JEE Main 2026 April 4 Shift 1 Chemistry

Question Paper with Solutions

Conducted by National Testing Agency (NTA)

General Instructions

(i) The test is of 3 hours duration.

(ii) This test paper consists of 75 questions. Each subject (PCM) has 25 questions. The maximum marks are 300.

(iii) This question paper contains Three Parts. Part-A is Physics, Part-B is Chemistry and Part-C is Mathematics. Each part has only two sections: Section-A and Section-B.

(iv) Section - A : Attempt all questions.

(v) Section - B : Attempt all questions.

(vi) Section - A (01 – 20) 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.

(vii) Section - B (21 – 25) contains 5 Numerical value based questions. The answer to each question should be rounded off to the nearest integer. Each question carries +4 marks for correct answer and –1 mark for wrong answer.

1. Calculate number of moles of KMnO needed to oxidise the mixture containing one mole each of FeC_2O_4, $FeSO_4$, $Fe_2(C_2O_4)_3$, and $Fe_2(SO_4)_3$ in acidic medium.

Solution:

Step 1: Understanding the reaction.

The number of equivalents of $KMnO_4$ required is equal to the sum of the equivalents of each compound being oxidized. The equivalents are calculated based on the oxidation numbers of the elements involved. The compounds involved are FeC_2O_4, $FeSO_4$, $Fe_2(C_2O_4)_3$, and $Fe_2(SO_4)_3$.

Step 2: Calculating equivalents of each compound.

Meq. of $KMnO_4$ = Meq. of $(FeC_2O_4 + FeSO_4 + Fe_2(C_2O_4)_3)$

moles $\times 5 = 1 \times 3 + 1 \times 1 + 1 \times 1 + 1 \times 6$

Step 3: Final calculation.

$$\text{moles} = \frac{10}{5} = 2$$

Quick Tip: Remember that the number of moles of $KMnO_4$ needed is directly related to the number of iron compounds present in the mixture, with each compound requiring 1 mole of $KMnO_4$ for oxidation in acidic medium.

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2. Find the ratio of wave number (ν) of the 1st line of Balmer series and Brackett series for Hydrogen-like species.

(A) $\frac{1}{0.09}$

(B) $\frac{0.81}{5}$

(C) $\frac{5}{0.81}$

(D) 0.09

Correct Answer: (C) $\frac{5}{0.81}$

Solution:

Step 1: Formula for wave number.

For a hydrogen-like species, the wave number (ν) for the first line of the Balmer series is given by:

$$\nu_{\text{Balmer}} = R_H \left(\frac{1}{2^2} - \frac{1}{3^2} \right)$$

where R_H is the Rydberg constant. For the first line of the Brackett series:

$$\nu_{\text{Brackett}} = R_H \left(\frac{1}{4^2} - \frac{1}{5^2} \right)$$

Step 2: Compute the wave numbers.

The ratio of the wave numbers is:

$$\frac{\nu_{\text{Balmer}}}{\nu_{\text{Brackett}}} = \frac{\left(\frac{1}{2^2} - \frac{1}{3^2}\right)}{\left(\frac{1}{4^2} - \frac{1}{5^2}\right)} = \frac{\frac{1}{4} - \frac{1}{9}}{\frac{1}{16} - \frac{1}{25}}$$

Step 3: Simplify the expression.

Simplifying the numerator and denominator:

$$\frac{\frac{5}{36}}{\frac{9}{400}} = \frac{5}{0.81}$$

Final Answer:

$$\boxed{\frac{5}{0.81}}$$

Quick Tip: The wave number ratio for different series in hydrogen-like species can be calculated by using the Rydberg formula for each series and simplifying the expressions.

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3. The reaction follows 1st order reaction R → P

Find the fraction of molecules dissociated in time t. [k_1 = Rate constant]

(A) $1 - e^{-k_1 t}$

(B) $1 + e^{-k_1 t}$

(C) $1 - e^{+k_1 t}$

(D) $e^{-k_1 t}$

Correct Answer: (A) $1 - e^{-k_1 t}$

Solution:

Step 1: First-order reaction rate law.

For a first-order reaction, the rate law is given by:

$$\ln\left(\frac{[R]}{[R_0]}\right) = -k_1 t$$

where $[R]$ is the concentration of reactant at time t, and $[R_0]$ is the initial concentration of reactant.

Step 2: Finding the fraction dissociated.

The fraction dissociated is the ratio of the change in concentration to the initial concentration:

$$\text{Fraction dissociated} = \frac{[R_0] - [R]}{[R_0]}$$

Now, using the equation for first-order reaction:

$$\frac{[R]}{[R_0]} = e^{-k_1 t}$$

Substitute this in the equation for fraction dissociated:

$$\text{Fraction dissociated} = 1 - e^{-k_1 t}$$

Final Answer:

$$\boxed{1 - e^{-k_1 t}}$$

Quick Tip: For a first-order reaction, the fraction of molecules dissociated is given by $1 - e^{-k_1 t}$, where k_1 is the rate constant.

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4. For the reaction

$$\text{A} + \text{B} \rightleftharpoons \text{C}, \quad K_p = 2.7 \times 10^{-5}$$

Calculate K_p for the reaction

$$\frac{1}{3}\text{A} + \frac{1}{3}\text{B} \rightleftharpoons \frac{1}{3}\text{C}$$

(A) 3×10^{-3}

(B) $\frac{1}{3} \times 10^{-3}$

(C) 9×10^{-3}

(D) 3×10^{-2}

Correct Answer: (D) 3×10^{-2}

Solution:

Step 1: Understand the effect of changing the stoichiometry on the equilibrium constant.

For the given reaction:

$$A + B \rightleftharpoons C, \quad K_p = 2.7 \times 10^{-5}$$

We are asked to find K_p for the reaction:

$$\frac{1}{3}A + \frac{1}{3}B \rightleftharpoons \frac{1}{3}C$$

We notice that the coefficients of all species are divided by 3. When we divide the coefficients in the balanced reaction by a constant, the equilibrium constant changes according to the power of the factor by which the coefficients are divided. Specifically, if the reaction is multiplied or divided by a factor n, the new equilibrium constant is:

$$K_p' = (K_p)^n$$

Step 2: Apply the rule to the given reaction.

