

AIPMT 2015 — Chemistry Question Paper with Solutions

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

AIPMT 2015

1. The enolic form of ethyl acetoacetate, $\text{CH}_3\text{-C(OH)=CH-COOC}_2\text{H}_5$ (in equilibrium with the keto form $\text{CH}_3\text{-CO-CH}_2\text{-COOC}_2\text{H}_5$), has:

- (A) 9 sigma bonds and 1 pi - bond
- (B) 18 sigma bonds and 2 pi - bonds
- (C) 16 sigma bonds and 1 pi-bond
- (D) 9 sigma bonds and 2 pi - bonds

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2. Which of the following species contain equal number of σ - and π -bonds?

- (A) $\text{CH}_2(\text{CN})_2$
- (B) HCO_3^-
- (C) XeO_4
- (D) $(\text{CN})_2$

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3. The correct bond order in the following species is:

- (A) $\text{O}_2^- < \text{O}_2^+ < \text{O}_2^{2+}$
- (B) $\text{O}_2^{2+} < \text{O}_2^+ < \text{O}_2^-$
- (C) $\text{O}_2^{2+} < \text{O}_2^- < \text{O}_2^+$
- (D) $\text{O}_2^+ < \text{O}_2^- < \text{O}_2^{2+}$

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4. Which of these statements about $[\text{Co}(\text{CN})_6]^{3-}$ is true?

- (A) $[\text{Co}(\text{CN})_6]^{3-}$ has no unpaired electrons and will be in a high-spin configuration
- (B) $[\text{Co}(\text{CN})_6]^{3-}$ has no unpaired electrons and will be in a low-spin configuration
- (C) $[\text{Co}(\text{CN})_6]^{3-}$ has four unpaired electrons and will be in a low-spin configuration
- (D) $[\text{Co}(\text{CN})_6]^{3-}$ has four unpaired electrons and will be in a high-spin configuration

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5. The activation energy of a reaction can be determined from the slope of which of the following graphs?

- (A) $T/\ln K$ vs. $1/T$
- (B) $\ln K$ vs. T
- (C) $\ln K/T$ vs. T
- (D) $\ln K$ vs. $1/T$

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6. The reaction $(\text{CH}_3)_3\text{C-ONa} + \text{CH}_3\text{CH}_2\text{Cl} \rightarrow (\text{CH}_3)_3\text{C-O-CH}_2\text{CH}_3 + \text{NaCl}$ is called:

- (A) Gatterman - Koch reaction
- (B) Williamson Synthesis
- (C) Williamson continuous etherification process
- (D) Etard reaction

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7. Which one is not equal to zero for an ideal solution?

- (A) $\Delta P = P(\text{observed}) - P(\text{Raoult})$
- (B) $\Delta H(\text{mix})$
- (C) $\Delta S(\text{mix})$
- (D) $\Delta V(\text{mix})$

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8. An organic compound 'X' having molecular formula $C_5H_{10}O$ yields phenyl hydrazone and gives negative response to the Iodoform test and Tollens' test. It produces n-pentane on reduction. 'X' could be:

- (A) n-amyl alcohol
- (B) pentanal
- (C) 2-pentanone
- (D) 3-pentanone

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9. Cobalt(III) chloride forms several octahedral complexes with ammonia. Which of the following will not give test for chloride ions with silver nitrate at $25^\circ C$?

- (A) $CoCl_3 \cdot 6NH_3$
- (B) $CoCl_3 \cdot 3NH_3$
- (C) $CoCl_3 \cdot 4NH_3$
- (D) $CoCl_3 \cdot 5NH_3$

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10. A mixture of gases contains H_2 and O_2 gases in the ratio of 1 : 4 (w/w). What is the molar ratio of the two gases in the mixture?

- (A) 2 : 1
- (B) 1 : 4
- (C) 4 : 1
- (D) 16 : 1

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11. The electrolytic reduction of nitrobenzene in strongly acidic medium produces:

- (A) Aniline
- (B) p-Aminophenol
- (C) Azoxybenzene
- (D) Azobenzene

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12. Which of the following statements is correct for a reversible process in a state of equilibrium?

