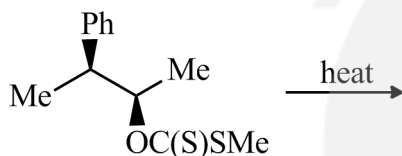
(C)



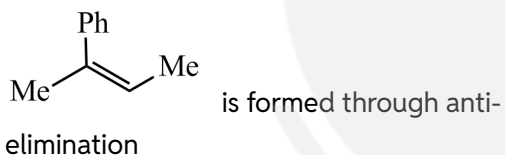
(D)



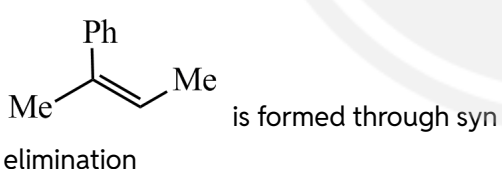
Q23 The correct statement about the following reaction is



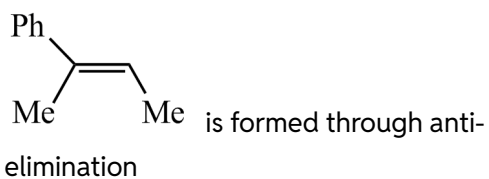
(A)



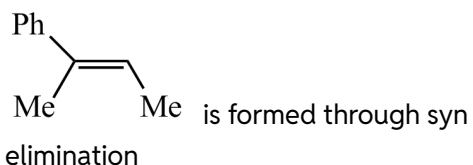
(B)



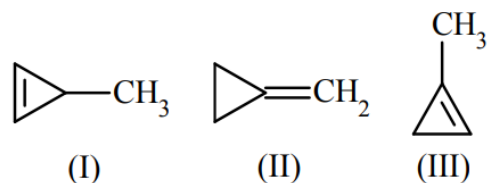
(C)



(D)



Q24 Which of the following order is correct for heat of hydrogenation of these compound?



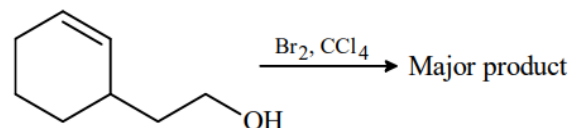
(A) I > II > III

(B) III > II > I

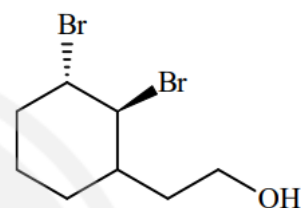
(C) III > I > II

(D) II > I > III

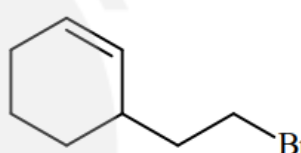
Q25 Give the major product of following reaction



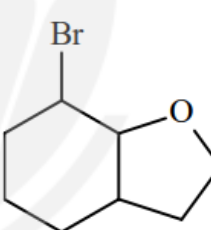
(A)



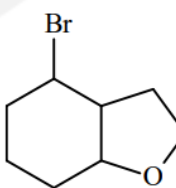
(B)



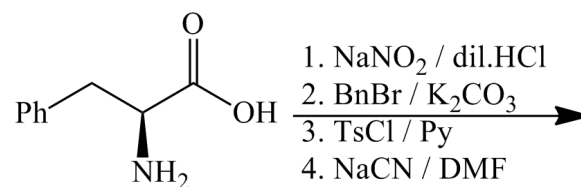
(C)



(D)

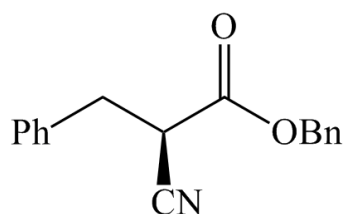


Q26

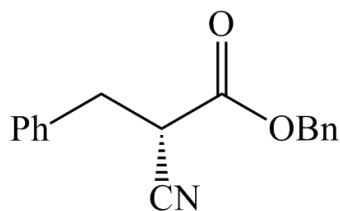


(A)

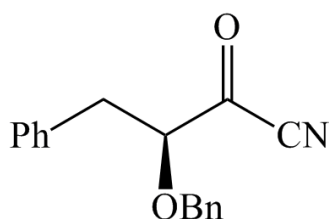




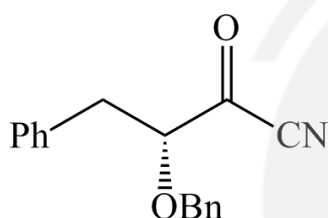
(B)



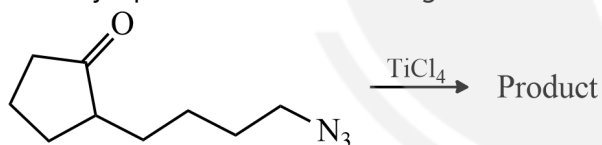
(C)



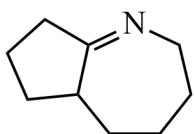
(D)



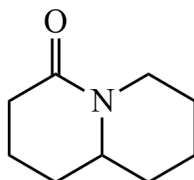
Q27 The major product for the following reaction is:



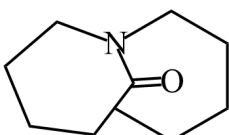
(A)



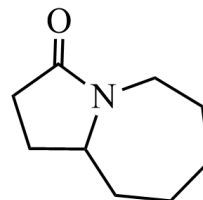
(B)



(C)

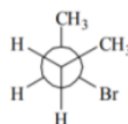


(D)

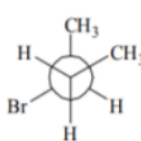


Q28 In the dehydrohalogenation of 2-bromobutane; which conformation leads to the formation of cis-2-butene?

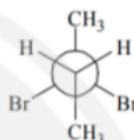
(A)



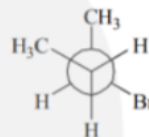
(B)



(C)



(D)



Q29 The energy separation of $^{12}\text{C}^{16}\text{O}$ rotational energy levels between $J'' = 3$ and $J'' = 9$ is 24 cm^{-1} . The rotational constant of $^{13}\text{C}^{16}\text{O}$ in cm^{-1} is closest to:

(A) 2.98

(B) 0.88

(C) 1.90

(D) 2.08

Q30 Match the following

CdS

– a. No transition

 $[\text{Pb}_3(\text{SbO}_4)_2]$ – b. LMCT $\pi_p \rightarrow 6s$ PbCrO₄– c. LMCT $\pi_p \rightarrow 5s$

or 5p

HgO

– d. LMCT $\pi_p \rightarrow 5s$ – e. LMCT $\pi_p \rightarrow 3d$

(A) i-c, ii-e, iii-a, iv-b

(B) i-d, ii-c, iii-e, iv-a

(C) i-d, ii-c, iii-e, iv-b

(D) i-b, ii-c, iii-e, iv-a

Q31 Among the following statement(s), which of the following statements about isobars is/are



correct?

- (A) Isobars have different mass numbers.
- (B) Isobars have different chemical properties.
- (C) Isobars of different elements are placed in different spaces in the periodic table.
- (D) Their physical properties are different because they have different numbers of electrons, protons, and neutrons.

Q32 Which of the following statements is/are true.