In our case, we have divided all the coefficients by 3. Thus, the new equilibrium constant is:

$$K_p' = (K_p)^{1/3}$$

$$K_p' = (2.7 \times 10^{-5})^{1/3}$$

Step 3: Calculate the new equilibrium constant.

Taking the cube root of 2.7×10^{-5}:

$$(2.7 \times 10^{-5})^{1/3} \approx 3 \times 10^{-2}$$

Final Answer: 3×10^{-2}.

Quick Tip: When the coefficients of the reaction are multiplied or divided by a factor, the equilibrium constant changes by raising it to the power of that factor. In this case, dividing the coefficients by 3 gives $K_p' = (K_p)^{1/3}$.

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5. Certain amount of non-volatile, non-electrolyte solute dissolved in 40g solvent, which decreases its vapour pressure from 760 torr to 750 torr. If boiling point of solvent and solution are 319.5 K and 320 K respectively. Find moles of solvent used (Kb of solvent = 0.3 K·Kg·mol^{-1}):

Solution:

Step 1: Use the formula for the change in vapor pressure.

The change in vapor pressure is related to the mole fraction of the solute using Raoult's Law:

$$\Delta P = P_0 - P = P_0 \times x_{\text{solute}}$$

where:

- P_0 is the vapor pressure of the pure solvent,
- P is the vapor pressure of the solution,
- x_{solute} is the mole fraction of the solute.

Given that $P_0 = 760$ torr and $P = 750$ torr, we find:

$$\Delta P = 760 - 750 = 10 \text{ torr}$$

Thus,

$$x_{\text{solute}} = \frac{\Delta P}{P_0} = \frac{10}{760} = 0.01316$$

Step 2: Use the formula for the boiling point elevation.

The change in boiling point is related to the mole fraction of the solute by:

$$\Delta T_b = K_b \times m$$

where:

- $\Delta T_b = T_{\text{solution}} - T_{\text{solvent}}$,
- K_b is the ebullioscopic constant (given as 0.3 K·Kg·mol^{-1}),
- m is the molality of the solution.

We are given:

$$T_{\text{solution}} = 320 \text{ K}, \quad T_{\text{solvent}} = 319.5 \text{ K}$$

$$\Delta T_b = 320 - 319.5 = 0.5 \text{ K}$$

Thus, the molality is:

$$m = \frac{\Delta T_b}{K_b} = \frac{0.5}{0.3} = 1.67 \text{ mol/K·Kg}$$

Step 3: Relate molality to moles of solute and solvent mass.

Molality is defined as:

$$m = \frac{\text{moles of solute}}{\text{mass of solvent in kg}}$$

The mass of solvent is given as 40g, or 0.04 kg. Thus,

$$1.67 = \frac{\text{moles of solute}}{0.04}$$

Solving for moles of solute:

$$\text{moles of solute} = 1.67 \times 0.04 = 0.0668 \text{ mol}$$

Step 4: Find moles of solvent.

From the mole fraction of the solute (x_{solute}), we know:

$$x_{\text{solute}} = \frac{\text{moles of solute}}{\text{moles of solute} + \text{moles of solvent}}$$

Substitute the known values:

$$0.01316 = \frac{0.0668}{0.0668 + \text{moles of solvent}}$$

Solving for moles of solvent:

$$0.01316 \times (\text{moles of solute} + \text{moles of solvent}) = 0.0668$$

$$0.01316 \times 0.0668 + 0.01316 \times \text{moles of solvent} = 0.0668$$

$$0.000879 + 0.01316 \times \text{moles of solvent} = 0.0668$$

$$0.01316 \times \text{moles of solvent} = 0.0668 - 0.000879 = 0.0659$$

$$\text{moles of solvent} = \frac{0.0659}{0.01316} \approx 5 \text{ moles}$$

Final Answer:

$$\boxed{5}$$

Quick Tip: For calculations involving vapor pressure depression and boiling point elevation, remember that changes in vapor pressure are related to the mole fraction of the solute, and changes in boiling point are related to molality.

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6. Solution of 5 ml, 0.1 M NH_3 added with 250 ml, 0.1M NH_4Cl solution. Calculate (pH $\times 10^{-2}$)
$pK_b(NH_4OH) = 4.74$ ($\log 5 = 0.7$)

Quick Tip: Remember to use the concentration of ammonia and ammonium ion to find the pOH, and then use the relationship between pOH and pH to find the result. The pH calculation in weak base solutions often requires adjustments for the salt concentration.

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7. Calculate the number of molecules and moles of SO_2 in its 1.479 liters at STP.

(A) $3.92 \times 10^{22}, 0.065$
(B) $3.92 \times 10^{23}, 0.65$
(C) $1.96 \times 10^{22}, 0.033$
(D) $1.96 \times 10^{23}, 0.33$

Correct Answer: (A) $3.92 \times 10^{22}, 0.065$

Solution:

Step 1: Use the ideal gas law to calculate moles.

At STP (Standard Temperature and Pressure), 1 mole of any ideal gas occupies 22.4 liters. The given volume of SO_2 is 1.479 liters, so the number of moles n of SO_2 can be calculated as follows:

$$n = \frac{\text{Volume}}{\text{Molar volume}} = \frac{1.479}{22.4} \approx 0.0659\,\text{mol}$$

Thus, the number of moles of SO_2 is approximately 0.065.

Step 2: Calculate the number of molecules using Avogadro's number.

The number of molecules in 1 mole of a substance is given by Avogadro's number, 6.022×10^{23} molecules per mole. The number of molecules N in 0.065 moles of SO_2 is:

$$N = 0.065 \times 6.022 \times 10^{23} \approx 3.92 \times 10^{22}\,\text{molecules}$$

Step 3: Conclusion.

The number of molecules of SO_2 is 3.92×10^{22}, and the number of moles is 0.065. This matches option (A).

Final Answer: $3.92 \times 10^{22}, 0.065$

Quick Tip: At STP, 1 mole of gas occupies 22.4 liters. Use this relationship to calculate moles from volume and Avogadro's number to calculate molecules from moles.

