

# NEET 2021 — Chemistry Question Paper with Solutions

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

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**1. Which one among the following is the correct option for right relationship between  $C_p$  and  $C_v$  for one mole of ideal gas ?**

- (A)  $C_p + C_v = R$
- (B)  $C_p - C_v = R$
- (C)  $C_p = RC_v$
- (D)  $C_v = RC_p$

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**2. The major product formed in dehydrohalogenation reaction of 2-Bromo pentane is Pent-2-ene. This product formation is based on ?**

- (A) Saytzeff's Rule
- (B) Hund's Rule
- (C) Hofmann Rule
- (D) Huckel's Rule

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**3. The compound which shows metamerism is :**

- (A)  $C_5H_{12}$
- (B)  $C_3H_8O$
- (C)  $C_3H_6O$
- (D)  $C_4H_{10}O$

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**4.  $BF_3$  is planar and electron deficient compound. Hybridization and number of electrons around the central atom, respectively are :**

- (A)  $sp^3$  and 4
- (B)  $sp^3$  and 6
- (C)  $sp^2$  and 6
- (D)  $sp^2$  and 8

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**5. The major product of the following chemical reaction is :**

**$(CH_3)_2CH-CH=CH_2 + HBr \xrightarrow{(C_6H_5CO)_2O_2} ?$**

- (A)  $(CH_3)_2CH-CH_2-CH_2-Br$
- (B)  $(CH_3)_2CH-CH_2-CH_2-O-COC_6H_5$
- (C)  $(CH_3)_2CH-CH(Br)-CH_3$
- (D)  $(CH_3)_2CBr-CH_2-CH_3$

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**6. Dihedral angle of least stable conformer of ethane is :**

- (A)  $120^\circ$
- (B)  $180^\circ$
- (C)  $60^\circ$
- (D)  $0^\circ$

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**7. The following solutions were prepared by dissolving 10 g of glucose ( $C_6H_{12}O_6$ ) in 250 ml of water ( $P_1$ ), 10 g of urea ( $CH_4N_2O$ ) in 250 ml of water ( $P_2$ ) and 10 g of sucrose ( $C_{12}H_{22}O_{11}$ ) in 250 ml of water ( $P_3$ ). The right option for the decreasing order of osmotic pressure of these solutions is :**

- (A)  $P_2 > P_1 > P_3$
- (B)  $P_1 > P_2 > P_3$
- (C)  $P_2 > P_3 > P_1$
- (D)  $P_3 > P_1 > P_2$

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**8. Zr (Z = 40) and Hf (Z = 72) have similar atomic and ionic radii because of :**

- (A) belonging to same group
- (B) diagonal relationship
- (C) lanthanoid contraction
- (D) having similar chemical properties

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**9. The molar conductance of NaCl, HCl and CH<sub>3</sub>COONa at infinite dilution are 126.45, 426.16 and 91.0 S cm<sup>2</sup> mol<sup>-1</sup> respectively. The molar conductance of CH<sub>3</sub>COOH at infinite dilution is. Choose the right option for your answer.**

- (A) 201.28 S cm<sup>2</sup> mol<sup>-1</sup>
- (B) 390.71 S cm<sup>2</sup> mol<sup>-1</sup>
- (C) 698.28 S cm<sup>2</sup> mol<sup>-1</sup>
- (D) 540.48 S cm<sup>2</sup> mol<sup>-1</sup>

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**10. A particular station of All India Radio, New Delhi, broadcasts on a frequency of 1,368 kHz (kilohertz). The wavelength of the electromagnetic radiation emitted by the transmitter is : [speed of light,  $c = 3.0 \times 10^8 \text{ ms}^{-1}$ ]**

- (A) 219.3 m
- (B) 219.2 m
- (C) 2192 m
- (D) 21.92 cm

NEET 2021 · Q52

**11. The correct option for the number of body centred unit cells in all 14 types of Bravais lattice unit cells is :**

- (A) 7
- (B) 5
- (C) 2
- (D) 3

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**12. Ethylene diaminetetraacetate (EDTA) ion is :**

- (A) Hexadentate ligand with four "O" and two "N" donor atoms
- (B) Unidentate ligand
- (C) Bidentate ligand with two "N" donor atoms
- (D) Tridentate ligand with three "N" donor atoms

NEET 2021 · Q53

**13. Noble gases are named because of their inertness towards reactivity. Identify an incorrect statement about them.**

- (A) Noble gases are sparingly soluble in water.
- (B) Noble gases have very high melting and boiling points.
- (C) Noble gases have weak dispersion forces.
- (D) Noble gases have large positive values of electron gain enthalpy.

