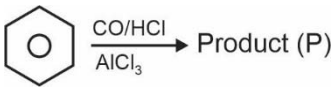
CHEMISTRY

SECTION - A

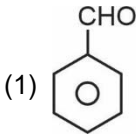
Multiple Choice Questions: This section contains 20 multiple choice questions. Each question has 4 choices (1), (2), (3) and (4), out of which **ONLY ONE** is correct.

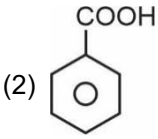
Choose the correct answer :

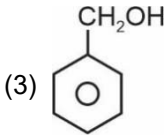
1. For the reaction:

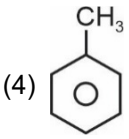


Product (P) is

(1) 

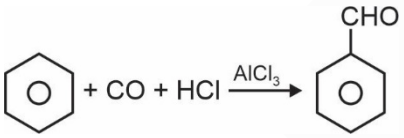
(2) 

(3) 

(4) 

Answer (1)

Sol. This is Gattermann – Koch reaction



2. Chemical formula of compound present in tooth enamel?

(1) $Ca_{10}(PO_4)_6(OH)_2$

(2) $Ca_8(PO_4)_4(OH)_2$

(3) $Ca_6(PO_4)_3(OH)_2$

(4) $Ca_8(PO_4)_6(OH)_2$

Answer (1)

Sol. The chemical formula of compound present in tooth enamel is $[3Ca_3(PO_4)_2 \cdot Ca(OH)_2]$.

3. Which of the following has sp^2 hybridisation?

(1) BF_3

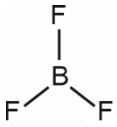
(2) H_2SO_4

(3) NH_4^+

(4) NH_3

Answer (1)

Sol.



Steric number = 3

Hybridisation = sp^2

4. Which of the following orbitals has the highest energy?

(1) n = 6 l = 0

(2) n = 5 l = 2

(3) n = 4 l = 2

(4) n = 3 l = 1

Answer (2)

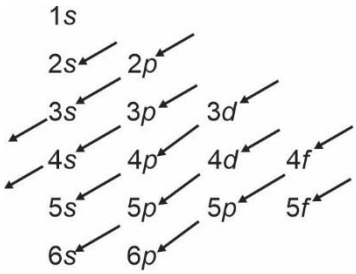
Sol. (i) n = 6 l = 0 $\Rightarrow$ 6*s*

(ii) n = 5 l = 2 $\Rightarrow$ 5*d*

(iii) n = 4 l = 2 $\Rightarrow$ 4*d*

(iv) n = 3 l = 1 $\Rightarrow$ 3*p*

Energy of 3*p* < 4*d* < 6*s* < 5*d*



5. Equal volume of 1 M HCl and 1 M H_2SO_4 neutralised by dil. NaOH and heat released is x and y KCal mol^{-1} respectively which is correct.

(1) x = y

(2) x = 0.5y

(3) x = 0.4y

(4) x = 2y

Answer (2)

Sol. When 1 mol of H^+ is neutralised by 1 mol of OH^- then 13.7 KCal mol^{-1} energy is released energy during neutralisation of 1M HCl is equal to x, then energy released during complete neutralisation of H_2SO_4 by dil. NaOH = 2x

y = 2x

x = 0.5y

6. Consider the following electronic configuration :

Cu^{2+} = [Ar] $3d^9 4s^0$

Cu^{+} = [Ar] $3d^{10} 4s^0$

Which option is correct?

(1) Cu^{2+} is more stable in aqueous solution

(2) Cu^{+} is more stable in aqueous solution

(3) Cu^{+} and Cu^{2+} are equally stable in aqueous solution

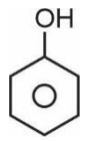
(4) Depends upon copper salt

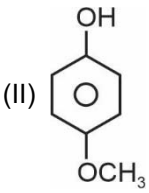
Answer (1)

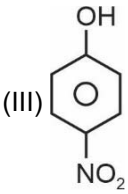
Sol. $Cu^{+} \longrightarrow Cu^{2+} + Cu$

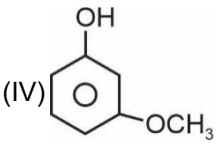
Cu^{+} undergoes disproportionation due to high hydration energy of Cu^{2+}.