- (A) $\Delta G^\circ = 2.30 RT \log K$
- (B) $\Delta G = -2.30 RT \log K$
- (C) $\Delta G = 2.30 RT \log K$
- (D) $\Delta G^\circ = -2.30 RT \log K$

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13. Which of the following pairs of ions are isoelectronic and isostructural?

- (A) ClO_3^- , SO_3^{2-}
- (B) CO_3^{2-} , SO_3^{2-}
- (C) ClO_3^- , CO_3^{2-}
- (D) SO_3^{2-} , NO_3^-

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14. The angular momentum of electron in 'd' orbital is equal to:

- (A) $0 \hbar$
- (B) $\sqrt{6} \hbar$
- (C) $\sqrt{2} \hbar$
- (D) $2\sqrt{3} \hbar$

15. Biodegradable polymer which can be produced from glycine and aminocaproic acid is:

- (A) Nylon 6,6
- (B) Nylon 2-nylon 6
- (C) PHBV
- (D) Buna-N

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16. Which of the following options represents the correct bond order?

- (A) $O_2^- < O_2 > O_2^+$
- (B) $O_2^- > O_2 > O_2^+$
- (C) $O_2^- < O_2 < O_2^+$
- (D) $O_2^- > O_2 < O_2^+$

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17. Magnetic moment 2.84 B.M. is given by : (At. Nos., Ni = 28, Ti = 22, Cr = 24, Co = 27)

- (A) Co^{2+}
- (B) Ni^{2+}
- (C) Ti^{3+}
- (D) Cr^{2+}

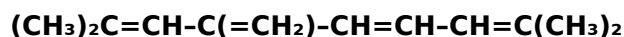
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18. A single compound of the structure $OHC-CH_2-CH(CH_3)-CH_2-CO-CH_3$ is obtainable from ozonolysis of which of the following cyclic compounds?

- (A) 1,2-Dimethylcyclopentene
- (B) 1,4-Dimethylcyclopentene
- (C) 3,4-Dimethylcyclopentene
- (D) 3,3-Dimethylcyclopentene

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19. The total number of π -bond electrons in the following structure is:



- (A) 16
- (B) 4
- (C) 8
- (D) 12

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20. The K_{sp} of Ag_2CrO_4 , $AgCl$, $AgBr$ and AgI are respectively, 1.1×10^{-12} , 1.8×10^{-10} , 5.0×10^{-13} , 8.3×10^{-17} . Which one of the following salts will precipitate last if $AgNO_3$ solution is added to the solution containing equal moles of $NaCl$, $NaBr$, NaI and Na_2CrO_4 ?

- (A) Ag_2CrO_4
- (B) AgI
- (C) $AgCl$
- (D) $AgBr$

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21. When initial concentration of a reactant is doubled in a reaction, its half-life period is not affected. The order of the reaction is:

- (A) More than zero but less than first
- (B) Zero
- (C) First
- (D) Second

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22. Which of the following processes does not involve oxidation of iron?

- (A) Liberation of H_2 from steam by iron at high temperature
- (B) Rusting of iron sheets
- (C) Decolourization of blue $CuSO_4$ solution by iron
- (D) Formation of $Fe(CO)_5$ from Fe

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23. The boiling point of 0.2 mol kg^{-1} solution of X in water is greater than equimolal solution of Y in water. Which one of the following statements is true in this case?

- (A) Y is undergoing dissociation in water while X undergoes no change
- (B) X is undergoing dissociation in water
- (C) Molecular mass of X is greater than the molecular mass of Y
- (D) Molecular mass of X is less than the molecular mass of Y

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24. In Dumas' method for estimation of nitrogen, 0.25 g of an organic compound gave 40 mL of nitrogen collected at 300 K temperature and 725 mm pressure. If the aqueous tension at 300 K is 25 mm, the percentage of nitrogen in the compound is:

- (A) 15.76
- (B) 17.36
- (C) 18.20
- (D) 16.76

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25. The species Ar, K^+ and Ca^{2+} contain the same number of electrons. In which order do their radii increase?