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**14. The correct sequence of bond enthalpy of 'C-X' bond is :**

- (A) CH<sub>3</sub>-F < CH<sub>3</sub>-Cl < CH<sub>3</sub>-Br < CH<sub>3</sub>-I
- (B) CH<sub>3</sub>-F > CH<sub>3</sub>-Cl > CH<sub>3</sub>-Br > CH<sub>3</sub>-I
- (C) CH<sub>3</sub>-F < CH<sub>3</sub>-Cl > CH<sub>3</sub>-Br > CH<sub>3</sub>-I
- (D) CH<sub>3</sub>-Cl > CH<sub>3</sub>-F > CH<sub>3</sub>-Br > CH<sub>3</sub>-I

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**15. The  $pK_b$  of dimethylamine and  $pK_a$  of acetic acid are 3.27 and 4.77 respectively at T (K). The correct option for the pH of dimethylammonium acetate solution is :**

- (A) 8.50
- (B) 5.50
- (C) 7.75
- (D) 6.25

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**16. Match List - I with List - II.**

**List - I | List - II**

**(a)  $PCl_5$  | (i) Square pyramidal**

**(b)  $SF_6$  | (ii) Trigonal planar**

**(c)  $BrF_5$  | (iii) Octahedral**

**(d)  $BF_3$  | (iv) Trigonal bipyramidal**

**Choose the correct answer from the options given below.**

- (A) (a)-(iv), (b)-(iii), (c)-(i), (d)-(ii)
- (B) (a)-(ii), (b)-(iii), (c)-(iv), (d)-(i)
- (C) (a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)
- (D) (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i)

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**17. Statement I : Acid strength increases in the order given as  $HF \ll HCl \ll HBr \ll HI$ .**

**Statement II : As the size of the elements F, Cl, Br, I increases down the group, the bond strength of HF, HCl, HBr and HI decreases and so the acid strength increases. 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.

NEET 2021 · Q57

**18. The right option for the statement "Tyndall effect is exhibited by", is :**

- (A) NaCl solution
- (B) Glucose solution
- (C) Starch solution
- (D) Urea solution

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**19. Identify the compound that will react with Hinsberg's reagent to give a solid which dissolves in alkali.**

- (A)  $CH_3-CH_2-NO_2$
- (B)  $CH_3-CH_2-NH-CH_3$
- (C)  $CH_3-CH_2-NH_2$
- (D)  $CH_3-CH_2-N(CH_3)-CH_2-CH_3$

NEET 2021 · Q58

**20. Among the following alkaline earth metal halides, one which is covalent and soluble in organic solvents is :**

- (A) Calcium chloride
- (B) Strontium chloride
- (C) Magnesium chloride
- (D) Beryllium chloride

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**21. What is the IUPAC name of the organic compound formed in the following chemical reaction ?**

**Acetone —[(i)  $\text{C}_2\text{H}_5\text{MgBr}$ , dry Ether; (ii)  $\text{H}_2\text{O}$ ,  $\text{H}^+$ ]→ Product**

- (A) 2-methyl propan-2-ol
- (B) pentan-2-ol
- (C) pentan-3-ol
- (D) 2-methyl butan-2-ol

NEET 2021 · Q59

**22. Which one of the following methods can be used to obtain highly pure metal which is liquid at room temperature ?**

- (A) Electrolysis
- (B) Chromatography
- (C) Distillation
- (D) Zone refining

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**23. Which of the following reactions is the metal displacement reaction ? Choose the right option.**

- (A)  $2\text{KClO}_3 \xrightarrow{\Delta} 2\text{KCl} + 3\text{O}_2$
- (B)  $\text{Cr}_2\text{O}_3 + 2\text{Al} \xrightarrow{\Delta} \text{Al}_2\text{O}_3 + 2\text{Cr}$
- (C)  $\text{Fe} + 2\text{HCl} \rightarrow \text{FeCl}_2 + \text{H}_2 \uparrow$
- (D)  $2\text{Pb}(\text{NO}_3)_2 \rightarrow 2\text{PbO} + 4\text{NO}_2 + \text{O}_2 \uparrow$

