JEE Main 2025 April 2 Shift 1 Question Paper with Solutions

Time Allowed :3 Hours	Maximum Marks :300	Total Questions :75

General Instructions

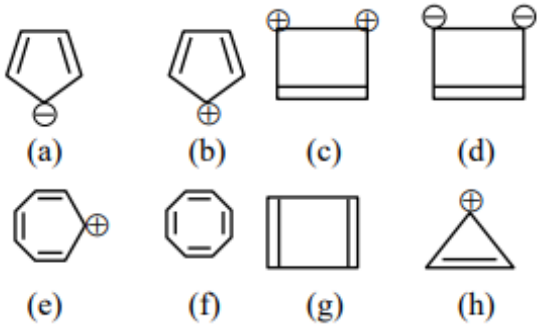
Read the following instructions very carefully and strictly follow them:

1. Multiple choice questions (MCQs)
2. Questions with numerical values as answers.
3. There are three sections: **Mathematics, Physics, Chemistry**.
4. **Mathematics:** 25 (20+5) 10 Questions with answers as a numerical value. Out of 10 questions, 5 questions are compulsory.
5. **Physics:** 25 (20+5) 10 Questions with answers as a numerical value. Out of 10 questions, 5 questions are compulsory..
6. **Chemistry:** 25 (20+5) 10 Questions with answers as a numerical value. Out of 10 questions, 5 questions are compulsory.
7. Total: 75 Questions (25 questions each).
8. 300 Marks (100 marks for each section).
9. **MCQs:** Four marks will be awarded for each correct answer and there will be a negative marking of one mark on each wrong answer.
10. **Questions with numerical value answers:** Candidates will be given four marks for each correct answer and there will be a negative marking of 1 mark for each wrong answer.

Chemistry

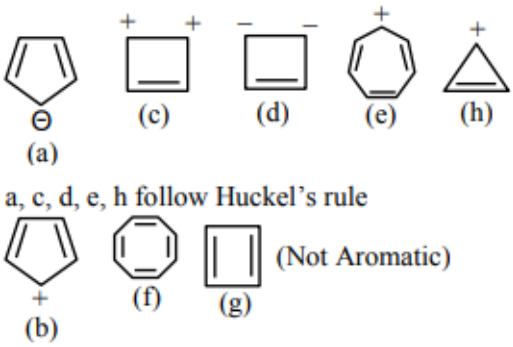
Section - A

51. Designate whether each of the following compounds is aromatic or not aromatic.



(1) e, g aromatic and a, b, c, d, f, h not aromatic
(2) b, e, f, g aromatic and a, c, d, h not aromatic
(3) a, b, c, d aromatic and e, f, g, h not aromatic
(4) a, c, d, e, h aromatic and b, f, g not aromatic

Correct Answer: (4)
Solution:



Aromatic compounds (follow Huckel's rule):

- **(a)** Cyclic, planar, conjugated with 6π electrons (4n+2 where n=1)
- **(c)** Cyclic, planar, conjugated with 6π electrons
- **(d)** Cyclic, planar, conjugated with 6π electrons
- **(e)** Cyclic, planar, conjugated with 6π electrons
- **(h)** Cyclic, planar, conjugated with 6π electrons

Non-aromatic compounds:

- **(b)** Not fully conjugated (sp^3 hybridized carbon breaks conjugation)
- **(f)** Not planar (twisted structure prevents conjugation)
- **(g)** Has 4π electrons (doesn't satisfy 4n+2 rule)

Quick Tip

Huckel's Rule for Aromaticity:

- Cyclic, planar molecule
- Fully conjugated π-system
- Contains 4n+2 π electrons (n=0,1,2...)

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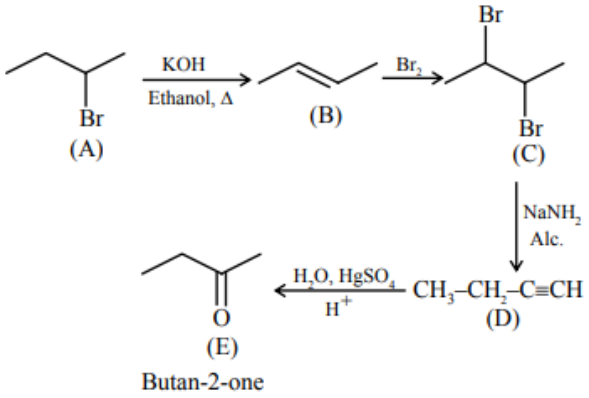
52. An optically active alkyl halide C_4H_9Br [A] reacts with hot KOH dissolved in ethanol and forms alkene [B] as major product which reacts with bromine to give dibromide [C]. The compound [C] is converted into a gas [D] upon reacting with alcoholic $NaNH_2$. During hydration 18 gram of water is added to 1 mole of gas [D] on warming with mercuric sulphate and dilute

acid at 333 K to form compound [E]. The IUPAC name of compound [E] is :