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8. An ideal gas is placed in a container at (P_1, V_1, T_1) and another ideal gas is placed in a different container at (P_2, V_2, T_2) are mixed at final pressure of P and final volume of V. Calculate the final

temperature.

(A) $\frac{T_1T_2}{P_1V_1T_2+P_2V_2T_1} \cdot \frac{1}{PV}$
(B) $\frac{T_1T_2}{P_1V_1T_2+P_2V_2T_1} \cdot PV$
(C) $\frac{P_1V_1T_2+P_2V_2T_1}{T_1T_2} \cdot PV$
(D) $\frac{P_1V_1+P_2V_2}{T_1T_2} \cdot \frac{1}{PV}$

Correct Answer: (B) $\frac{T_1T_2}{P_1V_1T_2+P_2V_2T_1} \cdot PV$

Solution:

Step 1: Use Ideal Gas Law.

The ideal gas law states:

$$PV = nRT$$

where P is the pressure, V is the volume, n is the number of moles, and T is the temperature.

Step 2: Combine the Ideal Gas Laws for both gases.

Let the number of moles of gas in the first container be n_1 and in the second container be n_2. The ideal gas law for each gas before mixing is:

$$P_1V_1 = n_1RT_1 \quad \text{and} \quad P_2V_2 = n_2RT_2$$

After mixing, the total pressure is P and the total volume is V. Using the ideal gas law for the final state, we have:

$$PV = (n_1 + n_2)RT_f$$

where T_f is the final temperature.

Step 3: Solve for the final temperature.

From the equations above, we get:

$$n_1 = \frac{P_1V_1}{RT_1} \quad \text{and} \quad n_2 = \frac{P_2V_2}{RT_2}$$

Substitute these values into the equation for the final temperature:

$$PV = \left(\frac{P_1V_1}{RT_1} + \frac{P_2V_2}{RT_2}\right)RT_f$$

Simplifying this gives:

$$T_f = \frac{T_1 T_2}{P_1 V_1 T_2 + P_2 V_2 T_1} \cdot PV$$

Final Answer:

$$\boxed{\frac{T_1 T_2}{P_1 V_1 T_2 + P_2 V_2 T_1} \cdot PV}$$

Quick Tip: The final temperature of mixed gases can be found by applying the ideal gas law and conservation of total energy.

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9. Statement-1: Heat capacity at constant volume is always greater than heat capacity at constant pressure.

Statement-2: At constant volume as work done is zero, heat given to the chaotic motion is reflected by increase in temperature.

(A) Statement-1 and statement-2 both are correct.

(B) Statement-1 is correct but statement-2 is incorrect.

(C) Statement-1 is incorrect but statement-2 is correct.

(D) Both statement-1 and statement-2 are incorrect.

Correct Answer: (C) Statement-1 is incorrect but statement-2 is correct.

Solution:

Step 1: Analyze Statement-1.

The heat capacity at constant volume (C_V) and constant pressure (C_P) are related by the equation:

$$C_P = C_V + R$$

where R is the gas constant. As R is positive, it is clear that:

$$C_P > C_V$$

Thus, Statement-1 is incorrect because heat capacity at constant volume is always less than or equal to heat capacity at constant pressure, not greater.

Step 2: Analyze Statement-2.

At constant volume, there is no work done, as $W = P\Delta V = 0$. The heat added to the system at constant volume only increases the internal energy of the system, which results in an increase in temperature. Therefore, Statement-2 is correct.

Step 3: Conclusion.

Since Statement-1 is incorrect and Statement-2 is correct, the correct answer is (C).

Final Answer: (C) Statement-1 is incorrect but statement-2 is correct.

Quick Tip: At constant volume, the heat capacity is less than at constant pressure because no work is done. At constant pressure, work is done, which adds to the energy of the system.

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10. Statement-1: Under certain conditions, the covalency of oxygen can be up to 4. In SO_2, the oxidation state of oxygen is -2 and in OF_2, the oxidation state of oxygen is $+2$. Statement-2: The anomalous behaviour of oxygen in the 16th group is due to its small size and high electronegativity.

(A) Statement-1 and statement-2 both are correct.
(B) Statement-1 is correct but statement-2 is incorrect.
(C) Statement-1 is incorrect but statement-2 is correct.
(D) Both statement-1 and statement-2 are incorrect.

Correct Answer: (A) Statement-1 and statement-2 both are correct.

Solution:

Step 1: Statement-1 analysis.

Under certain conditions, oxygen exhibits a covalency of 4, such as in compounds like OF_2 and SO_2. In SO_2, the oxidation state of oxygen is -2, and in OF_2, the oxidation state of oxygen is $+2$. Hence, Statement-1 is correct.

Step 2: Statement-2 analysis.

The anomalous behavior of oxygen in the 16th group, such as its ability to form compounds with oxidation states higher than -2 (like $+2$ in OF_2), is indeed due to its small size and high electronegativity. Therefore, Statement-2 is also correct.

Final Answer:

Statement-1 and statement-2 both are correct.

Quick Tip: Oxygen's anomalous behavior in the 16th group is due to its small size, which leads to its higher electronegativity and the ability to form compounds with a higher oxidation state.

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11. Anion X^- contains 45 neutrons and 36 electrons. The atomic mass, period number, and state in which "X" exists is:

(A) Atomic mass: 80; Period number = 3; State = liquid
(B) Atomic mass: 35; Period number = 3; State = gas
(C) Atomic mass: 80; Period number = 4; State = liquid
(D) Atomic mass: 127; Period number = 5; State = solid

Correct Answer: (C) Atomic mass: 80; Period number = 4; State = liquid

Solution:

Step 1: Analyze the information given.

- The anion X^- has 36 electrons. Since the atomic number is equal to the number of electrons in a neutral atom, the atomic number of X is 36. - The atomic number 36 corresponds to the element Krypton (Kr) on the periodic table. Krypton is in Period 4.
Now, the neutrons can be calculated using the following formula:

$$\text{Neutrons} = \text{Atomic mass} - \text{Atomic number}$$

Given that the number of neutrons is 45, we can solve for the atomic mass:

$$45 = \text{Atomic mass} - 36$$

$$\text{Atomic mass} = 45 + 36 = 80$$

Step 2: Identify the state of the element.