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**24. The incorrect statement among the following is :**

- (A) Actinoid contraction is greater for element to element than Lanthanoid contraction.
- (B) Most of the trivalent Lanthanoid ions are colorless in the solid state.
- (C) Lanthanoids are good conductors of heat and electricity.
- (D) Actinoids are highly reactive metals, especially when finely divided.

NEET 2021 · Q61

**25. Which one of the following polymers is prepared by addition polymerisation ?**

- (A) Teflon
- (B) Nylon-66
- (C) Novolac
- (D) Dacron

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**26. The RBC deficiency is deficiency disease of :**

- (A) Vitamin  $\text{B}_{12}$
- (B) Vitamin  $\text{B}_6$
- (C) Vitamin  $\text{B}_1$
- (D) Vitamin  $\text{B}_2$

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**27.  $\text{CH}_3\text{CH}_2\text{COO}^-\text{Na}^+ \xrightarrow{(\text{NaOH}, + ?; \text{Heat})} \text{CH}_3\text{CH}_3 + \text{Na}_2\text{CO}_3$ .**

**Consider the above reaction and identify the missing reagent/chemical.**

- (A)  $\text{B}_2\text{H}_6$
- (B) Red Phosphorus
- (C)  $\text{CaO}$
- (D) DIBAL-H

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**28. Match List - I with List - II.**

**List - I | List - II**

**(a)  $[\text{Fe}(\text{CN})_6]^{3-}$  | (i) 5.92 BM**

**(b)  $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$  | (ii) 0 BM**

**(c)  $[\text{Fe}(\text{CN})_6]^{4-}$  | (iii) 4.90 BM**

**(d)  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$  | (iv) 1.73 BM**

**Choose the correct answer from the options given below.**

(A) (a)-(iv), (b)-(ii), (c)-(i), (d)-(iii)

(B) (a)-(ii), (b)-(iv), (c)-(iii), (d)-(i)

(C) (a)-(i), (b)-(iii), (c)-(iv), (d)-(ii)

(D) (a)-(iv), (b)-(i), (c)-(ii), (d)-(iii)

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**29. From the following pairs of ions which one is not an iso-electronic pair ?**

(A)  $\text{O}^{2-}$ ,  $\text{F}^-$

(B)  $\text{Na}^+$ ,  $\text{Mg}^{2+}$

(C)  $\text{Mn}^{2+}$ ,  $\text{Fe}^{3+}$

(D)  $\text{Fe}^{2+}$ ,  $\text{Mn}^{2+}$

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**30. The reagent 'R' in the given sequence of chemical reaction is :**

**2,4,6-Tribromoaniline  $\xrightarrow{(\text{NaNO}_2, \text{HCl}, 0-5^\circ\text{C})}$  2,4,6-Tribromobenzenediazonium chloride  $\xrightarrow{\text{R}}$  1,3,5-Tribromobenzene**

(A)  $\text{H}_2\text{O}$

(B)  $\text{CH}_3\text{CH}_2\text{OH}$

(C)  $\text{HI}$

(D)  $\text{CuCN/KCN}$

NEET 2021 · Q66

**31. The maximum temperature that can be achieved in blast furnace is :**

(A) upto 1200 K

(B) upto 2200 K

(C) upto 1900 K

(D) upto 5000 K

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**32. Which of the following molecules is non-polar in nature ?**

(A)  $\text{POCl}_3$

(B)  $\text{CH}_2\text{O}$

(C)  $\text{SbCl}_5$

(D)  $\text{NO}_2$

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**33. The correct option for the value of vapour pressure of a solution at  $45^\circ\text{C}$  with benzene to octane in molar ratio 3 : 2 is :**

**[At  $45^\circ\text{C}$  vapour pressure of benzene is 280 mm Hg and that of octane is 420 mm Hg.**

**Assume Ideal gas]**

(A) 160 mm of Hg

(B) 168 mm of Hg

(C) 336 mm of Hg

(D) 350 mm of Hg

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**34. The molar conductivity of 0.007 M acetic acid is  $20 \text{ S cm}^2 \text{ mol}^{-1}$ . What is the dissociation constant of acetic acid ? Choose the correct option.**

