

AIPMT 2007 Prelims — Chemistry Question Paper with Solutions

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

AIPMT 2007 Prelims · Q21

1. A steady current of 1.5 amp flows through a copper voltameter for 10 minutes. If the electrochemical equivalent of copper is 30×10^{-5} g coulomb⁻¹, the mass of copper deposited on the electrode will be

- (A) 0.50 g
- (B) 0.67 g
- (C) 0.27 g
- (D) 0.40 g

AIPMT 2007 Prelims · Q38

2. For a cubic crystal structure which one of the following relations indicating the cell characteristics is correct?

- (A) $a \neq b \neq c$ and $\alpha = \beta = \gamma = 90^\circ$
- (B) $a = b = c$ and $\alpha \neq \beta \neq \gamma = 90^\circ$
- (C) $a = b = c$ and $\alpha = \beta = \gamma = 90^\circ$
- (D) $a \neq b \neq c$ and $\alpha \neq \beta$ and $\gamma \neq 90^\circ$

AIPMT 2007 Prelims · Q51

3. Which one of the following on reduction with lithium aluminium hydride yields a secondary amine?

- (A) Methyl isocyanide
- (B) Acetamide
- (C) Methyl cyanide
- (D) Nitroethane

AIPMT 2007 Prelims · Q52

4. RNA and DNA are chiral molecules, their chirality is due to

- (A) chiral bases
- (B) chiral phosphate ester units
- (C) D-sugar component
- (D) L-sugar component

AIPMT 2007 Prelims · Q53

5. The Langmuir adsorption isotherm is deduced using the assumption

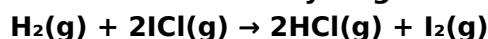
- (A) the adsorption sites are equivalent in their ability to adsorb the particles
- (B) the heat of adsorption varies with coverage
- (C) the adsorbed molecules interact with each other
- (D) the adsorption takes place in multilayers

AIPMT 2007 Prelims · Q54

6. A weak acid, HA, has a K_a of 1.00×10^{-5} . If 0.100 mole of this acid dissolved in one litre of water, the percentage of acid dissociated at equilibrium is closest to

- (A) 1.00%
- (B) 99.9%
- (C) 0.100%
- (D) 99.0%

7. The reaction of hydrogen and iodine monochloride is given as:



The reaction is of first order with respect to $\text{H}_2(\text{g})$ and $\text{ICl}(\text{g})$, following mechanisms were proposed.

Mechanism A: $\text{H}_2(\text{g}) + 2\text{ICl}(\text{g}) \rightarrow 2\text{HCl}(\text{g}) + \text{I}_2(\text{g})$

Mechanism B: $\text{H}_2(\text{g}) + \text{ICl}(\text{g}) \rightarrow \text{HI}(\text{g})$; slow

$\text{HI}(\text{g}) + \text{ICl}(\text{g}) \rightarrow \text{HCl}(\text{g}) + \text{I}_2(\text{g})$; fast

Which of the above mechanism(s) can be consistent with the given information about the reaction?

- (A) A and B both
- (B) neither A nor B
- (C) A only
- (D) B only

8. The efficiency of a fuel cell is given by

- (A) $\Delta G/\Delta S$
- (B) $\Delta G/\Delta H$
- (C) $\Delta S/\Delta G$
- (D) $\Delta H/\Delta G$

9. Consider the following reactions:

(i) $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) = \text{H}_2\text{O}(\text{l})$, $\Delta H = -X_1 \text{ kJ mol}^{-1}$

(ii) $\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) = \text{H}_2\text{O}(\text{l})$, $\Delta H = -X_2 \text{ kJ mol}^{-1}$

(iii) $\text{CO}_2(\text{g}) + \text{H}_2(\text{g}) = \text{CO}(\text{g}) + \text{H}_2\text{O}$, $\Delta H = -X_3 \text{ kJ mol}^{-1}$

(iv) $\text{C}_2\text{H}_2(\text{g}) + (5/2)\text{O}_2(\text{g}) = 2\text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$, $\Delta H = -X_4 \text{ kJ mol}^{-1}$

Enthalpy of formation of $\text{H}_2\text{O}(\text{l})$ is

- (A) $+X_3 \text{ kJ mol}^{-1}$
- (B) $-X_4 \text{ kJ mol}^{-1}$
- (C) $+X_1 \text{ kJ mol}^{-1}$
- (D) $-X_2 \text{ kJ mol}^{-1}$