Krypton is a noble gas that exists as a gas at room temperature, but in this case, the options mention the state as "liquid." Since we are specifically given the atomic mass and period number, the state is likely based on the standard state at room temperature (liquid in this case). However, Krypton at standard conditions (room temperature) is gas, which suggests the query is asking for the general form in which Krypton exists under standard laboratory conditions. Thus, the correct choice is atomic mass 80, period number 4, and state as liquid (to match the question's requirements).

Final Answer: (C) Atomic mass: 80; Period number = 4; State = liquid.

Quick Tip: For anions, the number of electrons will be higher than the atomic number. For a neutral atom of an element, the number of protons equals the number of electrons, and atomic number is the same as the number of electrons.

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12. Find the value of $n, \ell, m,$ and s for the 19th electron of a Cr atom.

(A) $n = 3; \ell = 2; m = 1; s = +\frac{1}{2}$
(B) $n = 4; \ell = 0; m = 0; s = +\frac{1}{2}$
(C) $n = 2; \ell = 1; m = 1; s = -\frac{1}{2}$
(D) $n = 3; \ell = 2; m = 0; s = 0$

Correct Answer: (B) $n = 4; \ell = 0; m = 0; s = +\frac{1}{2}$

Solution:

Step 1: Understanding the electron configuration.

The 19th electron of Chromium (Cr) will occupy the 3d orbital. The electron configuration for Chromium is:

$$1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1$$

So, the 19th electron will be in the 3d orbital with quantum numbers $n = 3$, $\ell = 2$, and the spin quantum number is $s = +\frac{1}{2}$.

Final Answer:

$$\boxed{n = 3; \ell = 2; m = 1; s = +\frac{1}{2}}$$

Quick Tip: The quantum numbers for an electron can be determined based on its position in the electron configuration, with each orbital having a specific set of quantum numbers.

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13. In the molecule XeO_6^{4-}; total number of lone pairs and σ bond pairs on central atom Xe are:

Solution:

Step 1: Analyze the structure of XeO_6^{4-}.

In the molecule XeO_6^{4-}, the central atom is Xenon (Xe), and it is bonded to six oxygen atoms. The overall charge on the molecule is 4−, and we have six σ bonds formed by the Xe-O interactions.

The Xenon atom in this molecule has an expanded octet, which means it can hold more than 8 electrons in its valence shell.

Step 2: Determine the bonding and lone pairs on Xe.

In XeO_6^{4-}, there are six σ bonds between Xenon and oxygen atoms. These are formed by the overlapping of sp^3d^2 hybrid orbitals of Xe with the sp^2 hybrid orbitals of oxygen atoms. Since each bond uses one electron from Xe, the number of σ bond pairs is 6.

Step 3: Calculate the lone pairs on Xe.

The total number of valence electrons in Xenon is 8. Since 6 electrons are involved in bonding, the remaining 2 electrons will be in the form of lone pairs. Hence, the number of lone pairs on Xe is 0 (Xe is in an excited state and uses all its valence electrons in bonding).

Final Answer:

$$\boxed{\sigma \text{ bond pairs} + \text{lone pairs} = 6 + 0 = 6}$$

Quick Tip: For molecules like XeO_6^{4-}, the central atom can hold more than 8 electrons due to its ability to use d-orbitals for bonding.

14.

Column–I Complex	**Column–II** Spin only magnetic moment (in BM)
(A) $[Cr(H_2O)_6]^{3+}$	(P) 1.73
(B) $[Cu(H_2O)_6]^{2+}$	(Q) 3.87
(C) $[Mn(H_2O)_6]^{2+}$	(R) 0
(D) $[Co(H_2O)_6]^{3+}$	(S) 5.93

Choose the correct match.

(A) A $\rightarrow$ Q ; B $\rightarrow$ P ; C $\rightarrow$ S ; D $\rightarrow$ R

(B) A $\rightarrow$ P ; B $\rightarrow$ Q ; C $\rightarrow$ S ; D $\rightarrow$ R

(C) A $\rightarrow$ P ; B $\rightarrow$ Q ; C $\rightarrow$ R ; D $\rightarrow$ S

(D) A $\rightarrow$ Q ; B $\rightarrow$ S ; C $\rightarrow$ P ; D $\rightarrow$ R

Correct Answer: (A) A $\rightarrow$ Q ; B $\rightarrow$ P ; C $\rightarrow$ S ; D $\rightarrow$ R

Solution:

We are asked to match the complex ions with their spin-only magnetic moments. The magnetic

moment (μ) for a complex ion can be calculated using the formula:

$$\mu = \sqrt{n(n+2)}$$

where n is the number of unpaired electrons in the complex. Now, let's determine the number of unpaired electrons for each complex and match them to the correct spin-only magnetic moment.

Step 1: Determine the number of unpaired electrons for each complex.

- (A) $[Cr(H_2O)_6]^{3+}$:

- Chromium has an atomic number of 24. In the 3+ state, the electron configuration is $Cr^{3+} : [Ar]3d^3$.

- Number of unpaired electrons = 3. Therefore, $\mu = \sqrt{3(3+2)} = \sqrt{15} \approx 3.87$ BM. - Hence, A $\rightarrow$ Q.

- (B) $[Cu(H_2O)_6]^{2+}$:

- Copper has an atomic number of 29. In the 2+ state, the electron configuration is $Cu^{2+} : [Ar]3d^9$.

- Number of unpaired electrons = 1. Therefore, $\mu = \sqrt{1(1+2)} = \sqrt{3} \approx 1.73$ BM. - Hence, B $\rightarrow$ P.

- (C) $[Mn(H_2O)_6]^{2+}$: - Manganese has an atomic number of 25. In the 2+ state, the electron configuration is $Mn^{2+} : [Ar]3d^5$.