**$[\Lambda^\circ(\text{H}^+) = 350 \text{ S cm}^2 \text{ mol}^{-1}, \Lambda^\circ(\text{CH}_3\text{COO}^-) = 50 \text{ S cm}^2 \text{ mol}^{-1}]$**

- (A)  $1.75 \times 10^{-4} \text{ mol L}^{-1}$
- (B)  $2.50 \times 10^{-4} \text{ mol L}^{-1}$
- (C)  $1.75 \times 10^{-5} \text{ mol L}^{-1}$
- (D)  $2.50 \times 10^{-5} \text{ mol L}^{-1}$

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**35. The slope of Arrhenius Plot ( $\ln k$  v/s  $1/T$ ) of first order reaction is  $-5 \times 10^3 \text{ K}$ . The value of  $E_a$  of the reaction is. Choose the correct option for your answer. [Given  $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$ ]**

- (A)  $41.5 \text{ kJ mol}^{-1}$
- (B)  $83.0 \text{ kJ mol}^{-1}$
- (C)  $166 \text{ kJ mol}^{-1}$
- (D)  $-83 \text{ kJ mol}^{-1}$

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**36. Match List - I with List - II.**

**List - I | List - II**

**(a)  $\text{C}_6\text{H}_6 \xrightarrow{(\text{CO, HCl; Anhyd. AlCl}_3/\text{CuCl})} \text{ | (i) Hell-Volhard-Zelinsky reaction}$**

**(b)  $\text{R-CO-CH}_3 + \text{NaOX} \rightarrow \text{ | (ii) Gattermann-Koch reaction}$**

**(c)  $\text{R-CH}_2\text{-OH} + \text{R'COOH} \xrightarrow{(\text{Conc. H}_2\text{SO}_4)} \text{ | (iii) Haloform reaction}$**

**(d)  $\text{R-CH}_2\text{COOH} \xrightarrow{((\text{i) X}_2/\text{Red P; (ii) H}_2\text{O})} \text{ | (iv) Esterification}$**

**Choose the correct answer from the options given below.**

- (A) (a)-(iv), (b)-(i), (c)-(ii), (d)-(iii)
- (B) (a)-(iii), (b)-(ii), (c)-(i), (d)-(iv)
- (C) (a)-(i), (b)-(iv), (c)-(iii), (d)-(ii)
- (D) (a)-(ii), (b)-(iii), (c)-(iv), (d)-(i)

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**37. The intermediate compound 'X' in the following chemical reaction is :**

**$\text{C}_6\text{H}_5\text{-CH}_3 + \text{CrO}_2\text{Cl}_2 \xrightarrow{\text{CS}_2} \text{X} \xrightarrow{\text{H}_3\text{O}^+} \text{C}_6\text{H}_5\text{-CHO}$**

- (A)  $\text{C}_6\text{H}_5\text{-CH(OCrOHCl}_2)_2$
- (B)  $\text{C}_6\text{H}_5\text{-CH(OCOCH}_3)_2$
- (C)  $\text{C}_6\text{H}_5\text{-CHCl}_2$
- (D)  $\text{C}_6\text{H}_5\text{-CH}_2\text{Cl}$

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**38. For irreversible expansion of an ideal gas under isothermal condition, the correct option is :**

- (A)  $\Delta U = 0, \Delta S(\text{total}) = 0$
- (B)  $\Delta U \neq 0, \Delta S(\text{total}) \neq 0$
- (C)  $\Delta U = 0, \Delta S(\text{total}) \neq 0$
- (D)  $\Delta U \neq 0, \Delta S(\text{total}) = 0$

NEET 2021 · Q75

**39. The structures of beryllium chloride in solid state and vapour phase, are :**

- (A) Chain and dimer, respectively
- (B) Linear in both
- (C) Dimer and Linear, respectively
- (D) Chain in both