- (A) $K^+ < Ar < Ca^{2+}$
- (B) $Ar < K^+ < Ca^{2+}$
- (C) $Ca^{2+} < Ar < K^+$
- (D) $Ca^{2+} < K^+ < Ar$

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26. Because of lanthanoid contraction, which of the following pairs of elements have nearly same atomic radii ? (Numbers in the parenthesis are atomic numbers).

- (A) Zr (40) and Ta (73)
- (B) Ti (22) and Zr (40)
- (C) Zr (40) and Nb (41)
- (D) Zr (40) and Hf (72)

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27. The number of d-electrons in Fe^{2+} ($Z = 26$) is not equal to the number of electrons in which one of the following?

- (A) p-electrons in Ne ($Z = 10$)
- (B) s-electrons in Mg ($Z = 12$)
- (C) p-electrons in Cl ($Z = 17$)
- (D) d-electrons in Fe ($Z = 26$)

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28. Which one of the following electrolytes has the same value of van't Hoff's factor (i) as that of $Al_2(SO_4)_3$ (if all are 100% ionised)?

- (A) $K_4[Fe(CN)_6]$
- (B) K_2SO_4
- (C) $K_3[Fe(CN)_6]$
- (D) $Al(NO_3)_3$

AIPMT 2015 · Q153

29. Nitrogen dioxide and sulphur dioxide have some properties in common. Which property is shown by one of these compounds, but not by the other?

- (A) is used as a food-preservative
- (B) forms 'acid-rain'
- (C) is a reducing agent
- (D) is soluble in water

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30. Maximum bond angle at nitrogen is present in which of the following?

- (A) NO_3^-
- (B) NO_2
- (C) NO_2^-
- (D) NO_2^+

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31. The reaction of $\text{C}_6\text{H}_5\text{CH}=\text{CHCH}_3$ with HBr produces:

- (A) $\text{p-Br-C}_6\text{H}_4\text{-CH}=\text{CHCH}_3$
- (B) $\text{C}_6\text{H}_5\text{CH}(\text{Br})\text{CH}_2\text{CH}_3$
- (C) $\text{C}_6\text{H}_5\text{CH}_2\text{CH}(\text{Br})\text{CH}_3$
- (D) $\text{C}_6\text{H}_5\text{CH}_2\text{CH}_2\text{CH}_2\text{Br}$

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32. A device that converts energy of combustion of fuels like hydrogen and methane, directly into electrical energy is known as:

- (A) Ni-Cd cell
- (B) Fuel Cell
- (C) Electrolytic Cell
- (D) Dynamo

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33. If the value of an equilibrium constant for a particular reaction is 1.6×10^{12} , then at equilibrium the system will contain:

- (A) similar amounts of reactants and products
- (B) all reactants
- (C) mostly reactants
- (D) mostly products

AIPMT 2015 · Q165

34. Bithional is generally added to the soaps as an additive to function as a/an:

- (A) Antiseptic
- (B) Softener
- (C) Dryer
- (D) Buffering agent

AIPMT 2015 · Q167

35. A given metal crystallizes out with a cubic structure having edge length of 361 pm. If there are four metal atoms in one unit cell, what is the radius of one atom?

- (A) 108 pm
- (B) 40 pm
- (C) 127 pm
- (D) 80 pm

36. Which property of colloidal solution is independent of charge on the colloidal particles?

- (A) Tyndall effect
- (B) Coagulation
- (C) Electrophoresis
- (D) Electro-osmosis

37. Solubility of the alkaline earth metal sulphates in water decreases in the sequence:

- (A) Ba > Mg > Sr > Ca
- (B) Mg > Ca > Sr > Ba
- (C) Ca > Sr > Ba > Mg
- (D) Sr > Ca > Mg > Ba

Answer key and explanations

1. Answer: (B) 18 sigma bonds and 2 pi - bonds

$\text{CH}_3\text{-C(OH)=CH-COOC}_2\text{H}_5$ has 9 C-H, 4 C-C, 4 C-O and 1 O-H σ bonds = 18 σ bonds, and two π bonds (one C=C, one C=O). 9 σ bonds counts only the skeleton without hydrogens.

