CHEMISTRY

SECTION - A

Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

Choose the correct answer :

1. Elements of group 13 having maximum and minimum first ionisation energy respectively are

   (1) B, In (2) Al, B

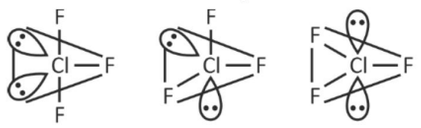
   (3) Ga, B (4) Tl, B

Answer (1)

Sol.

	B	Al	Ga	In	Tl	
(IE_1)	801	577	579	558	589	(in kJ/mol)

2. **Statement-I:** ClF_3 has 3 possible structures



(I) (II) (III)

Statement-II: III is most stable structure due to least lp-bp repulsion.

(1) Statement-I is correct and statement-II is incorrect

(2) Statement-I is incorrect and statement-II is correct

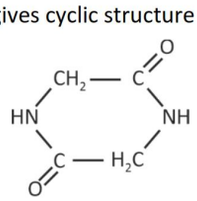
(3) Both statement-I and II are correct

(4) Both statement-I and II are incorrect

Answer (1)

Sol. lp is placed at equatorial position in stable structure.

3. x is a dipeptide which is hydrolysed to 2 amino acids y and z. y when treated with HNO_2 gives lactic acid. z when heated gives cyclic structure as below:



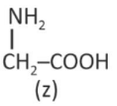
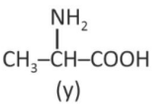
y and z respectively are

(1) Alanine and Lysine (2) Alanine and Glycine

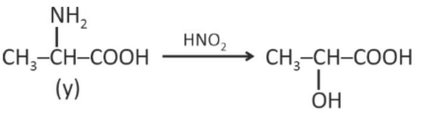
(3) Glycine and Alanine (4) Valine and Glycine

Answer (2)

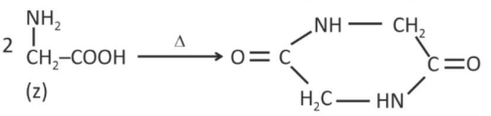
Sol.

x gives  (z) and  (y)

upon hydrolysis



(Lactic acid)

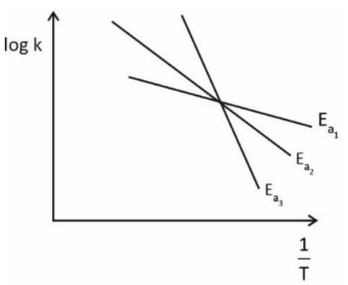


(Cyclic structure)

y = Alanine

z = Glycine

4. Consider the following graph between Rate Constant (k) and $\frac{1}{T}$.



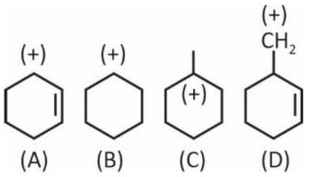
(1) $E_{a_1} > E_{a_2} > E_{a_3}$ (2) $E_{a_3} > E_{a_2} > E_{a_1}$

(3) $E_{a_3} > E_{a_1} > E_{a_2}$ (4) $E_{a_1} > E_{a_3} > E_{a_2}$

Answer (2)

Sol. $|\text{slope}| \propto E_a$

5. Arrange the following carbocation in decreasing order of their stability

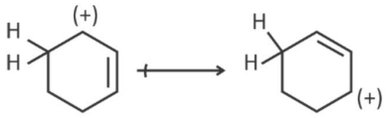


(1) (A) > (B) > (C) > (D) (2) (A) > (C) > (B) > (D)

(3) (C) > (A) > (B) > (D) (4) (B) > (C) > (A) > (D)

Answer (2)

Sol. (A) is most stable as it is stabilised by resonance as well hyperconjugation due to two α-hydrogen atoms.



(C), (B), (D) are 3°, 2° and 1° alkyl carbocations having 7,4 and 1 α-hydrogen atom. Number of hyperconjugation structure is same as the number of α-hydrogen atoms.

