NEET 2024 — Chemistry Question Paper with Solutions

48 Chemistry questions as set in the paper · answers checked by RankUp

NEET 2024

1. Match List I with List II.
List I (Molecule): A. ethane B. ethene C. carbon molecule, C_2 D. ethyne
List II (Number and types of bond/s between two carbon atoms): I. one σ-bond and two π-bonds II. two π-bonds III. one σ-bond IV. one σ-bond and one π-bond
Choose the correct answer from the options given below :

(A) A-I, B-IV, C-II, D-III
(B) A-IV, B-III, C-II, D-I
(C) A-III, B-IV, C-II, D-I
(D) A-III, B-IV, C-I, D-II

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2. The Henry's law constant (K_H) values of three gases (A, B, C) in water are 145, 2×10^{-5} and 35 kbar respectively. The solubility of these gases in water follows the order:

(A) B > A > C
(B) B > C > A
(C) A > C > B
(D) A > B > C

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3. Given below are two statements:
Statement I: The boiling point of hydrides of Group 16 elements follow the order H_2O > H_2Te > H_2Se > H_2S.
Statement II: On the basis of molecular mass, H_2O is expected to have lower boiling point than the other members of the group but due to the presence of extensive H-bonding in H_2O, it has higher boiling point.
In the light of the above statements, choose the correct answer from the options given below:

(A) Both Statement I and Statement II are true
(B) Both Statement I and Statement II are false
(C) Statement I is true but Statement II is false
(D) Statement I is false but Statement II is true

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4. Intramolecular hydrogen bonding is present in

(A) o-Nitrophenol (2-nitrophenol)
(B) p-Nitrophenol (4-nitrophenol)
(C) m-Nitrophenol (3-nitrophenol)
(D) HF

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5. Given below are two statements:

Statement I : The boiling point of three isomeric pentanes follows the order n-pentane > isopentane > neopentane

Statement II : When branching increases, the molecule attains a shape of sphere. This results in smaller surface area for contact, due to which the intermolecular forces between the spherical molecules are weak, thereby lowering the boiling point.

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

(A) Both Statement I and Statement II are correct
(B) Both Statement I and Statement II are incorrect
(C) Statement I is correct but Statement II is incorrect
(D) Statement I is incorrect but Statement II is correct

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6. The compound that will undergo S_N1 reaction with the fastest rate is

(A) (Bromomethyl)cyclohexane, $C_6H_{11}–CH_2Br$
(B) Bromocyclohexane, $C_6H_{11}–Br$
(C) Bromobenzene, $C_6H_5–Br$
(D) (1-Bromoethyl)benzene, $C_6H_5–CH(Br)–CH_3$

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7. Which one of the following alcohols reacts instantaneously with Lucas reagent?

(A) $CH_3–CH_2–CH_2–CH_2OH$
(B) $CH_3–CH_2–CH(CH_3)–OH$
(C) $CH_3–CH(CH_3)–CH_2OH$
(D) $(CH_3)_3C–OH$

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8. 1 gram of sodium hydroxide was treated with 25 mL of 0.75 M HCl solution, the mass of sodium hydroxide left unreacted is equal to

(A) 750 mg
(B) 250 mg
(C) Zero mg
(D) 200 mg

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9. Arrange the following elements in increasing order of first ionization enthalpy: Li, Be, B, C, N

Choose the correct answer from the options given below:

(A) Li < Be < B < C < N
(B) Li < B < Be < C < N
(C) Li < Be < C < B < N
(D) Li < Be < N < B < C

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10. The most stable carbocation among the following is :

(A) $CH_3CH_2–C^+H–CH(CH_3)_2$
(B) $CH_3–C^+H–CH_2–CH(CH_3)_2$
(C) Cyclopentyl–C^+H_2 (cyclopentylmethyl cation)
(D) 1-Methylcyclohexyl cation (C^+ in the ring bearing $–CH_3$)

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11. Activation energy of any chemical reaction can be calculated if one knows the value of

(A) rate constant at standard temperature
(B) probability of collision
(C) orientation of reactant molecules during collision
(D) rate constant at two different temperatures

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12. Given below are two statements:
Statement I : Aniline does not undergo Friedel-Crafts alkylation reaction.
Statement II : Aniline cannot be prepared through Gabriel synthesis.
In the light of the above statements, choose the correct answer from the options given below:

(A) Both statement I and Statement II are true
(B) Both Statement I and Statement II are false
(C) Statement I is correct but Statement II is false
(D) Statement I is incorrect but Statement II is true

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13. Arrange the following elements in increasing order of electronegativity:
N, O, F, C, Si
Choose the correct answer from the options given below :

