JEE Main 2023 6 April Shift 2 Chemsitry Question Paper with Solutions

Time Allowed :3 Hours	Maximum Marks :300	Total Questions :90

General Instructions

Read the following instructions very carefully and strictly follow them:

1. The test is of 3 hours duration.
2. The question paper consists of 90 questions, out of which 75 are to attempted. The maximum marks are 300.
3. There are three parts in the question paper consisting of Physics, Chemistry and Mathematics having 30 questions in each part of equal weightage.
4. Each part (subject) has two sections.
   (i) Section-A: This section contains 20 multiple choice questions which have only one correct answer. Each question carries 4 marks for correct answer and –1 mark for wrong answer.
   (ii) Section-B: This section contains 10 questions. In Section-B, attempt any five questions out of 10. The answer to each of the questions is a numerical value. Each question carries 4 marks for correct answer and –1 mark for wrong answer. For Section-B, the answer should be rounded off to the nearest integer

CHEMISTRY

Section-A

61. Match List I with List II

List I (Natural Amino acid)	List II (One Letter Code)
(A) Arginine	(I) D
(B) Aspartic acid	(II) N
(C) Asparagine	(III) A
(D) Alanine	(IV) R

Choose the correct answer from the options given below:

(1) (A) – III, (B) – I, (C) – II (D) – IV

(2) (A) – IV, (B) – I, (C) – II (D) – III

(3) (A) – IV, (B) – I, (C) – III (D) – II

(4) (A) – I, (B) – III, (C) – IV (D) – II

Correct Answer: (2) (A) – IV, (B) – I, (C) – II, (D) – III

Solution:

Natural Amino acid	One Letter Code
(i) Arginine	R
(ii) Aspartic acid	D
(iii) Asparagine	N
(iv) Alanine	A

Quick Tip

Amino acids can be represented by their one-letter codes, which are used in protein sequences. This matching question tests your knowledge of such representations.

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62. Formation of which complex, among the following, is not a confirmatory test of Pb^{2+} ions

(1) lead sulphate

(2) lead nitrate

(3) lead chromate

(4) lead iodide

Solution: $Pb(NO_3)_2$ is a soluble colourless compound so it cannot be used in confirmatory test of Pb^{2+} ion. **Correct Answer:** (2) lead nitrate

Quick Tip

For confirmatory tests of ions, it is crucial to recognize soluble and insoluble compounds. Lead nitrate is soluble and does not form a visible precipitate with Pb^{2+} ions.

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63. The volume of 0.02 M aqueous HBr required to neutralize 10.0 mL of 0.01 M aqueous $Ba(OH)_2$ is (Assume complete neutralization)

(1) 5.0 mL

(2) 10.0 mL

(3) 2.5 mL

(4) 7.5 mL

Solution:

$$\text{m.e.q of HBr} = \text{m.e.q of } Ba(OH)_2$$

$$M_1 \times n_1 \times V_1 = M_2 \times n_2 \times V_2$$

$$0.02 \times 1 \times V_1 = 0.01 \times 2 \times 10$$

$$V_1 = \frac{0.01 \times 10}{0.02} = 10\,\text{mL}$$

Correct Answer: (2) 10.0 mL

Quick Tip

In titration problems, always apply the principle of equivalence where moles of acid and base are equal. Use the relation $M_1 \times V_1 = M_2 \times V_2$ for calculations.

64. Group–13 elements react with O_2 in amorphous form to form oxides of type M_2O_3 (M = element). Which among the following is the most basic oxide?

(1) Al_2O_3

(2) Tl_2O_3

(3) Ga_2O_3

(4) B_2O_3

Solution: As electropositive character increases, basic character of oxide increases:

$$B_2O_3 < Al_2O_3 < Ga_2O_3 < In_2O_3 < Tl_2O_3$$

Correct Answer: (4) B_2O_3

Quick Tip

When comparing the basicity of oxides, the trend follows the electropositivity of the elements. Oxides of more electropositive elements tend to be more basic.