**40. Given below are two statements :**

**Statement I : Aspirin and Paracetamol belong to the class of narcotic analgesics.**

**Statement II : Morphine and Heroin are non-narcotic analgesics.**

**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.

**41. Tritium, a radioactive isotope of hydrogen, emits which of the following particles ?**

- (A) Beta ( $\beta^-$ )
- (B) Alpha ( $\alpha$ )
- (C) Gamma ( $\gamma$ )
- (D) Neutron (n)

**42. Choose the correct option for the total pressure (in atm.) in a mixture of 4 g  $O_2$  and 2 g  $H_2$  confined in a total volume of one litre at  $0^\circ C$  is :**

**[Given  $R = 0.082 \text{ L atm mol}^{-1} \text{ K}^{-1}$ ,  $T = 273 \text{ K}$ ]**

- (A) 2.518
- (B) 2.602
- (C) 25.18
- (D) 26.02

## Answer key and explanations

### 1. Answer: (B) $C_p - C_v = R$

For one mole of an ideal gas,  $C_p$  exceeds  $C_v$  by the work done in expansion at constant pressure, which is  $R$  per kelvin. So Mayer's relation is  $C_p - C_v = R$ ; a product relation like  $C_p = RC_v$  is dimensionally inconsistent.

### 2. Answer: (A) Saytzeff's Rule

In base-induced dehydrohalogenation, the more substituted (more stable) alkene is the main product, which is Saytzeff's rule. Pent-2-ene is more substituted than pent-1-ene. Hofmann's rule predicts the less substituted alkene and applies to bulky bases or quaternary ammonium bases.

### 3. Answer: (D) $C_4H_{10}O$

Metamerism arises when different alkyl groups are attached to the same polyvalent functional group, e.g. ethers.  $C_4H_{10}O$  gives  $CH_3-O-C_3H_7$  and  $C_2H_5-O-C_2H_5$ , which are metamers.  $C_3H_8O$  has only one ether ( $CH_3OC_2H_5$ ), so it cannot show metamerism.

### 4. Answer: (C) $sp^2$ and 6

Boron in  $BF_3$  forms three  $\sigma$  bonds and has no lone pair, so it is  $sp^2$  hybridised and trigonal planar. It has only 6 electrons in its valence shell, which is why it is electron deficient; 8 would complete the octet.

### 5. Answer: (A) $(CH_3)_2CH-CH_2-CH_2-Br$

Benzoyl peroxide makes HBr add by a free-radical chain (peroxide or Kharasch effect), giving anti-Markovnikov addition. Br adds to the terminal  $CH_2$  so that the more stable secondary radical forms, giving  $(CH_3)_2CH-CH_2-CH_2-Br$ . The Markovnikov product  $(CH_3)_2CH-CH(Br)-CH_3$  would form without peroxide.

### 6. Answer: (D) $0^\circ$

The least stable conformer of ethane is the eclipsed form, where the C-H bonds on adjacent carbons line up and torsional strain is maximum; its dihedral angle is  $0^\circ$ .  $60^\circ$  corresponds to the most stable staggered form.

### 7. Answer: (A) $P_2 > P_1 > P_3$

$\pi = (w/M)RT/V$ ; with the same mass and volume,  $\pi \propto 1/M$ . Molar masses: urea 60, glucose 180, sucrose 342 g/mol. So  $\pi(\text{urea}) > \pi(\text{glucose}) > \pi(\text{sucrose})$ , i.e.  $P_2 > P_1 > P_3$ .

**8. Answer: (C) lanthanoid contraction**

Between Zr (4d) and Hf (5d) the fourteen 4f elements are filled; poor shielding by 4f electrons causes the lanthanoid contraction, cancelling the expected size increase. Being in the same group alone would predict Hf to be larger.

**9. Answer: (B) 390.71 S cm<sup>2</sup> mol<sup>-1</sup>**

Kohlrausch's law:  $\Lambda^\circ(\text{CH}_3\text{COOH}) = \Lambda^\circ(\text{CH}_3\text{COONa}) + \Lambda^\circ(\text{HCl}) - \Lambda^\circ(\text{NaCl}) = 91.0 + 426.16 - 126.45 = 390.71 \text{ S cm}^2 \text{ mol}^{-1}$ . Simply adding all three gives 643.61, which is not the right combination.