(1) But-2-yne (2) Butan-2-ol (3) Butan-2-one (4) Butan-1-al

Correct Answer: (3) Butan-2-one

Solution:



The reaction sequence is as follows:

- **(A)** Reacts with KOH to form alkene [B] (Elimination of HBr).
- **(B)** Reacts with Br_2 to give dibromide [C].
- **(C)** Dibromide reacts with $NaNH_2$ to form [D] (Alkyne formation).
- **(D)** The alkyne [D] undergoes hydration with mercuric sulfate to give [E].

Quick Tip

For alkene to alkyne conversions, always check for the necessary reagents such as $NaNH_2$ and the correct conditions for hydration ($HgSO_4$).

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53. The property/properties that show irregularity in the first four elements of group-17 are:
(A) Covalent radius
(B) Electron affinity
(C) Ionic radius
(D) First ionization energy

Choose the correct answer from the options given below: (1) B and D only (2) A and C only (3) B only (4) A, B, C and D

Correct Answer: (3) B only

Solution:

The order of first four elements of group-17 are as follows.

- F ¡ Cl ¡ Br ¡ I (Covalent radius)
- Cl ¿ F ¿ Br ¿ I (Electron affinity)
- F ¡ Cl ¡ Br ¡ I (Ionic radius)
- F ¿ Cl ¿ Br ¿ I (First ionization energy)

Electron affinity order is irregular.

Quick Tip

For group-17 elements, remember that the irregularities mainly arise due to the electron configuration and atomic size trends.

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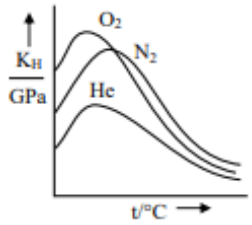
54. Which of the following graph correctly represents the plots of K_H at 1 bar gases in water versus temperature?

(1)



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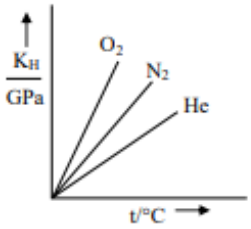
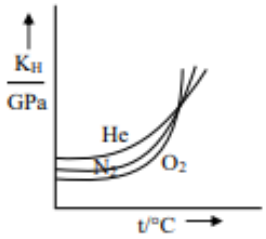
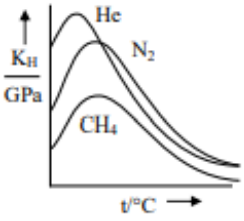


(3)



(4)

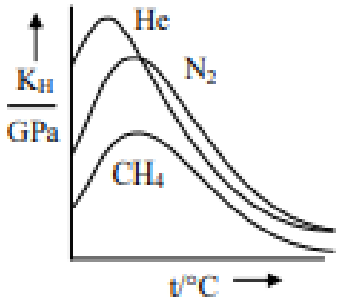


Correct Answer: (4)

Solution:

As temperature increases, solubility first decreases then increases, hence K_H first increases, then decreases. At moderate temperature, the value of K_H follows the order:

$$\text{He} > \text{N}_2 > \text{CH}_4$$



Quick Tip

For gases in water, the temperature dependence of Henry's Law constant shows an initial decrease followed by an increase in solubility at higher temperatures. This behavior varies across different gases.

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55. According to Bohr's model of hydrogen atom, which of the following statement is incorrect?

(1) Radius of 3rd orbit is nine times larger than that of 1st orbit. (2) Radius of 8th orbit is four times larger than that of 4th orbit. (3) Radius of 6th orbit is three times larger than that of 4th orbit. (4) Radius of 4th orbit is four times larger than that of 2nd orbit.

