

AIPMT 2010 Mains — Chemistry Question Paper with Solutions

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

AIPMT 2010 Mains · Q91

1. Among the elements Ca, Mg, P and Cl, the order of increasing atomic radii is

- (A) $\text{Mg} < \text{Ca} < \text{Cl} < \text{P}$
- (B) $\text{Cl} < \text{P} < \text{Mg} < \text{Ca}$
- (C) $\text{P} < \text{Cl} < \text{Ca} < \text{Mg}$
- (D) $\text{Ca} < \text{Mg} < \text{P} < \text{Cl}$

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2. The reaction $2\text{A}(\text{g}) + \text{B}(\text{g}) \rightleftharpoons 3\text{C}(\text{g}) + \text{D}(\text{g})$ is begun with the concentrations of A and B both at an initial value of 1.00 M. When equilibrium is reached, the concentration of D is measured and found to be 0.25 M. The value for the equilibrium constant for this reaction is given by the expression

- (A) $[(0.75)^3(0.25)] \div [(1.00)^2(1.00)]$
- (B) $[(0.75)^3(0.25)] \div [(0.50)^2(0.75)]$
- (C) $[(0.75)^3(0.25)] \div [(0.50)^2(0.25)]$
- (D) $[(0.75)^3(0.25)] \div [(0.75)^2(0.25)]$

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3. The pressure exerted by 6.0 g of methane gas in a 0.03 m^3 vessel at 129°C is (Atomic masses: C = 12.01, H = 1.01 and R = $8.314 \text{ J K}^{-1} \text{ mol}^{-1}$)

- (A) 215216 Pa
- (B) 13409 Pa
- (C) 41648 Pa
- (D) 31684 Pa

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4. Among the following four compounds

- a. Phenol
- b. Methyl phenol
- c. Metanitrophenol
- d. Paranitrophenol

The acidity order is

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

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5. Among the following which one has the highest cation to anion size ratio?

- (A) CsI
- (B) CsF
- (C) LiF
- (D) NaF

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6. Three moles of an ideal gas expanded spontaneously into vacuum. The work done will be

- (A) Infinite
- (B) 3 Joules
- (C) 9 Joules
- (D) Zero

7. Which of the following species is not electrophilic in nature?

- (A) Cl^+
- (B) BH_3
- (C) H_3O^+
- (D) NO_2^+

8. A 0.66 kg ball is moving with a speed of 100 m/s. The associated wavelength will be ($h = 6.6 \times 10^{-34} \text{ J s}$)

- (A) $6.6 \times 10^{-32} \text{ m}$
- (B) $6.6 \times 10^{-34} \text{ m}$
- (C) $1.0 \times 10^{-35} \text{ m}$
- (D) $1.0 \times 10^{-32} \text{ m}$

9. Consider the following relations for emf of an electrochemical cell:

- (a) $\text{emf of cell} = (\text{Oxidation potential of anode}) - (\text{Reduction potential of cathode})$
- (b) $\text{emf of cell} = (\text{Oxidation potential of anode}) + (\text{Reduction potential of cathode})$
- (c) $\text{emf of cell} = (\text{Reduction potential of anode}) + (\text{Reduction potential of cathode})$
- (d) $\text{emf of cell} = (\text{Oxidation potential of anode}) - (\text{Oxidation potential of cathode})$

Which of the above relations are correct?

- (A) (c) and (a)
- (B) (a) and (b)
- (C) (c) and (d)
- (D) (b) and (d)

10. In which of the following molecules the central atom does not have sp^3 hybridization?

- (A) CH_4
- (B) SF_4
- (C) BF_4^-
- (D) NH_4^+

11. For vaporization of water at 1 atmospheric pressure, the values of ΔH and ΔS are $40.63 \text{ kJ mol}^{-1}$ and $108.8 \text{ J K}^{-1} \text{ mol}^{-1}$, respectively. The temperature when Gibbs energy change (ΔG) for this transformation will be zero, is

- (A) 273.4 K
- (B) 393.4 K
- (C) 373.4 K
- (D) 293.4 K

12. Match List-I (substances) with List-II (process) employed in the manufacture of the substances and select the correct option.

