Time Allowed: 3 Hours **Maximum Marks: 80**

CBSE Class 12 Chemistry Practice Examination Paper

CBSE Class 12 Chemistry Full Syllabus Practice Paper

Q1. What is the value of the van 't Hoff factor (i) for a dilute aqueous solution of potassium sulfate (K2SO4) assuming complete dissociation? [1 Mark]
(a) 1
(b) 2
(c) 3
(d) 4

Q2. Which of the following first-row transition metal ions exhibits the highest spin-only magnetic moment in its gaseous state? [1 Mark]
(a) Mn2+
(b) Fe2+
(c) Co2+
(d) Ni2+

Q3. For a first-order chemical reaction, if the rate constant k is 2.303 x 10^-3 s^-1, what is the half-life period (t1/2) of the reaction? [1 Mark]
(a) 100 s
(b) 300 s
(c) 500 s
(d) 1000 s

Q4. According to Crystal Field Theory, what is the electronic configuration of a d4 ion in an octahedral crystal field when Δo < P (weak field ligand)? [1 Mark]
(a) t2g4 eg0
(b) t2g3 eg1
(c) t2g2 eg2
(d) t2g0 eg4

Q5. Which of the following alkyl halides undergoes SN1 reaction at the fastest rate? [1 Mark]
(a) Chlorobenzene
(b) 1-Chloropropane
(c) 2-Chloropropane
(d) 2-Chloro-2-methylpropane

Q6. Which reagent is used in Hinsberg's test to distinguish between primary, secondary, and tertiary amines? [1 Mark]
(a) Benzene sulfonyl chloride
(b) Acetyl chloride
(c) Nitrous acid
(d) p-Toluenesulfonyl chloride only

Q7. Which structural level of proteins remains intact and unaffected during denaturation? [1 Mark]
(a) Primary structure
(b) Secondary structure
(c) Tertiary structure
(d) Quaternary structure

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Q8. Calculate the molarity of a solution containing 5.0 g of NaOH dissolved in enough water to prepare 450 mL of solution. [2 Marks]

Q9. Give reason for each of the following observations: [2 Marks]
(a) Transition metals and their compounds exhibit excellent catalytic properties.
(b) Zirconium (Zr) and Hafnium (Hf) exhibit almost identical atomic radii.

Q10. Arrange the following compounds in increasing order of their basic strength in aqueous medium with reasoning: [2 Marks]
(C2H5)NH2, (C2H5)2NH, (C2H5)3N, NH3

Q11. The resistance of a conductivity cell filled with 0.1 mol L^-1 KCl solution is 100 Ω. If the resistance of the same cell when filled with 0.02 mol L^-1 KCl solution is 520 Ω, calculate the conductivity and molar conductivity of 0.02 mol L^-1 KCl solution. (Given: Conductivity of 0.1 mol L^-1 KCl solution is 1.29 S m^-1). [3 Marks]

Q12. For the complex coordination compound [Fe(CN)6]3-: [3 Marks]
(a) Write the IUPAC name of the complex.
(b) Predict its hybridization state and geometry.
(c) State whether it is paramagnetic or diamagnetic, calculating its spin-only magnetic moment.

Q13. How will you convert the following? Write the chemical equations involved: [3 Marks]
(a) Propene to Propan-1-ol
(b) Phenol to Anisole
(c) Propanone to Propene

Q14. An organic compound (A) with molecular formula C8H8O forms an orange-red precipitate with 2,4-DNP reagent and gives a yellow precipitate of iodoform when heated with NaOH and I2. Compound (A) neither reduces Tollens' reagent nor Fehling's solution, and it does not decolorize bromine water. On vigorous oxidation with chromic acid (H2CrO4), it yields a carboxylic acid (B) having molecular formula C7H6O2. [5 Marks]
(a) Identify compounds (A) and (B).
(b) Write balanced chemical reactions for the 2,4-DNP test and Iodoform test given by compound (A).
(c) Write the oxidation reaction converting compound (A) to compound (B).