- (A) Hydration energy of Co^{3+} is exceptionally too high
- (B) Lattice energy of ZnX_2 is greater than MnX_2 .
- (C) In ionic radii curve Ca^{2+} , Mn^{2+} (HS) Zn^{2+} lies on straight line
- (D) In ionic radii curve metal ion with d^0 and d^{10} configuration lies on straight line.

Q33 Which of the following is/are true?

- (A) V(III) is more inert than V(II).
- (B) V(III) (d^2) is more labile than V(II) (d^3).
- (C) CFAE is much higher for V(II) than V(III).
- (D) CFAE is much higher for V(III) than V(II).

Q34 Which of the following options is/are correct

- (A) For a gas, $\left(\frac{\partial G}{\partial T}\right)_P = \left(\frac{\partial A}{\partial T}\right)_V$
- (B) For a gas obeying equation $P(V - b) = RT$, the value of $\left(\frac{\partial U}{\partial V}\right)_T$ is equal to zero.
- (C) For ideal gas $\left(\frac{\partial U}{\partial P}\right)_T = \left(\frac{\partial H}{\partial P}\right)_T$
- (D) If $w < 0$ it implies work is done on the system

Q35 For a mixture of ideal gases, which of the following are correct according to Dalton's Law of Partial Pressures?

- (A) Total pressure is the sum of partial pressures of all gases.
- (B) Partial pressure is directly proportional to the mole fraction.
- (C) Gases react chemically to contribute to total pressure.
- (D) Each gas behaves independently of others in the mixture.

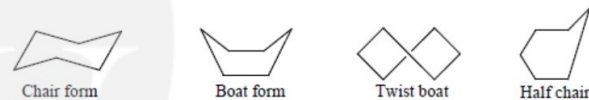
Q36 Which of the following statement(s) is(are) correct regarding the root mean square speed (U_{rms}) and average translational kinetic energy (ϵ_{av}) of molecules in a gas at equilibrium?

- (A) ϵ_{av} at a given temperature does not depend on its molecular mass.
- (B) U_{rms} is doubled when its temperature is increased four times.
- (C) ϵ_{av} is doubled when its temperature is increased four times.
- (D) U_{rms} is inversely proportional to the square root of its molecular mass.

Q37 Which of the following reaction represent(s) hydrolysis?

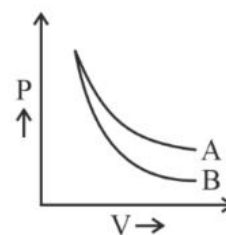
- (A) $NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$
- (B) $NH_4^+ + 2H_2O \rightleftharpoons NH_4OH + H_3O^+$
- (C) $HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + OH^-$
- (D) $HCO_3^- + H_2O \rightleftharpoons CO_3^{2-} + H_2O^+$

Q38 The correct statement(s) regarding the following conformation.



- (A) All structures are the conformational isomers of cyclohexane.
- (B) Stability order = chair > twist boat > boat > half chair
- (C) Angular strain is the most destabilising factor of the least stable conformer.
- (D) More flagpole interaction in twist boat conformation as compared to boat form.

Q39 P–V plot for two gases (assuming ideal) during adiabatic processes are given in the figure. Plot A and plot B should correspond respectively to:



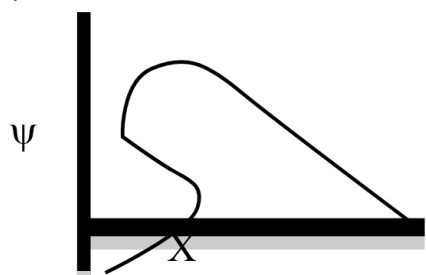
- (A) He and H_2
- (B) H_2 and He



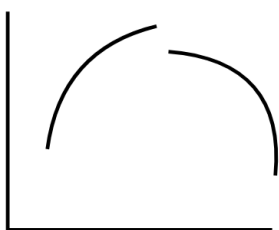
(C) SO_3 and CO_2 (D) N_2 and Ar

Q40 Which of the following function graph depicts an acceptable function?

(A)



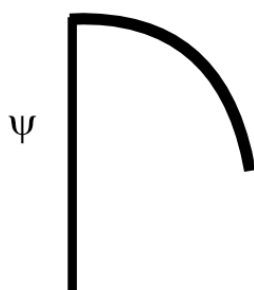
(B)



(C)

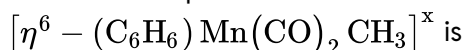


(D)



Q41 The formal oxidation state of the metal in the complex $[ReH_9]^{2-}$ is

Q42 Following the 18-electron rule as guide, the value of x in the complex



Q43 When $^{238}_{92}U$ nuclide release two α and one β particles to form 'A'. The sum of atomic mass and atomic number in 'A' is

Q44 At constant temperature, the gas is expanded from 5 atm to 2 atm, the change in entropy is JK^{-1}

mol^{-1} (Use: $R=8.3 JK^{-1}mol^{-1}$) (Round off to one decimal place)

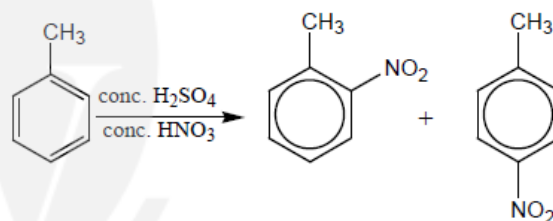
Q45 Acetic acid associates in benzene to form a dimer. 1.65 g of acetic acid when dissolved in 100 g of benzene raised the boiling point by $0.36^\circ C$. The van't Hoff factor is (k_b for benzene= $2.57^\circ C M^{-1}$) (Round off to two decimal places)

Q46 The value of d_{111} in a cubic crystal is $325.6^\circ C$. The value of d_{333} is

Q47 The orbital degeneracy of the level of a one-electron atomic system with $z=5$ and energy approx $-13.6 eV$ is

Q48 The amount of NH_4Cl required to prepare a buffer solution of NH_3 and NH_4Cl of pH 9, when the total concentration of buffering reagent is $0.8 mol L^{-1}$ ____ M. (Round off to two decimal places).

Q49



For above electrophilic substitution reaction, the number of [T.S] transition state will be formed in energy profile diagram is

Q50 The number of diastereoisomers possible for the compound 1-Bromo-2-chloro-3-iodocyclopropane is

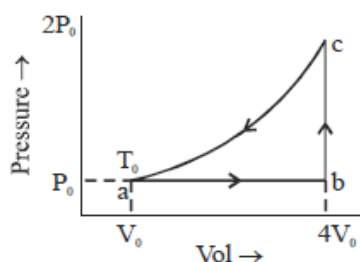
Q51 Number of framework electrons present in $[B_{12}H_{12}]^{2-}$ is

Q52 The bond length in HF is 92 pm and the dipole moment is 1.83D. The charge distribution on H atom is/are (Round off to two decimal places)

Q53 One mole of an ideal mono-atomic gas is subjected to go through the cycle shown in the figure below. Then the change in internal energy



in expanding gas from 'a' to 'c' along path abc is ___ times of RT_0 . (Round off to one decimal place)



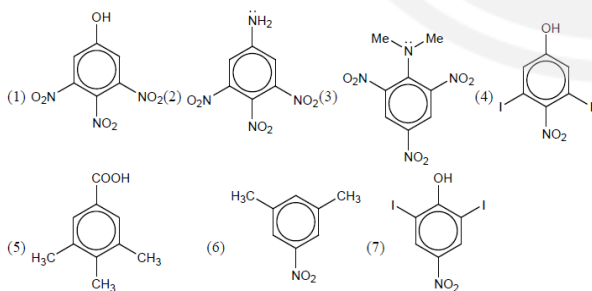
Q54 The standard EMF of a galvanic cell involving cell reaction with $n = 2$ (number of electrons) is found to be 0.295 V at 25 °C. The equilibrium constant of the reaction is ___ $\times 10^9$. (Round off to two decimal places).