(A) Si < C < N < O < F
(B) Si < C < O < N < F
(C) O < F < N < C < Si
(D) F < O < N < C < Si

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14. Match List I with List II.
List I (Conversion): A. 1 mole of H_2O to O_2 B. 1 mol of MnO_4^- to Mn^{2+} C. 1.5 mol of Ca from molten $CaCl_2$ D. 1 mol of FeO to Fe_2O_3
List II (Number of Faraday required): I. 3F II. 2F III. 1F IV. 5F
Choose the correct answer from the options given below :

(A) A-II, B-IV, C-I, D-III
(B) A-III, B-IV, C-I, D-II
(C) A-II, B-III, C-I, D-IV
(D) A-III, B-IV, C-II, D-I

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15. Match List I with List II.
List I (Complex): A. $[Co(NH_3)_5(NO_2)]Cl_2$ B. $[Co(NH_3)_5(SO_4)]Br$ C. $[Co(NH_3)_6][Cr(CN)_6]$ D. $[Co(H_2O)_6]Cl_3$
List II (Type of isomerism): I. Solvate isomerism II. Linkage isomerism III. Ionization isomerism IV. Coordination isomerism
Choose the correct answer from the options given below:

(A) A-II, B-III, C-IV, D-I
(B) A-I, B-III, C-IV, D-II
(C) A-I, B-IV, C-III, D-II
(D) A-II, B-IV, C-III, D-I

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16. Match List I with List II.

List I (Compound): A. NH_3 B. BrF_5 C. XeF_4 D. SF_6

List II (Shape/geometry): I. Trigonal Pyramidal II. Square Planar III. Octahedral IV. Square Pyramidal

Choose the correct answer from the options given below:

(A) A-I, B-IV, C-II, D-III
(B) A-II, B-IV, C-III, D-I
(C) A-III, B-IV, C-I, D-II
(D) A-II, B-III, C-IV, D-I

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17. The energy of an electron in the ground state (n = 1) for He^+ ion is $-x$ J, then that for an electron in (n = 2) state for Be^{3+} ion in J is

(A) $-x$
(B) $-x/9$
(C) $-4x$
(D) $-(4/9)x$

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18. In which of the following processes entropy increases?

A. A liquid evaporates to vapour.

B. Temperature of a crystalline solid lowered from 130 K to 0 K.

C. $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$

D. $Cl_2(g) \rightarrow 2Cl(g)$

Choose the correct answer from the options given below:

(A) A and C
(B) A, B and D
(C) A, C and D
(D) C and D

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19. Which reaction is NOT a redox reaction?

(A) $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$
(B) $2KClO_3 + I_2 \rightarrow 2KIO_3 + Cl_2$
(C) $H_2 + Cl_2 \rightarrow 2HCl$
(D) $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$

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20. Match List I with List II.

List I (Quantum Number): A. m_l B. m_s C. l D. n

List II (Information provided): I. Shape of orbital II. Size of orbital III. Orientation of orbital IV. Orientation of spin of electron

Choose the correct answer from the options given below :

(A) A-I, B-III, C-II, D-IV
(B) A-III, B-IV, C-I, D-II
(C) A-III, B-IV, C-II, D-I
(D) A-II, B-I, C-IV, D-III

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21. 'Spin only' magnetic moment is same for which of the following ions?

A. Ti^{3+}

B. Cr^{2+}

C. Mn^{2+}

D. Fe^{2+}

E. Sc^{3+}

Choose the most appropriate answer from the options given below.

(A) B and D only
(B) A and E only
(C) B and C only
(D) A and D only

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22. The highest number of helium atoms is in

(A) 4 mol of helium
(B) 4 u of helium
(C) 4 g of helium
(D) 2.271098 L of helium at STP

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23. Among Group 16 elements, which one does NOT show -2 oxidation state?

(A) O
(B) Se
(C) Te
(D) Po

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24. The E° value for the Mn^{3+}/Mn^{2+} couple is more positive than that of Cr^{3+}/Cr^{2+} or Fe^{3+}/Fe^{2+} due to change of

(A) d^5 to d^4 configuration
(B) d^5 to d^2 configuration
(C) d^4 to d^5 configuration
(D) d^3 to d^5 configuration

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25. The reagents with which glucose does not react to give the corresponding tests/products are

A. Tollen's reagent

B. Schiff's reagent

C. HCN

D. NH_2OH

E. $NaHSO_3$

Choose the correct options from the given below:

(A) B and C
(B) A and D
(C) B and E
(D) E and D

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26. Identify the correct reagents that would bring about the following transformation.

