

AIPMT 2008 Prelims — Chemistry Question Paper with Solutions

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

AIPMT 2008 Prelims · Q48

1. If the lattice parameter for a crystalline structure is 3.6 Å, then the atomic radius in fcc crystal is

- (A) 1.27 Å
- (B) 1.81 Å
- (C) 2.10 Å
- (D) 2.92 Å

AIPMT 2008 Prelims · Q51

2. If uncertainty in position and momentum are equal, then uncertainty in velocity is

- (A) $\sqrt{h/\pi}$
- (B) $(1/2m)\sqrt{h/\pi}$
- (C) $\sqrt{h/2\pi}$
- (D) $(1/m)\sqrt{h/\pi}$

AIPMT 2008 Prelims · Q52

3. If a gas expands at constant temperature, it indicates that

- (A) Number of the molecules of gas increases
- (B) Kinetic energy of molecules decreases
- (C) Pressure of the gas increases
- (D) Kinetic energy of molecules remains the same

AIPMT 2008 Prelims · Q53

4. The value of equilibrium constant of the reaction

$\text{HI(g)} \rightleftharpoons \frac{1}{2}\text{H}_2\text{(g)} + \frac{1}{2}\text{I}_2\text{(g)}$ is 8.0.

The equilibrium constant of the reaction

$\text{H}_2\text{(g)} + \text{I}_2\text{(g)} \rightleftharpoons 2\text{HI(g)}$ will be

- (A) 1/8
- (B) 1/16
- (C) 1/64
- (D) 16

AIPMT 2008 Prelims · Q54

5. If 'a' stands for the edge length of the cubic systems: simple cubic, body centred cubic and face centred cubic, then the ratio of radii of the spheres in these systems will be respectively

- (A) $1a : \sqrt{3}a : \sqrt{2}a$
- (B) $(1/2)a : (\sqrt{3}/4)a : (1/(2\sqrt{2}))a$
- (C) $(1/2)a : \sqrt{3}a : (1/\sqrt{2})a$
- (D) $(1/2)a : (\sqrt{3}/2)a : (\sqrt{2}/2)a$

AIPMT 2008 Prelims · Q55

6. Kohlrausch's law states that at

- (A) Infinite dilution, each ion makes definite contribution to equivalent conductance of an electrolyte, whatever be the nature of the other ion of the electrolyte
- (B) Finite dilution, each ion makes definite contribution to equivalent conductance of an electrolyte, whatever be the nature of the other ion of the electrolyte
- (C) Infinite dilution each ion makes definite contribution to equivalent conductance of an electrolyte depending on the nature of the other ion of the electrolyte
- (D) Infinite dilution, each ion makes definite contribution to conductance of an electrolyte whatever be the nature of the other ion of the electrolyte

7. The measurement of the electron position is associated with an uncertainty in momentum, which is equal to $1 \times 10^{-18} \text{ g cm s}^{-1}$. The uncertainty in electron velocity is, (mass of an electron is $9 \times 10^{-28} \text{ g}$)

- (A) $1 \times 10^{11} \text{ cm s}^{-1}$
- (B) $1 \times 10^9 \text{ cm s}^{-1}$
- (C) $1 \times 10^6 \text{ cm s}^{-1}$
- (D) $1 \times 10^5 \text{ cm s}^{-1}$

8. Which of the following are not state functions?

(I) $q + w$

(II) q

(III) w

(IV) $H - TS$

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

9. The bromination of acetone that occurs in acid solution is represented by this equation



These kinetic data were obtained for given reaction concentrations.

Initial concentrations (M) $[\text{CH}_3\text{COCH}_3]$, $[\text{Br}_2]$, $[\text{H}^+] \rightarrow$ initial rate of disappearance of Br_2 (M s^{-1}):

0.30, 0.05, 0.05 $\rightarrow 5.7 \times 10^{-5}$

0.30, 0.10, 0.05 $\rightarrow 5.7 \times 10^{-5}$

0.30, 0.10, 0.10 $\rightarrow 1.2 \times 10^{-4}$

0.40, 0.05, 0.20 $\rightarrow 3.1 \times 10^{-4}$

Based on these data, the rate equation is

- (A) $\text{Rate} = k[\text{CH}_3\text{COCH}_3][\text{Br}_2][\text{H}^+]$
- (B) $\text{Rate} = k[\text{CH}_3\text{COCH}_3][\text{H}^+]$
- (C) $\text{Rate} = k[\text{CH}_3\text{COCH}_3][\text{Br}_2]$
- (D) $\text{Rate} = k[\text{CH}_3\text{COCH}_3][\text{Br}_2][\text{H}^+]^2$

10. What volume of oxygen gas (O_2) measured at 0°C and 1 atm, is needed to burn completely 1 L of propane gas (C_3H_8) measured under the same conditions?