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65. The IUPAC name of $K_3[Co(C_2O_4)_3]$ is

(1) Potassium tris(oxalate) cobalte(III)

(2) Potassium trioxalatocobalt(III)

(3) Potassium tris(oxalate)cobalt(III)

(4) Potassium trioxalatocobaltate(III)

Solution: The IUPAC name of $K_3[Co(C_2O_4)_3]$ is Potassium trioxalatocobaltate(III). **Correct Answer:** (4) Potassium trioxalatocobaltate(III)

Quick Tip

When naming coordination compounds, the ligands are named first followed by the metal center. The oxidation state of the metal is included in parentheses in Roman numerals.

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66. If the radius of the first orbit of hydrogen atom is a_0, then de Broglie's wavelength of electron in 3rd orbit is:

(A) $\frac{\pi a_0}{6}$

(B) $\frac{\pi a_0}{3}$

(C) $6\pi a_0$

(D) $3\pi a_0$

Correct Answer: (C) $6\pi a_0$

Solutions:

By De-Broglie principle, we have:

$$2\pi r = n\lambda$$

$$2\pi \frac{n^2 a_0}{z} = n\lambda$$

$$\lambda = 2\pi \frac{3a_0}{1} = 6\pi a_0$$

Quick Tip

Use the De-Broglie relation $2\pi r = n\lambda$ to find the wavelength of an electron in any orbit.

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67. The group of chemicals used as pesticide is:

(A) Sodium chlorate, DDT, PAN

(B) DDT, Aldrin

(C) Aldrin, Sodium chlorate, Sodium arsenite

(D) Dieldrin, Sodium arsenite, Tetrachlorothene

Correct Answer: (B) DDT, Aldrin

Solutions:

DDT and Aldrin are widely used as pesticides for controlling insect pests.

Quick Tip

Remember that DDT and Aldrin are both chlorinated organic compounds used in pest control.

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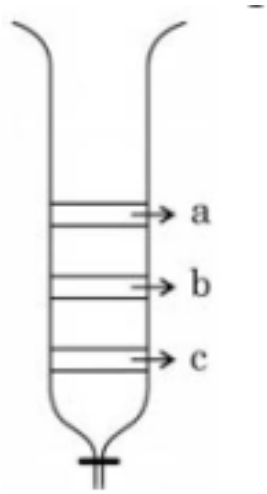
68. From the figure of column chromatography given below, identify incorrect statements.



(A) Compound ‘c’ is more polar than ‘a’ and ‘b’

(B) Compound ‘a’ is least polar

(C) Compound ‘b’ comes out of the column before ‘c’ and after ‘a’

(D) Compound ‘a’ spends more time in the column

Choose the correct answer from the options given below:

(1) A, B and D only

(2) A, B and C only

(3) B and D only

(4) B, C and D only

Correct Answer: (4) B, C and D only

Solutions:

From the given chromatography column, compound ’c’ is the most polar, as it spends the most time in the column. Compound ’a’ is the least polar as it elutes last. Compound ’b’ elutes between ’a’ and ’c’.

Quick Tip

In chromatography, polar compounds interact more strongly with the stationary phase and take longer to elute.

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69. Ion having highest hydration enthalpy among the given alkaline earth metal ions is:

(1) Be^{2+}

(2) Ba^{2+}

(3) Ca^{2+}

(4) Sr^{2+}

Correct Answer: (1) Be^{2+}

Solution:

Hydration enthalpy is inversely proportional to the size of the ion, i.e.,

$$\text{Hydration enthalpy} \propto \frac{1}{\text{size}}.$$

As the size of the ion increases down the group, hydration enthalpy decreases. Therefore, the order of hydration enthalpy is:

$$Be^{2+} > Mg^{2+} > Ca^{2+} > Sr^{2+} > Ba^{2+}.$$

Thus, Be^{2+} has the highest hydration enthalpy.

Quick Tip

Hydration enthalpy is a key concept for understanding the solvation process. Smaller ions have higher hydration enthalpies due to their higher charge density.