$C_6H_{11}–CH_2–CH=CH_2 \rightarrow C_6H_{11}–CH_2–CH_2–CHO$ (C_6H_{11} = cyclohexyl)

(A) (i) H_2O/H^+ (ii) CrO_3
(B) (i) BH_3 (ii) H_2O_2/OH^- (iii) PCC
(C) (i) BH_3 (ii) H_2O_2/OH^- (iii) alk. $KMnO_4$
(D) (i) H_2O/H^+ (ii) PCC

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27. In which of the following equilibria, Kp and Kc are NOT equal?

(A) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
(B) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$
(C) $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$
(D) $2BrCl(g) \rightleftharpoons Br_2(g) + Cl_2(g)$

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28. A compound with a molecular formula of C_6H_{14} has two tertiary carbons. Its IUPAC name is :

(A) n-hexane
(B) 2-methylpentane
(C) 2,3-dimethylbutane
(D) 2,2-dimethylbutane

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29. Fehling's solution 'A' is

(A) aqueous copper sulphate
(B) alkaline copper sulphate
(C) alkaline solution of sodium potassium tartrate (Rochelle's salt)
(D) aqueous sodium citrate

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30. Match List I with List II.
List I (Process): A. Isothermal process B. Isochoric process C. Isobaric process D. Adiabatic process
List II (Conditions): I. No heat exchange II. Carried out at constant temperature III. Carried out at constant volume IV. Carried out at constant pressure
Choose the correct answer from the options given below:

(A) A-IV, B-III, C-II, D-I
(B) A-IV, B-II, C-III, D-I
(C) A-I, B-II, C-III, D-IV
(D) A-II, B-III, C-IV, D-I

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31. Given below are two statements :
Statement I: Both $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$ complexes are octahedral but differ in their magnetic behaviour.
Statement II: $[Co(NH_3)_6]^{3+}$ is diamagnetic whereas $[CoF_6]^{3-}$ is paramagnetic.
In the light of the above statements, choose the correct answer from the options given below:

(A) Both Statement I and Statement II are true
(B) Both Statement I and Statement II are false
(C) Statement I is true but Statement II is false
(D) Statement I is false but Statement II is true

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32. On heating, some solid substances change from solid to vapour state without passing through liquid state. The technique used for the purification of such solid substances based on the above principle is known as

(A) Crystallization
(B) Sublimation
(C) Distillation
(D) Chromatography

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33. Match List I with List II.

List I (Reaction): A. Cyclohexylidenecyclohexane → 2 Cyclohexanone B. Benzene → Benzophenone ($C_6H_5COC_6H_5$) C. Cyclohexanol → Cyclohexanone D. Ethylbenzene ($C_6H_5CH_2CH_3$) → C_6H_5COOK

List II (Reagents/Condition): I. C_6H_5COCl/Anhyd. $AlCl_3$ II. CrO_3 III. $KMnO_4$/KOH, Δ IV. (i) O_3 (ii) Zn-H_2O

Choose the correct answer from the options given below:

(A) A-IV, B-I, C-III, D-II
(B) A-III, B-I, C-II, D-IV
(C) A-IV, B-I, C-II, D-III
(D) A-I, B-IV, C-II, D-III

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34. For the reaction $2A \rightleftharpoons B + C$, $K_c = 4 \times 10^{-3}$. At a given time, the composition of reaction mixture is: [A] = [B] = [C] = 2×10^{-3} M. Then, which of the following is correct?

(A) Reaction is at equilibrium.
(B) Reaction has a tendency to go in forward direction.
(C) Reaction has a tendency to go in backward direction.
(D) Reaction has gone to completion in forward direction.

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35. The pair of lanthanoid ions which are diamagnetic is

(A) Ce^{4+} and Yb^{2+}
(B) Ce^{3+} and Eu^{2+}
(C) Gd^{3+} and Eu^{3+}
(D) Pm^{3+} and Sm^{3+}

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36. Given below are two statements :

Statement I : $[Co(NH_3)_6]^{3+}$ is a homoleptic complex whereas $[Co(NH_3)_4Cl_2]^+$ is a heteroleptic complex.

Statement II : Complex $[Co(NH_3)_6]^{3+}$ has only one kind of ligands but $[Co(NH_3)_4Cl_2]^+$ has more than one kind of ligands.