10. The correct order of increasing thermal stability of K_2CO_3 , MgCO_3 , CaCO_3 and BeCO_3 is

- (A) $\text{BeCO}_3 < \text{MgCO}_3 < \text{CaCO}_3 < \text{K}_2\text{CO}_3$
- (B) $\text{MgCO}_3 < \text{BeCO}_3 < \text{CaCO}_3 < \text{K}_2\text{CO}_3$
- (C) $\text{K}_2\text{CO}_3 < \text{MgCO}_3 < \text{CaCO}_3 < \text{BeCO}_3$
- (D) $\text{BeCO}_3 < \text{MgCO}_3 < \text{K}_2\text{CO}_3 < \text{CaCO}_3$

11. In which of the following pairs, the two species are iso-structure?

- (A) SO_3^{2-} and NO_3^-
- (B) BF_3 and NF_3
- (C) BrO_3^- and XeO_3
- (D) SF_4 and XeF_4

12. Which of the following oxidation states are the most characteristic for lead and tin respectively?

- (A) + 2, + 4
- (B) + 4, + 4
- (C) + 2, + 2
- (D) + 4, + 2

13. Which of the following statements, about the advantage of roasting of sulphide ore before reduction is not true?

- (A) The ΔG°_f of the sulphide is greater than those for CS_2 and H_2S .
- (B) The ΔG°_f is negative for roasting of sulphide ore to oxide.
- (C) Roasting of the sulphide to the oxide is thermodynamically feasible.
- (D) Carbon and hydrogen are suitable reducing agents for metal sulphides.

14. In a first-order reaction $A \rightarrow B$, if k is rate constant and initial concentration of the reactant A is 0.5 M , then the half-life is

- (A) $\log 2/k$
- (B) $\log 2/(k\sqrt{0.5})$
- (C) $\ln 2/k$
- (D) $0.693/(0.5k)$

15. Consider the following compounds.

(i) $\text{C}_6\text{H}_5\text{COCl}$

(ii) $\text{O}_2\text{N}-\text{C}_6\text{H}_4-\text{COCl}$ (para)

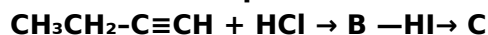
(iii) $\text{H}_3\text{C}-\text{C}_6\text{H}_4-\text{COCl}$ (para)

(iv) $\text{OHC}-\text{C}_6\text{H}_4-\text{COCl}$ (para)

The correct decreasing order of their reactivity towards hydrolysis is

- (A) (i) > (ii) > (iii) > (iv)
- (B) (iv) > (ii) > (i) > (iii)
- (C) (ii) > (iv) > (i) > (iii)
- (D) (ii) > (iv) > (iii) > (i)

16. Predict the product C obtained in the following reaction of butyne-1.



- (A) $\text{CH}_3-\text{CH}_2-\text{CH}_2-\text{CH}(\text{I})(\text{Cl})$
- (B) $\text{CH}_3-\text{CH}_2-\text{CH}(\text{I})-\text{CH}_2\text{Cl}$
- (C) $\text{CH}_3\text{CH}_2-\text{C}(\text{I})(\text{Cl})-\text{CH}_3$
- (D) $\text{CH}_3-\text{CH}(\text{Cl})-\text{CH}_2\text{CH}_2\text{I}$

17. Concentrated aqueous sulphuric acid is 98% H_2SO_4 by mass and has a density of 1.80 g mL^{-1} . Volume of acid required to make one litre of $0.1 \text{ M H}_2\text{SO}_4$ solution is

- (A) 16.65 mL
- (B) 22.20 mL
- (C) 5.55 mL
- (D) 11.10 mL

18. Reduction of aldehydes and ketones into hydrocarbons using zinc amalgam and conc. HCl is called

- (A) Cope reduction
- (B) Dow reduction
- (C) Wolff-Kishner reduction
- (D) Clemmensen reduction

AIPMT 2007 Prelims · Q67

19. Given that bond energies of H-H and Cl-Cl are 430 kJ mol^{-1} and 240 kJ mol^{-1} respectively and ΔH_f for HCl is -90 kJ mol^{-1} , bond enthalpy of HCl is

- (A) 380 kJ mol^{-1}
- (B) 425 kJ mol^{-1}
- (C) 245 kJ mol^{-1}
- (D) 290 kJ mol^{-1}