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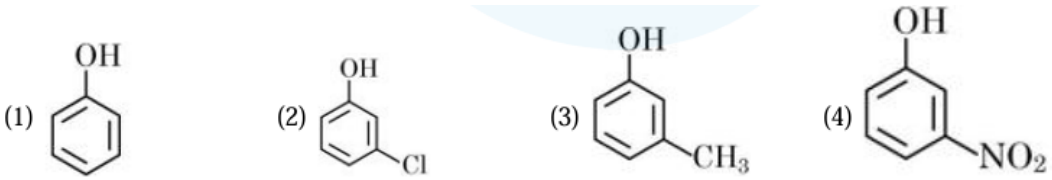
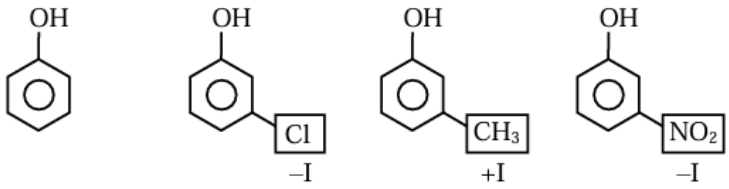
70. The strongest acid from the following is:



Correct Answer: (4)

Solution:



The acid strength of a phenolic compound depends on the electron-withdrawing or electron-donating groups attached to the benzene ring. The electron-withdrawing group increases the acidity of the compound. Among the options, the nitro group (-NO_2) is a strong electron-withdrawing group through the inductive effect (-I), making the compound with -NO_2 attached to the ring the most acidic.

Quick Tip

When determining the acidity of substituted phenols, remember that electron-withdrawing groups (-I) increase acidity by stabilizing the negative charge on the conjugate base.

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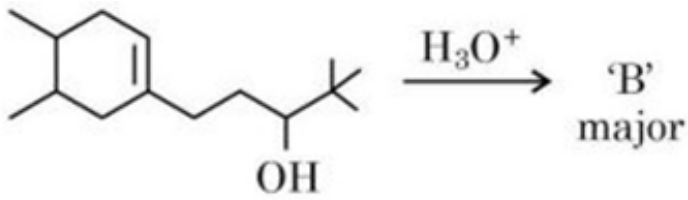
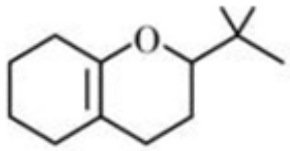
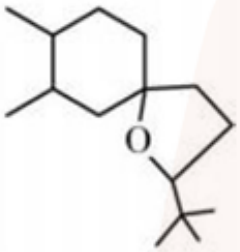
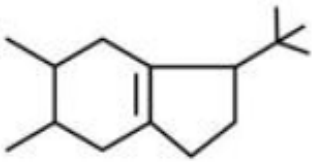
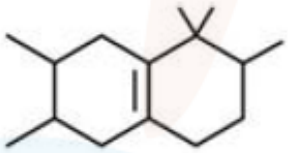
71. In the following reaction, 'B' is



(1) 

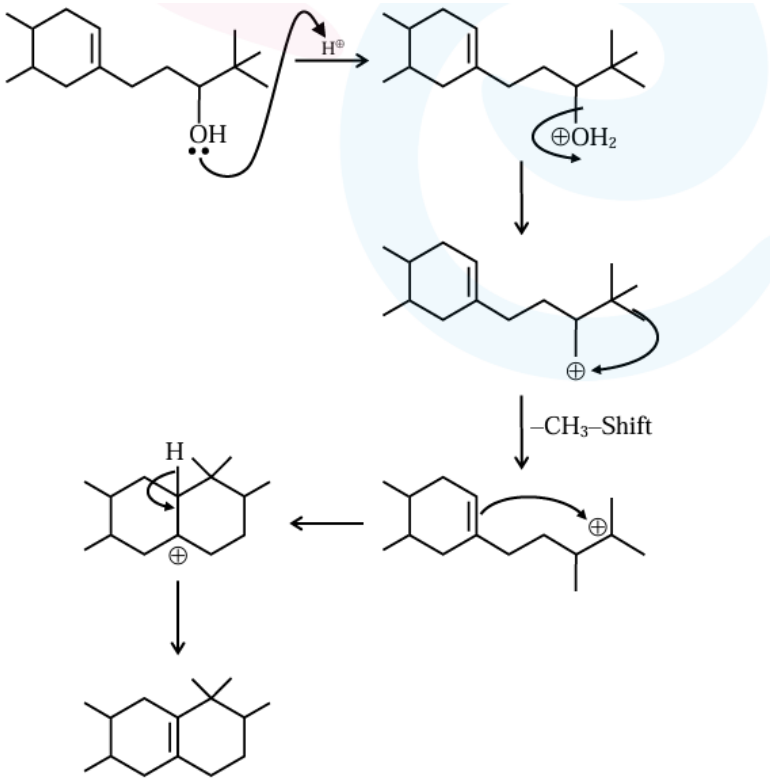
(2) 