Correct Answer: (3)

Solution:
We know that for Bohr's model:

$$r \propto n^2$$

Where n is the principal quantum number. Hence, we have:

$$\frac{r_3}{r_1} = \left(\frac{3}{1}\right)^2 = 9, \quad \frac{r_8}{r_4} = \left(\frac{8}{4}\right)^2 = 4, \quad \frac{r_6}{r_4} = \left(\frac{6}{4}\right)^2 = 2.25, \quad \frac{r_4}{r_2} = \left(\frac{4}{2}\right)^2 = 4$$

Thus, the incorrect statement is option (3).

Quick Tip

For Bohr's model, the radius of each orbit increases with the square of the principal quantum number n. Thus, radius comparisons can be calculated using the formula $r \propto n^2$.

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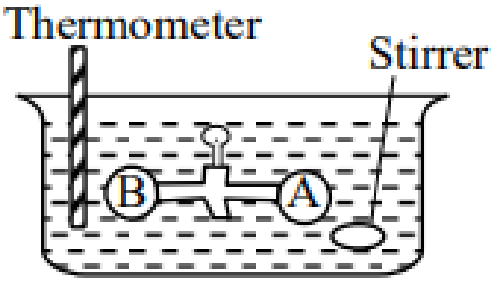
56. Two vessels A and B are connected via stopcock. Vessel A is filled with a gas at a certain pressure. The entire assembly is immersed in water and allowed to come to thermal equilibrium with water. After opening the stopcock the gas from vessel A expands into vessel B and no change in temperature is observed in the thermometer. Which of the following statement is

true?



(1) $dw = 0$
(2) $dq = 0$
(3) $du = 0$
(4) The pressure in the vessel B before opening the stopcock is zero

Correct Answer: (4)

Solution:
Since there is no change in temperature after the stopcock is opened, it is a free expansion, implying:

$$w = 0, \quad q = 0, \quad \Delta U = 0$$

Thus, the correct answer is option (4). The pressure in vessel B before opening the stopcock is zero.

Quick Tip

In a free expansion, there is no work done, no heat transfer, and no change in internal energy, as the process is adiabatic and occurs without a temperature change.

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57. A solution is made by mixing one mole of volatile liquid A with 3 moles of volatile liquid B. The vapor pressure of pure A is 200 mm Hg and that of the solution is 500 mm Hg. The vapor pressure of pure B and the least volatile component of the solution, respectively, are:

(1) 1400 mm Hg, A (2) 1400 mm Hg, B
(3) 600 mm Hg, A (4) 600 mm Hg, B

Correct Answer: (4)

Solution:
The relation between vapor pressures is given by Raoult's law:

$$P_A = P_A^0 \cdot X_A, \quad P_B = P_B^0 \cdot X_B$$

Given:

$$P_A + P_B = 500\,\text{mm Hg}, \quad P_A^0 = 200\,\text{mm Hg}, \quad P_B^0 = 600\,\text{mm Hg}$$

Using the mole fractions and Raoult's law:

$$P_A = 200 \times \frac{1}{4}, \quad P_B = 600 \times \frac{3}{4}$$

Thus, the answer is $P_A = 600\,\text{mm Hg}, P_B = 600\,\text{mm Hg}$.

Quick Tip

Raoult's Law is useful for determining the vapor pressure of components in an ideal solution. It states that the vapor pressure is proportional to the mole fraction of the component in the solution.

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58. Consider the above reaction, what mass of CaCl will be formed if 250 ml of 0.76 M HCl reacts with 1000 g of CaCO?

(1) 3.908 g (2) 2.636 g
(3) 10.545 g (4) 5.272 g

Correct Answer: (3)

Solution:
Using stoichiometry, the moles of $CaCO_3$ are calculated:

$$\text{Moles of } CaCO_3 = \frac{1000}{100} = 10\,\text{mol}$$

Now, for the reaction:

$$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

Hence, the moles of $CaCl_2$ formed will be 10 mol. Finally:

$$\text{Mass of } CaCl_2 = 10.545\,\text{g}$$

Quick Tip

In stoichiometry, make sure the balanced chemical equation is used to relate the moles of reactants and products. Converting moles to grams requires using the molar mass.

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59. If equal volumes of AB and XY (both are salts) aqueous solutions are mixed, which of the following combination will give precipitate of AY, at 300 K?