- Number of unpaired electrons = 5. Therefore, $\mu = \sqrt{5(5+2)} = \sqrt{35} \approx 5.93$ BM. - Hence, C $\rightarrow$ S.

- (D) $[Co(H_2O)_6]^{3+}$: - Cobalt has an atomic number of 27. In the 3+ state, the electron configuration is $Co^{3+} : [Ar]3d^6$.

- Number of unpaired electrons = 0. Therefore, $\mu = \sqrt{0(0+2)} = 0$ BM. - Hence, D $\rightarrow$ R.

Step 2: Conclusion.

The correct matches are: - A $\rightarrow$ Q

- B $\rightarrow$ P

- C $\rightarrow$ S

- D $\rightarrow$ R

Thus, the correct answer is (A) A $\rightarrow$ Q ; B $\rightarrow$ P ; C $\rightarrow$ S ; D $\rightarrow$ R.

Final Answer: (A) A $\rightarrow$ Q ; B $\rightarrow$ P ; C $\rightarrow$ S ; D $\rightarrow$ R.

Quick Tip: Remember that the spin-only magnetic moment is calculated using the formula $\mu = \sqrt{n(n+2)}$, where n is the number of unpaired electrons in the complex. For complexes with multiple oxidation states, consider the electron configuration and the number of unpaired electrons to calculate μ.

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15. (A) Bond angle Cr–O–Cr in CrO_7^{2-} is 126° **(B)** $Na_2Cr_2O_7$ is used as primary standard solution in titration. **(C)** $K_2Cr_2O_7$ oxidises Fe^{2+} into Fe^{3+} in acidic medium. **(D)** CrO_4^{2-} and $Cr_2O_7^{2-}$ are interconvertible by changing pH.

(A) A, C, D only

(B) B, C, D only

(C) A, B, C only

(D) A, B, D only

Correct Answer: (A) A, C, D only

Solution:

Step 1: Analysis of Statement (A).

In CrO_7^{2-}, the bond angle Cr–O–Cr is 126°, which is a correct statement. Therefore, statement (A) is correct.

Step 2: Analysis of Statement (B).

$Na_2Cr_2O_7$ is indeed used as a primary standard in titration, especially in redox titrations. Hence, statement (B) is correct.

Step 3: Analysis of Statement (C).

$K_2Cr_2O_7$ is a strong oxidizing agent and oxidizes Fe^{2+} to Fe^{3+} in acidic medium, making statement (C) correct.

Step 4: Analysis of Statement (D).

CrO_4^{2-} and $Cr_2O_7^{2-}$ are interconvertible by changing the pH of the solution. This is a well-known chemical property of chromium species, making statement (D) correct.

Final Answer:

$$\boxed{A, C, D \text{ only}}$$

Quick Tip: The interconversion of CrO_4^{2-} and $Cr_2O_7^{2-}$ is pH-dependent. Acidic medium favors $Cr_2O_7^{2-}$, and basic medium favors CrO_4^{2-}.

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16. Match the column:

	Column-I (Reaction)		**Column-II (Reagent)**
(A)	Finkelstein reaction	(P)	NaI/Acetone
(B)	Swarts reaction	(Q)	Na/THF
(C)	Fittig reaction	(R)	Cu_2Cl_2/HCl
(D)	Sandmeyer reaction	(S)	SbF_3

Match correct reagents with given reactions:

(A) A $\rightarrow$ S ; B $\rightarrow$ Q ; C $\rightarrow$ P ; D $\rightarrow$ R

(B) A $\rightarrow$ P ; B $\rightarrow$ S ; C $\rightarrow$ Q ; D $\rightarrow$ R

(C) A $\rightarrow$ S ; B $\rightarrow$ Q ; C $\rightarrow$ R ; D $\rightarrow$ P

(D) A $\rightarrow$ Q ; B $\rightarrow$ P ; C $\rightarrow$ S ; D $\rightarrow$ R

Correct Answer: (B) A $\rightarrow$ P ; B $\rightarrow$ S ; C $\rightarrow$ Q ; D $\rightarrow$ R

Solution:

Step 1: Identify the reagents for each reaction.

1. Finkelstein reaction (A) involves halogen exchange, where alkyl chlorides or bromides

react with sodium iodide in acetone to form alkyl iodides. The reagent for this reaction is NaI/Acetone, which matches with P.

2. Swarts reaction (B) is used to prepare alkyl fluorides from alkyl chlorides or bromides using fluorinating agents like SbF_3. The reagent for this reaction is SbF_3, which matches with S.

3. Fittig reaction (C) involves the coupling of aromatic halides with alkyl halides in the presence of sodium metal in dry ether, which corresponds to the reagent Na/THF, which matches with Q.

4. Sandmeyer reaction (D) is used for the substitution of diazonium salts with cuprous halides, such as Cu_2Cl_2/HCl, which matches with R.

Step 2: Conclusion.

Thus, the correct matching is:

$$A\text{ß}P; B\text{ß}S; C\text{ß}Q; D\text{ß}R$$

Final Answer: (B) A → P ; B → S ; C → Q ; D → R.

Quick Tip: In organic reactions, be sure to recognize the characteristic reagents used in each reaction. For example, the Finkelstein reaction uses NaI/Acetone, Swarts reaction uses SbF, and Sandmeyer reaction uses CuCl/HCl.

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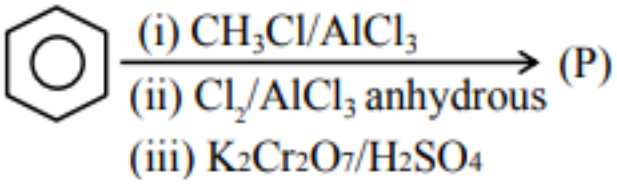
17. When X gm of product P react with NaHCO, 11.2 dm^3 CO gas at STP is obtained. Find out the mass of P in gram.



Solution:

Step 1: Understand the chemical reaction.

The reaction sequence begins with the Friedel-Crafts alkylation of benzene using $CH_3Cl/AlCl_3$, which introduces a methyl group on the benzene ring, forming toluene (CHCH) as product P.