(3) 

(4) 

Correct Answer: (4)

Solution:



The reaction shows a typical mechanism where the protonation of the alcohol leads to a carbocation formation, followed by a shift of the CH_3 group. The major product corresponds to the compound shown in option (4).

Quick Tip

In elimination and rearrangement reactions, the carbocation intermediate plays a crucial role in determining the product.

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72. Structures of $BeCl_2$ in solid state, vapour phase and at very high temperature respectively are:

(1) Polymeric, Dimeric, Monomeric

(2) Dimeric, Polymeric, Monomeric

(3) Monomeric, Dimeric, Polymeric

(4) Polymeric, Monomeric, Dimeric

Correct Answer: (1) Polymeric, Dimeric, Monomeric

Solution:

In the solid state, $BeCl_2$ exists as a polymer. In the vapour phase, it forms a chloro-bridged dimer. At very high temperatures (above 1200K), it exists as a monomer.

Quick Tip

$BeCl_2$ is an example of a molecule whose structure changes depending on temperature, showcasing the effect of temperature on molecular structure.

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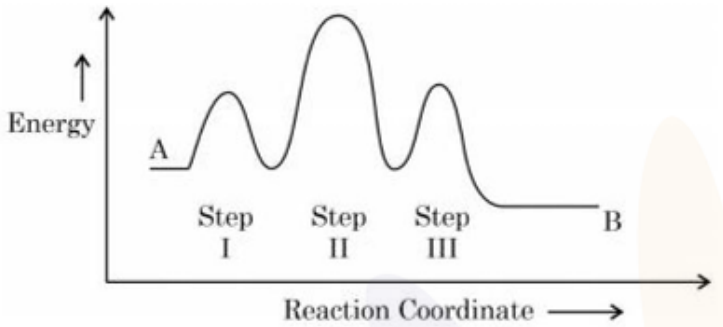
73. Consider the following reaction that goes from A to B in three steps as shown below:

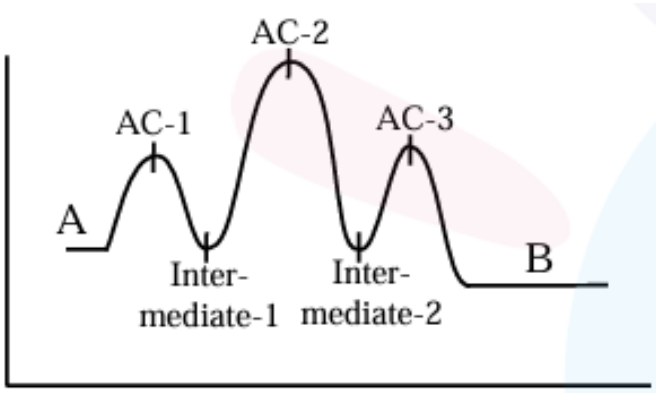


Choose the correct option

	Number of intermediates	Number of Activated complex	Rate determining step
(1)	2	3	II
(2)	3	2	II
(3)	2	3	III
(4)	2	3	I

Correct Answer: (1)

Solution:



Number of Intermediate → 2
Number of Activated complex → 3
Rate determining step → II

From the diagram, we see that there are two intermediates and three activated complexes. The rate determining step is the second step (II), where the highest energy barrier occurs.