- (A) 10 L
- (B) 7 L
- (C) 6 L
- (D) 5 L

11. Bond dissociation enthalpy of H_2 , Cl_2 and HCl are 434, 242 and 431 kJ mol^{-1} respectively. Enthalpy of formation of HCl is

- (A) 245 kJ mol^{-1}
- (B) 93 kJ mol^{-1}
- (C) -245 kJ mol^{-1}
- (D) -93 kJ mol^{-1}

12. Equal volumes of three acid solutions of pH 3, 4 and 5 are mixed in a vessel. What will be the H^+ ion concentration in the mixture?

- (A) $1.11 \times 10^{-3} \text{ M}$
- (B) $1.11 \times 10^{-4} \text{ M}$
- (C) $3.7 \times 10^{-4} \text{ M}$
- (D) $3.7 \times 10^{-3} \text{ M}$

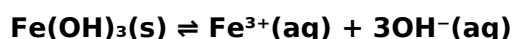
13. The values of K_{p1} and K_{p2} for the reactions



are in ratio of 9 : 1. If degree of dissociation of X and A be equal, then total pressure at equilibrium (1) and (2) are in the ratio

- (A) 1 : 1
- (B) 3 : 1
- (C) 1 : 9
- (D) 36 : 1

14. If the concentration of OH^- ions in the reaction



is decreased by $1/4$ times, then equilibrium concentration of Fe^{3+} will increase by

- (A) 4 times
- (B) 8 times
- (C) 16 times
- (D) 64 times

15. For the gas phase reaction, $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$, which of the following conditions is correct?

- (A) $\Delta H > 0$ and $\Delta S < 0$
- (B) $\Delta H = 0$ and $\Delta S < 0$
- (C) $\Delta H > 0$ and $\Delta S > 0$
- (D) $\Delta H < 0$ and $\Delta S < 0$

16. The rate constants k_1 and k_2 for two different reactions are $10^{16} \cdot e^{(-2000/T)}$ and $10^{15} \cdot e^{(-1000/T)}$ respectively. The temperature at which $k_1 = k_2$ is

- (A) $(1000/2.303) \text{ K}$
- (B) 1000 K
- (C) $(2000/2.303) \text{ K}$
- (D) 2000 K

17. Standard free energies of formation (in kJ/mol) at 298 K are -237.2 , -394.4 and -8.2 for $H_2O(l)$, $CO_2(g)$ and pentane(g) respectively. The value of E°_{cell} for the pentane-oxygen fuel cell is

- (A) 0.0968 V
- (B) 1.968 V
- (C) 2.0968 V
- (D) 1.0968 V

**18. The dissociation equilibrium of a gas AB_2 can be represented as,
 $2AB_2(g) \rightleftharpoons 2AB(g) + B_2(g)$**

The degree of dissociation is 'x' and is small compared to 1. The expression relating the degree of dissociation (x) with equilibrium constant K_p and total pressure P is

- (A) (K_p/P)
- (B) $(2K_p/P)$
- (C) $(2K_p/P)^{(1/3)}$
- (D) $(2K_p/P)^{(1/2)}$

19. The sequence of ionic mobility in aqueous solution is

- (A) $Na^+ > K^+ > Rb^+ > Cs^+$
- (B) $K^+ > Na^+ > Rb^+ > Cs^+$
- (C) $Cs^+ > Rb^+ > K^+ > Na^+$
- (D) $Rb^+ > K^+ > Cs^+ > Na^+$

20. Percentage of free space in a body centred cubic unit cell is

- (A) 28%
- (B) 30%
- (C) 32%
- (D) 34%

21. The correct order of decreasing second ionisation enthalpy of Ti (22), V (23), Cr (24) and Mn (25) is

- (A) $Ti > V > Cr > Mn$
- (B) $Cr > Mn > V > Ti$
- (C) $V > Mn > Cr > Ti$
- (D) $Mn > Cr > Ti > V$

22. How many moles of lead (II) chloride will be formed from a reaction between 6.5 g of PbO and 3.2 g of HCl ?

- (A) 0.029
- (B) 0.044
- (C) 0.333
- (D) 0.011

23. Volume occupied by one molecule of water (density = 1 g cm^{-3}) is

- (A) $5.5 \times 10^{-23} \text{ cm}^3$
- (B) $9.0 \times 10^{-23} \text{ cm}^3$
- (C) $6.023 \times 10^{-23} \text{ cm}^3$
- (D) $3.0 \times 10^{-23} \text{ cm}^3$