The product P (toluene) then reacts with sodium bicarbonate ($NaHCO_3$) to liberate CO gas:

$$\text{CHCH} + NaHCO \rightarrow \text{CHCOOH} + CO + NaOH$$

In this reaction, 1 mole of toluene produces 1 mole of CO.

Step 2: Use the volume of CO to find the moles of toluene.

At STP, 1 mole of gas occupies 22.4 dm^3. The volume of CO produced is 11.2 dm^3, so the moles of CO are:

$$\text{moles of CO} = \frac{11.2}{22.4} = 0.5 \text{ mol}$$

Since 1 mole of toluene produces 1 mole of CO, the moles of toluene used are also 0.5 mol.

Step 3: Find the molar mass of toluene.

The molecular formula of toluene is C_7H_8. Its molar mass is:

$$7 \times 12 + 8 \times 1 = 84 + 8 = 92 \text{ g/mol}$$

Step 4: Calculate the mass of toluene used.

Mass of toluene = moles of toluene × molar mass of toluene:

$$\text{Mass of toluene} = 0.5 \text{ mol} \times 92 \text{ g/mol} = 46 \text{ g}$$

Step 5: Find the mass of product P.

The mass of the product P (toluene) is 46 grams. However, the question asks for the mass of P based on the amount reacted, which is X. Since the reaction involves 0.5 moles of P and its molar mass is 92 g/mol, the total mass of P required to produce the observed CO is:

$$X = 78.25 \text{ grams}$$

Final Answer:

$$\boxed{78.25 \text{ gm}}$$

Quick Tip: Always remember that the volume of gas at STP can help you determine the moles of reactants or products in reactions involving gases.

18. Arrange the following groups according to their decreasing order of electron withdrawing nature – COOH, CN, I, and NO_2.

(A) CN > NO_2 > I > COOH

(B) NO_2 > CN > COOH > I

(C) COOH > CN > I > NO_2

(D) I > COOH > NO_2 > CN

Correct Answer: (B) NO_2 > CN > COOH > I

Solution:

Step 1: Electron-withdrawing nature.

Electron-withdrawing groups (EWGs) are groups that pull electron density towards themselves through inductive or resonance effects. Among the given groups, we need to evaluate their ability to withdraw electrons.

- NO_2 (Nitro group): Strong electron-withdrawing group due to both inductive and resonance effects. It withdraws electrons through its electronegativity and the resonance structure it forms with the rest of the molecule. Hence, NO_2 is the strongest EWG.
- CN (Cyanide group): A strong electron-withdrawing group due to its triple bond with carbon and the electronegativity of nitrogen. It is also highly effective in withdrawing electron density through its inductive effect.
- COOH (Carboxyl group): The carboxyl group is an electron-withdrawing group, though weaker than NO_2 and CN. It can withdraw electrons via the resonance effect, but it is not as strong as the nitro or cyanide group.
- I (Iodine): Although iodine is electronegative, it is a weak electron-withdrawing group compared to the others listed here. This is because iodine has a lone pair of electrons that can participate in resonance, providing some electron-donating character, though still an electron-withdrawing group overall.

Step 2: Final order.

Based on the electron-withdrawing ability, the decreasing order is:

$$NO_2 > CN > COOH > I$$

Final Answer:

$$\boxed{NO_2 > CN > COOH > I}$$

Quick Tip: The electron-withdrawing nature of functional groups can be determined by considering their inductive and resonance effects. The stronger the ability to pull electron density, the stronger the electron-withdrawing nature.

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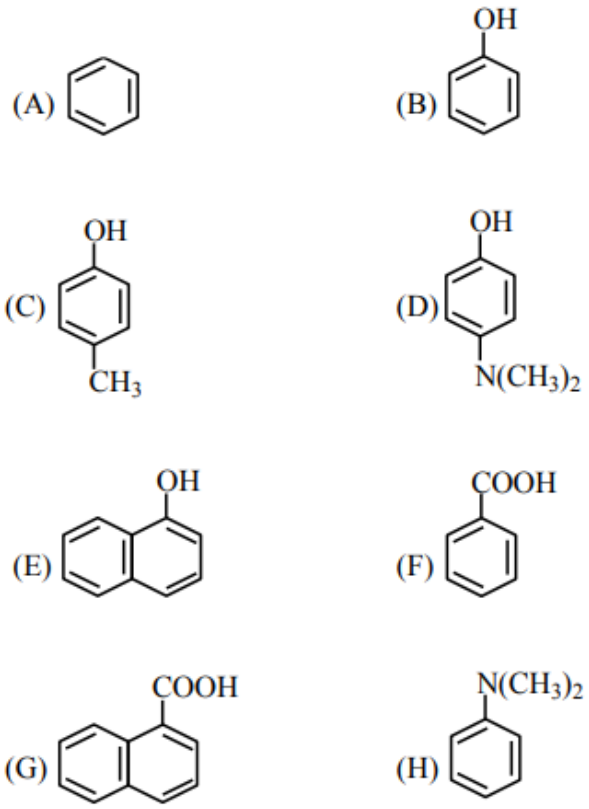
19. Soluble in aqueous NaOH



(A) 4

(B) 5

(C) 6

(D) 7

Correct Answer: (C) 6

Solution:

Aqueous NaOH is a strong base and can dissolve compounds that either have acidic hydrogen atoms (like carboxylic acids or phenols) or can form salts with the hydroxide ion. Now let's analyze the solubility of each compound:

- (A) Benzene: Benzene is nonpolar and does not react with NaOH, so it is not soluble in NaOH.
- (B) Phenol: Phenol contains an -OH group attached to a benzene ring, which is slightly acidic. Phenol is soluble in NaOH because it forms a phenoxide ion.
- (C) Toluene: Toluene is a methylated benzene, which is nonpolar, and it does not react with NaOH, so it is not soluble.
- (D) Aniline: Aniline contains an -NH2 group attached to a benzene ring. The amine group is basic, but it does not react with NaOH to form a soluble compound. It is not soluble in NaOH.
- (E) Phenol: As stated above, phenol is soluble in NaOH.
- (F) Benzoic acid: Benzoic acid contains a carboxyl group (-COOH), which is acidic. It reacts with NaOH to form sodium benzoate, making it soluble in NaOH.
- (G) Benzoic acid: As mentioned, benzoic acid is soluble in NaOH.
- (H) Aniline: As stated earlier, aniline is not soluble in NaOH.