Q55 The kinetic energy of 64g of O_2 at 300K _____ kJ.

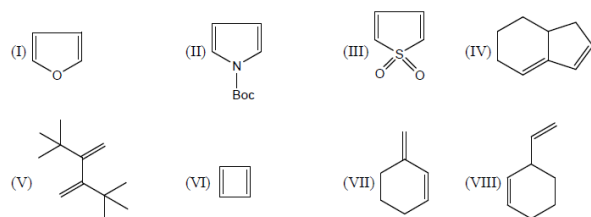
Q56 The number of components in the following system is _____. A solution containing Na^+ , Cl^- , Ag^+ , NO_3^- , $AgCl(s)$ and H_2O .

Q57 The rate constant of a reaction is 10^{-3} sec^{-1} . The time required to decompose 10% of the initial amount is

Q58 The number of compound(s) among the following exhibits SIR effect is



Q59 The number of compound(s) which can not be used as a Diene in the Diels-Alder reaction is



Q60 Calculate the mass defect of ${}^4_2\text{He}$ nucleus in amu:

Given:

- Mass of one proton = **1.00728 amu**
- Mass of one neutron = **1.00866 amu**
- Mass of one electron = **0.0005486 amu**
- Mass of ${}^4_2\text{He}$ atom = **4.00260 amu**



Answer Key

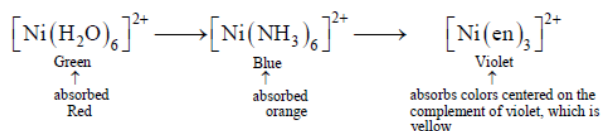
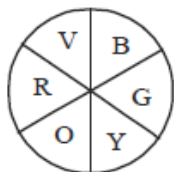
Q1	(D)	Q31	(B, C, D)
Q2	(D)	Q32	(A, B, C, D)
Q3	(A)	Q33	(B, C)
Q4	(A)	Q34	(A, B, C)
Q5	(D)	Q35	(A, B, D)
Q6	(B)	Q36	(A, B, D)
Q7	(D)	Q37	(B, C)
Q8	(C)	Q38	(A, B, C)
Q9	(C)	Q39	(B, C, D)
Q10	(C)	Q40	(C, D)
Q11	(B)	Q41	7~7
Q12	(C)	Q42	0~0
Q13	(D)	Q43	319~319
Q14	(C)	Q44	7.5~7.7
Q15	(B)	Q45	0.5~0.52
Q16	(B)	Q46	108.5~108.55
Q17	(B)	Q47	25~25
Q18	(D)	Q48	0.51~0.55
Q19	(A)	Q49	2~2
Q20	(B)	Q50	4~4
Q21	(B)	Q51	26~26
Q22	(D)	Q52	0.4~0.45
Q23	(D)	Q53	10.4~10.6
Q24	(A)	Q54	9.58~9.64
Q25	(C)	Q55	7.4~7.6
Q26	(B)	Q56	4~4
Q27	(B)	Q57	105.3~105.5
Q28	(A)	Q58	4~4
Q29	(C)	Q59	4~4
Q30	(B)	Q60	0.028~0.031



Hints & Solutions

Q1 Text Solution:

Colors that are opposite to each other on the color wheel are considered to be complementary colors.



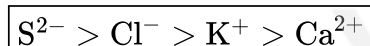
Q2 Text Solution:

All the given species are **isoelectronic (18 electrons)**:

- $\text{S}^{2-} \rightarrow Z = 16$
- $\text{Cl}^- \rightarrow Z = 17$
- $\text{K}^+ \rightarrow Z = 19$
- $\text{Ca}^{2+} \rightarrow Z = 20$

For **isoelectronic species**, ionic radius decreases with increasing nuclear charge (Z).

Therefore, decreasing ionic radii order:



Thus, (D) > (C) > (A) > (B).

Q3 Text Solution:

Acidic oxides and amphoteric oxides react with NaOH. Whereas Basic oxides do not react with NaOH

Applying this:

$\text{CaO} \rightarrow$ basic oxide \rightarrow does not react with NaOH.

$\text{SiO}_2 \rightarrow$ acidic oxide \rightarrow reacts with NaOH.

$\text{BeO} \rightarrow$ amphoteric oxide \rightarrow reacts with NaOH.

$\text{B}_2\text{O}_3 \rightarrow$ acidic oxide \rightarrow reacts with NaOH.

Thus, CaO is not expected to react with sodium hydroxide.

Q4 Text Solution:

The **reduced mass (μ)** of a diatomic molecule is given by:

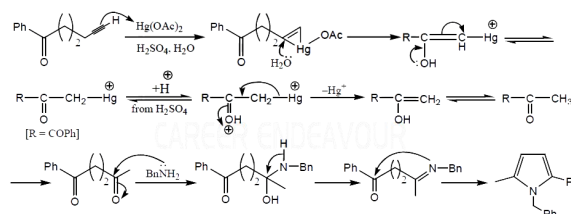
$$\mu = \frac{m_1 m_2}{m_1 + m_2}$$

Now,

$$\mu = \frac{(1.67)(58.06)}{1.67+58.06} \times 10^{-27}$$

$$\mu = \frac{96.95}{59.73} \times 10^{-27} \approx 1.62 \times 10^{-27} \text{ kg}$$

Q5 Text Solution:



Q6 Text Solution:

(b) have equal volume.

By Avogadro's law, at the same T and P, equal numbers of molecules of gases occupy equal volumes (not necessarily 22.4 dm³ unless at STP).

Q7 Text Solution:

(A) Both are diamagnetic — False.

- Ca / Ca²⁺ is diamagnetic.
- Eu²⁺ has configuration 4f⁷ (7 unpaired electrons) \rightarrow paramagnetic.

(B) Insolubility of sulphates and carbonates — True.

- CaSO₄ is sparingly soluble; CaCO₃ is insoluble.
- EuSO₄ is also sparingly soluble, and Eu₂(CO₃)₃ is insoluble.

(C) Solubility of these metals in liquid NH₃ — True.

- Calcium dissolves in liquid NH₃ giving solvated electrons (blue solution).
- Europium (like Ca, Yb) also dissolves due to stable Eu²⁺ formation.

(D) Insolubility of their dichlorides in strong HCl — True.

Hence, The correct answer is (B). (C) and (D) only.

Q8 Text Solution:

Solution:

Partial pressure of N₂ applying Boyle's Law at



constant temperature $P_1 V_1 = P_2 V_2$

$$P_{N_2} = \frac{200 \times 740}{1000} = 148 \text{ mm Hg}$$

Similarly, partial pressure of oxygen

$$P_{O_2} = \frac{500 \times 720}{1000} = 360 \text{ mm Hg}$$

Total pressure

$$\begin{aligned} P_{Total} &= P_{N_2} + P_{O_2} = (148 + 360) \text{ mm Hg} \\ &= 508 \text{ mm Hg} \end{aligned}$$

Therefore, correct option is C.