Quick Tip

In reaction mechanisms, the rate determining step is the one with the highest activation energy, which slows down the overall reaction.

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74. The product, which is not obtained during the electrolysis of brine solution is:

(1) HCl

(2) NaOH

(3) Cl_2

(4) H_2

Correct Answer: (1) HCl

Solution:

During electrolysis of brine solution (NaCl + H_2O), at the cathode, hydrogen gas (H_2) is released, and at the anode, chlorine gas (Cl_2) is produced. Na^+ and OH^- combine to form

NaOH. HCl is not formed during this process.

Quick Tip

The electrolysis of brine is used to produce chlorine gas, hydrogen gas, and sodium hydroxide.

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75. Which one of the following elements will remain as liquid inside pure boiling water?

(1) Li

(2) Ga

(3) Cs

(4) Br

Correct Answer: (2) Ga

Solution:

Li and Cs react vigorously with water. Br is a non-metal that does not react in this manner. Ga, however, remains liquid at the boiling point of water, which is 100°C (boiling point of Ga = 2400°C).

Quick Tip

Remember that elements with high melting points, such as Gallium, can remain liquid even at temperatures above the boiling point of water.

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76. Given below are two statements: one is labelled as "Assertion A" and the other is labelled as "Reason R"

Assertion A: In the complex $Ni(CO)_4$ and $Fe(CO)_5$, the metals have zero oxidation state.

Reason R: Low oxidation states are found when a complex has ligands capable of π-donor

character in addition to the σ-bonding.

In the light of the above statement, choose the most appropriate answer from the options given below.

(1) A is not correct but R is correct.

(2) A is correct but R is not correct.

(3) Both A and R are correct and R is the correct explanation of A.

(4) Both A and R are correct but R is NOT the correct explanation of A.

Correct Answer: (2) A is correct but R is not correct.

Solution:

The oxidation states of Ni and Fe in $Ni(CO)_4$ and $Fe(CO)_5$ are indeed zero. However, while low oxidation states can be stabilized by π-acceptor ligands, this is not the reason why Ni and Fe exhibit zero oxidation states in these complexes.

Quick Tip

Zero oxidation states in metal carbonyls are due to the ligand's ability to donate electron density through σ-donation and accept electron density through π-back donation.

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77. Given below are two statements:

Statement I: Morphine is a narcotic analgesic. It helps in relieving pain without producing sleep.

Statement II: Morphine and its derivatives are obtained from opium poppy.

In the light of the above statements, choose the correct answer from the options given below.

(1) Statement I is true but Statement II is false.

(2) Statement I is false but Statement II is true.

(3) Both Statement I and Statement II are true.

(4) Both Statement I and Statement II are false.

Correct Answer: (2) Statement I is false but Statement II is true.

Solution:

Morphine is indeed a narcotic analgesic and helps in relieving pain. However, it also causes drowsiness, so Statement I is false. Statement II is true as morphine and its derivatives are obtained from the opium poppy.

Quick Tip

Morphine and its derivatives have medicinal properties but also cause drowsiness, which makes Statement I incorrect.

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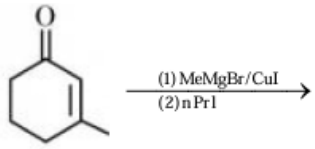
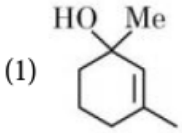
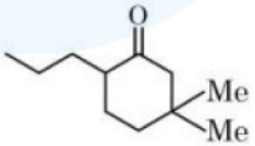
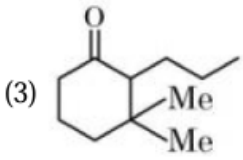
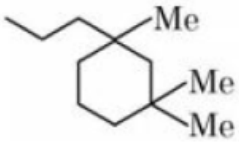
78. Find out the major product from the following reaction.