24. Number of moles of MnO_4^- required to oxidize one mole of ferrous oxalate completely in acidic medium will be

- (A) 0.2 moles
- (B) 0.6 moles
- (C) 0.4 moles
- (D) 7.5 moles

25. On the basis of the following E° values, the strongest oxidizing agent is
 $[\text{Fe}(\text{CN})_6]^{4-} \rightarrow [\text{Fe}(\text{CN})_6]^{3-} + e^-$; $E^\circ = -0.35 \text{ V}$
 $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+} + e^-$; $E^\circ = -0.77 \text{ V}$

- (A) $[\text{Fe}(\text{CN})_6]^{3-}$
- (B) $[\text{Fe}(\text{CN})_6]^{4-}$
- (C) Fe^{2+}
- (D) Fe^{3+}

26. The alkali metals form salt-like hydrides by the direct synthesis at elevated temperature. The thermal stability of these hydrides decreases in which of the following orders?

- (A) $\text{LiH} > \text{NaH} > \text{KH} > \text{RbH} > \text{CsH}$
- (B) $\text{CsH} > \text{RbH} > \text{KH} > \text{NaH} > \text{LiH}$
- (C) $\text{KH} > \text{NaH} > \text{LiH} > \text{CsH} > \text{RbH}$
- (D) $\text{NaH} > \text{LiH} > \text{KH} > \text{RbH} > \text{CsH}$

27. In which of the following coordination entities the magnitude of Δ_o (CFSE in octahedral field) will be maximum? (at. no. Co = 27)

- (A) $[\text{Co}(\text{C}_2\text{O}_4)_3]^{3-}$
- (B) $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$
- (C) $[\text{Co}(\text{NH}_3)_6]^{3+}$
- (D) $[\text{Co}(\text{CN})_6]^{3-}$

28. The angular shape of ozone molecule (O_3) consists of

- (A) 2 sigma and 1 pi bond
- (B) 1 sigma and 2 pi bonds
- (C) 2 sigma and 2 pi bonds
- (D) 1 sigma and 1 pi bond

29. The correct order of increasing bond angles in the following triatomic species is

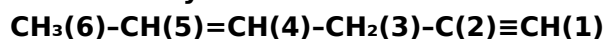
- (A) $\text{NO}_2^+ < \text{NO}_2^- < \text{NO}_2$
- (B) $\text{NO}_2^- < \text{NO}_2^+ < \text{NO}_2$
- (C) $\text{NO}_2^- < \text{NO}_2 < \text{NO}_2^+$
- (D) $\text{NO}_2^+ < \text{NO}_2 < \text{NO}_2^-$

30. Four diatomic species are listed below in different sequences. Which of these presents the correct order of their increasing bond order?

- (A) $\text{He}_2^+ < \text{O}_2^- < \text{NO} < \text{C}_2^{2-}$
- (B) $\text{O}_2^- < \text{NO} < \text{C}_2^{2-} < \text{He}_2^+$
- (C) $\text{NO} < \text{C}_2^{2-} < \text{O}_2^- < \text{He}_2^+$
- (D) $\text{C}_2^{2-} < \text{He}_2^+ < \text{NO} < \text{O}_2^-$

31. Equimolar solutions of the following were prepared in water separately. Which one of the solutions will record the highest pH?

- (A) CaCl_2
- (B) SrCl_2
- (C) BaCl_2
- (D) MgCl_2

32. In the hydrocarbon**The state of hybridization of carbons 1, 3 and 5 are in the following sequence**

- (A) sp^3 , sp^2 , sp
- (B) sp^2 , sp , sp^3
- (C) sp , sp^3 , sp^2
- (D) sp , sp^2 , sp^3

33. Green chemistry means such reactions which

- (A) Study the reactions in plants
- (B) Produce colour during reactions
- (C) Reduce the use and production of hazardous chemicals
- (D) Are related to the depletion of ozone layer

34. A strong base can abstract an α -hydrogen from

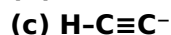
- (A) Alkane
- (B) Alkene
- (C) Amine
- (D) Ketone

35. How many stereoisomers does the molecule have?

- (A) 2
- (B) 4
- (C) 6
- (D) 8

36. The relative reactivities of acyl compounds towards nucleophilic substitution are in the order of

- (A) Acyl chloride > Ester > Acid anhydride > Amide
- (B) Acyl chloride > Acid anhydride > Ester > Amide
- (C) Ester > Acyl chloride > Amide > Acid anhydride
- (D) Acid anhydride > Amide > Ester > Acyl chloride