Q9 Text Solution:

Value of enthalpy of physisorption is directly proportional to the polarity. Polar molecules have more value of enthalpy of physisorption.

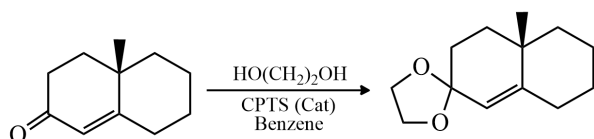
Therefore, H_2O has more value of enthalpy of physisorption because it is a polar molecule.

Hence, correct option is C.

Q10 Text Solution:

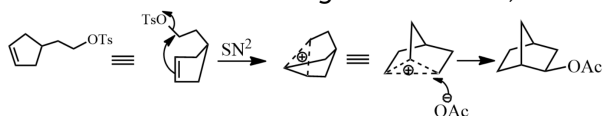
- Chemoselective acetalization of an α - β -unsaturated ketone moiety in the presence of 2, 4, 6-collidinium p-toluenesulfonate (CPTS) as a catalyst takes place.
- In the presence of CPTS ethylene glycol protect the ketonic group without migration of double bond.
- Therefore correct option is C.

Mechanism :



Q11 Text Solution:

Mechanism of the reaction given as follows,



Therefore, option (B) is correct.

Q12 Text Solution:

The more the electron density on the bonded atom, the more will be the C-X (X= -H/-D/-T) bond strength.

Hyperconjugation effect order is in the following order of, $-CH_3 > -CD_3 > -CT_3$

Although +I effect order is $-CH_3 < -CD_3 < -CT_3$

The hyperconjugation effect is more effective compared to the inductive effect.

Therefore, option (C) is correct.

Q13 Text Solution:

Given Data

- Molarity (M) = 2.0 M
- Density of solution = 1.2 g/mL = 1200 g/L
- Molar mass of acetic acid (CH_3COOH) = 60 g/mol
- Molality (m) = ?

1. Mass of 1 liter of solution (since density is 1.2 g/mL):

$$\text{Mass of solution} = 1.2 \times 1000 = 1200 \text{ g}$$

2. Mass of solute (acetic acid) in 1 liter of solution:

$$\text{Mass of solute} = \text{Molarity} \times \text{Molar mass}$$

$$= 2.0 \times 60 = 120 \text{ g}$$

3. Mass of solvent (water):

Mass of

$$\text{solvent} = \text{Mass of solution} - \text{Mass of solute}$$

$$= 1200 - 120 = 1080 \text{ g} = 1.08 \text{ kg}$$

Molality (m) is given by:

$$m = \frac{\text{Moles of solute}}{\text{Mass of solvent (kg)}}$$

$$m = \frac{2.0}{1.08}$$



$m \approx 1.85 \text{ m}$

Final Answer:

1.85 m

Q14 Text Solution:

Electron spin 'S' = 1

Total possible z-component of electronic spin angular momentum quantum number = $2S+1 = 2(1)+1 = 3$

$$\therefore m_s = +1, 0, -1$$

The Pauli exclusion principle states that in a single atom no two electrons will have an identical set or the same quantum numbers (n , l , m_l and m_s).

So, three electrons can be accommodated in a level, due to their different spin (m_s) quantum number.

Q15 Text Solution:

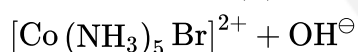
$$\log \frac{k}{k_0} = -4 \times 0.51 (\sqrt{I})$$

$$\log \frac{k}{k_0} \approx +2Z_A Z_B (0.501) \sqrt{I}$$

$$2Z_A Z_B = -4$$

$$Z_A Z_B = -2$$

So, for option (b),



$$Z_A Z_B \Rightarrow (+2)(-1) = -2$$

$$\text{so; } \log \frac{k}{k_0} = 2(-2)(0.501) \sqrt{I}$$

$$= -4 \times 0.501 \sqrt{I}$$

Hence, the correct option is (b).

Q16 Text Solution:

The de Broglie relation:

$$\lambda = \frac{h}{mv}$$

Now,

$$\lambda = \frac{6.626 \times 10^{-34}}{(1.67 \times 10^{-27})(1.0 \times 10^3)}$$

$$\lambda \approx 3.97 \times 10^{-10} \text{ m}$$

Convert to nanometers:

$$1 \text{ nm} = 10^{-9} \text{ m}$$

$$\lambda = 0.4 \text{ nm}$$

Q17 Text Solution:

Correct Answer:

(b) 40 L

Solution:

We use the **combined gas law**:

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Given Data:

- Initial pressure, $P_1 = 2 \text{ atm}$
- Initial volume, $V_1 = 10 \text{ L}$
- Initial temperature, $T_1 = 27^\circ \text{C} = (27 + 273) = 300 \text{K}$
- Final pressure, $P_2 = 1 \text{ atm}$
- Final temperature, $T_2 = 127^\circ \text{C} = (127 + 273) = 400 \text{K}$
- Final volume, $V_2 = ?$

$$\frac{(2)(10)}{300} = \frac{(1)(V_2)}{400}$$

$$\frac{20}{300} = \frac{V_2}{400}$$

$$V_2 = \frac{20 \times 400}{300}$$

$$V_2 = \frac{8000}{300} = 40 \text{ L}$$

Final Answer:

(b) 40 L

Q18 Text Solution:

Solution: The crystal field splitting is maximum for square complexes it is nearly 1.3 times than crystal field splitting of octahedral complexes.

Crystal field splitting of cubic complexes is $8/9$ of Δ_0 .

Crystal field splitting of tetrahedral complexes is $4/9$ of Δ_0 .

Crystal Field splitting for icosahedral is zero.

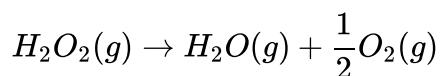
Therefore, the correct option is D.



Q19 Text Solution:

Solution:

To find the enthalpy change (ΔH) for the reaction:



we use the bond enthalpy method:

$$\Delta H = \sum \text{Bond Energies of Reactants} - \sum \text{Bond Energies of Products}$$

Reactants: H_2O_2 (g)

- Hydrogen peroxide (H_2O_2) contains two H–O bonds and one O–O bond.
- Total bond energy in reactants:

$$\begin{aligned} & (2 \times \text{H-O}) + (1 \times \text{O-O}) \\ &= (2 \times 463) + (1 \times 146) \\ &= 926 + 146 = 1072 \text{ kJ} \end{aligned}$$

Products: H_2O (g) and $\frac{1}{2}O_2$ (g)

- Water (H_2O) has two H–O bonds.
- Oxygen molecule (O_2) has one O=O bond, but only half of it is involved.
- Total bond energy in products:

$$\begin{aligned} & (2 \times \text{H-O}) + \left(\frac{1}{2} \times \text{O=O}\right) \\ &= (2 \times 463) + \left(\frac{1}{2} \times 498\right) \\ &= 926 + 249 = 1175 \text{ kJ} \end{aligned}$$

Calculate Enthalpy Change

$$\begin{aligned} \Delta H &= \text{Bond energy of reactants} \\ &- \text{Bond energy of products} \end{aligned}$$

$$= 1072 - 1175$$

$$= -103 \text{ kJ}$$

Final Answer: (A) -103 kJ/mol

Q20 Text Solution:

The mean ionic activity coefficient (γ_{\pm}) of an electrolyte decreases as its concentration increases due to greater inter-ionic interactions in solution. According to the Debye-Hückel theory, this decrease is more pronounced for electrolytes with higher ionic charges. Therefore, among NaCl (1:1), $CaCl_2$ (1:2), and $LaCl_3$ (1:3), $LaCl_3$ shows the greatest decrease in γ_{\pm} , followed by $CaCl_2$ and then NaCl. This means that in a plot of $\ln \gamma_{\pm}$ versus molar concentration, the slope becomes more negative as the charge on the ions increases.