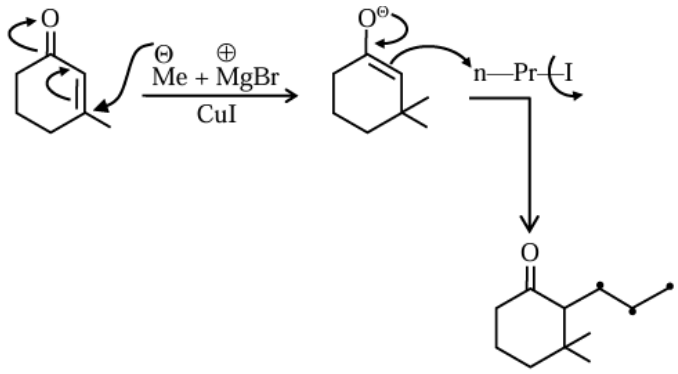
(1) 

(2) 

(3) 

(4) 

Correct Answer: (3) **Solution:**



The reaction is a Grignard reagent reaction with the carbonyl group, followed by reaction with n-PrI. The major product is the one shown in option (3), as a new carbon-carbon bond is formed.

Quick Tip

In Grignard reactions, a nucleophilic attack on the carbonyl group leads to the formation of an alcohol after the addition of a halide.

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79. During the reaction of permanganate with thiosulphate, the change in oxidation of manganese occurs by value of 3. Identify which of the below medium will favour the reaction.

(1) aqueous neutral

(2) aqueous acidic

(3) both aqueous acidic and neutral

(4) both aqueous acidic and faintly alkaline

Correct Answer: (1) aqueous neutral

Solution:

In neutral or weakly alkaline solution, the oxidation state of Mn changes by 3 units: MnO_4^- $\rightarrow$ MnO_2. Therefore, the reaction favours the neutral medium.

Quick Tip

The oxidation state change of Mn in reactions involving permanganate depends on the solution's pH. Neutral or slightly alkaline solutions are best for this reaction.

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80. Element not present in Nessler's reagent is

(1) K

(2) N

(3) I

(4) Hg

Correct Answer: (2) N

Solution:

Nessler reagent is $K_2[HgI_4]$, which contains K, Hg, and I. Nitrogen (N) is not present in the reagent.

Quick Tip

Nessler's reagent is used for the detection of ammonia and is made of mercury and iodine, but does not contain nitrogen.

Section-B

81. The standard reduction potentials at 298 K for the following half cells are given below:

NO_3^- + 4H^+ + 3e^- $\rightarrow$ NO(g) + 2H_2O $\quad E^0 = 0.97V$

V^{2+} + 2e^- $\rightarrow$ V $\quad E^0 = -1.19V$

Fe^{3+} + 3e^- $\rightarrow$ Fe $\quad E^0 = -0.04V$

Ag^+ + e^- $\rightarrow$ Ag(s) $\quad E^0 = 0.80V$

$Au^{3+} + 3e^- \rightarrow Au(s) \quad E^0 = 1.40V$

The number of metal(s) which will be oxidized by NO_3^- in aqueous solution is

Solution:

In the given half reactions, metals V, Fe, and Ag will be oxidized by NO_3^- because their reduction potentials are less than 0.97 V. Thus, three metals will be oxidized by NO_3^-.

Quick Tip

When comparing reduction potentials, metals with lower reduction potentials are more easily oxidized.

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82. Number of crystal system from the following where body centred unit cell can be found is ____

Cubic, tetragonal, orthorhombic, hexagonal, rhombohedral, monoclinic, triclinic

Solution:

Body-centered cubic (BCC) crystal structure is found in cubic, tetragonal, and orthorhombic systems. Thus, the number of crystal systems where BCC can be found is 3.

Quick Tip

BCC structure is commonly found in metals like iron and chromium.