**10. Answer: (A) 219.3 m**

$\lambda = c/\nu = (3.0 \times 10^8)/(1368 \times 10^3) = 219.30 \text{ m}$ . 2192 m results from a decimal slip; the value 219.2 m is a rounding error.

**11. Answer: (D) 3**

Body-centred unit cells occur in only three of the 14 Bravais lattices: cubic, tetragonal and orthorhombic. Monoclinic has end-centred but not body-centred, so the count is 3.

**12. Answer: (A) Hexadentate ligand with four "O" and two "N" donor atoms**

EDTA<sup>4-</sup> donates through its two amine nitrogen atoms and four carboxylate oxygen atoms, so it is a hexadentate ligand. Ethylenediamine (en), not EDTA, is the bidentate ligand with two N donors.

**13. Answer: (B) Noble gases have very high melting and boiling points.**

Noble gases are monatomic and held only by weak dispersion forces, so their melting and boiling points are very low, not high. They are sparingly soluble in water and have large positive electron gain enthalpy because their shells are full.

**14. Answer: (B) CH<sub>3</sub>-F > CH<sub>3</sub>-Cl > CH<sub>3</sub>-Br > CH<sub>3</sub>-I**

As the halogen gets larger (F < Cl < Br < I), the C-X bond becomes longer and overlap poorer, so bond enthalpy decreases: CH<sub>3</sub>-F > CH<sub>3</sub>-Cl > CH<sub>3</sub>-Br > CH<sub>3</sub>-I. This is why C-I bonds break most easily.

**15. Answer: (C) 7.75**

For a salt of a weak acid and weak base,  $\text{pH} = 7 + (\text{pK}_a - \text{pK}_b)/2 = 7 + (4.77 - 3.27)/2 = 7 + 0.75 = 7.75$ . The solution is slightly basic because dimethylamine (pK<sub>b</sub> 3.27) is a stronger base than acetic acid is an acid.

**16. Answer: (A) (a)-(iv), (b)-(iii), (c)-(i), (d)-(ii)**

PCl<sub>5</sub>: 5 bond pairs, trigonal bipyramidal. SF<sub>6</sub>: 6 bond pairs, octahedral. BrF<sub>5</sub>: 5 bond pairs + 1 lone pair, square pyramidal. BF<sub>3</sub>: 3 bond pairs, trigonal planar.

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

Acid strength of hydrogen halides increases HF < HCl < HBr < HI. This is because the halogen size increases down the group, the H-X bond becomes longer and weaker, and H<sup>+</sup> is released more easily. Both statements are true.

**18. Answer: (C) Starch solution**

Tyndall effect is the scattering of light by colloidal particles. Starch forms a colloidal (lyophilic) sol, whereas NaCl, glucose and urea form true solutions whose particles are too small to scatter light.

**19. Answer: (C) CH<sub>3</sub>-CH<sub>2</sub>-NH<sub>2</sub>**

A primary amine (CH<sub>3</sub>CH<sub>2</sub>NH<sub>2</sub>) reacts with benzenesulphonyl chloride to give N-ethylbenzenesulphonamide, whose N-H is acidic, so it dissolves in alkali. The secondary amine gives a sulphonamide without N-H (insoluble in alkali), and tertiary amines and nitroalkanes do not react.

**20. Answer: (D) Beryllium chloride**

Be<sup>2+</sup> is very small and highly polarising, so BeCl<sub>2</sub> has largely covalent character and dissolves in organic solvents. The chlorides of Mg, Ca and Sr are ionic.

**21. Answer: (D) 2-methyl butan-2-ol**

C<sub>2</sub>H<sub>5</sub>MgBr adds to the carbonyl carbon of acetone, and hydrolysis gives the tertiary alcohol (CH<sub>3</sub>)<sub>2</sub>C(OH)CH<sub>2</sub>CH<sub>3</sub>. Its longest chain has four carbons with OH and CH<sub>3</sub> on C-2: 2-methylbutan-2-ol. 2-methylpropan-2-ol would come from CH<sub>3</sub>MgBr.

**22. Answer: (C) Distillation**

Distillation purifies low-boiling metals such as mercury (liquid at room temperature) and zinc: the metal is vaporised and condensed, leaving impurities behind. Zone refining is for semiconductors like Si and Ge, which are solids.