37. Base strength of**is in the order of**

- (A) $a > b > c$
- (B) $b > a > c$
- (C) $c > b > a$
- (D) $a > c > b$

38. In DNA, the complementary bases are

- (A) Uracil and adenine; cytosine and guanine
- (B) Adenine and thymine; guanine and cytosine
- (C) Adenine and thymine; guanine and uracil
- (D) Adenine and guanine; thymine and cytosine

39. Which one of the following is most reactive towards electrophilic attack?

- (A) Chlorobenzene ($\text{C}_6\text{H}_5\text{Cl}$)
- (B) Benzyl alcohol ($\text{C}_6\text{H}_5\text{CH}_2\text{OH}$)
- (C) Nitrobenzene ($\text{C}_6\text{H}_5\text{NO}_2$)
- (D) Phenol ($\text{C}_6\text{H}_5\text{OH}$)

40. An organic compound contains carbon, hydrogen and oxygen. Its elemental analysis gave C, 38.71% and H, 9.67%. The empirical formula of the compound would be

- (A) CH_4O
- (B) CH_3O
- (C) CH_2O
- (D) CHO

41. In a $\text{S}_\text{N}2$ substitution reaction of the type



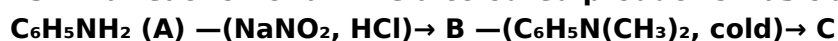
Which one of the following has the highest relative rate?

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

42. Acetophenone when reacted with a base, $\text{C}_2\text{H}_5\text{ONa}$, yields a stable compound which has the structure?

- (A) $\text{C}_6\text{H}_5\text{-CH(OH)-CH(OH)-C}_6\text{H}_5$
- (B) $\text{C}_6\text{H}_5\text{-C(CH}_3\text{)=CH-CO-C}_6\text{H}_5$
- (C) $\text{C}_6\text{H}_5\text{-CH(CH}_3\text{)-CH}_2\text{-CO-C}_6\text{H}_5$
- (D) $\text{C}_6\text{H}_5\text{-C(CH}_3\text{)(OH)-C(CH}_3\text{)(OH)-C}_6\text{H}_5$

43. In a reaction of aniline a coloured product C was obtained.



The structure of C would be

- (A) $\text{C}_6\text{H}_5\text{-N=N-C}_6\text{H}_4\text{-N(CH}_3\text{)}_2$ (para)
- (B) $\text{C}_6\text{H}_5\text{-N=N-CH}_2\text{-N(CH}_3\text{)-C}_6\text{H}_5$
- (C) $2\text{-CH}_3\text{C}_6\text{H}_4\text{-N=N-C}_6\text{H}_4\text{-2-CH}_3$
- (D) $\text{C}_6\text{H}_5\text{-NH-NH-C}_6\text{H}_4\text{-N(CH}_3\text{)}_2$ (para)

44. Which of the following statements is not true?

- (A) Natural rubber is a 1,4-polymer of isoprene
- (B) In vulcanization, the formation of sulphur bridges between different chains make rubber harder and stronger
- (C) Natural rubber has the trans-configuration at every double bond
- (D) Buna-S is a copolymer of butadiene and styrene

45. Which one of the following is an amine hormone?

- (A) Progesterone
- (B) Thyroxine
- (C) Oxypurin
- (D) Insulin

Answer key and explanations

1. Answer: (A) 1.27 Å

In fcc, atoms touch along the face diagonal: $4r = \sqrt{2}a$, so $r = a/(\sqrt{2}) = 3.6/2.828 \approx 1.27 \text{ Å}$. 1.81 Å is just $a/2$, which applies to simple cubic.

2. Answer: (B) $(1/2m)\sqrt{(h/\pi)}$

$\Delta x \cdot \Delta p = h/4\pi$ with $\Delta x = \Delta p$ gives $\Delta p^2 = h/4\pi$, so $\Delta p = (1/2)\sqrt{(h/\pi)}$. Then $\Delta v = \Delta p/m = (1/2m)\sqrt{(h/\pi)}$. The forms without m are momenta, not velocities.

3. Answer: (D) Kinetic energy of molecules remains the same

The average kinetic energy of gas molecules is $(3/2)kT$ and depends only on temperature, so at constant temperature it stays the same. In an isothermal expansion the pressure actually falls (Boyle's law), and the number of molecules is fixed.

4. Answer: (C) 1/64

Doubling the given reaction gives $2\text{HI} \rightleftharpoons \text{H}_2 + \text{I}_2$ with $K = 8^2 = 64$. Reversing it gives $\text{H}_2 + \text{I}_2 \rightleftharpoons 2\text{HI}$ with $K = 1/64$. 1/8 only reverses the reaction and forgets that doubling the equation squares K .