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83. Among the following the number of compounds which will give positive iodoform reaction is ___

(a) 1-Phenylbutan-2-one

(b) 2-Methylbutan-2-ol

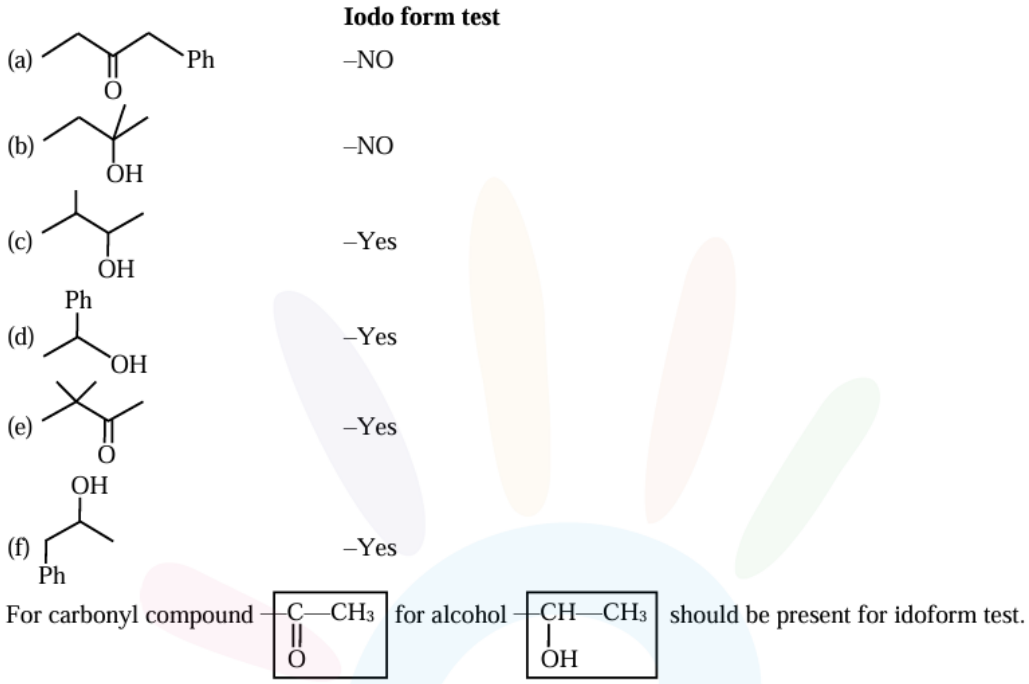
(c) 3-Methylbutan-2-ol

(d) 1-Phenylethanol

(e) 3,3-dimethylbutan-2-one

(f) 1-Phenylpropan-2-ol

Solution:



The iodoform test is positive for compounds that contain a methyl group ($-CH_3$) adjacent to a carbonyl group ($C = O$) or for alcohols that can be oxidized to acetone. Based on the structure and functional groups, compounds (c), (d), (e), and (f) will give a positive iodoform test. Thus, the answer is 4 compounds.

Quick Tip

For iodoform test to be positive, the structure must have either a $-COCH_3$ group or a secondary alcohol adjacent to a methyl group.

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84. Number of isomeric aromatic amines with molecular formula C_8H_11N, which can be synthesized by Gabriel Phthalimide synthesis is_____

Solution:

By Gabriel phthalimide synthesis, i-amine is prepared, which should be aromatic and a-amine.

The degree of unsaturation (Du) helps in determining the number of possible isomers.

Du = C + 1 - H - N/2, which equals 4, indicating the presence of a benzene ring. Thus, the number of isomeric aromatic amines that can be synthesized is 5.

Quick Tip

Gabriel Phthalimide synthesis is a key reaction for preparing aromatic amines from halides, especially when the structure is aromatic.

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85. Consider the following pairs of solution which will be isotonic at the same temperature. The number of pairs of solutions is/are_____

A. 1 M aq. NaCl and 2 M aq. Urea

B. 1 M aq. $CaCl_2$ and 1.5 M aq. KCl

C. 1.5 M aq. $AlCl_3$ and 2 M aq. Na_2SO_4

D. 2.5 M aq. KCl and 1 M aq. $Al_2(SO_4)_3$

Solution:

For two solutions to be isotonic, the total number of ions should be the same. Checking the pairs for ion concentration:

- A: 1 M NaCl gives 2 ions, and 2 M Urea gives 2 ions — isotonic.
- B: 1 M $CaCl_2$ gives 3 ions, and 1.5 M KCl gives 3 ions — isotonic.
- C: 1.5 M $AlCl_3$ gives 6 ions, and 2 M Na_2SO_4 gives 6 ions — isotonic.
- D: 2.5 M KCl gives 5 ions, and 1 M $Al_2(SO_4)_3$ gives 5 ions — isotonic.