Q15. Answer the following questions related to Chemical Kinetics: [5 Marks]
(a) Derive/state the integrated rate law equation for a first-order reaction.
(b) A first-order reaction takes 40 minutes for 30% decomposition. Calculate its half-life period (t1/2). [Given: log 10 = 1, log 7 = 0.8451]

Time Allowed: 3 Hours **Maximum Marks: 80**

Detailed Solutions & Marking Scheme

CBSE Class 12 Chemistry Full Syllabus Practice Paper

Q1. What is the value of the van 't Hoff factor (i) for a dilute aqueous solution of potassium sulfate (K2SO4) assuming complete dissociation? [1 Mark]
(a) 1
(b) 2
(c) 3
(d) 4

Correct Option / Answer: (c) 3
Detailed Solution: Potassium sulfate dissociates in aqueous solution as follows:
K2SO4 (aq) -> 2 K+ (aq) + SO4^2- (aq)
Since one molecule of K2SO4 yields a total of 3 ions (2 K+ ions and 1 SO4^2- ion) upon complete dissociation, the van 't Hoff factor i = 3.
Marking Scheme: 1 mark for selecting the correct option (c).

Q2. Which of the following first-row transition metal ions exhibits the highest spin-only magnetic moment in its gaseous state? [1 Mark]
(a) Mn2+
(b) Fe2+
(c) Co2+
(d) Ni2+

Correct Option / Answer: (a) Mn2+
Detailed Solution: Electronic configurations and number of unpaired electrons (n):
Mn2+ (3d5) -> n = 5 unpaired electrons
Fe2+ (3d6) -> n = 4 unpaired electrons
Co2+ (3d7) -> n = 3 unpaired electrons
Ni2+ (3d8) -> n = 2 unpaired electrons
Spin-only magnetic moment μ = sqrt(n(n+2)) BM. Since Mn2+ has maximum number of unpaired electrons (n = 5), it exhibits the highest spin-only magnetic moment (5.92 BM).
Marking Scheme: 1 mark for correct option selection.

Q3. For a first-order chemical reaction, if the rate constant k is 2.303 x 10^-3 s^-1, what is the half-life period (t1/2) of the reaction? [1 Mark]
(a) 100 s
(b) 300 s
(c) 500 s
(d) 1000 s

Correct Option / Answer: (b) 300 s
Detailed Solution: For a first-order reaction:
t1/2 = 0.693 / k
t1/2 = 0.693 / (2.303 x 10^-3 s^-1) = (2.303 x 0.3010) / (2.303 x 10^-3) = 301 s ≈ 300 s.
Marking Scheme: 1 mark for correct answer calculation.

Q4. According to Crystal Field Theory, what is the electronic configuration of a d4 ion in an octahedral crystal field when Δo < P (weak field ligand)? [1 Mark]

Time Allowed: 3 Hours **Maximum Marks: 80**

(a) t2g4 eg0
(b) t2g3 eg1
(c) t2g2 eg2
(d) t2g0 eg4

Correct Option / Answer: (b) t2g3 eg1
Detailed Solution: When Δo < P, the crystal field splitting energy is less than the pairing energy (weak field ligand limit). Pairing of electrons requires more energy than jumping to the eg orbital. Therefore, high-spin configuration results, where electrons enter eg orbitals individually before pairing occurs in t2g orbitals. Thus, d4 gives t2g3 eg1 configuration.
Marking Scheme: 1 mark for correct option selection.

Q5. Which of the following alkyl halides undergoes SN1 reaction at the fastest rate? [1 Mark]
(a) Chlorobenzene
(b) 1-Chloropropane
(c) 2-Chloropropane
(d) 2-Chloro-2-methylpropane

Correct Option / Answer: (d) 2-Chloro-2-methylpropane
Detailed Solution: SN1 reactions proceed via a carbocation intermediate. The order of carbocation stability is 3° > 2° > 1° > aryl. 2-Chloro-2-methylpropane generates a tertiary carbocation (tert-butyl cation), which is exceptionally stable due to hyperconjugation and inductive effects, thereby reacting fastest via SN1 mechanism.
Marking Scheme: 1 mark for correct option.