2. Answer: (C) XeO_4

XeO_4 has four Xe-O σ bonds and four π bonds (each Xe=O is one σ + one π). $\text{CH}_2(\text{CN})_2$ has 6 σ and 4 π , $(\text{CN})_2$ has 3 σ and 4 π , and HCO_3^- has 4 σ and 1 π .

3. Answer: (A) $\text{O}_2^- < \text{O}_2^+ < \text{O}_2^{2+}$

By MO theory O_2 has bond order 2; removing antibonding electrons raises it: $\text{O}_2^+ = 2.5$, $\text{O}_2^{2+} = 3$, while adding one gives $\text{O}_2^- = 1.5$. So $\text{O}_2^- < \text{O}_2^+ < \text{O}_2^{2+}$.

4. Answer: (B) $[\text{Co}(\text{CN})_6]^{3-}$ has no unpaired electrons and will be in a low-spin configuration

Co^{3+} is $3d^6$. CN^- is a strong-field ligand, so the electrons pair up as $t_{2g}^6e_g^0$ (d^2sp^3 , inner orbital): low spin with no unpaired electrons. Four unpaired electrons would occur only with a weak-field ligand such as F^- .

5. Answer: (D) $\ln K$ vs. $1/T$

From the Arrhenius equation $\ln k = \ln A - E_a/RT$, a plot of $\ln k$ against $1/T$ is a straight line of slope $-E_a/R$, from which E_a is found. $\ln k$ against T is curved.

6. Answer: (B) Williamson Synthesis

An alkoxide reacting with a primary alkyl halide by $\text{S}_\text{N}2$ to give an ether is the Williamson synthesis. Gattermann-Koch and Etard reactions make aromatic aldehydes, not ethers.

7. Answer: (C) ΔS_{mix}

For an ideal solution $\Delta H_{\text{mix}} = 0$, $\Delta V_{\text{mix}} = 0$ and the vapour pressure obeys Raoult's law exactly, so $\Delta P = 0$. Mixing still increases randomness, so $\Delta S_{\text{mix}} > 0$ (this is what makes ΔG_{mix} negative).

8. Answer: (D) 3-pentanone

Forming a phenylhydrazone shows a C=O group; a negative Tollens' test rules out pentanal; a negative iodoform test rules out the $\text{CH}_3\text{CO-}$ group of 2-pentanone. Reduction to n-pentane needs an unbranched chain, so X is 3-pentanone ($\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$).

9. Answer: (B) $\text{CoCl}_3 \cdot 3\text{NH}_3$

Octahedral Co(III) needs six ligands. With only three NH_3 the complex is $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$, all three Cl^- inside the coordination sphere, so no Cl^- ions are free to precipitate with AgNO_3 . The 6, 5 and 4 NH_3 complexes have 3, 2 and 1 ionisable Cl^- .

10. Answer: (C) 4 : 1

Take 1 g H_2 and 4 g O_2 : moles = $1/2 = 0.5$ and $4/32 = 0.125$. Mole ratio $0.5 : 0.125 = 4 : 1$. 1 : 4 is just the mass ratio.

11. Answer: (B) p-Aminophenol

In strongly acidic medium nitrobenzene is reduced electrolytically to phenylhydroxylamine, which rearranges in acid to p-aminophenol. Aniline is the product of complete reduction in mildly acidic conditions (e.g. Sn/HCl), and azo/azoxy compounds form in alkaline medium.

12. Answer: (D) $\Delta G^\circ = -2.30 RT \log K$

$\Delta G = \Delta G^\circ + 2.303RT \log Q$, and at equilibrium $\Delta G = 0$ with $Q = K$. So $\Delta G^\circ = -2.303RT \log K$. $\Delta G = -2.303RT \log K$ is wrong because ΔG itself is zero at equilibrium.

13. Answer: (A) ClO_3^- , SO_3^{2-}

ClO_3^- ($17 + 24 + 1 = 42$ electrons) and SO_3^{2-} ($16 + 24 + 2 = 42$) are isoelectronic, and both have three bond pairs and one lone pair, so both are pyramidal. CO_3^{2-} and NO_3^- are trigonal planar with 32 electrons.