In such a plot, the curve for NaCl will have the least negative slope, indicating the smallest change in activity coefficient with concentration. $CaCl_2$ will show a steeper decline, and $LaCl_3$ will exhibit the steepest slope, reflecting the strongest ionic interactions. Hence, the correct graph or option is the one where the line for $LaCl_3$ drops the most sharply, followed by $CaCl_2$, and then NaCl.

$$\log \gamma_{\pm} = -2.303A |Z_- Z_+| \sqrt{I}$$

For same concentration of electrolyte $|Z_- Z_+| \sqrt{I}$ will be smallest for NaCl and largest for $LaCl_3$. As negative sign is there so slope of NaCl will be least negative and slope of $LaCl_3$ will be most negative.

Hence, the correct option is (b).

Q21 Text Solution:

Correct Answer: (b) β^- decay



• **Explanation:**

- The reaction shows **strontium-90** ($^{90}_{38}\text{Sr}$) decaying into **yttrium-90** ($^{90}_{39}\text{Y}$), along with the emission of a β^- particle (electron) and an antineutrino ($\bar{\nu}_e$).
- This is a classic case of β^- decay, where a neutron in the nucleus converts into a proton, increasing the atomic number by 1 while keeping the mass number the same.

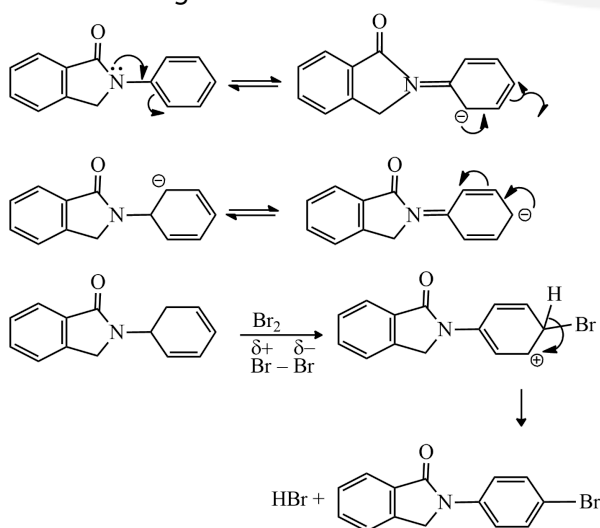
Q22 Text Solution:

Concept-

Electrophilic aromatic substitution reactions are organic reactions wherein an electrophile replaces an atom that is attached to an aromatic ring. Commonly, these reactions involve the replacement of a hydrogen atom of benzene ring with an electrophile.

Explanation-

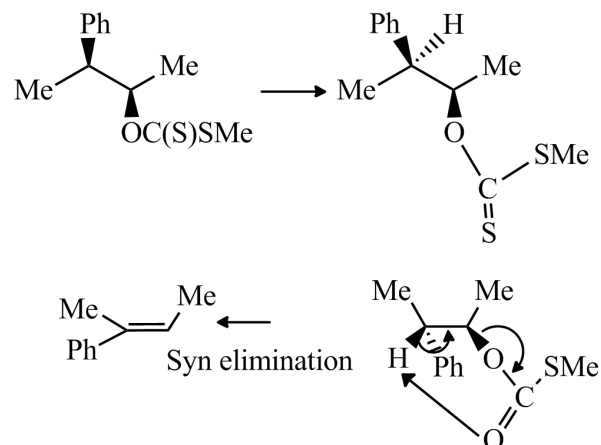
In a given reagent the substituent attached with the benzene ring is the electron donating group the lone pair electrons present on N atoms are good donors, which activates the ring for electrophilic substitution reaction and directs the incoming group towards ortho and para positions. Para product is major because ortho product will experience repulsion from the substituted group so it is formed in minor quantity. Br^+ act as an electrophile. The mechanism is given below.



So the answer is D.

Q23 Text Solution:

The reaction pathway is shown below:



Hence, option d is the correct answer.

Q24 Text Solution:

Concept-

The heat of hydrogenation is the measure of the stability of an alkene. Lower the heat of hydrogenation of alkene the more stable it is and vice versa. Alkyl substitution at unsaturated C lowers the heat of hydrogenation and therefore increases its stability. It is due to its hyperconjugative effect. More the number of hyperconjugative structures, lower the heat of hydrogenation hence more stability is incurred on it.

There is a phenomenon called Hyperconjugation, which determines stability. According to this factor, if there are more number of Alpha hydrogens, (hydrogens attached to the carbon adjacent to the carbon directly attached with double bond) there will be more no-bond resonating structures, and hence, the compound will be more stable.

Based on the heat of hydrogenation of alkenes, the trend in the stability of carbon-carbon double bonds is: tetrasubstituted > trisubstituted > disubstituted > monosubstituted > unsubstituted.

Explanation-

The compound (I) is disubstituted alkene but have only one alpha hydrogen, whereas compound (II) is disubstituted and has 4 alpha



hydrogens, compound (III) is trisubstituted and compound (II) is disubstituted and has 5 alpha hydrogens, so by comparing all these compound (I) has least number of alpha hydrogens hence less stable consumes less energy and releases more energy hence have highest negative heat of hydration. In the same compound (III) is highly stable since it is trisubstituted and has 5 alpha hydrogens so has least hydration value.

So order is (I) > (II) > (III)

So answer is A.

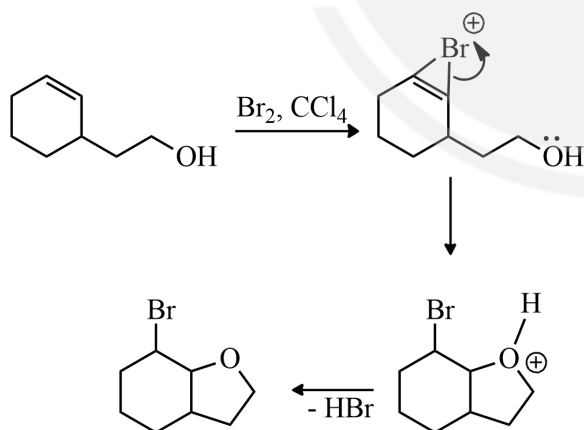
Q25 Text Solution:

Concept-

A halogen addition reaction is a simple organic reaction where a halogen molecule is added to the carbon-carbon double bond of an alkene functional group.