(1) K (300 K) for $AB = 5.2 \times 10^3$
(2) K (300 K) for $AB = 1.0 \times 10^3$
(3) K for $10^{-10}\,\text{M}\,AB$, $5 \times 10^{-10}\,\text{M}\,XY$
(4) K for $15 \times 10^{-10}\,\text{M}\,XY$

Correct Answer: (3)

Solution:
When equal volumes are mixed, the molarity of each component will be halved. Let's calculate the value of Q for precipitation and compare it with K_{sp}.
For precipitation, we use the equation:

$$Q = [A^{1-}][Y^{1-}]$$

Let's calculate Q for each option:

$$Q = (1.8 \times 10^{-7}) \left(\frac{5 \times 10^{-4}}{2} \right)^2$$

This will give:

$$Q = (1.8 \times 10^{-7}) \times (2.5 \times 10^{-4})^2 = 1.8 \times 10^{-7} \times 6.25 \times 10^{-8} = 1.125 \times 10^{-14}$$

We can see that the value of Q for this combination is smaller than K_{sp}, indicating that a precipitate will form.
Now let's check the other combinations for comparison:

$$Q = (10^{-7}) \left(\frac{0.4 \times 10^{-3}}{2} \right)^2$$

$$Q = (10^{-7}) \times (0.2 \times 10^{-3})^2 = 10^{-7} \times 4 \times 10^{-8} = 4 \times 10^{-15}$$

Again, this Q value is smaller than K_{sp}, indicating no precipitate.

Quick Tip

When dealing with solubility products, remember that the concentration of ions is key. Use the product of ion concentrations and compare it with K_{sp} to determine if a precipitate will form.

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60. Among SO, NF, NH, XeF, CIF, and SF, the hybridization of the molecule with non-zero dipole moment and one or more lone-pairs of electrons on the central atom is:

(1) sp^3
(2) sp^2
(3) sp^3d^2
(4) sp^3d

Correct Answer: (4)

Solution:

Molecule	Hybridisation	Dipole Moment	Lone pair on the central atom
SO_2	sp^2	Non-zero	1
NF_3	sp^3	Non-zero	1
NH_3	sp^3	Non-zero	1
XeF_2	sp^3d	zero	3
$C\ell F_3$	sp^3d	Non-zero	2
SF_4	sp^3d	Non-zero	1

Among the given molecules, SF has a non-zero dipole moment and lone-pair electrons on the central atom, thus the hybridization of SF is sp^3d.

Quick Tip

When determining hybridization, count the number of bonding and lone pairs of electrons on the central atom. The hybridization depends on this count (e.g., sp^3d for SF).

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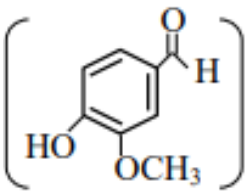
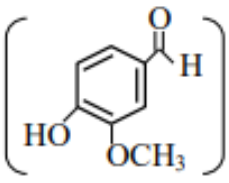
61. Given below are two statements:
Statement I: Vanillin will react with NaOH and also with Tollen's reagent.



Statement II: Vanillin will undergo self-aldol condensation very easily.

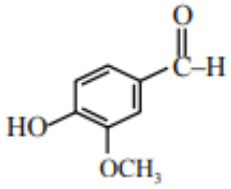


In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Statement I is correct but Statement II is incorrect (2) Statement I is incorrect but Statement II is correct
(3) Both Statement I and Statement II are incorrect (4) Both Statement I and Statement II are correct

Correct Answer: (1) Statement I is correct but Statement II is incorrect

Solution:
Vanillin does not give self-aldol reaction due to the lack of acidic H for condensation. It will react with NaOH and Tollen's reagent, thus making Statement I correct. Statement II is incorrect because vanillin does not undergo self-aldol condensation easily.



Quick Tip

Aromatic aldehydes generally do not undergo self-aldol condensation due to the lack of an active hydrogen atom, which is required for the reaction.

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62. Identify the correct statement among the following:

(1) All naturally occurring amino acids except glycine contain one chiral centre.
(2) All naturally occurring amino acids are optically active.
(3) Glutamic acid is the only amino acid that contains a –COOH group at the side chain.
(4) Amino acid, cysteine easily undergoes dimerization due to the presence of free SH group.

Correct Answer: (1) All naturally occurring amino acids except glycine contain one chiral centre.