$\therefore$ Correct stability order is

(A) > (C) > (B) > (D)

6. Consider the following complex species

(a) $Ni(CO)_4$ (b) $[Ni(CN)_6]^{2-}$

(c) $[FeF_6]^{3-}$ (d) $[CoF_6]^{3-}$

Which of the following order is correct for their number of unpaired electrons

(1) c > d > a = b (2) c > d > a > b

(3) a > b > c > d (4) c > a > d > b

Answer (1)

Sol. (a) $Ni(CO)_4 \Rightarrow Ni^0 \Rightarrow 3d^{10}\ 4s^0$ in presence of CO ligand

No. of unpaired electron = 0

(b) $[Ni(CN)_6]^{2-}$

$Ni^{4+} \Rightarrow t_{2g}^6 e_g^0$

No. of unpaired electron = 0

(c) $[FeF_6]^{3-}$

$Fe^{3+} \Rightarrow t_{2g}^3 e_g^2$

No. of unpaired electron = 5

(d) $[CoF_6]^{3-}$

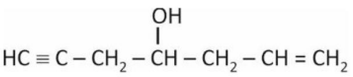
$Co^{3+} \Rightarrow t_{2g}^4 e_g^2$

No. of unpaired electron = 4

Order of no. of unpaired electron

c > d > a = b

7. The correct IUPAC name of the following compound is



(1) 4-Hydroxyhept-1-en-6-yne

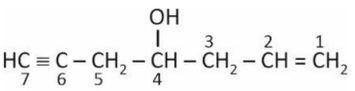
(2) 4-Hydroxyhept-6-en-1-yne

(3) 4-Hydroxyhept-1-yn-6-ene

(4) 4-Hydroxyhept-6-yn-1-ene

Answer (1)

Sol.



4-Hydroxy-hept-1-en-6-yne

8. Given below are two statements:

Statement-I: Aqueous KOH gives elimination reaction as major product always.

Statement-II: Alcoholic KOH eliminates H^+ from β-carbon atom

In the light of the above statements, choose the correct answer from the options given below:

(1) Statement-I is correct and statement-II is incorrect

(2) Statement-I is incorrect and statement-II is correct

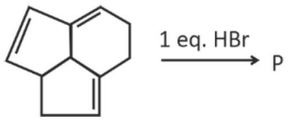
(3) Both statement-I and statement-II are correct

(4) Both statement-I and statement-II are incorrect

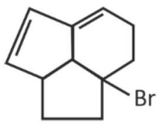
Answer (2)

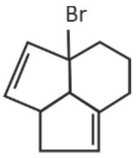
Sol. Aqueous KOH can give substitution product as major product.

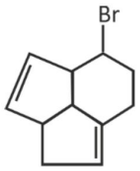
9. Consider the following reaction

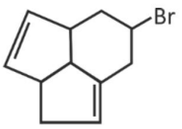


Identify the major product 'P'

(1) 

(2) 

(3) 

(4) 

Answer (2)

Sol. Product is obtained by carbocation formation which is 3° and allylic.

10. Given below are two statements.

Statement I: The formula of cryoscopy constant is given as $K_f = \frac{MRT_f^2}{1000 \times \Delta S_{fusion}}$

Statement II: K_f of water is greater than benzene.

In light of the above statements choose the most appropriate option.

(1) Statement I is correct, Statement II is incorrect

(2) Statement I is incorrect, Statement II is correct

(3) Statement I and II both are correct

(4) Statement I and II are incorrect

Answer (4)

Sol. $K_f = \frac{MRT_f^2}{1000 \times \Delta H_{fusion}}$

K_f (H_2O) = 1.86 K kg mol^{-1}

K_f (benzene) = 5.12 K mol^{-1}

11. Match the column

	List-I (Process)		List-II (Thermodynamic parameter)
(A)	Adiabatic	(1)	w = 0
(B)	Isobaric	(2)	q = –w
(C)	Isochoric	(3)	q = 0
(D)	Isothermal	(4)	q = $\Delta U + P\Delta V$

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

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

Answer (3)