5. Answer: (B) $(1/2)a : (\sqrt{3}/4)a : (1/(2\sqrt{2}))a$

Simple cubic: atoms touch along the edge, $2r = a$, so $r = a/2$. bcc: they touch along the body diagonal, $4r = \sqrt{3}a$, so $r = (\sqrt{3}/4)a$. fcc: they touch along the face diagonal, $4r = \sqrt{2}a$, so $r = a/(2\sqrt{2})$. The $(\sqrt{3}/2)a$ and $(\sqrt{2}/2)a$ forms forget that the diagonal spans four radii.

6. Answer: (A) Infinite dilution, each ion makes definite contribution to equivalent conductance of an electrolyte, whatever be the nature of the other ion of the electrolyte

Kohlrausch's law of independent migration says that at infinite dilution each ion contributes a fixed amount to the limiting equivalent (or molar) conductivity, whatever the other ion is. It does not hold at finite dilution, where interionic attractions matter, and it is stated for equivalent/molar conductance, not plain conductance.

7. Answer: (B) $1 \times 10^9 \text{ cm s}^{-1}$

$\Delta v = \Delta p/m = (1 \times 10^{-18} \text{ g cm s}^{-1})/(9 \times 10^{-28} \text{ g}) \approx 1.1 \times 10^9 \text{ cm s}^{-1}$. Both quantities are already in CGS units, so no conversion is needed, and converting only one of them gives the wrong power of ten.

8. Answer: (A) (II) and (III)

Heat q and work w depend on the path, so they are not state functions. Their sum $q + w$ equals ΔU , and $H - TS$ is the Gibbs energy G ; both depend only on the state. So only q and w are not state functions.

9. Answer: (B) Rate = $k[\text{CH}_3\text{COCH}_3][\text{H}^+]$

Runs 1 and 2: doubling $[\text{Br}_2]$ leaves the rate unchanged, so the reaction is zero order in Br_2 . Runs 2 and 3: doubling $[\text{H}^+]$ doubles the rate, so it is first order in H^+ . Run 4 checks acetone: $5.7 \times 10^{-5} \times (0.40/0.30) \times (0.20/0.05) \approx 3.0 \times 10^{-4}$, matching 3.1×10^{-4} , so it is first order in acetone. Rate = $k[\text{CH}_3\text{COCH}_3][\text{H}^+]$; any form containing $[\text{Br}_2]$ contradicts runs 1 and 2.

10. Answer: (D) 5 L

$\text{C}_3\text{H}_8 + 5\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O}$. At the same temperature and pressure, volumes are in the same ratio as moles, so 1 L of propane needs 5 L of O_2 . 7 L comes from adding the volumes of the products, which is not what the question asks.

11. Answer: (D) -93 kJ mol^{-1}

For $\frac{1}{2}\text{H}_2 + \frac{1}{2}\text{Cl}_2 \rightarrow \text{HCl}$, $\Delta H_f = \frac{1}{2}(434) + \frac{1}{2}(242) - 431 = 338 - 431 = -93 \text{ kJ mol}^{-1}$. The ± 245 values come from using the full bond enthalpies of H_2 and Cl_2 with only one H-Cl bond ($434 + 242 - 431 = 245$); that equation actually forms 2 mol HCl.

12. Answer: (C) $3.7 \times 10^{-4} \text{ M}$

With equal volumes V , total $\text{H}^+ = (10^{-3} + 10^{-4} + 10^{-5})V = 1.11 \times 10^{-3} V \text{ mol}$ in a total volume $3V$. $[\text{H}^+] = 1.11 \times 10^{-3}/3 = 3.7 \times 10^{-4} \text{ M}$. $1.11 \times 10^{-3} \text{ M}$ forgets the threefold dilution.

13. Answer: (D) 36 : 1

With degree of dissociation α : for the first reaction, moles $1 - \alpha$, α , α (total $1 + \alpha$) give $K_{p1} = \alpha^2 P_1/(1 - \alpha^2)$. For the second reaction, moles $1 - \alpha$, 2α (total $1 + \alpha$) give $K_{p2} = 4\alpha^2 P_2/(1 - \alpha^2)$. Then $K_{p1}/K_{p2} = P_1/(4P_2) = 9$, so $P_1 : P_2 = 36 : 1$. 9 : 1 would forget the factor 4 from $(2\alpha)^2$.