Solution:
- Glycine is optically inactive. - Aspartic acid also contains COOH group at the side chain. - α-Amino acids have a chiral carbon except for glycine. - Cysteine undergoes dimerization due to the presence of free –SH group, but the dimerization process is not as common.

Quick Tip

For amino acids, remember that glycine is the only amino acid without a chiral centre. Most amino acids, except for glycine, have one chiral carbon.

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63. The correct order of basic nature on aqueous solution for the bases NH_3, NH_2, CH_3NH_2, $CH_3CH_2NH_2$, $(CH_3CH_2)_2NH$ is:

(1) $NH_3 > NH_2 > CH_3NH_2 > CH_3CH_2NH_2 > (CH_3CH_2)_2NH$

(2) $NH_2 > NH_3 > CH_3NH_2 > CH_3CH_2NH_2 > (CH_3CH_2)_2NH$
(3) $NH_3 > CH_3NH_2 > NH_2 > CH_3CH_2NH_2 > (CH_3CH_2)_2NH$
(4) $NH_3 > CH_3CH_2NH_2 > NH_2 > CH_3NH_2 > (CH_3CH_2)_2NH$

Correct Answer: (4) $NH_3 > CH_3CH_2NH_2 > NH_2 > CH_3NH_2 > (CH_3CH_2)_2NH$

Solution:
Basic strength of amines depends on hydrogen bonding and electronic inductive effect. Thus, the correct order is:

$$NH_3 > NH_2 > CH_3NH_2 > CH_3CH_2NH_2 > (CH_3CH_2)_2NH$$

Quick Tip

The presence of alkyl groups enhances basic strength due to the electron-donating effect, but the bulkier groups like $(CH_3CH_2)_2NH$ decrease the basicity due to steric hindrance and reduced availability of the lone pair.

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64. Given below are two statements:
Statement I: The metallic radius of Al is less than that of Ga.

Statement II: The ionic radius of Al^{3+} is less than that of Ga^{3+}.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Both Statement I and Statement II are correct (2) Statement I is correct but Statement II is incorrect
(3) Statement I is incorrect but Statement II is correct (4) Both Statement I and Statement II are incorrect

Correct Answer: (2) The metallic radius of Al is less than that of Ga

Solution:
The metallic radius of Al is less than Ga, which is correct. The ionic radius of Al^{3+} is more than Ga^{3+}, making Statement II incorrect.

Quick Tip

The metallic radius of an element generally increases down a group. The ionic radius decreases with an increase in positive charge on the ion.

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65. Given below are two statements:
Statement I: High spin complexes have high values of Δ_o.

Statement II: Low spin complexes are formed when Δ_o is high.

In the light of the above statements, choose the most appropriate answer from the options given below:

(1) Statement I is correct but Statement II is incorrect (2) Statement I is incorrect but Statement II is correct
(3) Both Statement I and Statement II are incorrect (4) Both Statement I and Statement II are correct

Correct Answer: (4) Both Statement I and Statement II are correct

Solution:
High spin complexes have low values of Δ_o, whereas low spin complexes are formed when Δ_o is large. Thus, Statement I is incorrect, and Statement II is correct.

Quick Tip

High spin complexes generally form in weak field ligands, while low spin complexes form in strong field ligands due to the splitting of d-orbitals.

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66. Choose the correct sets with respective observations:
(1) $CuSO_4$ (acidified with acetic acid) + $K_2Fe(CN)_6$ (neutralized with NaOH) $\rightarrow$ Blue precipitate

(2) $2CuSO_4 + K_2Fe(CN)_6 \rightarrow$ Blue precipitate

(3) $4FeCl_3 + 3K_4Fe(CN)_6 \rightarrow \frac{1}{2}K_4Fe(CN)_6$

(4) $37Cl_2 + 2KFe(CN)_6 \rightarrow 6KC1$

In the light of the above options, choose the correct set:

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

Correct Answer: (3) $37Cl_2 + 2KFe(CN)_6$

Solution:
The correct option based on the given observations and reactions is Option (3).