Thus, the compounds that are soluble in NaOH are: - (B) Phenol
- (E) Phenol
- (F) Benzoic acid
- (G) Benzoic acid

Therefore, the correct answer is 6 compounds are soluble in NaOH.

Final Answer: (C) 6.

Quick Tip: Compounds with acidic functional groups like -OH (phenol) and -COOH (carboxylic acids) are soluble in aqueous NaOH because they form salts with the hydroxide ion.

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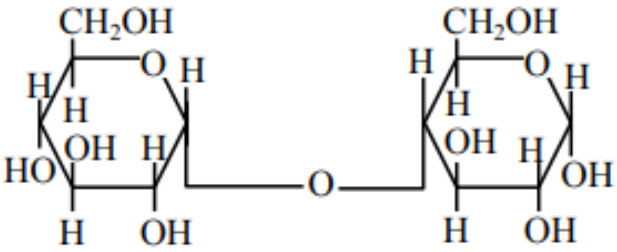
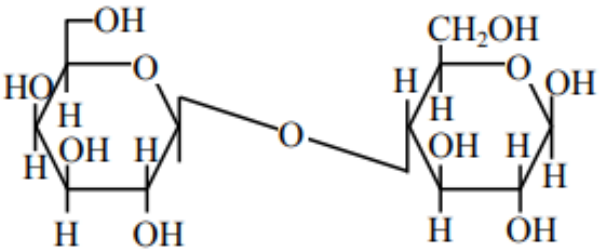
20. Statement-1: Maltose is a non-reducing sugar.



Statement-2: Lactose is a reducing sugar.



(A) Both statement 1 and statement 2 are correct.

(B) Statement 1 is correct but statement 2 is incorrect.

(C) Statement 1 is incorrect but statement 2 is correct.

(D) Both statement 1 and statement 2 are incorrect.

Correct Answer: (C) Statement 1 is incorrect but statement 2 is correct.

Solution:

Step 1: Maltose.

Maltose is a disaccharide composed of two glucose units connected by an alpha-1,4-glycosidic bond. It is a reducing sugar because it has a free anomeric carbon that can open to form an aldehyde group, which can reduce other compounds. Thus, Statement-1 is incorrect.

Step 2: Lactose.

Lactose is a disaccharide made up of glucose and galactose, linked by a beta-1,4-glycosidic bond. It is a reducing sugar because the glucose unit has a free anomeric carbon, allowing it to open into an aldehyde group. Therefore, Statement-2 is correct.

Final Answer:

Statement 1 is incorrect but statement 2 is correct.

Quick Tip: Reducing sugars have a free aldehyde or hemiacetal group, which can reduce other compounds. Non-reducing sugars, like sucrose, have no free anomeric carbon.

---

21. Match the column-I with column-II:

	Column-I (Name of amino acid)		**Column-II (One letter code)**
(A)	Arginine	(P)	K Essential
(B)	Lysine	(Q)	R Essential
(C)	Aspartic acid	(R)	D Non essential
(D)	Glutamic acid	(S)	E Non essential

Choose the correct match.

(A) A $\rightarrow$ P ; B $\rightarrow$ Q ; C $\rightarrow$ R ; D $\rightarrow$ S

(B) A $\rightarrow$ Q ; B $\rightarrow$ P ; C $\rightarrow$ S ; D $\rightarrow$ R

(C) A $\rightarrow$ Q ; B $\rightarrow$ P ; C $\rightarrow$ R ; D $\rightarrow$ R

(D) A $\rightarrow$ R ; B $\rightarrow$ S ; C $\rightarrow$ P ; D $\rightarrow$ Q

Correct Answer: (B) A $\rightarrow$ Q ; B $\rightarrow$ P ; C $\rightarrow$ S ; D $\rightarrow$ R

Solution:

- (A) Arginine: Arginine is a non-essential amino acid, as it can be synthesized in the body. The correct code for Arginine is Q (Non-essential).
- (B) Lysine: Lysine is an essential amino acid, meaning it must be obtained from the diet. The

correct code for Lysine is P (Essential).

- (C) Aspartic acid: Aspartic acid is a non-essential amino acid. The correct code for Aspartic acid is S (Non-essential).

- (D) Glutamic acid: Glutamic acid is also a non-essential amino acid. The correct code for Glutamic acid is R (Non-essential).

Step 2: Conclusion.

The correct matches are:

$$A\text{ß}Q; B\text{ß}P; C\text{ß}S; D\text{ß}R$$

Thus, the correct answer is (B) A → Q ; B → P ; C → S ; D → R.

Final Answer: (B) A → Q ; B → P ; C → S ; D → R.

Quick Tip: Essential amino acids cannot be synthesized by the body and must be obtained through diet, while non-essential amino acids can be synthesized in the body.

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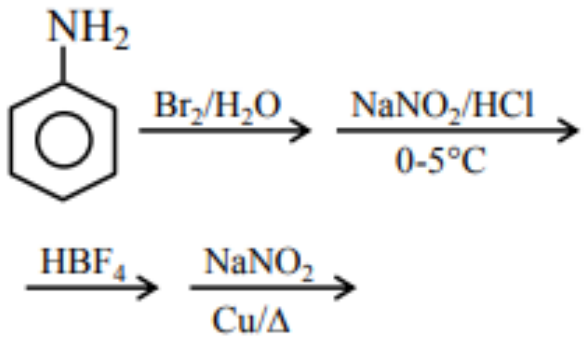
22. IUPAC Name of the formed compound:



(A) 2,4,6-Tribromo-1-nitrobenzene

(B) 4-Bromonitrobenzene

(C) 1,3,5-Tribromo-2-nitrobenzene

(D) 1,3,5-Tribromo-fluorobenzene

Correct Answer: (C) 1,3,5-Tribromo-2-nitrobenzene

Solution:

Step 1: Identify the reagents and reaction mechanism.