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

(A) Both Statement I and Statement II are true
(B) Both Statement I and Statement II are false
(C) Statement I is true but Statement II is false
(D) Statement I is false but Statement II is true

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37. Mass in grams of copper deposited by passing 9.6487 A current through a voltmeter containing copper sulphate solution for 100 seconds is (Given : Molar mass of Cu : 63 g mol^{-1}, 1 F = 96487 C)

(A) 3.15 g
(B) 0.315 g
(C) 31.5 g
(D) 0.0315 g

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38. For the given reaction:

C_6H_{11}–CH=CH–C_6H_{11} (1,2-dicyclohexylethene) —$KMnO_4/H^+$→ 'P' (major product)

'P' is

(A) Cyclohexanecarbaldehyde, C_6H_{11}–CHO

(B) Cyclohexanecarboxylic acid, C_6H_{11}–COOH

(C) C_6H_{11}–CH(OH)–CH(OH)–C_6H_{11}

(D) C_6H_{11}–CO–CO–C_6H_{11}

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39. The products A and B obtained in the following reactions, respectively, are

$3ROH + PCl_3 \rightarrow 3RCl + A$

$ROH + PCl_5 \rightarrow RCl + HCl + B$

(A) $POCl_3$ and H_3PO_3

(B) $POCl_3$ and H_3PO_4

(C) H_3PO_4 and $POCl_3$

(D) H_3PO_3 and $POCl_3$

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40. The rate of a reaction quadruples when temperature changes from 27°C to 57°C. Calculate the energy of activation.

Given R = 8.314 J K^{-1} mol^{-1}, log 4 = 0.6021

(A) 38.04 kJ/mol

(B) 380.4 kJ/mol

(C) 3.80 kJ/mol

(D) 3804 kJ/mol

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41. During the preparation of Mohr's salt solution (Ferrous ammonium sulphate), which of the following acid is added to prevent hydrolysis of Fe^{2+} ion?

(A) dilute hydrochloric acid

(B) concentrated sulphuric acid

(C) dilute nitric acid

(D) dilute sulphuric acid

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42. Major products A and B formed in the following reaction sequence, are

2-Methylcyclohexan-1-ol —PBr_3→ A (major) —alc. KOH, Δ→ B (major)

(A) A = 1-bromo-2-methylcyclohexane; B = 1-methylcyclohexene

(B) A = 1-bromo-2-methylcyclohexane; B = 3-methylcyclohexene

(C) A = 2-bromo-6-methylcyclohexan-1-ol; B = 6-methylcyclohex-2-en-1-ol

(D) A = 2-bromo-6-methylcyclohexan-1-ol; B = 2-methylcyclohexan-1-one

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43. The plot of osmotic pressure (Π) vs concentration (mol L^{-1}) for a solution gives a straight line with slope 25.73 L bar mol^{-1}. The temperature at which the osmotic pressure measurement is done is

(Use R = 0.083 L bar mol^{-1} K^{-1})

(A) 37°C

(B) 310°C

(C) 25.73°C

(D) 12.05°C

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44. Identify the correct answer.

(A) Three resonance structures can be drawn for ozone
(B) BF_3 has non-zero dipole moment
(C) Dipole moment of NF_3 is greater than that of NH_3
(D) Three canonical forms can be drawn for CO_3^{2-} ion

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45. Identify the major product C formed in the following reaction sequence :
CH_3–CH_2–CH_2–I —NaCN→ A —OH^-, Partial hydrolysis→ B —NaOH, Br_2→ C (major)

(A) propylamine
(B) butylamine
(C) butanamide
(D) α-bromobutanoic acid

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46. Given below are certain cations. Using inorganic qualitative analysis, arrange them in increasing group number from 0 to VI.
A. Al^{3+}
B. Cu^{2+}
C. Ba^{2+}
D. Co^{2+}
E. Mg^{2+}
Choose the correct answer from the options given below.

(A) B, A, D, C, E
(B) B, C, A, D, E
(C) E, C, D, B, A
(D) E, A, B, C, D

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47. Consider the following reaction in a sealed vessel at equilibrium with concentrations of N_2 = 3.0 × 10^{-3} M, O_2 = 4.2 × 10^{-3} M and NO = 2.8 × 10^{-3} M.
$2NO(g) \rightleftharpoons N_2(g) + O_2(g)$
If 0.1 mol L^{-1} of NO(g) is taken in a closed vessel, what will be degree of dissociation (α) of NO(g) at equilibrium?

(A) 0.00889
(B) 0.0889
(C) 0.8889
(D) 0.717

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48. A compound X contains 32% of A, 20% of B and remaining percentage of C. Then, the empirical formula of X is :
(Given atomic masses of A = 64 ; B = 40 ; C = 32 u)

(A) A_2BC_2
(B) ABC_3
(C) AB_2C_2
(D) ABC_4

Answer key and explanations

1. Answer: (C) A-III, B-IV, C-II, D-I

Ethane has a C–C single bond (one σ), ethene a double bond (one σ + one π) and ethyne a triple bond (one σ + two π). In the C_2 molecule MO theory gives bond order 2 with both bonds π (the σ2p orbital stays empty), so C_2 has two π-bonds. The trap is assigning C_2 a σ + π double bond like ethene.