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67. On complete combustion 1.0 g of an organic compound (X) gave 1.46 g of CO and 0.567 g of HO. The empirical formula mass of compound (X) is:
(Given molar mass in g mol^{-1}: C: 12, H: 1, O: 16)

(1) 30 (2) 45 (3) 60 (4) 15

Correct Answer: (1) 30

Solution:

Moles of 'C' $= n_{CO_2} = \frac{1.46}{44} = 0.033$
Moles of 'C' $= W_c = 0.033 \times 12 = 0.396$
Moles of 'H' $= 2 \times n_{H_2O} = 2 \times \frac{0.567}{18} = 0.063$
Mass of 'H' $= 0.0063$
Mass of Oxygen $O = 1 - (W_c + W_h) = 1 - (0.033 \times 12 + 0.063 \times 1) = 0.541$
Moles of 'O' $= \frac{0.541}{16} = 0.033$

Empirical formula $= CH_2O$
Empirical formula mass $= 30$

Quick Tip

When calculating the empirical formula, first determine the moles of each element from the given combustion data. Then, divide each element's mass by its atomic mass to obtain the ratio of atoms.

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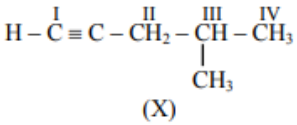
68. Consider the following compound (X):



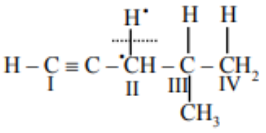
(X)

The most stable and least stable carbon radicals, respectively, produced by homolytic cleavage of corresponding C - H bond are:

(1) I, IV (2) III, II (3) II, IV (4) I, III

Correct Answer: (4) I, III

Solution:
The most stable carbon radical due to stabilization by adjacent alkyl groups is III, while the least stable radical is I as it lacks such stabilization.



Quick Tip

Radical stability increases with the number of alkyl groups attached to the carbon carrying the radical. The more alkyl groups, the more stable the radical.

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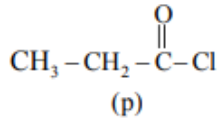
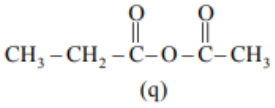
69. Consider the following molecules:


(p)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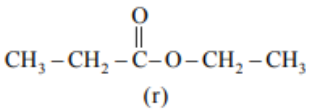
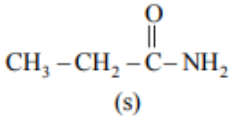

(r)

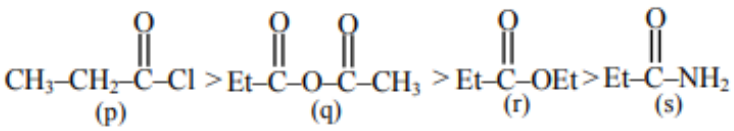

(s)

The order of rate of hydrolysis is:

(1) $r > q > p > s$ (2) $q > p > r > s$
(3) $p > r > q > s$ (4) $p > q > r > s$

Correct Answer: (3)

Solution:
The rate of hydrolysis is influenced by the availability of the leaving group, and the stability of the leaving group. In this case, the order is determined based on the ease of displacement of chloride ions.


(p) (q) (r) (s)

Quick Tip

For nucleophilic substitution reactions, the stability of the leaving group is key. Chlorine, being a good leaving group, affects the rate of hydrolysis.

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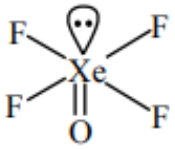
70. A molecule with the formula AX_2Y_2 has all it's elements from p-block. Element A is rarest, monotomic, non-radioactive from its group and has the lowest ionization energy value among X and Y. Elements X and Y have first and second highest electronegativity values respectively among all the known elements. The shape of the molecule is:

(1) Square pyramidal
(2) Octahedral
(3) Planar
(4) Tetrahedral

Correct Answer: (1)

Solution:
The molecule AX_2Y_2 follows the square pyramidal structure based on the given criteria. The electronegativity and ionization energy of element A explain its rarest behavior.



Quick Tip

In molecules with elements from the p-block, consider the electron configuration and the electronegativity values to determine the most likely molecular geometry.