AIPMT 2007 Prelims · Q68

20. Which of the following represents the correct order of the acidity in the given compounds?

- (A) $\text{FCH}_2\text{COOH} > \text{CH}_3\text{COOH} > \text{BrCH}_2\text{COOH} > \text{ClCH}_2\text{COOH}$
- (B) $\text{BrCH}_2\text{COOH} > \text{ClCH}_2\text{COOH} > \text{FCH}_2\text{COOH} > \text{CH}_3\text{COOH}$
- (C) $\text{FCH}_2\text{COOH} > \text{ClCH}_2\text{COOH} > \text{BrCH}_2\text{COOH} > \text{CH}_3\text{COOH}$
- (D) $\text{CH}_3\text{COOH} > \text{BrCH}_2\text{COOH} > \text{ClCH}_2\text{COOH} > \text{FCH}_2\text{COOH}$

AIPMT 2007 Prelims · Q69

21. If there is no rotation of plane polarised light by a compound in a specific solvent, though to be chiral, it may mean that

- (A) the compound is certainly meso
- (B) there is no compound in the solvent
- (C) the compound may be a racemic mixture
- (D) the compound is certainly achiral

AIPMT 2007 Prelims · Q71

22. Which of the following is water-soluble?

- (A) Vitamin E
- (B) Vitamin K
- (C) Vitamin A
- (D) Vitamin B

AIPMT 2007 Prelims · Q73

23. 0.5 molal aqueous solution of a weak acid (HX) is 20% ionised. If K_f for water is $1.86 \text{ K kg mol}^{-1}$, the lowering in freezing point of the solution is

- (A) 0.56 K
- (B) 1.12 K
- (C) -0.56 K
- (D) -1.12 K

AIPMT 2007 Prelims · Q74

24. Sulphide ores of metals are usually concentrated by froth flotation process. Which one of the following sulphide ores offers an exception and is concentrated by chemical leaching?

- (A) Galena
- (B) Copper pyrite
- (C) Sphalerite
- (D) Argentite

AIPMT 2007 Prelims · Q75

25. If 60% of a first order reaction was completed in 60 minutes, 50% of the same reaction would be completed in approximately ($\log 4 = 0.60$, $\log 5 = 0.69$)

- (A) 45 minutes
- (B) 60 minutes
- (C) 40 minutes
- (D) 50 minutes

26. Which of the following will give a pair of enantiomorphs? (en = $\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2$)

- (A) $[\text{Cr}(\text{NH}_3)_6][\text{Co}(\text{CN})_6]$
- (B) $[\text{Co}(\text{en})_2\text{Cl}_2]\text{Cl}$
- (C) $[\text{Pt}(\text{NH}_3)_4][\text{PtCl}_6]$
- (D) $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{NO}_2$

27. If NaCl is doped with 10^{-4} mol % of SrCl_2 , the concentration of cation vacancies will be ($N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$)

- (A) $6.02 \times 10^{16} \text{ mol}^{-1}$
- (B) $6.02 \times 10^{17} \text{ mol}^{-1}$
- (C) $6.02 \times 10^{14} \text{ mol}^{-1}$
- (D) $6.02 \times 10^{15} \text{ mol}^{-1}$

28. The d electron configurations of Cr^{2+} , Mn^{2+} , Fe^{2+} and Ni^{2+} are $3d^4$, $3d^5$, $3d^6$ and $3d^8$ respectively. Which one of the following aqua complexes will exhibit the minimum paramagnetic behaviour? (At. No. Cr = 24, Mn = 25, Fe = 26, Ni = 28)

- (A) $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$
- (B) $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$
- (C) $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$
- (D) $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$

29. In which of the following the hydration energy is higher than the lattice energy?

- (A) MgSO_4
- (B) RaSO_4
- (C) SrSO_4
- (D) BaSO_4

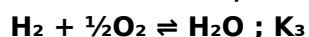
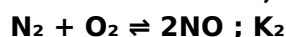
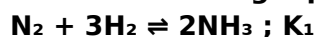
30. Which of the compounds with molecular formula C_5H_{10} yields acetone on ozonolysis?

- (A) 3-methyl-1-butene
- (B) cyclopentane
- (C) 2-methyl-1-butene
- (D) 2-methyl-2-butene