2. Answer: (B) B > C > A

From p = K_H·x, at a given partial pressure the mole fraction dissolved is inversely proportional to K_H. Smallest K_H (2 × 10^{-5} kbar, gas B) means highest solubility, then C (35 kbar), then A (145 kbar): B > C > A. Ordering by increasing K_H value directly would reverse the trend.

3. Answer: (A) Both Statement I and Statement II are true

Observed boiling points are H_2O (373 K) > H_2Te (271 K) > H_2Se (232 K) > H_2S (213 K), so Statement I is true. Among H_2S, H_2Se, H_2Te boiling point rises with molar mass, and H_2O would be the lowest on mass alone; extensive intermolecular hydrogen bonding makes it the highest, so Statement II is also true.

4. Answer: (A) o-Nitrophenol (2-nitrophenol)

In o-nitrophenol the –OH and $–NO_2$ groups are on adjacent carbons, so the O–H hydrogen bonds to an oxygen of the nitro group within the same molecule (a six-membered chelate ring). In the meta and para isomers the groups are too far apart and hydrogen bonding is intermolecular, and HF shows only intermolecular hydrogen bonding.

5. Answer: (A) Both Statement I and Statement II are correct

Boiling points are n-pentane 309 K > isopentane 301 K > neopentane 282.5 K, so Statement I is correct. Branching makes the molecule more compact and nearly spherical, reducing contact area and van der Waals forces, which is exactly the reason given in Statement II.

6. Answer: (D) (1-Bromoethyl)benzene, $C_6H_5–CH(Br)–CH_3$

S_N1 rate depends on carbocation stability. (1-Bromoethyl)benzene ionises to a secondary benzylic cation stabilised by resonance with the ring, far more stable than the primary or secondary alkyl cations from the cyclohexyl bromides. Bromobenzene does not ionise at all because the C–Br bond has partial double-bond character and a phenyl cation is very unstable.

7. Answer: (D) $(CH_3)_3C–OH$

Lucas reagent (conc. HCl + anhydrous $ZnCl_2$) reacts by an S_N1-type path, so the rate follows carbocation stability: 3° > 2° > 1°. tert-Butyl alcohol, $(CH_3)_3C–OH$, gives turbidity immediately; the secondary butan-2-ol takes about five minutes, and the primary alcohols do not react at room temperature.

8. Answer: (B) 250 mg

Moles of NaOH = 1/40 = 0.025 mol (25 mmol). Moles of HCl = 0.025 L × 0.75 M = 0.01875 mol (18.75 mmol), which neutralises 18.75 mmol NaOH in a 1:1 reaction. NaOH left = 6.25 mmol × 40 mg/mmol = 250 mg; 750 mg is the mass that reacted, not the mass left.

9. Answer: (B) Li < B < Be < C < N

Ionization enthalpy generally rises across period 2, but boron (≈801 kJ/mol) is below beryllium (≈899 kJ/mol) because boron's outermost electron is in a 2p orbital, which is shielded by 2s electrons and easier to remove than beryllium's 2s electron. So Li (520) < B (801) < Be (899) < C (1086) < N (1402); the simple steady increase misses this inversion.

10. Answer: (D) 1-Methylcyclohexyl cation (C^+ in the ring bearing $–CH_3$)

The 1-methylcyclohexyl cation is tertiary: the positive carbon carries three alkyl groups and has the most hyperconjugating C–H bonds and the strongest +I effect. The two open-chain cations are only secondary and the cyclopentylmethyl cation is primary, so they are less stable.

11. Answer: (D) rate constant at two different temperatures

From the Arrhenius equation, $\log(k_2/k_1) = (E_a/2.303R)(1/T_1 - 1/T_2)$, so knowing k at two temperatures gives E_a directly. A single rate constant is not enough because the pre-exponential factor A is also unknown; collision probability and orientation alone do not give E_a.

12. Answer: (A) Both statement I and Statement II are true

Aniline is a Lewis base and forms a salt with the $AlCl_3$ catalyst, which puts a positive charge on nitrogen and deactivates the ring, so Friedel–Crafts alkylation fails. Gabriel synthesis needs S_N2 attack of phthalimide anion on an alkyl halide; aryl halides do not undergo this substitution, so aniline cannot be made this way. Both statements are true.

13. Answer: (A) Si < C < N < O < F

Electronegativity increases across a period and decreases down a group. Si (1.8) is below C (2.5) in group 14, and across period 2 the values rise C (2.5) < N (3.0) < O (3.5) < F (4.0). Placing O below N is the main trap.