**23. Answer: (B) Cr<sub>2</sub>O<sub>3</sub> + 2Al  $\xrightarrow{\Delta}$  Al<sub>2</sub>O<sub>3</sub> + 2Cr**

In Cr<sub>2</sub>O<sub>3</sub> + 2Al  $\rightarrow$  Al<sub>2</sub>O<sub>3</sub> + 2Cr, aluminium displaces chromium metal from its oxide, a metal displacement reaction. Fe + 2HCl displaces hydrogen, not a metal, and the other two are decomposition reactions.

**24. Answer: (B) Most of the trivalent Lanthanoid ions are colorless in the solid state.**

Most trivalent lanthanoid ions are coloured in the solid state and in solution because of f-f transitions ( $\text{La}^{3+}$  and  $\text{Lu}^{3+}$  are exceptions), so calling them colourless is the incorrect statement. Actinoid contraction from element to element is indeed greater, because 5f electrons shield poorly.

**25. Answer: (A) Teflon**

Teflon is formed by addition polymerisation of tetrafluoroethene ( $\text{CF}_2=\text{CF}_2$ ). Nylon-66, Novolac and Dacron are condensation polymers that eliminate small molecules such as water.

**26. Answer: (A) Vitamin B<sub>12</sub>**

Vitamin B<sub>12</sub> is needed for red blood cell formation; its deficiency causes pernicious anaemia. Vitamin B<sub>1</sub> deficiency causes beriberi and B<sub>2</sub> deficiency causes cheilosis, not an RBC deficiency.

**27. Answer: (C) CaO**

Heating a sodium carboxylate with soda lime ( $\text{NaOH} + \text{CaO}$ ) removes  $\text{CO}_2$  as  $\text{Na}_2\text{CO}_3$  and gives an alkane with one carbon fewer: sodium propanoate  $\rightarrow$  ethane. The missing reagent is CaO; red phosphorus is used with HI or in HVZ halogenation.

**28. Answer: (D) (a)-(iv), (b)-(i), (c)-(ii), (d)-(iii)**

$[\text{Fe}(\text{CN})_6]^{3-}$ :  $\text{Fe}^{3+}$  ( $d^5$ ) low spin, 1 unpaired electron, 1.73 BM.  $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ : high spin  $d^5$ , 5 unpaired, 5.92 BM.  $[\text{Fe}(\text{CN})_6]^{4-}$ :  $\text{Fe}^{2+}$  ( $d^6$ ) low spin, 0 unpaired, 0 BM.  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ : high spin  $d^6$ , 4 unpaired, 4.90 BM.

**29. Answer: (D)  $\text{Fe}^{2+}$ ,  $\text{Mn}^{2+}$**

$\text{Fe}^{2+}$  has  $26 - 2 = 24$  electrons,  $\text{Mn}^{2+}$  has  $25 - 2 = 23$ , so they are not isoelectronic.  $\text{O}^{2-}/\text{F}^-$  and  $\text{Na}^+/\text{Mg}^{2+}$  each have 10 electrons, and  $\text{Mn}^{2+}/\text{Fe}^{3+}$  each have 23.

**30. Answer: (B)  $\text{CH}_3\text{CH}_2\text{OH}$**

Ethanol (like  $\text{H}_3\text{PO}_2$ ) reduces an arenediazonium salt, replacing  $-\text{N}_2^+\text{Cl}^-$  by  $-\text{H}$  and itself being oxidised to ethanal. This converts 2,4,6-tribromobenzenediazonium chloride into 1,3,5-tribromobenzene. Water would give a phenol and  $\text{CuCN}/\text{KCN}$  a nitrile.

**31. Answer: (B) upto 2200 K**

In the lower zone of the blast furnace, coke burns in a blast of preheated air and the temperature reaches about 2200 K, the maximum in the furnace. Around 1200 K and below are typical of the upper reduction zones.

**32. Answer: (C)  $\text{SbCl}_5$**

$\text{SbCl}_5$  is trigonal bipyramidal with five identical Sb-Cl bonds, so the bond dipoles cancel and the molecule is non-polar.  $\text{POCl}_3$  (unequal P=O and P-Cl bonds),  $\text{CH}_2\text{O}$  (trigonal planar with C=O) and bent  $\text{NO}_2$  all have net dipoles.