Thus, all 4 pairs are isotonic.

Quick Tip

Isotonic solutions have the same osmotic pressure, which is determined by the concentration of dissolved particles.

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86. The number of colloidal systems from the following, which will have 'liquid' as the dispersion medium, is_____

Gem stones, paints, smoke, cheese, milk, hair cream, milk, insecticide sprays, froth, soap lather

Solution:

Liquid dispersion medium colloidal systems include paints, milk, hair cream, froth, soap lather. Thus, there are 5 such systems.

Quick Tip

Liquid colloidal systems are common in everyday life, especially in products like paints and creams where the dispersion medium is liquid.

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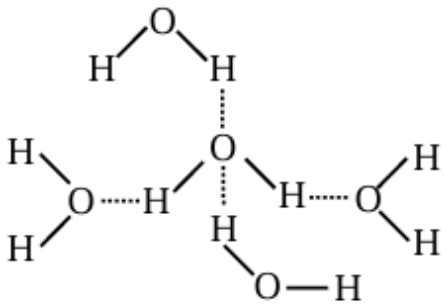
87. In an ice crystal, each water molecule is hydrogen bonded to_____ neighbouring molecules.

Solution:



In an ice crystal, each water molecule is hydrogen bonded to four neighbouring molecules, forming a tetrahedral arrangement.

Quick Tip

Hydrogen bonding in ice leads to the characteristic structure that makes ice less dense than liquid water.

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88. Consider the following data:

Heat of combustion of H_2 (g) = -241.8 kJ mol^{-1}

Heat of combustion of C(s) = -393.5 kJ mol^{-1}

Heat of combustion of C_2H_5OH(l) = -1234.7 kJ mol^{-1}

The heat of formation of C_2H_5OH(l) is (-) _____ kJ mol^{-1} (Nearest integer).

Solution:

We can use Hess's Law and combine the equations to calculate the heat of formation of C_2H_5OH(l):

$\Delta H_f = -393.5 \times 2$ - $241.5 \times 8 \times 3$ + 1234.7 = -277.7 kJ mol^{-1}

Quick Tip

Hess's Law states that the heat of a reaction is the sum of the heats of the reactions into which it can be divided.

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89. The equilibrium composition for the reaction PCl_3 + Cl_2 PCl_5 at 298 K is given below:

l_3

= 0.2 mol L^{-1}, [Cl_2] = 0.1 mol L^{-1}, [PCl_5] = 0.40 mol L^{-1}

If 0.2 mol of Cl_2 is added at the same temperature, the equilibrium concentrations of PCl_5 is _____ $\times 10^{-2}$ mol L^{-1}.

Solution:

We are given the equilibrium constant Kc for the reaction at 298 K as 20.

$K_c = \frac{[PCl_5]}{[PCl_3][Cl_2]} = \frac{0.40}{0.20 \times 0.10} = 20$

$After adding 0.2 mol of Cl_2$, the new concentrations become:

PCl_3 = 0.2 - x, Cl_2 = 0.2 + x, PCl_5 = 0.4 + x.

Solving for x, we find that x = 0.084. Thus, the equilibrium concentration of PCl_5 is 0.484 mol L^{-1}.

Quick Tip

For equilibrium reactions, the change in concentrations due to shifting of equilibrium can be calculated using the reaction's equilibrium constant.

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90. The number of species having a square planar shape from the following is_____

XeF_4, SF_4, SiF_4, BF_4, BrF_4, $[Cu(NH_3)_4]^{2+}$, $[FeCl_4]^{2-}$, $[PtCl_4]^{2-}$

Solution:

The species with square planar geometry include XeF_4, $[Cu(NH_3)_4]^{2+}$, $[PtCl_4]^{2-}$. Thus, there are 4 species with a square planar shape.

Quick Tip

Square planar geometry is common in transition metal complexes, especially for d^8 configuration metals.