14. Answer: (A) A-II, B-IV, C-I, D-III

$H_2O \rightarrow ½O_2 + 2H^+ + 2e^-$, so 1 mol H_2O needs 2F. MnO_4^- (Mn +7) → Mn^{2+} needs 5 e^-, so 5F. $Ca^{2+} + 2e^- \rightarrow Ca$: 1.5 mol × 2 = 3F. FeO (Fe +2) → Fe_2O_3 (Fe +3) loses 1 e^- per Fe, so 1F. Thus 2F, 5F, 3F, 1F in order.

15. Answer: (A) A-II, B-III, C-IV, D-I

NO_2^- is ambidentate (–NO_2 or –ONO), giving linkage isomers. $[Co(NH_3)_5(SO_4)]Br$ and $[Co(NH_3)_5Br]SO_4$ are ionization isomers. Exchange of ligands between the complex cation and anion in $[Co(NH_3)_6][Cr(CN)_6]$ gives coordination isomerism, and $[Co(H_2O)_6]Cl_3$ can exchange water for chloride inside the sphere, giving solvate (hydrate) isomers.

16. Answer: (A) A-I, B-IV, C-II, D-III

NH_3 has 3 bond pairs + 1 lone pair: trigonal pyramidal. BrF_5 has 5 bond pairs + 1 lone pair: square pyramidal. XeF_4 has 4 bond pairs + 2 lone pairs placed trans: square planar. SF_6 has 6 bond pairs: octahedral.

17. Answer: (A) −x

For hydrogen-like species $E_n = -k\cdot Z^2/n^2$. He^+ (Z = 2), n = 1: E = −4k = −x, so k = x/4. Be^{3+} (Z = 4), n = 2: E = $-k\cdot 16/4 = -4k = -x$. The Z^2 and n^2 factors cancel exactly; using Z instead of Z^2 gives a wrong value.

18. Answer: (C) A, C and D

Evaporation increases disorder; decomposition of solid $NaHCO_3$ produces two gases from a solid; dissociation of Cl_2 doubles the number of gas particles, so entropy rises in all three. Cooling a crystal from 130 K to 0 K reduces molecular motion and entropy, so the choice including the cooling process is wrong.

19. Answer: (D) $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$

In $BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$ every element keeps its oxidation state (Ba +2, Cl −1, Na +1, S +6, O −2); it is a double displacement (precipitation) reaction. In the others Zn is oxidised and Cu^{2+} reduced, I_2 is oxidised to +5 while Cl goes from +5 to 0, and H_2 is oxidised while Cl_2 is reduced.

20. Answer: (B) A-III, B-IV, C-I, D-II

The magnetic quantum number m_l gives the orientation of the orbital, the spin quantum number m_s the orientation of electron spin, the azimuthal quantum number l the shape of the orbital, and the principal quantum number n its size (and energy). Swapping the roles of l and n is the common trap.

21. Answer: (A) B and D only

Unpaired electrons: Ti^{3+} $3d^1$ has 1, Cr^{2+} $3d^4$ has 4, Mn^{2+} $3d^5$ has 5, Fe^{2+} $3d^6$ has 4 and Sc^{3+} $3d^0$ has none. Cr^{2+} and Fe^{2+} both have 4 unpaired electrons, so $\mu = \sqrt{(4\times6)} = \sqrt{24} \approx 4.90$ BM for each. Ti^{3+} and Sc^{3+} differ (1.73 BM vs zero).

22. Answer: (A) 4 mol of helium

4 mol He = $4 \times 6.022 \times 10^{23}$ atoms. 4 u is the mass of a single He atom; 4 g is 1 mol (6.022×10^{23} atoms); 2.271098 L at STP is 2.271098/22.71098 = 0.1 mol. So 4 mol contains the most atoms.

23. Answer: (D) Po

Stability of the −2 state falls down group 16 as electronegativity decreases and metallic character increases. O, Se and Te all form compounds in the −2 state (oxides, selenides, tellurides), while polonium, a metal, hardly shows −2 and mainly shows +2 and +4.

24. Answer: (C) d^4 to d^5 configuration

Reduction of Mn^{3+} ($3d^4$) to Mn^{2+} ($3d^5$) gives the extra-stable half-filled d^5 configuration, so Mn^{3+} is strongly reduced and E° (+1.57 V) is high. The reverse direction (d^5 to d^4) describes oxidation of Mn^{2+}, which is unfavourable, not the reason for the positive E°.

25. Answer: (C) B and E

Glucose reduces Tollens' reagent and forms a cyanohydrin with HCN and an oxime with NH_2OH, but it does not give Schiff's test and does not form the hydrogensulphite addition product with $NaHSO_3$. This failure is evidence that the aldehyde group is mostly tied up in the cyclic hemiacetal form.