14. Answer: (B) $\sqrt{6} \hbar$

Orbital angular momentum $= \sqrt{l(l+1)} \hbar$. For a d orbital $l = 2$, giving $\sqrt{6} \hbar$. $\sqrt{2} \hbar$ is the value for a p orbital.

15. Answer: (B) Nylon 2-nylon 6

Nylon-2-nylon-6 is an alternating polyamide copolymer of glycine ($\text{H}_2\text{N}-\text{CH}_2-\text{COOH}$) and ϵ -aminocaproic acid, and it is biodegradable. PHBV is also biodegradable but is made from 3-hydroxybutanoic and 3-hydroxypentanoic acids.

16. Answer: (C) $\text{O}_2^- < \text{O}_2 < \text{O}_2^+$

MO bond orders: $\text{O}_2^- = 1.5$, $\text{O}_2 = 2$, $\text{O}_2^+ = 2.5$, because electrons are added to or removed from the π^* antibonding orbitals. Hence $\text{O}_2^- < \text{O}_2 < \text{O}_2^+$.

17. Answer: (B) Ni^{2+}

$\mu = \sqrt{n(n+2)} = 2.84 \text{ BM}$ gives $n = 2$. Ni^{2+} ($3d^8$) has 2 unpaired electrons, whereas Ti^{3+} ($3d^1$) has 1, Co^{2+} ($3d^7$) has 3 and Cr^{2+} ($3d^4$) has 4.

18. Answer: (B) 1,4-Dimethylcyclopentene

In 1,4-dimethylcyclopentene the ring $\text{C1}(\text{CH}_3)=\text{C2}$ bond is cleaved: C1 becomes a methyl ketone and C2 an aldehyde, still joined through $\text{C5}-\text{C4}(\text{CH}_3)-\text{C3}$. This gives the single product $\text{CH}_3\text{CO}-\text{CH}_2-\text{CH}(\text{CH}_3)-\text{CH}_2-\text{CHO}$. 1,2-Dimethylcyclopentene would give a diketone.

19. Answer: (C) 8

The structure contains four $\text{C}=\text{C}$ double bonds (including the exocyclic $=\text{CH}_2$), i.e. four π bonds. Each π bond has 2 electrons, so there are 8 π electrons; 4 is the number of π bonds, not electrons.

20. Answer: (A) Ag_2CrO_4

$[\text{Ag}^+]$ needed to start precipitation (for 1 M anion): $\text{AgI } 8.3 \times 10^{-17}$, $\text{AgBr } 5.0 \times 10^{-13}$, $\text{AgCl } 1.8 \times 10^{-10}$ M, but Ag_2CrO_4 needs $\sqrt{(1.1 \times 10^{-12})} \approx 1.05 \times 10^{-6}$ M. Ag_2CrO_4 needs the highest Ag^+ , so it precipitates last even though its K_{sp} is not the largest.

21. Answer: (C) First

$t_{1/2} \propto [\text{A}]_0^{1-n}$. It is independent of the initial concentration only when $n = 1$, as in $t_{1/2} = 0.693/k$. For zero order $t_{1/2}$ doubles when $[\text{A}]_0$ doubles.

22. Answer: (D) Formation of $\text{Fe}(\text{CO})_5$ from Fe

In $\text{Fe}(\text{CO})_5$ iron is in the zero oxidation state, as in the free metal, so no oxidation occurs. Iron is oxidised in rusting, in liberating H_2 from steam (to Fe_3O_4) and in displacing Cu from CuSO_4 (to Fe^{2+}).

23. Answer: (B) X is undergoing dissociation in water

$\Delta T_b = iK_b m$. At equal molality, a higher boiling point means a larger van't Hoff factor for X, so X dissociates in water. Molecular mass does not matter once molality is fixed.

24. Answer: (D) 16.76

Dry gas pressure $= 725 - 25 = 700 \text{ mm}$. $V(\text{STP}) = 40 \times 700 \times 273 / (300 \times 760) = 33.5 \text{ mL}$; mass of $\text{N}_2 = 28 \times 33.5 / 22400 = 0.0419 \text{ g}$. $\% \text{N} = 0.0419 / 0.25 \times 100 = 16.76$. Not subtracting aqueous tension gives a higher value.