Q6. Which reagent is used in Hinsberg's test to distinguish between primary, secondary, and tertiary amines? [1 Mark]
(a) Benzene sulfonyl chloride
(b) Acetyl chloride
(c) Nitrous acid
(d) p-Toluenesulfonyl chloride only

Correct Option / Answer: (a) Benzene sulfonyl chloride
Detailed Solution: Hinsberg's reagent is benzene sulfonyl chloride ($C_6H_5SO_2Cl$). Primary amines react to form a sulfonamide soluble in alkali; secondary amines form a product insoluble in alkali; tertiary amines do not react at room temperature.
Marking Scheme: 1 mark for correct identification of the reagent.

Q7. Which structural level of proteins remains intact and unaffected during denaturation? [1 Mark]
(a) Primary structure
(b) Secondary structure
(c) Tertiary structure
(d) Quaternary structure

Correct Option / Answer: (a) Primary structure
Detailed Solution: During denaturation of proteins by heat, pH change, or chemical reagents, secondary, tertiary, and quaternary structures are disrupted due to the cleavage of hydrogen bonds and non-covalent forces. However, covalent peptide bonds forming the primary structure remain intact.
Marking Scheme: 1 mark for correct option selection.

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Q8. Calculate the molarity of a solution containing 5.0 g of NaOH dissolved in enough water to prepare 450 mL of solution. [2 Marks]

Correct Option / Answer: Molarity = 0.278 M (or mol/L)
Detailed Solution:
1. Molar mass of NaOH = 23 + 16 + 1 = 40 g/mol.
2. Moles of NaOH = Mass / Molar mass = 5.0 g / 40 g/mol = 0.125 mol.
3. Volume of solution in liters = 450 mL / 1000 = 0.450 L.
4. Molarity (M) = Moles of solute / Volume of solution in L = 0.125 mol / 0.450 L = 0.278 M.
Marking Scheme:
- Calculation of moles (0.125 mol): 1 mark
- Calculation of molarity with correct units (0.278 M): 1 mark

Q9. Give reason for each of the following observations: [2 Marks]
(a) Transition metals and their compounds exhibit excellent catalytic properties.
(b) Zirconium (Zr) and Hafnium (Hf) exhibit almost identical atomic radii.

Correct Option / Answer: Detailed explanations provided below.
Detailed Solution:
(a) Transition metals act as good catalysts because: (i) They possess variable oxidation states allowing them to form reactive intermediates, and (ii) They provide a large surface area for adsorption of reactant molecules.
(b) Zr (4d series) and Hf (5d series) have almost identical atomic radii (160 pm and 159 pm) due to Lanthanoid Contraction—the poor shielding effect of 4f electrons preceding Hf, which counteracts the normal size increase down the group.
Marking Scheme:
- 1 mark for explaining catalytic behavior (variable oxidation state / surface area).
- 1 mark for attributing atomic radii similarity to Lanthanoid Contraction.

Q10. Arrange the following compounds in increasing order of their basic strength in aqueous medium with reasoning: [2 Marks]
(C2H5)NH2, (C2H5)2NH, (C2H5)3N, NH3

Correct Option / Answer: NH3 < (C2H5)3N < C2H5NH2 < (C2H5)2NH
Detailed Solution: In aqueous solution, basic strength of substituted ethyl amines depends on three factors: inductive effect (+I effect), steric hindrance, and hydration energy of the conjugate acid.
Due to the combination of these three factors, the order of basicity for ethyl substituted amines in aqueous solution is:
Secondary (2°) > Primary (1°) > Tertiary (3°) > Ammonia (NH3).
Hence: NH3 < (C2H5)3N < C2H5NH2 < (C2H5)2NH.
Marking Scheme:
- 1 mark for correct increasing order.
- 1 mark for mentioning the combined effect of +I effect, steric hindrance, and hydration enthalpy.