List-I: a. Sulphuric acid; b. Steel; c. Sodium hydroxide; d. Ammonia

List-II: (i) Haber's Process; (ii) Bessemer's Process; (iii) Leblanc Process; (iv) Contact Process

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

13. Match the compounds given in List-I with their characteristic reactions given in List-II. Select the correct option.

List-I: a. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2$; b. $\text{CH}_3\text{C}\equiv\text{CH}$; c. $\text{CH}_3\text{CH}_2\text{COOCH}_3$; d. $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$

List-II: (i) Alkaline hydrolysis; (ii) With KOH (alcohol) and CHCl_3 produces bad smell; (iii) Gives white ppt. with ammoniacal AgNO_3 ; (iv) With Lucas reagent cloudiness appears after 5 minutes

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

14. The rate of the reaction $2\text{NO} + \text{Cl}_2 \rightarrow 2\text{NOCl}$ is given by the rate equation rate = $k[\text{NO}]^2[\text{Cl}_2]$. The value of the rate constant can be increased by

- (A) Increasing the temperature
- (B) Increasing the concentration of NO
- (C) Increasing the concentration of the Cl_2
- (D) Doing all of these

15. Which one of the following complexes is not expected to exhibit isomerism?

- (A) $[\text{Ni}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$
- (B) $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$
- (C) $[\text{Ni}(\text{NH}_3)_2\text{Cl}_2]$
- (D) $[\text{Ni}(\text{en})_3]^{2+}$

16. The IUPAC name of the compound $\text{CH}_3\text{CH}=\text{CHC}\equiv\text{CH}$ is

- (A) Pent-4-yn-2-ene
- (B) Pent-3-en-1-yne
- (C) Pent-2-en-4-yne
- (D) Pent-1-yn-3-ene

17. Which of the following oxidation states is the most common among the lanthanoids?

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

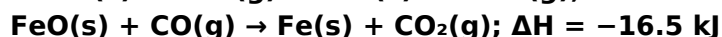
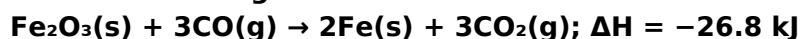
18. How many bridging oxygen atoms are present in P_4O_{10} ?

- (A) 6
- (B) 4
- (C) 2
- (D) 5

19. Some of the properties of the two species, NO_3^- and H_3O^+ are described below. Which one of them is correct?

- (A) Dissimilar in hybridization for the central atom with different structures
- (B) Isostructural with same hybridization for the central atom
- (C) Isostructural with different hybridization for the central atom
- (D) Similar in hybridization for the central atom with different structures

20. The following two reactions are known:



The value of ΔH for the following reaction $\text{Fe}_2\text{O}_3(\text{s}) + \text{CO}(\text{g}) \rightarrow 2\text{FeO}(\text{s}) + \text{CO}_2(\text{g})$ is

- (A) +10.3 kJ
- (B) -43.3 kJ
- (C) -10.3 kJ
- (D) +6.2 kJ

21. Following compounds are given



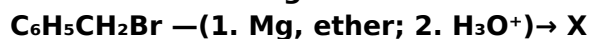
Which of the above compound(s), on being warmed with iodine solution and NaOH, will give iodoform?

- (A) a, c and d
- (B) Only b
- (C) a, b and c
- (D) a and b

22. Fructose reduces Tollens' reagent due to

- (A) Asymmetric carbons
- (B) Primary alcoholic group
- (C) Secondary alcoholic group
- (D) Enolisation of fructose followed by conversion to aldehyde by base

23. In the following reaction:



the product 'X' is

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

Answer key and explanations

1. Answer: (B) $\text{Cl} < \text{P} < \text{Mg} < \text{Ca}$

Across period 3 radius decreases ($\text{Mg} > \text{P} > \text{Cl}$), and down group 2 it increases ($\text{Ca} > \text{Mg}$). So the increasing order is $\text{Cl} < \text{P} < \text{Mg} < \text{Ca}$. Orders starting with Ca or Mg reverse the periodic trend.