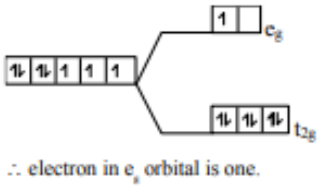
Chemistry

SECTION-B

71. A transition metal (M) among Mn, Cr, Co, and Fe has the highest standard electrode potential M^n/M^{n+1}. It forms a metal complex of the type $[M\text{CN}]^{n+}$. The number of electrons present in the e-orbital of the complex is .....
(1) 6 (2) 5 (3) 4 (4) 3

Correct Answer: (1)

Solution:
Co has the highest standard electrode potential among Mn, Cr, Co, and Fe. The complex is $[Co(CN)_6]^{3-}$, and its splitting is as follows:



The number of electrons in the e-orbital of the complex is 6.

Quick Tip

In coordination chemistry, the number of electrons in the e-orbital of a complex depends on its d-orbital splitting. This splitting occurs when ligands interact with the central metal ion, influencing the number of available electrons in the e-orbital.

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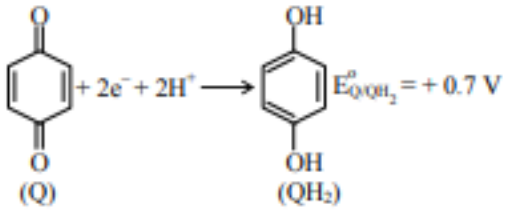
72. Consider the following electrochemical cell at standard condition.

$$Au(s) \text{ — } QH_2 \text{ — } QH_X(0.01M) \text{ — } Ag(1M) \text{ — } Ag(s) \quad E_{cell} = +0.4V$$

The couple QH/Q represents quinhydrone electrode, the half cell reaction is given below:

$$QH_2 \rightarrow Q + 2e^- + 2H^+ \; E^\circ_{QH/Q} = +0.7V$$



$$\left[\text{Given}: E^\circ_{Ag^+/Ag} = +0.8V \text{ and } \frac{2.303RT}{F} = 0.06V\right]$$

The pK_b value of the ammonium halide salt (NH_4X) used here is _____. (nearest integer)

(1) 6 (2) 5 (3) 4 (4) 3

Correct Answer: (6)

Solution:

The cell reaction is:

$$QH_2 + 2Ag^+ \rightarrow 2Ag + Q + 2H^+$$

The equation for this reaction is:

$$E = E^\circ - \frac{0.06}{2}\log[H^+]^2$$

$$E = E^\circ - 0.06 \log[H^+]$$

Now, using the given data and solving for pH:

$$\text{pH} = -\log[H^+] = \frac{E - E^\circ}{0.06} = \frac{0.4 - 0.1}{0.06} = 5$$

Now, we consider the ammonium halide salt (NHX) with the relation:

$$\text{pH} + \text{NH}_4X = 7 - \frac{1}{2}pK_a - \frac{1}{2}\log C$$

Substituting values:

$$5 = 7 - \frac{1}{2}pK_a - \frac{1}{2}\log(10^{-3})$$

$$5 = 7 - \frac{1}{2}pK_a + \frac{1}{2} \times 3$$

$$5 = 7 - \frac{1}{2}pK_a + 1.5$$

$$\Rightarrow pK_a = 6$$

Quick Tip

When dealing with electrochemical cells, use the Nernst equation to calculate potential at non-standard conditions. Additionally, in pH calculations, use the relationship between pH, pKa, and concentration to determine the equilibrium.

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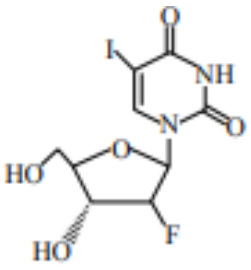
73. 0.1 mol of the following given antiviral compound (P) will weigh .....x 10^{-1} g.



(P)

(Given : molar mass in g mol^{-1} H: 1, C : 12, N : 14, O : 16, F : 19, I : 127)

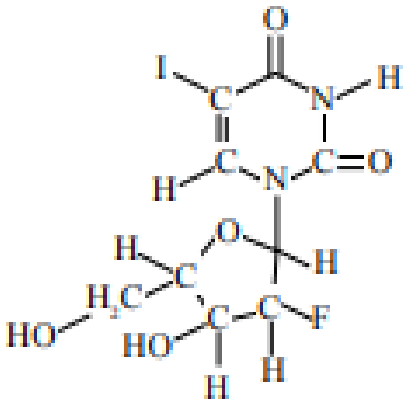
(1) 372 (2) 450 (3) 500 (4) 350

Correct Answer: (372)

Solution:

Molar mass is given as 372 g/mol for compound (P). Hence, for 0.1 mole, the mass will be:

$$\text{Mass} = \text{Molar mass} \times \text{Number of moles} = 372 \times 0.1 = 37.2\,\text{g}$$



Molar mass = 372 gm

$\therefore$ 0.1 mole has = 372×10^{-1} gm

Quick Tip

When calculating the weight of a compound, simply multiply the molar mass by the number of moles to get the total mass in grams.