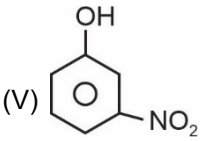
7. Arrange the following in increasing order of acidity:

(I) 

(II) 

(III) 

(IV) 

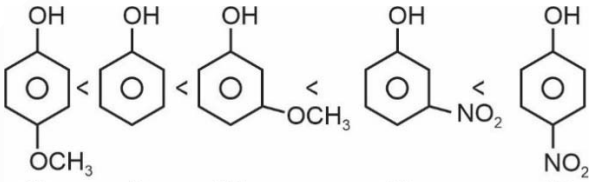
(V) 

(1) I < II < III < IV < V (2) II < I < IV < V < III

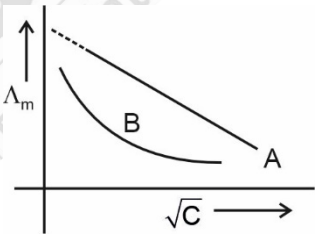
(3) III < V < IV < I < II (4) II < IV < III < I < V

Answer (2)

Sol. The acidic strength of:



8. Molar conductance vs $\sqrt{\text{concentration}}$ curve for two electrolytes 'A' and 'B' are shown. Identify the nature of both electrolytes-



(1) A → Strong Electrolyte
B → Strong Electrolyte

(2) A → Weak Electrolyte
B → Strong Electrolyte

(3) A → Strong Electrolyte
B → Weak Electrolyte

(4) A → Weak electrolyte
B → Weak Electrolyte

Answer (3)

Sol. Λ_m of strong electrolyte varies linearly with $\sqrt{C}$ according to Debye-Huckel – Onsager equation

$$\Lambda_m = \Lambda_m^0 - A\sqrt{C}$$

While Λ_m of weak electrolyte varies non-linearly with $\sqrt{C}$ due to change in percentage ionization with concentration.

9. Consider the following reactions:

(I) $CH_3 - CH = CH_2 \xrightarrow[(ii)\,H_2O_2/OH^-]{(i)\,B_2H_6/THF} (A)$

(II) $CH_3 - CH = CH_2 \xrightarrow{H^+/H_2O} (B)$

Identify the major product(s) (A) and (B) formed in the above reactions.

(1) (A): $CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3$

(B): $CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3$

(2) (A): $CH_3 - CH_2 - CH_2 - OH$

(B): $CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3$

(3) (A): $CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3$

(B): $CH_3 - CH_2 - CH_2 - OH$

(4) (A): $CH_3 - CH_2 - CH_2 - OH$

(B): $CH_3 - CH_2 - CH_2 - OH$

Answer (2)

Sol. Hydroboration of unsymmetrical alkene followed by hydrolysis by alkaline H_2O_2 results in the formation of a product as if H_2O has been added to alkene according to anti-Markovnikov rule.

$$3CH_3 - CH = CH_2 + B_2H_6 \xrightarrow{THF} 2(CH_3CH_2CH_2)_3B$$

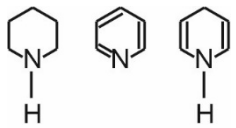
$$(CH_3CH_2CH_2)_3B + 3H_2O_2 \xrightarrow{OH^-} \underset{(A)}{3CH_3CH_2CH_2OH} + H_3BO_3$$

Acid catalysed addition of water to unsymmetrical alkene follows Markovnikov rule with the possibility of rearrangement.

$$CH_3 - CH = CH_2 + H^+ \longrightarrow \underset{\text{(More stable)}}{CH_3 - \overset{+}{C}H - CH_3}$$

$$CH_3 - \overset{+}{C}H - CH_3 + H_2O \longrightarrow (CH_3 - \underset{\displaystyle OH}{\underset{|}{CH}} - CH_3) + H^+$$

10. Consider the following compounds



(I) (II) (III)

Correct order of their basicity is

(1) III > II > I

(2) I > II > III

(3) II > I > III

(4) II > III > I

Answer (2)

Sol. In case of III the lone pair of N is delocalised by resonance hence III is weakest. In case of I and II the substituents of I are electron loosing due to their +I effect hence I is strongest nitrogenous base/Lewis base/base.

11. Which of the following is colourless?

(1) Eu^{3+}

(2) Lu^{3+}

(3) Nd^{3+}

(4) Sm^{3+}

Answer (2)

Sol. Lu^{3+} = [Xe] $4f^{14}$ $5d^0$ $6s^0$

Due to completely filled 4*f* subshell or absence, of unpaired electron Lu^{3+} is colourless.