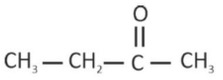
Sol. Adiabatic q = 0

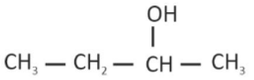
Isobaric ($\Delta P = 0$) $\Delta U + P\Delta V = q$

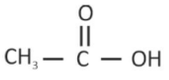
Isochoric ($\Delta V = 0$) w = 0

Isothermal ($\Delta T = 0$) q = w

12. Which of the following compound gives yellow precipitate with NaOI?

(A) 

(B) 

(C) 

(D) $CH_3 - CH_2 - OH$

(1) (A) and (D) only (2) (B), (C) and (D) only

(3) (A), (B) and (D) only (4) (A) and (C) only

Answer (3)

Sol. Compounds of the type $CH_3-\overset{\overset{O}{\|}}{C}-R$ and $CH_3-\overset{\overset{OH}{|}}{CH}-R$ where R is H, alkyl or aryl group give yellow precipitate of CHI_3 with NaOI.

(A) $CH_3-CH_2-\overset{\overset{O}{\|}}{C}-CH_3 \xrightarrow{NaOI} \underset{\text{Yellow}}{CHI_3\downarrow} + CH_3-CH_2-\overset{\overset{O}{\|}}{C}-ONa$

(B) $CH_3-CH_2-\overset{\overset{OH}{|}}{CH}-CH_3 \xrightarrow{NaOI} \underset{\text{Yellow}}{CHI_3\downarrow} + CH_3-CH_2-\overset{\overset{O}{\|}}{C}-ONa$

(D) $CH_3-CH_2-OH \xrightarrow{NaOI} \underset{\text{Yellow}}{CHI_3\downarrow} + HCOONa$

13. Among the following complexes of iron, the most stable complex having x number of electron in t_{2g} set of orbitals

$[Fe(NH_3)_6]^{3+}$, $[Fe(CN)_6]^{3-}$, $[FeF_6]^{3-}$

What is the nature of oxide V_2O_x?

(1) Acidic (2) Basic

(3) Neutral (4) Amphoteric

Answer (4)

Sol. $[Fe(CN)_6]^{3-}$ is most stable complex given among given

$Fe^{3+} \Rightarrow 3d^5 \Rightarrow t_{2g}^5 e_g^0$

$x = 5$

V_2O_5 is amphoteric.

14. Given below are two statements:

Statement-I: Group-13 has more ionisation energy than group-14 along the same period.

Statement-II: Silicon has higher boiling point than lead.

In the light of the above two statements, choose the most appropriate option.

(1) Statement-I is correct and statement-II is incorrect

(2) Statement-I is incorrect and statement-II is correct

(3) Both statement-I and II are correct

(4) Both statement-I and II are incorrect

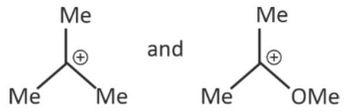
Answer (2)

Sol.

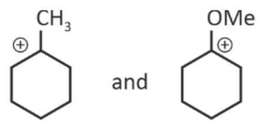
	Si	Pb
BP $\rightarrow$	3550 K	2024 K

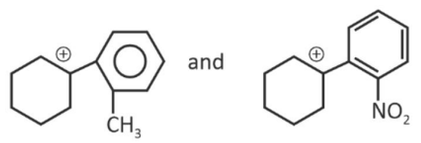
$\therefore$ On moving from left to right in periodic table, ionisation energy generally increases.

15. In which of the following pair of ions, first ion is more stable than second ion

(1) 

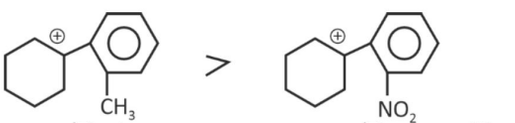
(2) 

(3) 

(4) 

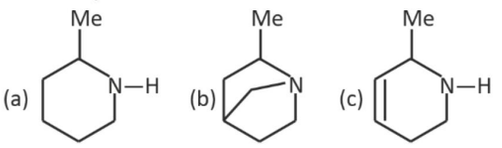
Answer (4)

Sol.