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74. Consider the following equilibrium,

$$CO(g) + H_2(g) \rightleftharpoons CH_3OH(g)$$

0.1 mol of CO along with a catalyst is present in a 2 dm^3 flask maintained at 500 K. Hydrogen is introduced into the flask until the pressure is 5 bar and 0.04 mol of CH_3OH is formed. The K_p is ..... x 10^7 (nearest integer).

Given: $R = 0.08\,dm^3\,bar\,K^{-1}\,mol^{-1}$

Assume only methanol is formed as the product and the system follows ideal gas behavior.
(1) 74 (2) 67 (3) 54 (4) 85

Correct Answer: (74)

Solution:

The reaction is:

$$CO(g) + H_2(g) \rightleftharpoons CH_3OH(g)$$

At time $t = 0$, moles of CO = 0.1 mol and moles of H_2 = 0.1 mol. At equilibrium, the number of moles is:

$$CO(g) = 0.1 - x \quad H_2(g) = 0.1 - 2x \quad CH_3OH(g) = x = 0.04\,mol$$

Substituting values:

$$x = 0.04 \quad CO(g) = 0.06 \quad H_2(g) = 0.08$$

Given:

$$V = 2\,\text{L} \quad T = 500\,\text{K} \quad P_{\text{total}} = 5\,\text{bar}$$

Using the ideal gas law:

$$n_{\text{total}} = 0.25\,\text{mol}$$

$$P_{\text{total}} = \frac{n_{\text{total}} \times R \times T}{V}$$

$$P_{\text{total}} = \frac{(0.06 + 0.08 + 0.04) \times 0.08 \times 500}{2} = 5\,\text{bar}$$

Thus, $K_p = 74$.
Now continuing the calculation:

$$K_p = \frac{X_{CH_3OH} \times X_{CO} \times X_{H_2}}{P_{\text{total}}^2}$$

$$K_p = \frac{0.04}{(0.06)(0.15)^2} = \frac{4}{6 \times 0.15 \times 16} \times \frac{1}{25}$$

$$K_p = \frac{100 \times 100}{24 \times 225 \times 25} = 0.074 \quad \Rightarrow K_p = 74 \times 10^7$$

Quick Tip

When calculating equilibrium constants, use the ideal gas law to determine the total moles and pressure. For equilibrium calculations, ensure that you account for the changes in the concentration of reactants and products.

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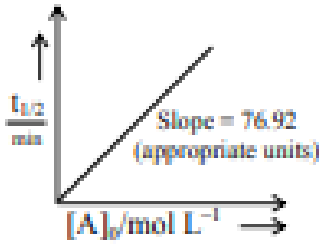
75. For the reaction $A \rightarrow$ products,



The concentration of A at 10 minutes is _____

$\times 10^{-1}$ mol L^{-1} (nearest integer).

The reaction was started with 2.5 mol L^{-1} of A.

(1) 2435 (2) 2000 (3) 1000 (4) 3000

Correct Answer: (2435)

Solution:

From the graph, we know that $t_{1/2}$ is proportional to $[A]$. The slope is given as 76.92. Thus, using the equation for zero-order reaction:

$$t_{1/2} = \frac{A_0}{2K} \quad \text{where} \quad \text{slope} = \frac{1}{2K} = 76.92$$

Thus,

$$K = \frac{1}{2 \times 76.92} = \frac{1}{153.84}$$

Now, applying the formula for zero-order reaction:

$$[A] = -Kt + A_0$$

$$[A] = -\frac{1}{2 \times 76.92} \times 10 + 2.5 = 2.435\,\text{mol/L}$$

Thus, the concentration of A at 10 minutes is $2435 \times 10^{-3}\,\text{mol/L}$.

Quick Tip

In a zero-order reaction, the rate of reaction is constant and the concentration of reactant decreases linearly with time. The equation $[A] = -Kt + A_0$ is used to calculate the concentration at any given time.