14. Answer: (D) 64 times

$K = [\text{Fe}^{3+}][\text{OH}^-]^3$ is constant (the solid does not appear). If $[\text{OH}^-]$ becomes one quarter, $[\text{OH}^-]^3$ falls by $4^3 = 64$, so $[\text{Fe}^{3+}]$ must increase 64 times. 4 times ignores the cube from the coefficient 3.

15. Answer: (C) $\Delta H > 0$ and $\Delta S > 0$

Dissociation of PCl_5 breaks P-Cl bonds, so it absorbs heat ($\Delta H > 0$). One mole of gas gives two moles of gas, so disorder increases ($\Delta S > 0$). A negative ΔS would require fewer gas molecules on the product side.

16. Answer: (A) (1000/2.303) K

Setting $10^{16}e^{-(2000/T)} = 10^{15}e^{-(1000/T)}$ gives $10 = e^{(1000/T)}$, so $1000/T = \ln 10 = 2.303$ and $T = 1000/2.303 \text{ K} \approx 434 \text{ K}$. 1000 K would come from wrongly taking $\ln 10$ as 1.

17. Answer: (D) 1.0968 V

$\text{C}_5\text{H}_{12} + 8\text{O}_2 \rightarrow 5\text{CO}_2 + 6\text{H}_2\text{O}$. $\Delta G^\circ = 5(-394.4) + 6(-237.2) - (-8.2) = -3387.0 \text{ kJ}$. Eight O_2 molecules take 4 electrons each, so $n = 32$, and $E^\circ = -\Delta G^\circ/nF = 3387000/(32 \times 96500) \approx 1.0968 \text{ V}$. Using a smaller n (for example 16) would double the voltage to about 2.19 V, which is not offered.

18. Answer: (C) $(2K_p/P)^{1/3}$

Starting with 1 mol AB_2 : $\text{AB}_2 = 1 - x$, $\text{AB} = x$, $\text{B}_2 = x/2$, total = $1 + x/2 \approx 1$. $K_p = (xP)^2(xP/2)/(P)^2 = x^3P/2$, so $x = (2K_p/P)^{1/3}$. The square-root form would hold for a reaction where x enters only as x^2 , e.g. $\text{AB}_2 \rightleftharpoons \text{AB} + \text{B}$.

19. Answer: (C) $\text{Cs}^+ > \text{Rb}^+ > \text{K}^+ > \text{Na}^+$

Smaller ions have higher charge density and hold a larger shell of water molecules, so the hydrated Na^+ ion is the bulkiest and moves slowest. Mobility therefore increases down the group: $\text{Cs}^+ > \text{Rb}^+ > \text{K}^+ > \text{Na}^+$. $\text{Na}^+ > \dots > \text{Cs}^+$ follows bare ionic size and ignores hydration.

20. Answer: (C) 32%

In bcc, 2 atoms of radius $r = \sqrt{3}a/4$ occupy $2 \times (4/3)\pi r^3 = (\sqrt{3}\pi/8)a^3 \approx 0.68a^3$, a packing efficiency of 68%. The free space is $100 - 68 = 32\%$. 26% would be the value for fcc/hcp.

21. Answer: (B) $\text{Cr} > \text{Mn} > \text{V} > \text{Ti}$

The second electron is removed from M^+ . Cr^+ is $3d^5$, a stable half-filled shell, so removing a 3d electron costs the most. Mn^+ ($3d^5 4s^1$) loses its 4s electron more easily, and V^+ and Ti^+ follow in order of nuclear charge. Observed values ($\approx 1590, 1510, 1410, 1310 \text{ kJ mol}^{-1}$) give $\text{Cr} > \text{Mn} > \text{V} > \text{Ti}$. $\text{Mn} > \text{Cr}$ would hold for the third, not the second, ionisation enthalpy.

22. Answer: (A) 0.029

$\text{PbO} + 2\text{HCl} \rightarrow \text{PbCl}_2 + \text{H}_2\text{O}$. Moles of $\text{PbO} = 6.5/223 \approx 0.029$, and of $\text{HCl} = 3.2/36.5 \approx 0.088$, more than the 0.058 needed. PbO is the limiting reagent, so 0.029 mol PbCl_2 forms. 0.044 would wrongly treat HCl as limiting (0.088/2).

23. Answer: (D) $3.0 \times 10^{-23} \text{ cm}^3$

One mole of water (18 g) occupies 18 cm^3 at density 1 g cm^{-3} . Volume per molecule = $18/(6.022 \times 10^{23}) \approx 3.0 \times 10^{-23} \text{ cm}^3$. $6.023 \times 10^{-23} \text{ cm}^3$ just reuses the digits of Avogadro's number.