Q11. The resistance of a conductivity cell filled with 0.1 mol L^-1 KCl solution is 100 Ω. If the resistance of the same cell when filled with 0.02 mol L^-1 KCl solution is 520 Ω, calculate the conductivity and molar conductivity of 0.02 mol L^-1 KCl solution. (Given: Conductivity of 0.1 mol L^-1 KCl solution is 1.29 S m^-1). [3 Marks]

Correct Option / Answer: Conductivity (κ) = 0.248 S m^-1; Molar conductivity (Λm) = 0.0124 S m^2 mol^-1 (or 124 S cm^2 mol^-1)
Detailed Solution:

Time Allowed: 3 Hours **Maximum Marks: 80**

1. Find Cell Constant (G*):
Cell constant (G*) = Conductivity (κ) x Resistance (R)
G* = 1.29 S m^-1 x 100 Ω = 129 m^-1.

2. Calculate Conductivity (κ) of 0.02 mol L^-1 KCl:
κ = Cell constant / R = 129 m^-1 / 520 Ω = 0.248 S m^-1.

3. Calculate Molar Conductivity (Λm):
Concentration C = 0.02 mol L^-1 = 0.02 x 1000 mol m^-3 = 20 mol m^-3.
Λm = κ / C = 0.248 S m^-1 / 20 mol m^-3 = 0.0124 S m^2 mol^-1.
Marking Scheme:
- Calculation of cell constant (129 m^-1): 1 mark
- Calculation of conductivity (0.248 S m^-1): 1 mark
- Calculation of molar conductivity with correct units (0.0124 S m^2 mol^-1): 1 mark

Q12. For the complex coordination compound [Fe(CN)6]3-: [3 Marks]
(a) Write the IUPAC name of the complex.
(b) Predict its hybridization state and geometry.
(c) State whether it is paramagnetic or diamagnetic, calculating its spin-only magnetic moment.

Correct Option / Answer:
(a) Hexacyanidoferrate(III) ion
(b) Hybridization: d2sp3, Geometry: Octahedral
(c) Paramagnetic; μ = 1.73 BM
Detailed Solution:
(a) IUPAC Name: Hexacyanidoferrate(III) ion.
(b) Oxidation state of Fe in [Fe(CN)6]3-: x + 6(-1) = -3 => x = +3.
Fe3+ has electronic configuration 3d5. CN- is a strong field ligand, forcing pairing of electrons in 3d subshell: t2g5 eg0.
Two 3d orbitals, one 4s, and three 4p orbitals hybridize to form d2sp3 hybrid orbitals. Geometry is octahedral (inner orbital complex).
(c) The complex has 1 unpaired electron (n = 1). Hence, it is paramagnetic.
Spin-only magnetic moment μ = sqrt(1(1+2)) = sqrt(3) = 1.73 BM.
Marking Scheme:
- 1 mark for correct IUPAC name.
- 1 mark for hybridization (d2sp3) and geometry (octahedral).
- 1 mark for paramagnetic nature and calculated magnetic moment (1.73 BM).

Q13. How will you convert the following? Write the chemical equations involved: [3 Marks]
(a) Propene to Propan-1-ol
(b) Phenol to Anisole
(c) Propanone to Propene

Correct Option / Answer: Detailed step-by-step reaction pathways provided below.
Detailed Solution:
(a) Propene to Propan-1-ol (Hydroboration-Oxidation):
CH3-CH=CH2 + (BH3)2 --(H2O2 / OH-)--> CH3-CH2-CH2-OH

(b) Phenol to Anisole:
C6H5-OH + NaOH -> C6H5-ONa + H2O
C6H5-ONa + CH3-I -> C6H5-O-CH3 (Anisole) + NaI (Williamson ether synthesis)

Time Allowed: 3 Hours **Maximum Marks: 80**

(c) Propanone to Propene:
CH3-CO-CH3 + NaBH4 -> CH3-CH(OH)-CH3 (Propan-2-ol)
CH3-CH(OH)-CH3 --(Conc. H2SO4, 443 K)--> CH3-CH=CH2 (Propene) + H2O
Marking Scheme:
- 1 mark for correct reaction steps and reagents for (a).
- 1 mark for correct reaction steps and reagents for (b).
- 1 mark for correct reaction steps and reagents for (c).