25. Answer: (D) $\text{Ca}^{2+} < \text{K}^+ < \text{Ar}$

All three have 18 electrons; the greater the nuclear charge ($\text{Ca } 20 > \text{K } 19 > \text{Ar } 18$), the more strongly the electrons are pulled in. So the radii increase $\text{Ca}^{2+} < \text{K}^+ < \text{Ar}$.

26. Answer: (D) Zr (40) and Hf (72)

The 14 lanthanoids between La and Hf cause a contraction that cancels the expected size increase from the 4d to the 5d series. So Zr (160 pm) and Hf (159 pm) have almost the same radius. Ti and Zr differ normally because no f-block intervenes.

27. Answer: (C) p-electrons in Cl (Z = 17)

Fe^{2+} is $[\text{Ar}]3d^6$, so it has 6 d-electrons. Ne has 6 p-electrons, Mg has 6 s-electrons and Fe has 6 d-electrons, but Cl ($1s^2 2s^2 2p^6 3s^2 3p^5$) has 11 p-electrons.

28. Answer: (A) $K_4[Fe(CN)_6]$

$Al_2(SO_4)_3 \rightarrow 2Al^{3+} + 3SO_4^{2-}$ gives $i = 5$. $K_4[Fe(CN)_6] \rightarrow 4K^+ + [Fe(CN)_6]^{4-}$ also gives 5 ions. $K_3[Fe(CN)_6]$ and $Al(NO_3)_3$ give 4 and K_2SO_4 gives 3.

29. Answer: (A) is used as a food-preservative

SO_2 (as sulphite/metabisulphite) is used as a food preservative, while NO_2 is not. Both are water-soluble acidic oxides that cause acid rain, and both can act as reducing agents.

30. Answer: (D) NO_2^+

NO_2^+ is isoelectronic with CO_2 and is linear (180°). NO_3^- is trigonal planar (120°), NO_2 is bent ($\sim 134^\circ$) and NO_2^- is bent ($\sim 115^\circ$) due to the lone pair.

31. Answer: (B) $C_6H_5CH(Br)CH_2CH_3$

H^+ adds to the carbon away from the ring so that the positive charge sits on the benzylic carbon, where it is stabilised by resonance with the ring. Br^- then attacks there, giving $C_6H_5CH(Br)CH_2CH_3$. Ring bromination does not occur with HBr .

32. Answer: (B) Fuel Cell

A fuel cell converts the free energy of combustion of fuels like H_2 or CH_4 directly into electricity. A Ni-Cd cell is a rechargeable storage cell, and a dynamo converts mechanical energy, not chemical.

33. Answer: (D) mostly products

$K = \frac{[\text{products}]}{[\text{reactants}]} = 1.6 \times 10^{12}$ is very large, so at equilibrium products far exceed reactants. Similar amounts would correspond to K near 1.

34. Answer: (A) Antiseptic

Bithional is added to medicated soaps as an antiseptic to reduce skin bacteria and odour. It does not soften, dry or buffer the soap.

35. Answer: (C) 127 pm

Four atoms per cubic unit cell means fcc, where atoms touch along the face diagonal: $4r = \sqrt{2}a$. So $r = \frac{\sqrt{2}}{4} \times 361 = 0.3536 \times 361 \approx 127.6 \text{ pm} \approx 127 \text{ pm}$. Using the bcc relation $\sqrt{3}a/4$ would give about 156 pm.

36. Answer: (A) Tyndall effect

The Tyndall effect is scattering of light by colloidal particles and depends on their size, not on their charge. Coagulation, electrophoresis and electro-osmosis all depend on the particle charge.

37. Answer: (B) $Mg > Ca > Sr > Ba$

Down group 2 the lattice energy of the sulphates changes little (large SO_4^{2-}), but hydration energy falls sharply as the cation grows. So solubility decreases $Mg > Ca > Sr > Ba$; $BaSO_4$ is practically insoluble.

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