24. Answer: (B) 0.6 moles

In FeC_2O_4 both parts are oxidised: $\text{Fe}^{2+} \rightarrow \text{Fe}^{3+}$ (1 e^-) and $\text{C}_2\text{O}_4^{2-} \rightarrow 2\text{CO}_2$ (2 e^-), so 3 electrons per mole. Each $\text{MnO}_4^- \rightarrow \text{Mn}^{2+}$ takes 5 electrons, so $3/5 = 0.6 \text{ mol MnO}_4^-$ is needed. 0.4 mol counts only the oxalate electrons.

25. Answer: (D) Fe^{3+}

The values given are oxidation potentials, so the reduction potentials are +0.35 V for $[\text{Fe}(\text{CN})_6]^{3-}/[\text{Fe}(\text{CN})_6]^{4-}$ and +0.77 V for $\text{Fe}^{3+}/\text{Fe}^{2+}$. The species with the higher reduction potential is the stronger oxidising agent, so Fe^{3+} . $[\text{Fe}(\text{CN})_6]^{4-}$ and Fe^{2+} are the reduced forms and act as reducing agents.

26. Answer: (A) $\text{LiH} > \text{NaH} > \text{KH} > \text{RbH} > \text{CsH}$

Down the group the cation gets larger, the lattice energy of the ionic hydride falls and the M-H interaction weakens, so the hydrides decompose more easily. Thermal stability decreases $\text{LiH} > \text{NaH} > \text{KH} > \text{RbH} > \text{CsH}$. The reverse order would follow increasing metallic character, not the stability of the hydride.

27. Answer: (D) $[\text{Co}(\text{CN})_6]^{3-}$

For the same metal ion (Co^{3+}), Δ_o depends on the ligand's place in the spectrochemical series, where CN^- is the strongest-field ligand here, well above NH_3 , H_2O and oxalate. So $[\text{Co}(\text{CN})_6]^{3-}$ has the largest splitting. $[\text{Co}(\text{NH}_3)_6]^{3+}$ is a strong-field complex too, but ammonia splits less than cyanide.

28. Answer: (A) 2 sigma and 1 pi bond

Ozone has two O-O σ bonds forming the bent skeleton, and one π bond that is delocalised over the three atoms by resonance (each O-O has bond order 1.5). Two π bonds would require one $\text{O}=\text{O}$ on each side, which is not the structure.

29. Answer: (C) $\text{NO}_2^- < \text{NO}_2 < \text{NO}_2^+$

NO_2^+ has no non-bonding electrons on N and is linear (180°). NO_2 has a single unpaired electron on N (about 134°), and NO_2^- has a full lone pair that repels more strongly (about 115°). So the increasing order is $\text{NO}_2^- < \text{NO}_2 < \text{NO}_2^+$. The reverse order wrongly treats the linear cation as the most bent.

30. Answer: (A) $\text{He}_2^+ < \text{O}_2^- < \text{NO} < \text{C}_2^{2-}$

From MO theory: He_2^+ ($3 e^-$) has bond order 0.5, O_2^- ($17 e^-$) 1.5, NO ($15 e^-$) 2.5, and C_2^{2-} ($14 e^-$, like N_2) 3. The increasing order is $\text{He}_2^+ < \text{O}_2^- < \text{NO} < \text{C}_2^{2-}$. Placing He_2^+ last mistakes its weak half bond for a strong one.

31. Answer: (C) BaCl_2

Small, highly polarising cations such as Mg^{2+} hydrolyse water slightly and make the solution acidic. This tendency falls down the group as the cation grows, and Ba^{2+} hardly hydrolyses, so BaCl_2 is nearly neutral and has the highest pH. MgCl_2 gives the lowest pH.

32. Answer: (C) sp, sp^3 , sp^2

C-1 is part of the $\text{C}\equiv\text{C}$ triple bond (sp), C-3 is a CH_2 with only single bonds (sp^3), and C-5 is part of the $\text{C}=\text{C}$ double bond (sp^2). The sp, sp^2 , sp^3 sequence wrongly gives C-3 a double bond.

33. Answer: (C) Reduce the use and production of hazardous chemicals

Green chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances. The word 'green' does not refer to plants, colour, or ozone depletion.

34. Answer: (D) Ketone

The α -hydrogen of a ketone is acidic (pK_a about 19–20), because the carbanion formed is stabilised as a resonance enolate by the $\text{C}=\text{O}$ group. Alkanes, alkenes and amines have no such electron-withdrawing group to stabilise the carbanion.