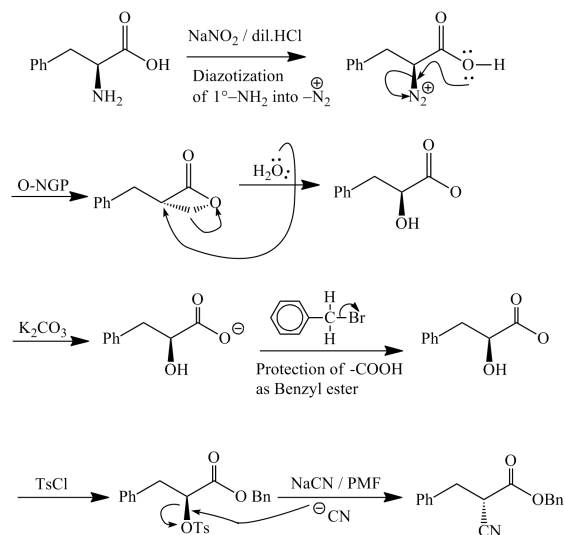
Explanation-

The addition of halogens takes place by forming an intermediate halonium cation. In next step intramolecular S_N2 reaction takes place to give fused system. Since intramolecular reactions are fast The -OH group in compound act as nucleophile so it will attack with opposite stereo. The mechanism is explained below.

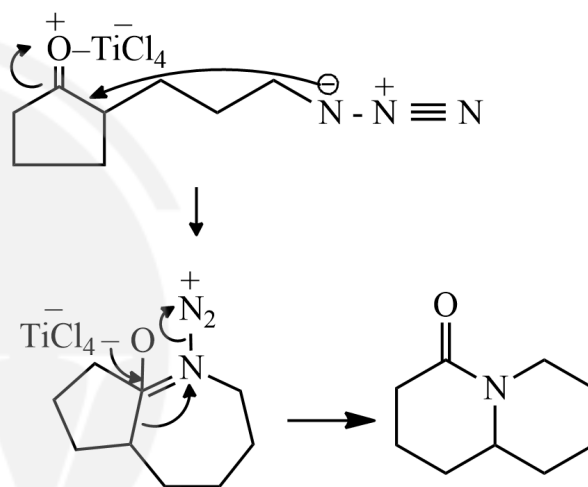


So answer is C

Q26 Text Solution:

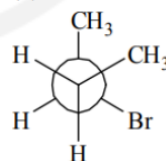


Q27 Text Solution:



Hence, correct option is (d).

Q28 Text Solution:



concept:

The conformation that leads to the formation of cis-2-butene in the dehydrohalogenation of 2-bromobutane is the anti-coplanar conformation, also known as the anti-periplanar conformation. In this conformation, the bromine atom and the beta hydrogen atom are in an anti-orientation, meaning they are on opposite sides of the carbon-carbon bond. This allows for a concerted removal of the bromine and the beta hydrogen, resulting in the formation of cis-2-butene.



Explanation of the mechanism:

1. The base (e.g., KOH) approaches the beta hydrogen atom from the opposite side of the bromine atom.

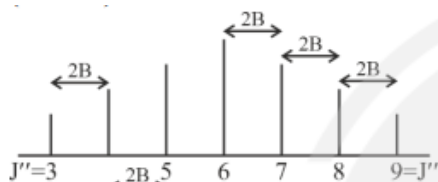
2. The bromine atom and the beta hydrogen atom are in an anti-coplanar conformation, allowing for a concerted removal.

3. The base removes the beta hydrogen atom, and the bromine atom leaves, resulting in the formation of cis-2-butene.

Note that the syn-coplanar conformation would lead to the formation of trans-2-butene.

Correct option is (1)

Q29 Text Solution:



$$12B = 24 \Rightarrow B = 2 \text{ cm}^{-1}$$

$$B_{12\text{C}^{16}\text{O}} = 2$$

$$\Rightarrow \frac{B_{13\text{C}^{16}\text{O}}}{B_{12\text{C}^{16}\text{O}}} = \frac{\mu_{12\text{C}^{16}\text{O}}}{\mu_{13\text{C}^{16}\text{O}}} B \propto \frac{1}{\mu}$$

$$= B_{13\text{C}^{16}\text{O}} = B_{12\text{C}^{16}\text{O}} \times \frac{\mu_{12\text{C}^{16}\text{O}}}{\mu_{13\text{C}^{16}\text{O}}} = 1.9 \text{ cm}^{-1}$$

Q30 Text Solution:

Concept-

Charge-transfer bands of transition metal complexes result from shift of charge density between molecular orbitals (MO) that are predominantly metal in character and those that are predominantly ligand in character. If the transfer occurs from the MO with ligand-like character to the metal-like one, the transition is called a ligand-to-metal charge-transfer (LMCT). If the electronic charge shifts from the MO with metal-like character to the ligand-like one, the band is called a metal-to-ligand charge-transfer (MLCT). Thus, a MLCT results in oxidation of the metal center, whereas a LMCT results in the reduction of the metal center.

Explanation-

In given compounds all metals are in high oxidation state hence ligand to metal charge transfer takes place to give respective transition bands. Metals are electron deficient in nature when compared to the ligands in the particular compounds, then ligand to metal electron transfer takes place. In (i) Cd(+2) and sulphur size is large so from pi (HOMO) orbitals sulphur to the 5s (LUMO) orbitals of the metal electron transfer takes place. In (ii) Sb(+5) so oxygen transfer the electrons to the metal (HOMO) pi of oxygen to the 5s or 5p (LUMO) of metal. In (iii) Cr(+6) so oxygen transfer the electrons to the metal (HOMO) pi of oxygen to the 3d (LUMO) of metal. In (iv) no transition takes place since energy gap between the HOMO 2p to the 6s of metal, so no transition takes place.

So answer is B.

Q31 Text Solution:

Solution:

Concept of Isobars:

- **Isobars** are atoms of different elements that have the **same mass number (A)** but different atomic numbers (Z).
- Since their atomic numbers differ, they belong to different elements and hence have **different chemical properties**.
- They are placed **at different positions in the periodic table** because elements are arranged based on atomic number (Z), not mass number (A).
- **Physical properties also differ** because they have different numbers of protons, neutrons, and electrons.

Evaluating the Statements:

- **Statement (a) is incorrect:** Isobars have the **same mass number**, not different.
- **Statement (b) is correct:** Isobars belong to different elements, so they have different chemical properties.



- **Statement (c) is correct:** Since they have different atomic numbers, they occupy different places in the periodic table.
- **Statement (d) is correct:** Their physical properties are different due to variations in atomic structure.

Correct Answer: (b), (c), and (d)

Q32 Text Solution:

Concept:-

1. Hydration Energy: High charge density ions like Co^{3+} have exceptionally high hydration energies due to strong interactions with water molecules.
2. Lattice Energy: Zn^{2+} has a higher lattice energy compared to Mn^{2+} due to its higher charge density and smaller ionic radius.
3. Ionic Radii Trends: For metal cations with similar charges (e.g., Ca^{2+} , Mn^{2+} , Zn^{2+}), the ionic radii often form a nearly straight line because they have similar effective nuclear charge and charge-to-radius ratios.
4. d^0 and d^{10} Ions: Metal ions with d^0 and d^{10} electronic configurations (like Zn^{2+} and Sc^{3+}) lie on a straight line in ionic radii plots due to similar effective nuclear charges and minimal electron-electron repulsion effects.

Explanation:-

A. Hydration energy of Co^{3+} is exceptionally too high

True. The high charge density of Co^{3+} results in a high hydration energy because the ion attracts water molecules strongly, which increases hydration energy.

B. Lattice energy of ZnX_2 is greater than MnX_2
True. Zinc has a higher charge density due to its smaller ionic radius compared to manganese. Thus, ZnX_2 typically has a higher lattice energy than MnX_2 .