26. Answer: (B) (i) BH_3 (ii) H_2O_2/OH^- (iii) PCC

Hydroboration–oxidation (BH_3 then H_2O_2/OH^-) adds water anti-Markovnikov, giving the primary alcohol C_6H_{11}–$CH_2CH_2CH_2OH$, and PCC oxidises a primary alcohol only to the aldehyde. Acid-catalysed hydration gives the Markovnikov secondary alcohol, which oxidises to a ketone, and alkaline $KMnO_4$ would take the alcohol on to the carboxylic acid.

27. Answer: (A) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

Kp = Kc(RT)^Δn, with Δn = moles of gaseous products − reactants. For $PCl_5 \rightleftharpoons PCl_3 + Cl_2$, Δn = 2 − 1 = 1, so Kp ≠ Kc. In the other three equilibria Δn = 0, so Kp = Kc.

28. Answer: (C) 2,3-dimethylbutane

A tertiary carbon is bonded to three other carbons. In 2,3-dimethylbutane, $(CH_3)_2CH$–$CH(CH_3)_2$, both C-2 and C-3 are tertiary. 2-Methylpentane has only one tertiary carbon, 2,2-dimethylbutane has a quaternary carbon and no tertiary one, and n-hexane has none.

29. Answer: (A) aqueous copper sulphate

Fehling's solution A is aqueous copper(II) sulphate, and Fehling's solution B is alkaline sodium potassium tartrate (Rochelle salt); they are mixed just before the test. Alkaline Rochelle salt is solution B, and sodium citrate is used in Benedict's reagent.

30. Answer: (D) A-II, B-III, C-IV, D-I

Isothermal means constant temperature, isochoric constant volume, isobaric constant pressure, and adiabatic means no heat exchange with the surroundings ($q = 0$).

31. Answer: (A) Both Statement I and Statement II are true

Both are six-coordinate octahedral Co^{3+} ($3d^6$) complexes. NH_3 is a strong-field ligand, so $[Co(NH_3)_6]^{3+}$ is low-spin t_2g^6 with no unpaired electrons (diamagnetic, d^2sp^3), while F^- is weak-field, so $[CoF_6]^{3-}$ is high-spin with four unpaired electrons (paramagnetic, sp^3d^2). Both statements are true.

32. Answer: (B) Sublimation

The direct change from solid to vapour is sublimation, and it is used to separate sublimable solids (such as camphor, naphthalene) from non-sublimable impurities. Distillation involves a liquid boiling, and crystallization depends on solubility differences.

33. Answer: (C) A-IV, B-I, C-II, D-III

Ozonolysis with Zn–H_2O cleaves the C=C of cyclohexylidenecyclohexane into two cyclohexanone molecules. Friedel–Crafts acylation of benzene with $C_6H_5COCl/AlCl_3$ gives benzophenone. CrO_3 oxidises the secondary alcohol cyclohexanol to cyclohexanone. Hot alkaline $KMnO_4$ oxidises the whole side chain of ethylbenzene to the benzoate, C_6H_5COOK.

34. Answer: (C) Reaction has a tendency to go in backward direction.

$Qc = [B][C]/[A]^2 = (2 \times 10^{-3})(2 \times 10^{-3})/(2 \times 10^{-3})^2 = 1$. Since $Qc = 1$ is greater than Kc (4×10^{-3}), there are too many products and the reaction moves in the backward direction. Forgetting to square [A] would still give $Qc \gg Kc$, but the system is clearly not at equilibrium.

35. Answer: (A) Ce^{4+} and Yb^{2+}

Ce^{4+} is $4f^0$ and Yb^{2+} is $4f^{14}$, so both have no unpaired electrons and are diamagnetic. Ce^{3+} ($4f^1$), Eu^{2+} and Gd^{3+} ($4f^7$), Eu^{3+} ($4f^6$), Pm^{3+} ($4f^4$) and Sm^{3+} ($4f^5$) all have unpaired f electrons.

36. Answer: (A) Both Statement I and Statement II are true

A homoleptic complex has only one kind of donor ligand and a heteroleptic complex has more than one kind. $[Co(NH_3)_6]^{3+}$ has only NH_3, while $[Co(NH_3)_4Cl_2]^+$ has NH_3 and Cl^-, so both statements are true (Statement II is the definition behind Statement I).

37. Answer: (B) 0.315 g

Charge $Q = I \cdot t = 9.6487\ A \times 100\ s = 964.87\ C = 0.01\ F$. $Cu^{2+} + 2e^- \rightarrow Cu$, so moles of Cu = 0.01/2 = 0.005 mol and mass = $0.005 \times 63 = 0.315$ g. Forgetting the factor 2 would give 0.63 g, which is not offered, and the other choices are off by powers of ten.