35. Answer: (B) 4

The $\text{C}=\text{C}$ bond has two different groups on each carbon, so it shows cis-trans isomerism (2 forms). The CHBr carbon carries H, Br, CH_3 and $\text{CH}_2\text{CH}=\text{CHCH}_3$, so it is a stereocentre (2 forms). These are independent, giving $2 \times 2 = 4$ stereoisomers. Counting only one source of isomerism would give 2.

36. Answer: (B) Acyl chloride > Acid anhydride > Ester > Amide

Reactivity in nucleophilic acyl substitution follows how easily the leaving group departs: $\text{Cl}^- > \text{RCOO}^- > \text{RO}^- > \text{NH}_2^-$, the weaker the base the better. So acyl chloride > acid anhydride > ester > amide. Placing ester above anhydride ignores that carboxylate is a better leaving group than alkoxide.

37. Answer: (A) $a > b > c$

The conjugate acids get more acidic from ethane (sp^3) to ethene (sp^2) to ethyne (sp), because more s-character holds the lone pair more tightly. The stronger the conjugate acid, the weaker the base, so the basicity order is ethyl > vinyl > acetylide anion. The reverse order (acetylide strongest) is the stability order, not the base strength.

38. Answer: (B) Adenine and thymine; guanine and cytosine

In DNA, adenine pairs with thymine (two hydrogen bonds) and guanine pairs with cytosine (three hydrogen bonds). Uracil occurs in RNA, not DNA, and adenine with guanine would pair two purines, which does not fit the helix.

39. Answer: (D) Phenol ($\text{C}_6\text{H}_5\text{OH}$)

The $-\text{OH}$ group of phenol donates its lone pair into the ring (+R effect), which strongly activates the ring towards electrophiles. $-\text{CH}_2\text{OH}$ is only weakly activating, $-\text{Cl}$ deactivates by its $-I$ effect, and $-\text{NO}_2$ strongly deactivates.

40. Answer: (B) CH_3O

$\text{O} = 100 - 38.71 - 9.67 = 51.62\%$. Moles: $\text{C} = 38.71/12 = 3.23$, $\text{H} = 9.67/1 = 9.67$, $\text{O} = 51.62/16 = 3.23$, a ratio of $1 : 3 : 1$, so the empirical formula is CH_3O . CH_4O (methanol) would need about 12.5% H.

41. Answer: (A) $\text{CH}_3\text{CH}_2\text{Br}$

$\text{S}_\text{N}2$ needs backside attack at the carbon bearing Br, so it slows as branching near that carbon increases steric hindrance. Ethyl bromide is the least hindered, so it reacts fastest. The neopentyl-type $(\text{CH}_3)_3\text{C}-\text{CH}_2\text{Br}$, though primary, is extremely hindered and reacts slowest.

42. Answer: (B) $\text{C}_6\text{H}_5-\text{C}(\text{CH}_3)=\text{CH}-\text{CO}-\text{C}_6\text{H}_5$

Ethoxide removes an α -hydrogen from the CH_3 group, and the enolate attacks a second acetophenone (aldol addition). The β -hydroxy ketone then dehydrates to the conjugated α,β -unsaturated ketone $\text{C}_6\text{H}_5\text{C}(\text{CH}_3)=\text{CH}-\text{CO}-\text{C}_6\text{H}_5$, which is stabilised by conjugation. The diols are pinacol-type reduction products, not products of base-catalysed condensation.

43. Answer: (A) $\text{C}_6\text{H}_5\text{-N=N-C}_6\text{H}_4\text{-N(CH}_3)_2$ (para)

Diazotisation of aniline gives benzenediazonium chloride, the intermediate B. In the cold it couples with N,N-dimethylaniline at the activated para position, giving the coloured azo dye p-(dimethylamino)azobenzene. The -NH-NH- (hydrazo) compound has no N=N chromophore, so it would not be the coloured coupling product.

44. Answer: (C) Natural rubber has the trans-configuration at every double bond

Natural rubber is cis-1,4-polyisoprene, so saying it has the trans configuration at every double bond is false; the all-trans polymer is gutta-percha. The other statements are true: vulcanization cross-links chains with sulphur, and Buna-S is a butadiene-styrene copolymer.

45. Answer: (B) Thyroxine

Thyroxine is made from the amino acid tyrosine and is classed as an amino acid-derived (amine) hormone. Progesterone is a steroid hormone, insulin is a polypeptide, and oxypurin is a purine derivative, not a hormone.

Questions as set in the AIPMT/NEET papers conducted by CBSE and NTA. Answers checked and explanations written by the RankUp team. RankUp is not affiliated with CBSE or NTA.