31. Which one of the following ionic species has the greatest proton affinity to form stable compound?

- (A) NH_2^-
- (B) F^-
- (C) I^-
- (D) HS^-

32. The following equilibrium constants are given:



The equilibrium constant for the oxidation of NH_3 by oxygen to give NO is

- (A) $K_2K_3^2/K_1$
- (B) $K_2^2K_3/K_1$
- (C) K_1K_2/K_3
- (D) $K_2K_3^3/K_1$

AIPMT 2007 Prelims · Q84

33. Which one of the following ions is the most stable in aqueous solution? (At. No. Ti = 22, V = 23, Cr = 24, Mn = 25)

- (A) V^{3+}
- (B) Ti^{3+}
- (C) Mn^{3+}
- (D) Cr^{3+}

AIPMT 2007 Prelims · Q85

34. The correct order of C-O bond length among CO , CO_3^{2-} , CO_2 is

- (A) $CO < CO_3^{2-} < CO_2$
- (B) $CO_3^{2-} < CO_2 < CO$
- (C) $CO < CO_2 < CO_3^{2-}$
- (D) $CO_2 < CO_3^{2-} < CO$

AIPMT 2007 Prelims · Q86

35. Which one of the following orders correctly represents the increasing acid strengths of the given acids?

- (A) $HOCIO < HOCl < HOCIO_3 < HOCIO_2$
- (B) $HOCIO_2 < HOCIO_3 < HOCIO < HOCl$
- (C) $HOCIO_3 < HOCIO_2 < HOCIO < HOCl$
- (D) $HOCl < HOCIO < HOCIO_2 < HOCIO_3$

AIPMT 2007 Prelims · Q87

36. Which one of the following on treatment with 50% aqueous sodium hydroxide yields the corresponding alcohol and acid?

- (A) C_6H_5CHO
- (B) $CH_3CH_2CH_2CHO$
- (C) CH_3COCH_3
- (D) $C_6H_5CH_2CHO$

AIPMT 2007 Prelims · Q88

37. For (i) I^- , (ii) Cl^- , (iii) Br^- , the increasing order of nucleophilicity would be

- (A) $Cl^- < Br^- < I^-$
- (B) $I^- < Cl^- < Br^-$
- (C) $Br^- < Cl^- < I^-$
- (D) $I^- < Br^- < Cl^-$

AIPMT 2007 Prelims · Q89

38. Calculate the pOH of a solution at 25°C that contains 1×10^{-10} M of hydronium ions, i.e. H_3O^+ .

- (A) 4.000
- (B) 9.000
- (C) 1.000
- (D) 7.000

AIPMT 2007 Prelims · Q90

39. Consider the following sets of quantum numbers (n, l, m, s):

- (i) 3, 0, 0, +1/2**
- (ii) 2, 2, 1, +1/2**
- (iii) 4, 3, -2, -1/2**
- (iv) 1, 0, -1, -1/2**
- (v) 3, 2, 3, +1/2**

Which of the following sets of quantum number is not possible?

- (A) (i), (ii), (iii) and (iv)
- (B) (ii), (iv) and (v)
- (C) (i) and (iii)
- (D) (ii), (iii) and (iv)

AIPMT 2007 Prelims · Q91

40. The equilibrium constant of the reaction:

$\text{Cu(s)} + 2\text{Ag}^+(\text{aq}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{Ag(s)} ; E^\circ = 0.46 \text{ V at } 298 \text{ K is}$

- (A) 2.0×10^{10}
- (B) 4.0×10^{10}
- (C) 4.0×10^{15}
- (D) 2.4×10^{10}

AIPMT 2007 Prelims · Q92

41. Which one of the following polymers is prepared by condensation polymerisation?

- (A) Teflon
- (B) Natural rubber
- (C) Styrene
- (D) Nylon-66

AIPMT 2007 Prelims · Q93

42. The order of decreasing reactivity towards an electrophilic reagent, for the following would be

(i) benzene (ii) toluene (iii) chlorobenzene (iv) phenol

- (A) (ii) > (iv) > (i) > (iii)
- (B) (iv) > (iii) > (ii) > (i)
- (C) (iv) > (ii) > (i) > (iii)
- (D) (i) > (ii) > (iii) > (iv)

AIPMT 2007 Prelims · Q94

43. Which of the following anions is present in the chain structure of silicates?

- (A) $(\text{Si}_2\text{O}_5^{2-})_n$
- (B) $(\text{SiO}_3^{2-})_n$
- (C) SiO_4^{4-}
- (D) $\text{Si}_2\text{O}_7^{6-}$

AIPMT 2007 Prelims · Q95

44. An element, X has the following isotopic composition:

$^{200}\text{X} : 90\%$, $^{199}\text{X} : 8.0\%$, $^{202}\text{X} : 2.0\%$

The weighted average atomic mass of the naturally occurring element X is closest to

- (A) 201 amu
- (B) 202 amu
- (C) 199 amu
- (D) 200 amu

AIPMT 2007 Prelims · Q96

45. The fraction of total volume occupied by the atoms present in a simple cube is

- (A) $\pi/(3\sqrt{2})$
- (B) $\pi/(4\sqrt{2})$
- (C) $\pi/4$
- (D) $\pi/6$

AIPMT 2007 Prelims · Q97

46. In the reaction:

$(\text{CH}_3)_2\text{CH-CH}_2\text{-O-CH}_2\text{-CH}_3 + \text{HI} \xrightarrow{\text{Heated}}$

Which of the following compounds will be formed?