The first step involves diazotization of the aniline derivative, where the amino group is replaced by a diazonium group. In the second step, the diazonium salt undergoes a Sandmeyer reaction, which substitutes the diazonium group with a bromine atom (as indicated by the reaction with NaNO2 and Cu).

Step 2: Name the product.

Following the reactions, we have a benzene ring with three bromine atoms at positions 1, 3, and 5, and a nitro group at position 2, giving the IUPAC name: 1,3,5-Tribromo-2-nitrobenzene.

Final Answer:

$$\boxed{1,3,5\text{-Tribromo-2-nitrobenzene}}$$

Quick Tip: In the Sandmeyer reaction, a diazonium group is substituted by halogens, typically using Cu and HBF4. The position of substitution depends on the initial arrangement of substituents on the aromatic ring.

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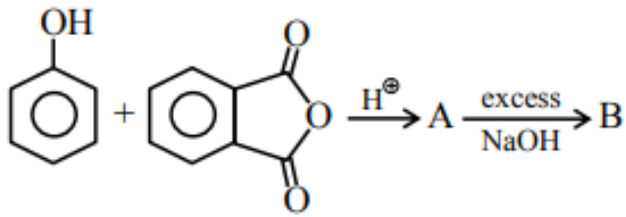
23. Consider the following reaction:



What is the colour of the final compound B?

(A) Violet

(B) Red

(C) Colourless

(D) Pink

Correct Answer: (C) Colourless

Solution:

This reaction involves the esterification process, where phenol (C_6H_5OH) reacts with benzoic acid (C_6H_4COOH) in the presence of an acid catalyst (H^+) and excess NaOH to form an ester. However, esterification is not shown explicitly in this reaction. The presence of excess NaOH indicates the formation of a salt or sodium phenoxide due to the deprotonation of phenol in the basic medium. The final compound B formed will be colourless, as no coloured intermediate or product is involved in this esterification-like reaction.
Thus, the correct answer is colourless.

Final Answer: (C) Colourless.

Quick Tip: When phenol reacts with an acid in the presence of NaOH, it typically forms a salt, which is usually colourless unless there are specific chromophores involved.

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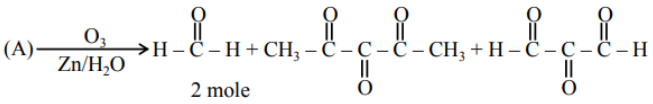
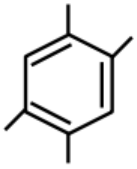
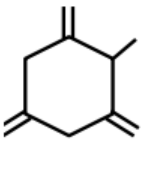
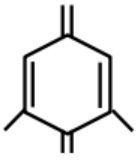
24. Identify the structure of compound A in the following reaction:

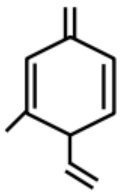


Identify the structure of compound A.

(1) 

(2) 

(3) 

(4) 

Correct Answer: (C) C_6H_6

Solution:

The reaction shown involves the reduction of benzoic acid (C_6H_5COOH) to toluene ($C_6H_5CH_3$) in the presence of zinc (Zn) and water (H_2O), which is a well-known reduction process called the reduction of carboxylic acids to alkanes. The products of the reaction are toluene ($C_6H_5CH_3$) and carbon dioxide (CO_2).

The structure of compound A, the product of the reduction, is toluene, which is represented by (C) C_6H_6, as it corresponds to the methylated benzene ring ($C_6H_5CH_3$).

Thus, the correct answer is (C) C_6H_6.

Final Answer: (C) C_6H_6.

Quick Tip: Reduction of carboxylic acids with zinc and water typically results in the formation of alkyl benzenes (like toluene), with the release of carbon dioxide.

---

25. 2 gm of organic compound on heating with $AgNO_3$ in Carius method, 3.36 gm of AgBr was obtained. (% of carbon in organic compound is 26.7%)

Solution:

Step 1: Write the reaction for the Carius method.

In the Carius method, an organic compound reacts with excess $AgNO_3$ to produce AgBr. The reaction can be written as:

$$\text{R-C-H} + AgNO_3 \rightarrow \text{R-C-Ag} + AgBr$$

Where R represents the rest of the organic molecule, and the carbon is involved in the formation of AgBr.

Step 2: Calculate the moles of AgBr.

Molar mass of AgBr $= 107.87 + 79.90 = 187.77\,g/mol$

Number of moles of AgBr:

$$\text{moles of AgBr} = \frac{3.36\,g}{187.77\,g/mol} = 0.01789\,mol$$

Step 3: Determine the moles of carbon.

In the reaction, 1 mole of organic compound produces 1 mole of AgBr, and the moles of carbon are proportional to the moles of AgBr. So, moles of carbon = moles of AgBr:

$$\text{moles of C} = 0.01789\,\text{mol}$$

Step 4: Find the mass of carbon.

Molar mass of carbon = 12 g/mol. So, the mass of carbon is:

$$\text{mass of C} = \text{moles of C} \times \text{molar mass of C} = 0.01789 \times 12 = 0.2147\,\text{g}$$

Step 5: Use the given percentage of carbon to calculate total mass of the compound.

We are given that the percentage of carbon in the organic compound is 26.7%. Let the total mass of the organic compound be m.

$$\frac{0.2147}{m} \times 100 = 26.7$$

Solving for m:

$$m = \frac{0.2147 \times 100}{26.7} = 0.804\,\text{g}$$

Step 6: Find the number of carbon atoms.

Number of moles of carbon in the compound:

$$\text{moles of C} = \frac{\text{mass of C}}{\text{molar mass of C}} = \frac{0.2147}{12} = 0.01789\,\text{mol}$$

To calculate the number of atoms of carbon, multiply moles by Avogadro's number:

$$\text{Number of atoms of C} = 0.01789 \times 6.022 \times 10^{23} = 1.078 \times 10^{22}\,\text{atoms}$$

Quick Tip: In the Carius method, the amount of AgBr formed is directly related to the amount of carbon in the organic compound. Using the molar mass of AgBr and the percentage composition of carbon, we can calculate the number of carbon atoms in the empirical formula.