Q14. An organic compound (A) with molecular formula C8H8O forms an orange-red precipitate with 2,4-DNP reagent and gives a yellow precipitate of iodoform when heated with NaOH and I2. Compound (A) neither reduces Tollens' reagent nor Fehling's solution, and it does not decolorize bromine water. On vigorous oxidation with chromic acid (H2CrO4), it yields a carboxylic acid (B) having molecular formula C7H6O2. [5 Marks]
(a) Identify compounds (A) and (B).
(b) Write balanced chemical reactions for the 2,4-DNP test and Iodoform test given by compound (A).
(c) Write the oxidation reaction converting compound (A) to compound (B).

Correct Option / Answer:
(a) Compound (A) = Acetophenone (C6H5COCH3), Compound (B) = Benzoic acid (C6H5COOH).
Detailed Solution:
Reasoning:
- Forms orange-red precipitate with 2,4-DNP => Contains a carbonyl group (C=O).
- Gives positive iodoform test => Contains a methyl ketone group (-COCH3).
- Does not reduce Tollens'/Fehling's reagent => It is a ketone, not an aldehyde.
- Unreactive towards bromine water => Aromatic ring present with no non-aromatic C=C double bonds.
- Formula C8H8O with -COCH3 group leaves C6H5- => Compound (A) is Acetophenone (C6H5COCH3).
- Vigorous oxidation of Acetophenone gives Benzoic acid (C6H5COOH, C7H6O2), which is compound (B).

Chemical Reactions:
1. 2,4-DNP Test:
C6H5COCH3 + H2NNH-C6H3(NO2)2 -> C6H5C(CH3)=NNH-C6H3(NO2)2 (Orange-red ppt) + H2O
2. Iodoform Test:
C6H5COCH3 + 3 I2 + 4 NaOH -> C6H5COONa + CHI3 (Yellow ppt) + 3 NaI + 3 H2O
3. Oxidation:
C6H5COCH3 --(H2CrO4 / K2Cr2O7 + H2SO4, Δ)--> C6H5COOH (Benzoic acid)
Marking Scheme:
- 1 mark each for correct identification of (A) and (B).
- 1 mark for 2,4-DNP reaction equation.
- 1 mark for Iodoform reaction equation.
- 1 mark for Oxidation reaction equation.

Q15. Answer the following questions related to Chemical Kinetics: [5 Marks]
(a) Derive/state the integrated rate law equation for a first-order reaction.
(b) A first-order reaction takes 40 minutes for 30% decomposition. Calculate its half-life period (t1/2). [Given: log 10 = 1, log 7 = 0.8451]

Correct Option / Answer:
(a) k = (2.303 / t) * log([R]0 / [R])
(b) t1/2 = 77.7 minutes
Detailed Solution:

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(a) Integrated Rate Law for First-Order Reaction:
Let reaction be R -> P.
Rate = -d[R]/dt = k[R]
d[R]/[R] = -k dt
Integrating both sides: ln[R] = -kt + I
At t = 0, [R] = [R]0 => I = ln[R]0
ln[R] = -kt + ln[R]0 => kt = ln([R]0 / [R])
k = (2.303 / t) * log([R]0 / [R])

(b) Calculation of half-life:
Let initial concentration [R]0 = 100.
After 30% decomposition at t = 40 min, remaining concentration [R] = 100 - 30 = 70.
Using rate equation:
k = (2.303 / 40) * log(100 / 70)
k = (2.303 / 40) * (log 10 - log 7)
k = (2.303 / 40) * (1 - 0.8451) = (2.303 / 40) * 0.1549 = 0.00892 min^-1.

Now, calculating t1/2:
t1/2 = 0.693 / k = 0.693 / 0.00892 min^-1 = 77.69 min ≈ 77.7 min.
Marking Scheme:
- 2 marks for integrated rate law derivation/statement.
- 1.5 marks for correct rate constant (k) calculation.
- 1.5 marks for correct half-life (t1/2) calculation with units.