- (A) $(\text{CH}_3)_2\text{CH-CH}_3 + \text{CH}_3\text{CH}_2\text{OH}$
- (B) $(\text{CH}_3)_2\text{CH-CH}_2\text{OH} + \text{CH}_3\text{CH}_3$
- (C) $(\text{CH}_3)_2\text{CH-CH}_2\text{OH} + \text{CH}_3\text{-CH}_2\text{-I}$
- (D) $(\text{CH}_3)_2\text{CH-CH}_2\text{-I} + \text{CH}_3\text{CH}_2\text{OH}$

47. The product formed in Aldol condensation is

- (A) a beta-hydroxy aldehyde or a beta-hydroxy ketone
- (B) an alpha-hydroxy aldehyde or ketone
- (C) an alpha, beta unsaturated ester
- (D) a beta-hydroxy acid

48. The number of moles of KMnO_4 that will be needed to react with one mole of sulphite ion in acidic solution is

- (A) 4/5
- (B) 2/5
- (C) 1
- (D) 3/5

49. Identify the incorrect statement among the following:

- (A) Lanthanoid contraction is the accumulation of successive shrinkages.
- (B) As a result of lanthanoid contraction, the properties of 4d series of the transition elements have no similarities with the 5d series of elements.
- (C) Shielding power of 4f electrons is quite weak.
- (D) There is a decrease in the radii of the atoms or ions as one proceeds from La to Lu.

Answer key and explanations**1. Answer: (C) 0.27 g**

Faraday's first law: $m = ZIt = 30 \times 10^{-5} \times 1.5 \times 600 = 0.27 \text{ g}$. Forgetting to convert 10 minutes to 600 s gives a far smaller value.

2. Answer: (C) $a = b = c$ and $\alpha = \beta = \gamma = 90^\circ$

A cubic unit cell has all edges equal and all axial angles 90° : $a = b = c$ and $\alpha = \beta = \gamma = 90^\circ$. Unequal edges with right angles describe an orthorhombic cell.

3. Answer: (A) Methyl isocyanide

LiAlH_4 reduces methyl isocyanide $\text{CH}_3\text{-N}\equiv\text{C}$ to $\text{CH}_3\text{-NH-CH}_3$, a secondary amine. Acetamide and methyl cyanide both give ethylamine (primary), and nitroethane also gives a primary amine.

4. Answer: (C) D-sugar component

The bases and phosphate groups are achiral; the chirality of DNA and RNA comes from the D-ribose/D-deoxyribose sugars. Natural nucleic acids contain D-, not L-, sugars.

5. Answer: (A) the adsorption sites are equivalent in their ability to adsorb the particles

Langmuir's model assumes a monolayer on equivalent adsorption sites, with no interaction between adsorbed molecules and a heat of adsorption independent of coverage. The other options contradict these assumptions.

6. Answer: (A) 1.00%

$\alpha = \sqrt{K_a/C} = \sqrt{(1.00 \times 10^{-5}/0.100)} = 1.00 \times 10^{-2}$, i.e. 1.00%. 0.100% would come from K_a/C without the square root.

7. Answer: (D) B only

The observed rate law is $\text{rate} = k[\text{H}_2][\text{ICl}]$. Mechanism A, as a single step, would be second order in ICl . In mechanism B the slow step $\text{H}_2 + \text{ICl}$ gives exactly $\text{rate} = k[\text{H}_2][\text{ICl}]$, so only B is consistent.

8. Answer: (B) $\Delta G/\Delta H$

A fuel cell converts the free-energy change into electrical work, while the total energy released is ΔH ; efficiency = $\Delta G/\Delta H$. Ratios involving ΔS are not an efficiency.

9. Answer: (D) $-X_2 \text{ kJ mol}^{-1}$

Enthalpy of formation is for forming 1 mol of the compound from elements in their standard states: $\text{H}_2(\text{g}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l})$, $\Delta H = -X_2$. The neutralisation enthalpy $-X_1$ does not start from elements.

10. Answer: (A) $\text{BeCO}_3 < \text{MgCO}_3 < \text{CaCO}_3 < \text{K}_2\text{CO}_3$

Thermal stability of carbonates increases as the cation becomes larger and less polarising: $\text{Be}^{2+} < \text{Mg}^{2+} < \text{Ca}^{2+}$, and K_2CO_3 (large, singly charged K^+) is the most stable. So $\text{BeCO}_3 < \text{MgCO}_3 < \text{CaCO}_3 < \text{K}_2\text{CO}_3$.