**33. Answer: (C) 336 mm of Hg**

Mole fractions: benzene  $3/5 = 0.6$ , octane  $2/5 = 0.4$ . By Raoult's law  $P = 0.6 \times 280 + 0.4 \times 420 = 168 + 168 = 336$  mm Hg. 168 mm Hg is only one component's partial pressure.

**34. Answer: (C)  $1.75 \times 10^{-5} \text{ mol L}^{-1}$**

$\Lambda^\circ \text{m} = 350 + 50 = 400 \text{ S cm}^2 \text{ mol}^{-1}$ , so  $\alpha = \Lambda \text{m} / \Lambda^\circ \text{m} = 20/400 = 0.05$ .  $K_a = c\alpha^2 / (1 - \alpha) \approx 0.007 \times 0.0025 = 1.75 \times 10^{-5} \text{ mol L}^{-1}$  (exactly  $1.84 \times 10^{-5}$  without approximation, still nearest).

**35. Answer: (A) 41.5 kJ mol<sup>-1</sup>**

$\ln k = \ln A - E_a / (RT)$ , so the slope of  $\ln k$  vs  $1/T$  is  $-E_a/R$ .  $E_a = 5 \times 10^3 \times 8.314 = 41,570 \text{ J mol}^{-1} \approx 41.5 \text{ kJ mol}^{-1}$ .  $E_a$  is positive since the slope is negative, and 83 kJ is double the correct value.

**36. Answer: (D) (a)-(ii), (b)-(iii), (c)-(iv), (d)-(i)**

Benzene +  $\text{CO}/\text{HCl}$  with  $\text{AlCl}_3/\text{CuCl}$  gives benzaldehyde (Gattermann-Koch). A methyl ketone with  $\text{NaOX}$  gives haloform (haloform reaction). Alcohol + carboxylic acid with conc.  $\text{H}_2\text{SO}_4$  gives an ester (esterification). An acid with  $\text{X}_2/\text{red P}$  gives an  $\alpha$ -halo acid (Hell-Volhard-Zelinsky).

**37. Answer: (A)  $\text{C}_6\text{H}_5\text{-CH(OCrOHCl}_2)_2$**

In the Etard reaction, chromyl chloride in  $\text{CS}_2$  converts the methyl group of toluene into a brown chromium complex,  $\text{C}_6\text{H}_5\text{CH(OCrOHCl}_2)_2$ , which is hydrolysed to benzaldehyde. The diacetate  $\text{C}_6\text{H}_5\text{CH(OCOCH}_3)_2$  is the intermediate of the  $\text{CrO}_3/\text{acetic anhydride}$  route, not chromyl chloride.

**38. Answer: (C)  $\Delta U = 0$ ,  $\Delta S(\text{total}) \neq 0$**

For an ideal gas, internal energy depends only on temperature, so  $\Delta U = 0$  in any isothermal process. An irreversible process always increases the total entropy of system + surroundings, so  $\Delta S(\text{total}) > 0$ .  $\Delta S(\text{total}) = 0$  holds only for a reversible process.

**39. Answer: (A) Chain and dimer, respectively**

Solid  $\text{BeCl}_2$  has a polymeric chain structure with chlorine bridges. In the vapour phase it exists mainly as a chlorine-bridged dimer, which dissociates to the linear monomer only at very high temperature (about 1200 K).

**40. Answer: (B) Both Statement I and Statement II are false.**

Aspirin and paracetamol are non-narcotic analgesics, while morphine and heroin are narcotic analgesics. Each statement swaps the classes, so both are false.

**41. Answer: (A) Beta ( $\beta^-$ )**

Tritium ( $^3\text{H}$ ) is radioactive and decays by emitting low-energy  $\beta^-$  particles, becoming  $^3\text{He}$  (half-life about 12.3 years). It does not emit alpha particles or neutrons.

**42. Answer: (C) 25.18**

Moles:  $\text{O}_2 = 4/32 = 0.125$  and  $\text{H}_2 = 2/2 = 1$ , total 1.125 mol.  $P = nRT/V = 1.125 \times 0.082 \times 273/1 = 25.18$  atm. 2.518 is a decimal slip.

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