(Electron donating group) (Electron with drawing group)

16. The correct order of basic strength of following amines in non-aqueous medium.



(1) b > a > c (2) b > c > a

(3) a > b > c (4) c > b > a

Answer (1)

Sol. Basic strength depends an availability of lone pair on nitrogen or donation ability of lone pair of nitrogen.

17. Which of the following order is incorrectly matched with respect to ionisation energy

(1) $Mn^{3+} > Mn^{2+}$ (2) $Fe^{2+} > Fe^{3+}$

(3) $Cr^{3+} > Cr^{+}$ (4) $Co^{3+} > Co^{2+}$

Answer (2)

Sol. Successive I·ε always increases Iε of $M^{3+} > M^{2+} > M^{+}$

18.

19.

20.

SECTION - B

Numerical Value Type Questions: This section contains 5 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. Total number of electrons in chromium (Z = 24) for which the value of azimuthal quantum number (l) is 1 and 2

Answer (17)

Sol. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$

$l = 1 \Rightarrow$ p-subshell $\Rightarrow 6 + 6 = 12e^-$

$l = 2 \Rightarrow$ d-subshell $\Rightarrow 5e^-$

Total electrons = $5 + 12 = 17e^- = 17$

22. Consider the following zero order reaction :

$A \rightarrow$ Products

Half-life of the reaction is 1 hr if initial concentration of the reactant is 2 mol/L. Find the half-life of the reaction in minutes if the initial concentration of the reaction is 0.5 mol/L.

Answer (15)

Sol. $[A]_o$: 2 M 0.5 M

$T^{1/2}$: 1 hr t

If n is the order of reaction, then

$T^{1/2} \propto ([A]^o)^{1-n}$

$\propto [A]_o$ if $n = 0$

$$\frac{t}{1} = \left(\frac{0.5}{2}\right)^1 = \left(\frac{1}{4}\right)^1$$

t = 0.25 hr = 15 min

23. If x mg of $Mg(OH)_2$ is added in 1 L of solution to make a solution with pH = 10, then find the value of x.

[Given : MW of $Mg(OH)_2$ = 58 g/mol]

Assume $Mg(OH)_2$ dissociates completely in water.

Answer (3)

Sol. Given, pH = 10

pOH = 4

$[OH^-] = 10^{-4}$ M

$Mg(OH)_2 \rightarrow Mg^{2+} + 2OH^-$

$[Mg(OH)_2] = 0.5 \times 10^{-4}$ M

Mol of $Mg(OH)_2$ in 1 L of solution = 5×10^{-5} mol

Mass of $Mg(OH)_2 = 5 \times 10^{-5}$

$= 5 \times 10^{-5} \times 58$

$= 290 \times 10^{-5}$ g

= 2.9 mg

≈ 3

24. An octahedral complex ion is formed using metal (M^{4+}) with ligands NH_3 and Cl^- 1 mol complex gives 'n' mol of AgCl with $AgNO_3$ solution. The value of n is same as number of lone pairs of electron present on central atom in BrF_3. Find the total number of isomers of complex ion.

Answer (2)

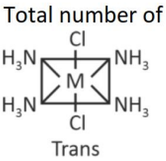
Sol. 

Br – F; number of lone pair = 2

$AgNO_3$ + Complex $\rightarrow$ 2 mol AgCl

Complex ion should be $[M(NH_3)_4Cl_2]Cl_2$

Total number of isomers = 2



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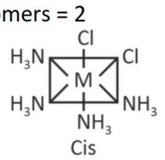

Cis

25. Find the mass of CaO formed in kg when 150 kg sample of 75% pure $CaCO_3$ is heated strongly.

Answer (63)

Sol. Mass of impure $CaCO_3$ = 150 kg

$$\text{Mass of pure } CaCO_3 = \frac{75 \times 150}{100} = 112.5 \text{ kg}$$

$$\text{NO. of moles of pure } CaCO_3 = \frac{112.5 \times 10^3}{100}$$

= 1125

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2(g)$$

No. of moles of CaO formed = 1125

$$\text{Mass of CaO} = \frac{1125 \times 56}{1000} = 63 \text{ kg}$$