11. Answer: (C) BrO_3^- and XeO_3

BrO_3^- and XeO_3 each have three bond pairs and one lone pair on the central atom, so both are trigonal pyramidal. SO_3^{2-} is pyramidal but NO_3^- is planar; BF_3 is planar but NF_3 pyramidal; SF_4 is see-saw but XeF_4 square planar.

12. Answer: (A) + 2, + 4

Due to the inert pair effect, +2 is the more stable state for lead, while +4 is more stable for tin. So the characteristic states are +2 (Pb) and +4 (Sn).

13. Answer: (D) Carbon and hydrogen are suitable reducing agents for metal sulphides.

Metal sulphides have ΔG°_f lower than CS_2 and H_2S , so carbon and hydrogen cannot reduce them; that is why sulphides are roasted to oxides first. The statement that C and H_2 are suitable reducing agents for sulphides is therefore the untrue one.

14. Answer: (C) $\ln 2/k$

For a first-order reaction $t_{1/2} = \ln 2/k = 0.693/k$, independent of the initial concentration. $\log 2/k$ uses the base-10 log, and $0.693/(0.5k)$ wrongly brings in the 0.5 M concentration.

15. Answer: (C) (ii) > (iv) > (i) > (iii)

Hydrolysis is a nucleophilic attack at the carbonyl carbon, faster when electron-withdrawing groups make it more positive. $-\text{NO}_2$ withdraws more strongly than $-\text{CHO}$, H is neutral and $-\text{CH}_3$ donates, so (ii) > (iv) > (i) > (iii).

16. Answer: (C) $\text{CH}_3\text{CH}_2\text{-C(I)(Cl)-CH}_3$

HCl adds by Markovnikov's rule to give $\text{CH}_3\text{CH}_2\text{C(Cl)=CH}_2$ as product B. HI then also adds Markovnikov, with I going to the carbon already carrying Cl (stabilised carbocation), giving $\text{CH}_3\text{CH}_2\text{C(I)(Cl)CH}_3$. Putting I and Cl on the terminal carbon would be anti-Markovnikov.

17. Answer: (C) 5.55 mL

Molarity of the concentrated acid = $(98/98) \text{ mol per } 100 \text{ g} \times 1.80 \text{ g/mL} \times 1000/100 = 18.0 \text{ M}$. $V = (0.1 \times 1000)/18.0 = 5.55 \text{ mL}$. 11.10 mL would result from treating the acid as 9 M.

18. Answer: (D) Clemmensen reduction

Clemmensen reduction uses Zn-Hg and concentrated HCl to convert C=O into CH_2 . Wolff-Kishner reduction does the same with hydrazine and KOH in ethylene glycol.

19. Answer: (B) 425 kJ mol^{-1}

$\frac{1}{2}\text{H}_2 + \frac{1}{2}\text{Cl}_2 \rightarrow \text{HCl}$: $\Delta H_f = \frac{1}{2}(430) + \frac{1}{2}(240) - x = -90$, so $x = 335 + 90 = 425 \text{ kJ mol}^{-1}$. 245 kJ mol^{-1} subtracts the 90 instead of adding it.

20. Answer: (C) $\text{FCH}_2\text{COOH} > \text{ClCH}_2\text{COOH} > \text{BrCH}_2\text{COOH} > \text{CH}_3\text{COOH}$

Electron-withdrawing halogens stabilise the carboxylate ion, more so with higher electronegativity: $\text{F} > \text{Cl} > \text{Br}$, and unsubstituted acetic acid is weakest. So $\text{FCH}_2\text{COOH} > \text{ClCH}_2\text{COOH} > \text{BrCH}_2\text{COOH} > \text{CH}_3\text{COOH}$.

21. Answer: (C) the compound may be a racemic mixture

A compound believed to be chiral can still show no rotation if it is present as a racemic mixture, where equal amounts of the two enantiomers cancel each other. 'Certainly meso' is too strong: a meso compound is not chiral at all, and a racemate explains the observation equally well.

22. Answer: (D) Vitamin B

B-group vitamins (and vitamin C) are water-soluble. Vitamins A, D, E and K are fat-soluble and stored in the liver and adipose tissue.

23. Answer: (B) 1.12 K

For $\text{HX} \rightleftharpoons \text{H}^+ + \text{X}^-$ with $\alpha = 0.2$, $i = 1 + \alpha = 1.2$. $\Delta T_f = iK_f m = 1.2 \times 1.86 \times 0.5 = 1.116 \approx 1.12 \text{ K}$. 0.56 K ignores the van 't Hoff factor and rounds wrongly; the depression itself is a positive quantity.