C. In ionic radii curve Ca^{2+} , Mn^{2+} (HS), Zn^{2+} lies on a straight line

True. Despite varying electronic configurations, the trend in ionic radii for metal cations with the same charge (e.g., Ca^{2+} , Mn^{2+} , Zn^{2+}) often forms a

nearly straight line due to their similar effective nuclear charge and charge-to-radius ratio.

D. In ionic radii curve, metal ions with d^0 and d^{10} configurations lie on a straight line

True. Metal ions with d^0 and d^{10} configurations (like Zn^{2+} and Sc^{3+}) have similar electronic structures that influence their ionic radii in a straightforward manner, leading to a near-straight line in the ionic radii curve.

The correct option is A, B, C, D.

Q33 Text Solution:

V^{3+} is expected to be more inert than V^{2+} in terms of the charge/radius ratio. But in reality, $\text{V(III)} (d^2)$ is more labile than $\text{V(II)} (d^3)$. It is expected in terms of CFAE which is much higher for V(II) .

Option (b) and (c) are correct answer.

Q34 Text Solution:

$$\left(\frac{\partial G}{\partial T}\right)_P = \left(\frac{\partial A}{\partial T}\right)_V = -S$$

For a gas, $P(V - b) = RT$;

$$\left(\frac{\partial U}{\partial V}\right)_T = T\left(\frac{\partial P}{\partial T}\right)_V - P = 0$$

$$\text{For an ideal gas, } \left(\frac{\partial U}{\partial P}\right)_T = \left(\frac{\partial H}{\partial P}\right)_T = 0$$

Q35 Text Solution:

Explanation:

- **A)** Dalton's Law states that the total pressure of a gas mixture is equal to the sum of the partial pressures of each individual gas.
- **B)** The partial pressure of a gas in a mixture is proportional to its mole fraction, i.e.,
 $P_i = X_i \times P_{Total}$.
- **D)** In an ideal gas mixture, each gas behaves as if it were alone in the container, without interacting with other gases.
- **C) is incorrect** because ideal gases do not react chemically in the mixture.

Final Answer: A, B, D

Q36 Text Solution:

We use the following formulas:

1. **Root Mean Square (RMS) Speed:**



$$U_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

- It depends on **temperature** (T) and **molecular mass** (M).

2. Average Translational Kinetic Energy per Molecule:

$$\epsilon_{\text{av}} = \frac{3}{2}kT$$

- It depends **only on temperature** and **not on molecular mass**.

Now, let's analyze the given statements:

(1) ϵ_{av} **at a given temperature does not depend on its molecular mass.** (Correct, as per the formula.)

(2) U_{rms} **Urms is doubled when its temperature is increased four times.**

- Since $U_{\text{rms}} \propto \sqrt{T}$, if T increases **4 times**, then U_{rms} becomes **2× its original value**.

(3) ϵ_{av} **is doubled when its temperature is increased four times.**

- From $\epsilon_{\text{av}} = \frac{3}{2}kT$, we see that $\epsilon_{\text{av}} \propto T$.
- So, if T increases **4 times**, ϵ_{av} also increases **4 times**, not **2 times**.

(4) U_{rms} **is inversely proportional to the square root of its molecular mass.**

- From $U_{\text{rms}} = \sqrt{\frac{3RT}{M}}$, we see that $U_{\text{rms}} \propto \frac{1}{\sqrt{M}}$.

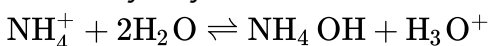
Final Answer :

(1), (2), and (4) are correct.

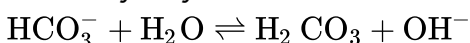
Q37 Text Solution:

(b,c)

Cationic hydrolysis:



Anionic hydrolysis:



Q38 Text Solution:

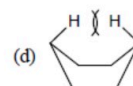
(a) All structures are the conformational isomers of cyclohexane. They are interconverted to each other through single bond rotation.

(b) Stability order = chair > twist boat > boat > half chair.

(c) The least stable conformation is half-chair.



Most destabilising factor is angular strain in half chair



(d) More flagpole-flagpole repulsive interaction occurs in boat conformation as compare to twist boat form

Q39 Text Solution:

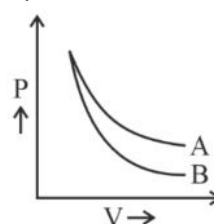
Concept:

A PV plot (pressure-volume plot) of a gas shows the relationship between the pressure (P) and volume (V) during various thermodynamic processes. Key processes on a PV plot include:

- **Isothermal:** Temperature remains constant, forming a hyperbolic curve.
- **Isobaric:** Pressure remains constant, showing a horizontal line.
- **Isochoric:** Volume remains constant, shown as a vertical line.
- **Adiabatic:** No heat exchange, forming a steeper curve than the isothermal process.

The area under the curve represents the work done by or on the gas.

Explanation:



$$\text{For gases, } Y = \frac{C_{P,m}}{C_{V,m}}$$

$$PVY = \text{Constant}$$

Y increase slope increase



$$Y = \frac{5}{3} \quad Y^2 = \frac{9}{7}$$



So, slope is high for He. As Y value is high.
Correct Options are (2, 3, 4)

Q40 Text Solution:

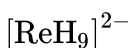
In the graph A, the function has two values at same value of x . So it is not single valued function. So it is not acceptable function.

In the graph B the wave function is discontinuous so it is not acceptable function.

In the graph C the graph represents the sin function and is acceptable

In the graph D the sin function is represented. It is also acceptable wave function

Hence, option c & d are correct.

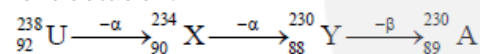
Q41 Text Solution:

$$\text{or, } x + 9(-1) = -2$$

$$\text{or, } x = 7$$

Q42 Text Solution:

$$6 + 7 + 4 + 1 + x = 18$$

Q43 Text Solution:

Sum of atomic mass and atomic number in 'A' is 319

Q44 Text Solution:

$$\Delta S = -nR \ln \left(\frac{P_2}{P_1} \right) = -8.3 \ln \left(\frac{2}{5} \right)$$

$$\Delta S = 7.6 \text{ JK}^{-1} \text{ mol}^{-1}$$

Q45 Text Solution:

$$\Delta T_b = i k_b m$$

$$\text{Molality (m)} = \frac{1.65}{60 \times 0.1} = 0.275$$

$$i = \frac{\Delta T_b}{k_b m} = \frac{0.36}{2.57 \times 0.275} = 0.509 \approx 0.51$$

Q46 Text Solution:

$$d_{111} = 325.6 \text{ pm}$$

$$d_{333} = \frac{1}{3} d_{111} = \frac{1}{3} \times 325.6 \text{ pm} = 108.53 \text{ pm}$$

Q47 Text Solution:

$$E_n = -13.6 \times \frac{z^2}{n^2} \Rightarrow -13.6 = -13.6$$

$$\times \frac{(5)^2}{n^2}$$

$$n^2 = 25$$

$$\text{Now, degeneracy} = n^2 = 25$$

Q48 Text Solution:

For basic buffer

$$\text{pOH} = \text{p}K_b + \log \left[\frac{\text{salt}}{\text{base}} \right] \Rightarrow 5 = 4.7$$