2. Answer: (B) $[(0.75)^3(0.25)] \div [(0.50)^2(0.75)]$

Forming 0.25 M of D consumes 0.25 M B and 0.50 M A and forms 0.75 M C. At equilibrium $[\text{A}] = 0.50$, $[\text{B}] = 0.75$, $[\text{C}] = 0.75$, $[\text{D}] = 0.25$, so $K = (0.75)^3(0.25)/[(0.50)^2(0.75)]$. Using the initial 1.00 M values in the denominator ignores the amounts consumed.

3. Answer: (C) 41648 Pa

$n = 6.0/16.05 = 0.374 \text{ mol}$ and $T = 129 + 273 = 402 \text{ K}$. $P = nRT/V = 0.374 \times 8.314 \times 402/0.03 \approx 4.16 \times 10^4 \text{ Pa} = 41648 \text{ Pa}$. Forgetting to convert $^\circ\text{C}$ to K gives a much smaller pressure (13409 Pa).

4. Answer: (A) $\text{d} > \text{c} > \text{a} > \text{b}$

Electron-withdrawing $-\text{NO}_2$ increases acidity of phenol most from the para position ($-\text{R}$ and $-\text{I}$), less from meta ($-\text{I}$ only), while $-\text{CH}_3$ donates electrons and lowers acidity. So para-nitrophenol > meta-nitrophenol > phenol > methylphenol. Putting meta above para ignores the resonance effect.

5. Answer: (B) CsF

The ratio is largest when the cation is largest and the anion smallest: Cs^+ is the biggest cation and F^- the smallest anion, so CsF (about $167/133 \approx 1.26$). CsI has a big cation but a much bigger anion, and LiF has the smallest cation.

6. Answer: (D) Zero

Work in expansion is $w = -p(\text{ext})\Delta V$, and for free expansion into vacuum $p(\text{ext}) = 0$, so no work is done whatever the number of moles. Values like 3 J or 9 J wrongly link the work to the amount of gas.

7. Answer: (C) H_3O^+

Electrophiles are electron-deficient: Cl^+ and NO_2^+ are positive and electron-poor, and BH_3 has an empty orbital on boron. In H_3O^+ the oxygen has a complete octet and still a lone pair, so it acts as an acid (proton donor) but not as an electrophile.

8. Answer: (C) $1.0 \times 10^{-35} \text{ m}$

$\lambda = h/(mv) = 6.6 \times 10^{-34}/(0.66 \times 100) = 6.6 \times 10^{-34}/66 = 1.0 \times 10^{-35} \text{ m}$. $6.6 \times 10^{-34} \text{ m}$ comes from forgetting to divide by the momentum.

9. Answer: (D) (b) and (d)

$\text{emf} = E(\text{red, cathode}) - E(\text{red, anode})$. Since oxidation potential = $-$ reduction potential, this equals (oxidation potential of anode) + (reduction potential of cathode), and also (oxidation potential of anode) $-$ (oxidation potential of cathode). The relation subtracting the reduction potential of the cathode from the anode's oxidation potential gets the sign wrong.

10. Answer: (B) SF_4

SF_4 has 4 bond pairs and 1 lone pair on S (5 electron pairs), so S is sp^3d with a see-saw shape. CH_4 , BF_4^- and NH_4^+ all have four electron pairs and are sp^3 .

11. Answer: (C) 373.4 K

$\Delta G = \Delta H - T\Delta S = 0$ gives $T = \Delta H/\Delta S = 40630/108.8 = 373.4 \text{ K}$. Forgetting to convert kJ to J (or mixing units) gives nonsensical values; 373 K is also the normal boiling point of water, as expected.

12. Answer: (D) a(iv), b(ii), c(iii), d(i)

Sulphuric acid is made by the Contact process, steel by the Bessemer process, ammonia by Haber's process, and the Leblanc process (soda) is the one left for sodium hydroxide. This gives a(iv), b(ii), c(iii), d(i). Matching sulphuric acid with Haber's process confuses it with ammonia.