24. Answer: (D) Argentite

Argentite (Ag_2S) is treated by leaching with dilute NaCN solution (cyanide process) to dissolve silver as $[\text{Ag}(\text{CN})_2]^-$. Galena, copper pyrites and sphalerite are concentrated by froth flotation.

25. Answer: (A) 45 minutes

$k = (2.303/60) \log(100/40) = (2.303/60)(0.69 - 0.30) \approx 0.0150 \text{ min}^{-1}$. $t_{1/2} = 0.693/0.0150 \approx 46 \text{ min}$, closest to 45 minutes. 50 minutes assumes a linear (zero-order) fall.

26. Answer: (B) $[\text{Co(en)}_2\text{Cl}_2]\text{Cl}$

cis- $[\text{Co(en)}_2\text{Cl}_2]^+$ has no plane of symmetry and exists as a pair of enantiomers. The other complexes show coordination or geometrical isomerism but no optical isomers ($[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$ cis/trans are both achiral).

27. Answer: (B) $6.02 \times 10^{17} \text{ mol}^{-1}$

Each Sr^{2+} replaces two Na^+ and creates one cation vacancy. $10^{-4} \text{ mol\%} = 10^{-6} \text{ mol SrCl}_2 \text{ per mol NaCl}$, giving $10^{-6} \times 6.02 \times 10^{23} = 6.02 \times 10^{17}$ vacancies per mol. 6.02×10^{19} would ignore the percent conversion.

28. Answer: (B) $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$

H_2O is a weak-field ligand, so the ions stay high-spin: Cr^{2+} (d^4) 4, Mn^{2+} (d^5) 5, Fe^{2+} (d^6) 4 and Ni^{2+} (d^8) 2 unpaired electrons. $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ has the fewest, so it is least paramagnetic; $[\text{Mn}(\text{H}_2\text{O})_6]^{2+}$ is the most.

29. Answer: (A) MgSO_4

For small Mg^{2+} the hydration energy is very large and exceeds the lattice energy with the large sulphate ion, so MgSO_4 is soluble. For Sr, Ba and Ra sulphates the lattice energy dominates and they are sparingly soluble.

30. Answer: (D) 2-methyl-2-butene

Acetone needs a $(\text{CH}_3)_2\text{C=}$ unit. 2-Methyl-2-butene $(\text{CH}_3)_2\text{C=CHCH}_3$ gives acetone + acetaldehyde on ozonolysis. 2-Methyl-1-butene gives butanone + formaldehyde, and cyclopentane has no double bond.

31. Answer: (A) NH_2^-

Proton affinity is greatest for the strongest base. NH_2^- is the conjugate base of NH_3 , an extremely weak acid, so it is the strongest base here. F^- , I^- and HS^- are conjugate bases of much stronger acids.

32. Answer: (D) $\text{K}_2\text{K}_3/\text{K}_1$

Target: $2\text{NH}_3 + (5/2)\text{O}_2 \rightleftharpoons 2\text{NO} + 3\text{H}_2\text{O} = (\text{reverse of eq. 1}) + (\text{eq. 2}) + 3 \times (\text{eq. 3})$. So $K = \text{K}_2\text{K}_3^3/\text{K}_1$. Using K_3 only once ignores that three water molecules form.

33. Answer: (D) Cr^{3+}

Cr^{3+} ($3d^3$) has a half-filled t_{2g} set and a very high hydration energy, making it the most stable in water. Ti^{3+} and V^{3+} are oxidised easily, and Mn^{3+} (d^4) disproportionates.

34. Answer: (C) $\text{CO} < \text{CO}_2 < \text{CO}_3^{2-}$

C-O bond order is about 3 in CO, 2 in CO_2 and $1\frac{1}{2}$ in CO_3^{2-} (resonance). Higher bond order means a shorter bond, so $\text{CO} < \text{CO}_2 < \text{CO}_3^{2-}$.

35. Answer: (D) $\text{HOCl} < \text{HOClO} < \text{HOClO}_2 < \text{HOClO}_3$

Acid strength of chlorine oxoacids increases with the number of oxygen atoms, which raises chlorine's oxidation state and stabilises the conjugate base by delocalisation. So $\text{HOCl} < \text{HOClO} < \text{HOClO}_2 < \text{HOClO}_3$.