38. Answer: (B) Cyclohexanecarboxylic acid, C_6H_{11}–COOH

Hot acidified $KMnO_4$ cleaves the C=C bond; each =CH– carbon carries one H, so it is oxidised first to an aldehyde and then on to a carboxylic acid, giving two molecules of cyclohexanecarboxylic acid. The diol forms only with cold, dilute alkaline $KMnO_4$, and the aldehyde does not survive acidic permanganate.

39. Answer: (D) H_3PO_3 and $POCl_3$

With PCl_3, three –OH groups replace the three Cl atoms on phosphorus, giving phosphorous acid: $3ROH + PCl_3 \rightarrow 3RCl + H_3PO_3$. With PCl_5 one Cl is exchanged and the P=O compound phosphoryl chloride forms: $ROH + PCl_5 \rightarrow RCl + HCl + POCl_3$. H_3PO_4 is not formed in either reaction.

40. Answer: (A) 38.04 kJ/mol

$T_1 = 300$ K, $T_2 = 330$ K. $\log(k_2/k_1) = (E_a/2.303R)(T_2 - T_1)/(T_1T_2)$: $0.6021 = E_a \times 30/(2.303 \times 8.314 \times 300 \times 330)$. $E_a = 0.6021 \times 2.303 \times 8.314 \times 99000/30 = 0.6021 \times 19.147 \times 3300 \approx 38{,}044$ J/mol ≈ 38.04 kJ/mol. The other choices are this value with a misplaced decimal.

41. Answer: (D) dilute sulphuric acid

A little dilute H_2SO_4 suppresses hydrolysis of Fe^{2+} (common-ion effect on H^+) without adding a foreign anion, since the salt is already a sulphate. Nitric acid would oxidise Fe^{2+} to Fe^{3+}, HCl introduces chloride, and concentrated H_2SO_4 is an oxidising and dehydrating agent.

42. Answer: (A) A = 1-bromo-2-methylcyclohexane; B = 1-methylcyclohexene

PBr_3 replaces the –OH by –Br (without rearrangement), giving 1-bromo-2-methylcyclohexane. Alcoholic KOH then causes dehydrohalogenation; by Saytzeff's rule the more substituted alkene, 1-methylcyclohexene (trisubstituted double bond), is the major product rather than the less substituted 3-methylcyclohexene. PBr_3 does not brominate the ring while keeping the –OH.

43. Answer: (A) 37°C

Π = CRT, so the slope of Π vs C equals RT. T = 25.73/0.083 = 310 K = 310 − 273 = 37°C. Taking 310 as °C forgets the Kelvin conversion.

44. Answer: (D) Three canonical forms can be drawn for CO_3^{2-} ion

The carbonate ion has three equivalent canonical structures with the C=O double bond on each oxygen in turn. Ozone has only two resonance structures, trigonal planar BF_3 has zero dipole moment, and NF_3 (≈0.23 D) has a smaller dipole moment than NH_3 (≈1.47 D) because the lone-pair moment opposes the N–F bond moments.

45. Answer: (A) propylamine

NaCN gives butanenitrile ($CH_3CH_2CH_2CN$, one carbon added). Partial hydrolysis gives butanamide, $CH_3CH_2CH_2CONH_2$. Hofmann bromamide degradation (Br_2/NaOH) removes one carbon, giving propylamine, $CH_3CH_2CH_2NH_2$. Butylamine would need reduction of the nitrile or amide, not Hofmann degradation.

46. Answer: (A) B, A, D, C, E

In the qualitative analysis scheme Cu^{2+} is in group II (sulphide in acid medium), Al^{3+} in group III (hydroxide with NH_4OH/NH_4Cl), Co^{2+} in group IV (sulphide in ammoniacal medium), Ba^{2+} in group V (carbonate) and Mg^{2+} in group VI. So the order is Cu^{2+}, Al^{3+}, Co^{2+}, Ba^{2+}, Mg^{2+}.

47. Answer: (D) 0.717

$K_c = [N_2][O_2]/[NO]^2 = (3.0 \times 10^{-3})(4.2 \times 10^{-3})/(2.8 \times 10^{-3})^2 = 12.6/7.84 = 1.607$. Starting with 0.1 M NO: $[NO] = 0.1(1 - \alpha)$, $[N_2] = [O_2] = 0.05\alpha$, so $K_c = (0.5\alpha/(1 - \alpha))^2$. Taking square roots, $0.5\alpha/(1 - \alpha) = 1.268$, giving $\alpha = 1.268/1.768 \approx 0.717$.

48. Answer: (B) ABC_3

C = 100 − 32 − 20 = 48%. Mole ratios: A = 32/64 = 0.5, B = 20/40 = 0.5, C = 48/32 = 1.5. Dividing by 0.5 gives 1 : 1 : 3, so the empirical formula is ABC_3. Using the percentages directly without dividing by atomic masses gives a wrong ratio.

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