12. Which among the following have single unpaired electron?

N_2, O_2, CN^-, O_2^-, C_2^{2-}, N_2^-

(1) O_2, N_2

(2) CN^-, C_2^{2-}

(3) CN^-, O_2^-

(4) N_2^-,O_2^-

Answer (4)

Sol. $N_2^- \ \sigma_{1s}^2 \ \sigma^{*2}_{1s} \ \sigma_{2s}^2 \ \sigma^{*2}_{2s} \ \pi_{2p_x}^2 = \pi_{2p_y}^2 \ \sigma_{2p_z}^2 \ \pi^{*1}_{2p_x}$

$O_2^- \ \sigma_{1s}^2 \ \sigma^{*2}_{1s} \sigma_{2s}^2 \sigma^{*2}_{2s} \sigma_{2p_z}^2 \ \pi_{2p_x}^2 = \pi_{2p_y}^2 \ \pi^{*2}_{2p_x} = \pi^{*1}_{2p_y}$

N_2^- and O_2^- have 1 unpaired electron.

13. **Statement-I:** Sulphur exist as S_8 while oxygen exist as O_2.

Statement-II: In oxygen $p\pi - p\pi$ bonding occurs while it is not effective in sulphur.

(1) Statement-I and Statement-II are true

(2) Statement-I is true and Statement-II is false

(3) Statement-I is false and Statement-II is true

(4) Both Statement-I and Statement-II are false

Answer (1)

Sol. Due to bigger size of sulphur atom, it doesn't have effective $p\pi - p\pi$ bonding.

Therefore, in molecular form, oxygen exist as O_2 while sulphur exist as S_8.

14. Identify the correct order of de-Broglie wavelength of proton (λ_p), electron (λ_e) and alpha(λ_a)– particles, moving with same kinetic energy.

(1) $\lambda_p < \lambda_a < \lambda_e$

(2) $\lambda_p < \lambda_e < \lambda_a$

(3) $\lambda_a < \lambda_p < \lambda_e$

(4) $\lambda_a < \lambda_e < \lambda_p$

Answer (3)

Sol. For moving particles, $\lambda = \dfrac{h}{\sqrt{2m(KE)}}$

As, KE $\rightarrow$ same and $m_e < m_p < m_a$

Therefore, $\lambda_a < \lambda_p < \lambda_e$

15. Consider the reaction between PbS and HNO_3 :

$PbS + HNO_3 \longrightarrow$

Which of the following is not formed?

(1) NO (2) NO_2

(3) S (4) $Pb(NO_3)_2$

Answer (2)

Sol. $3PbS + 8HNO_3 \longrightarrow 3Pb^{2+} + 6NO_3^- + 3S\downarrow + 2NO + 4H_2O$

Hence, NO_2 is not formed.

16. Which of the following statement is incorrect?

(1) $KMnO_4$ and NaOH can be used as secondary standard

(2) Primary standard should not undergo change in air

(3) Reaction of primary standard with another substance should not be instantaneous

(4) Primary standard should be soluble in H_2O

Answer (3)

Sol. Reaction of primary standard with another substance should be instantaneous and stoichiometric.

17. Purification method of organic compound does not depends on

(1) Name of compound

(2) Shape of compound

(3) Density of compound

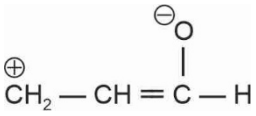
(4) Solubility of compound

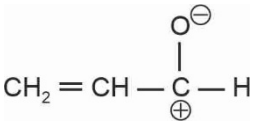
Answer (2)

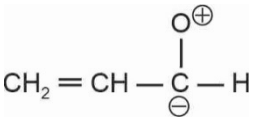
Sol. Organic compounds are purified based on their nature and impurity present in it, the solubility and density of impurity are different from organic compound and on the basis of these difference compounds are purified.

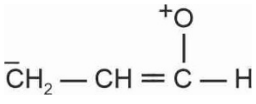
Shape of compound does not play role in purification.

18. Arrange the following in increasing order of their stability

(a) 

(b) 

(c) 

(d) 

(1) (a) < (b) < (c) < (d)

(2) (a) < (d) < (c) < (b)

(3) (a) < (c) < (d) < (b)

(4) (d) < (c) < (a) < (b)

Answer (4)

Sol. Stability of the given ionic species will be decided by the fact that +ve charge on more electronegative element will be less stable and as the distance between opposite charges increases, stability decreases.