13. Answer: (C) a(ii), b(iii), c(i), d(iv)

n-Butylamine, a primary amine, gives the foul-smelling isocyanide with $\text{CHCl}_3/\text{alcoholic KOH}$; propyne, a terminal alkyne, gives a white precipitate with ammoniacal AgNO_3 ; the ester undergoes alkaline hydrolysis; 2-propanol, a secondary alcohol, turns cloudy with Lucas reagent in about 5 minutes. So a(ii), b(iii), c(i), d(iv). Assigning the silver test to the amine misses that only terminal alkynes have an acidic H.

14. Answer: (A) Increasing the temperature

The rate constant depends on temperature (Arrhenius, $k = A e^{(-E_a/RT)}$), not on concentrations. Raising concentrations of NO or Cl_2 raises the rate but leaves k unchanged.

15. Answer: (C) $[\text{Ni}(\text{NH}_3)_2\text{Cl}_2]$

$[\text{Ni}(\text{NH}_3)_2\text{Cl}_2]$ is tetrahedral, and an MA_2B_2 tetrahedral complex shows no geometrical or optical isomers. $[\text{Ni}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$ (octahedral MA_4B_2) and square planar $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]$ show cis-trans isomerism, and $[\text{Ni}(\text{en})_3]^{2+}$ is optically active.

16. Answer: (B) Pent-3-en-1-yne

Number the chain so the multiple bonds get the lowest locants: from the $\text{C}\equiv\text{CH}$ end the triple bond is at C-1 and the double bond at C-3, giving pent-3-en-1-yne. Numbering from the CH_3 end gives the higher set {2,4}, so pent-2-en-4-yne is wrong.

17. Answer: (D) 3

All lanthanoids show the +3 oxidation state, which is the characteristic and most common one. +2 (Eu, Yb) and +4 (Ce) occur only for a few elements with stable f^0 , f^7 or f^{14} configurations.

18. Answer: (A) 6

In P_4O_{10} each of the six P-P edges of the P_4 tetrahedron is bridged by an oxygen (P-O-P), and each P also carries one terminal P=O. So there are 6 bridging and 4 terminal oxygens. 4 is the number of terminal oxygens.

19. Answer: (A) Dissimilar in hybridization for the central atom with different structures

In NO_3^- nitrogen has three σ -bonds and no lone pair, so it is sp^2 and trigonal planar. In H_3O^+ oxygen has three bonds and one lone pair, so it is sp^3 and pyramidal. Thus both the hybridization and the shapes differ; they are not isostructural.

20. Answer: (D) +6.2 kJ

Target = (first equation) $- 2 \times$ (second equation): $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{FeO} + 2\text{CO}_2$ $\rightarrow 2\text{Fe} + 3\text{CO}_2 - 2\text{Fe} - 2\text{CO}_2$, i.e. $\text{Fe}_2\text{O}_3 + \text{CO} \rightarrow 2\text{FeO} + \text{CO}_2$. $\Delta H = -26.8 - 2(-16.5) = -26.8 + 33.0 = +6.2 \text{ kJ}$. -10.3 kJ comes from subtracting the second equation only once.

21. Answer: (C) a, b and c

The iodoform test is given by compounds with $\text{CH}_3\text{CO}-$ or $\text{CH}_3\text{CH}(\text{OH})-$ groups: ethanol, acetone and 2-propanol all qualify. Methanol has no such group and gives no iodoform.

22. Answer: (D) Enolisation of fructose followed by conversion to aldehyde by base

Fructose is a ketose, but in alkaline Tollens' reagent it undergoes enolisation (via an enediol) and isomerises to aldoses, which are then oxidised. The alcoholic groups or asymmetric carbons do not reduce Tollens' reagent.

23. Answer: (C) $\text{C}_6\text{H}_5\text{CH}_3$

Benzyl bromide with Mg in dry ether forms the Grignard reagent $\text{C}_6\text{H}_5\text{CH}_2\text{MgBr}$, and hydrolysis with H_3O^+ replaces MgBr by H, giving toluene $\text{C}_6\text{H}_5\text{CH}_3$. Benzyl alcohol would need reaction with O_2 or formaldehyde, not plain hydrolysis; bibenzyl is a Wurtz-type side product.

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