36. Answer: (A) $\text{C}_6\text{H}_5\text{CHO}$

The Cannizzaro reaction (disproportionation into alcohol and acid salt with concentrated alkali) needs an aldehyde with no α -hydrogen, such as benzaldehyde. Butanal and phenylacetaldehyde have α -H and undergo aldol condensation instead.

37. Answer: (A) $\text{Cl}^- < \text{Br}^- < \text{I}^-$

In protic solvents the larger, more polarisable iodide is least solvated and the best nucleophile, so nucleophilicity increases $\text{Cl}^- < \text{Br}^- < \text{I}^-$. The reverse order applies to basicity, not nucleophilicity.

38. Answer: (A) 4.000

$\text{pH} = -\log(1 \times 10^{-10}) = 10$, and at 25°C $\text{pOH} = 14 - 10 = 4.000$. 10 would be the pH itself, which is not an option.

39. Answer: (B) (ii), (iv) and (v)

(ii) is impossible because l must be less than n ($l = 2$ with $n = 2$), (iv) because m must lie between $-l$ and $+l$ ($m = -1$ with $l = 0$) and (v) because $m = 3$ exceeds $l = 2$. (i) and (iii) are valid, so the impossible sets are (ii), (iv) and (v).

40. Answer: (C) 4.0×10^{15}

$\log K = nE^\circ/0.0591 = 2 \times 0.46/0.0591 = 15.57$, so $K = 10^{15.57} \approx 3.7 \times 10^{15} \approx 4.0 \times 10^{15}$. Taking $n = 1$ would give a value near 10^8 .

41. Answer: (D) Nylon-66

Nylon-66 forms from hexamethylenediamine and adipic acid with loss of water, a condensation polymerisation. Teflon and polystyrene are addition polymers, and natural rubber is a polyisoprene addition polymer.

42. Answer: (C) (iv) > (ii) > (i) > (iii)

$-\text{OH}$ strongly activates the ring by resonance, $-\text{CH}_3$ activates weakly by hyperconjugation, and $-\text{Cl}$ deactivates ($-\text{I}$ effect dominates). So phenol > toluene > benzene > chlorobenzene.

43. Answer: (B) $(\text{SiO}_3^{2-})_n$

Single-chain silicates (pyroxenes) share two oxygens per SiO_4 tetrahedron, giving the repeating unit $(\text{SiO}_3^{2-})_n$. $(\text{Si}_2\text{O}_5^{2-})_n$ is the sheet silicate unit, SiO_4^{4-} is the orthosilicate and $\text{Si}_2\text{O}_7^{6-}$ the pyrosilicate.

44. Answer: (D) 200 amu

Average mass = $200 \times 0.90 + 199 \times 0.08 + 202 \times 0.02 = 180 + 15.92 + 4.04 = 199.96 \approx 200$ amu.
201 amu would be a simple average of the three masses.

45. Answer: (D) $\pi/6$

A simple cube has 1 atom per cell with $a = 2r$, so packing fraction = $(4/3)\pi r^3 / (2r)^3 = \pi/6 \approx 0.52$. $\pi/(3\sqrt{2})$ is the value for fcc.

46. Answer: (C) $(\text{CH}_3)_2\text{CH}-\text{CH}_2\text{OH} + \text{CH}_3-\text{CH}_2-\text{I}$

With two primary alkyl groups, I^- attacks the less hindered carbon by $\text{S}_\text{N}2$ after protonation of the ether oxygen. The ethyl carbon is less hindered than the isobutyl carbon, so the products are $\text{CH}_3\text{CH}_2\text{I}$ and $(\text{CH}_3)_2\text{CHCH}_2\text{OH}$.

47. Answer: (A) a beta-hydroxy aldehyde or a beta-hydroxy ketone

The aldol addition of an enolisable aldehyde or ketone gives a β -hydroxy aldehyde or β -hydroxy ketone (which may then dehydrate). The OH ends up on the β -carbon, not the α -carbon, and no ester or acid is formed.

48. Answer: (B) 2/5

$\text{SO}_3^{2-} \rightarrow \text{SO}_4^{2-}$ loses 2 electrons, while $\text{MnO}_4^- \rightarrow \text{Mn}^{2+}$ gains 5 in acidic medium. So 1 mol sulphite needs 2/5 mol KMnO_4 . 4/5 counts the sulphite change twice.

49. Answer: (B) As a result of lanthanoid contraction, the properties of 4d series of the transition elements have no similarities with the 5d series of elements.

Because of lanthanoid contraction, 4d and 5d elements of the same group have nearly identical radii (e.g. Zr and Hf) and very similar properties. Saying they have no similarities is therefore the incorrect statement; the others are true.

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