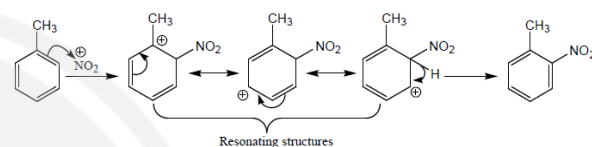
$$+ \log \frac{a}{b}$$

$$\Rightarrow a = 2b$$

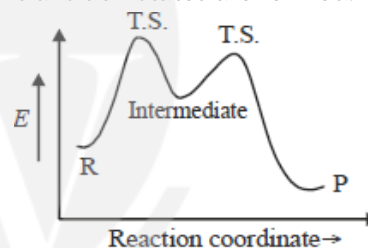
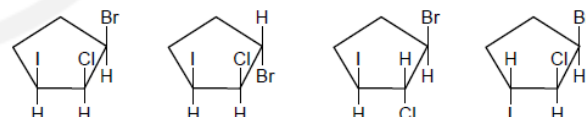
$$\text{Given : } a + b = 0.8 \Rightarrow a + \frac{a}{2} = 0.8 \Rightarrow 2a$$

$$+ a = 1.6 \Rightarrow 3a = 1.6$$

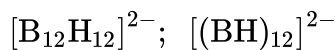
$$\Rightarrow a = 0.53 \text{ mol. L}^{-1}$$

Q49 Text Solution:

Carbocation will be formed as an intermediate and only one intermediate is formed. So, two transition states are formed.

**Q50 Text Solution:**

Total number of Diastereoisomers = 4

Q51 Text Solution:

One BH unit contributes number of framework electrons = $2e^-$

$$\text{Frame work electrons} = 2 \times 12 + 2 = 26$$

Q52 Text Solution:

$$\mu = 1.83 \text{ D}$$

$$\text{H-F (bond length)} = 92 \text{ pm}$$

$$\mu = qed; \quad q = \frac{\mu}{ed} = \frac{1.83 \times 3.336 \times 10^{-30} \text{ m}}{1.6 \times 10^{-19} \text{ C} \times 92 \times 10^{-12} \text{ m}} = 0.041 \times 10$$

$$q = 0.414$$

$$+0.414 \quad -0.414$$

H — F
Charge distribution on hydrogen atom = +0.414

Q53 Text Solution:

For cyclic process, $\Delta U = \Delta U_{a \rightarrow b} + \Delta U_{b \rightarrow c} + \Delta U_{c \rightarrow a} =$

$$\text{Or, } \Delta U_{a \rightarrow b} + \Delta U_{b \rightarrow c} = -\Delta U_{c \rightarrow a} = \Delta U_{a \rightarrow c}$$

For process, $a \rightarrow b$ (Isobaric process)

$$\Delta U_{a \rightarrow b} = nC_{v,m} (T_b - T_a)$$

$T \propto V$ (at constant pressure)

$$\Rightarrow T_b = 4T_0 \quad \{T_A = T_0\}$$

$$\Delta U_{a \rightarrow b} = \frac{3R}{2} \{4T_0 - T_0\} = \frac{9}{2} RT_0$$

For process, $b \rightarrow c$ (Isochoric process)

$T \propto P$

$$\text{Or, } T_c = 2T_b = 2 \times 4T_0 = 8T_0$$

$$\Delta U_{b \rightarrow c} = nC_{v,m} (T_c - T_b) = \frac{3R}{2} \{8T_0 - 4T_0\} = 6RT_0$$

$$\Rightarrow \Delta U_{a \rightarrow b} + \Delta U_{b \rightarrow c} = \Delta U_{a \rightarrow c} = 10.5 RT_0$$

Q54 Text Solution:

$$E^0 = \frac{0.0591}{2} \log K \Rightarrow \log K = 9.9830$$

$$\text{Or, } K = 10^{9.983} = 9.6178 \times 10^9 \simeq 9.62 \times 10^9$$

Q55 Text Solution:

$$\text{Number of moles } n = \frac{w}{M} = \frac{64}{32} = 2$$

$$\text{Average kinetic energy} = \frac{3}{2} nRT = \frac{3}{2} \times 2 \times 8.314 \times 300 = 7.5 \text{ kJ}$$

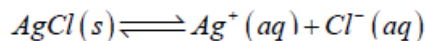
Q56 Text Solution:

$$C' = C - r - Z$$

Number of constituents, $C = 6$

$\text{Na}^+, \text{Cl}^-, \text{Ag}^+, \text{NO}_3^-, \text{AgCl}(s)$ and H_2O .

Number of reactions, $r = 1$



Number of restricting conditions, $Z = 1$

$$x(\text{Ag}^+) = x(\text{Cl}^-)$$

Then number of components

$$C' = 6 - 1 - 1 = 4$$

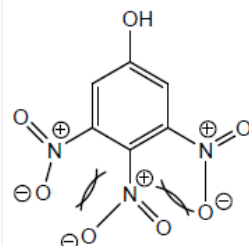
Q57 Text Solution:

$$\text{Let } a = 100$$

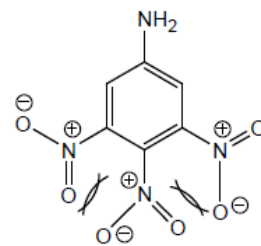
$$\Rightarrow x = 10$$

$$\Rightarrow kt = \ln \frac{a}{a-x} = \ln \frac{1000}{100-10} = \ln \left(\frac{10}{9} \right)$$

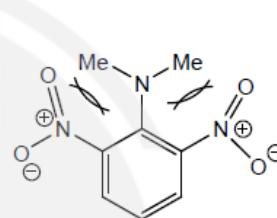
$$\Rightarrow t = \frac{1}{10^{-3}} \ln \left(\frac{10}{9} \right) \Rightarrow t = 105.36 \text{ sec}$$

Q58 Text Solution:

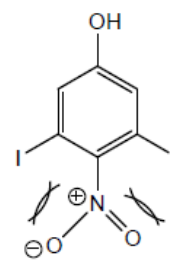
Due to SIR effect, NO_2 group goes to perpendicular to benzene ring



SIR effect



SIR effect

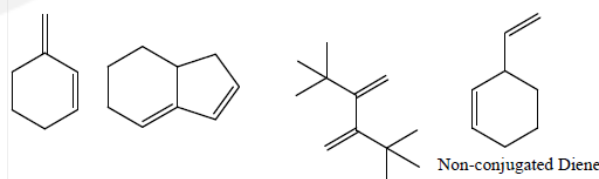


SIR effect

SIR effect creates crowdness (steric hindrance) due to bulky ortho substituted group. Because, the delocalisation is restricted.

Q59 Text Solution:

Trans 1, 3-diene non-conjugated dienes can not be used in Diels Alder reaction.



Non-conjugated Diene

Q60 Text Solution:

Solution:

Mass defect (Δm) is the difference between the total mass of the nucleons (protons + neutrons) and the actual mass of the nucleus.

1. Number of protons in He = 2

$$\rightarrow \text{Total mass of protons} = 2 \times 1.00728 =$$

$$2.01456 \text{ amu}$$



2. Number of neutrons in He = 2

$$\rightarrow \text{Total mass of neutrons} = 2 \times 1.00866 = \\ \mathbf{2.01732 \text{ amu}}$$

3. Total mass of nucleons (protons + neutrons):

$$2.01456 + 2.01732 = 4.03188 \text{ amu}$$

4. Mass defect (Δm):

$$\Delta m = \text{Total mass of nucleons} \\ - \text{Actual mass of He nucleus}$$

$$\Delta m = 4.03188 - 4.00260 \\ = 0.02928 \text{ amu}$$

Answer: 0.02928 amu



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