Therefore, the correct stability order is

(d) < (c) < (a) < (b)

19. Consider the given complex: $[Co(en)_2)Cl_2]^+$

Statement-I: The number of stereoisomers for the above compound is 3.

Statement-II: Geometry of the above complex is octahedral.

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

(2) Both statements-I and II are correct

(3) Statements-I is incorrect but statement-II is correct

(4) Both statements-I and II are incorrect

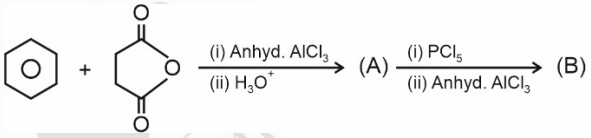
Answer (2)

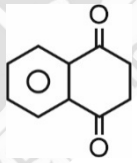
Sol. cis-2

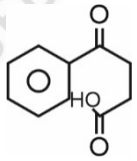
trans-1

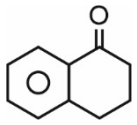
Hybridisation is $sp^3d^2 \Rightarrow$ Geometry = octahedral

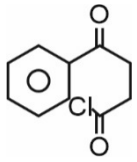
20. Identify the final product (B) obtained in the given reaction sequence:



(1) 

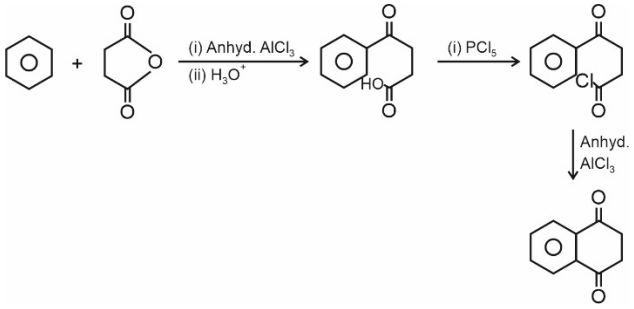
(2) 

(3) 

(4) 

Answer (1)

Sol.



SECTION - B

Numerical Value Type Questions: This section contains 10 Numerical based questions. The answer to each question should be rounded-off to the nearest integer.

21. Number of ambident nucleophile among following is

$CN^{\ominus}$; $SCN^{\ominus}$; $NO_2^{\ominus}$; $CH_3-COO^{\ominus}$; $C_2O_4^{2\ominus}$

$NH_2^{\ominus}$; SO_4^{2-}

Answer (3)

Sol. Nucleophiles which have more than one different points of linkage (i.e. electron rich centres) are called as ambident nucleophiles.

Examples are $CN^{\ominus}$; $SCN^{\ominus}$; $NO_2^{\ominus}$

(1) $CN^{\ominus} \rightarrow$ C – or N – atom can donate $e^{\ominus}$ pair

(2) $SCN^{\ominus} \rightarrow$ S – or N – atom can donate $e^{\ominus}$ pair

(3) $NO_2^{\ominus} \rightarrow$ N – or O – atom can donate $e^{\ominus}$ pair

22. Total number of essential amino acids are _____.

Answer (10)

Sol.

Valine
Leucine
Isoleucine
Arginine
Lysine
Threonine
Methionine
Phenylalanine
Tryptophan
Histidine

→ Total 10 amino acids are essential which is not synthesised in our body and need to be included in our diet.

23. Heat of solution of $CuSO_4$ and $CuSO_4 \cdot 5H_2O$ is given as (–70 kJ/mole) and (+12 kJ/mole) respectively. Then $\Delta H_{hydration}$ for converting $CuSO_4$ to $CuSO_4 \cdot 5H_2O$ is (–x kJ/mole). Find out x (Nearest integer)

Answer (82)

Sol. $CuSO_4 \xrightarrow{-x} CuSO_4 \cdot 5H_2O \xrightarrow{+12} CuSO_4 \cdot tH_2O$

$\underbrace{\qquad\qquad\qquad\qquad}_{-70}$

$-x + 12 = -70$

$x = 82$ kJ/mole

24. Calculate the molality of 500 mL solution of $CuSO_4$ having density of 1.25 g mL^{-1} and having molarity 2×10^{-1} M at 32°C. What is the value of x if the molality calculated is $x \times 10^{-2}$ molal?

Answer (16)

Sol. Molarity = $0.2 = \frac{n_{CuSO_4}}{V_{sol^n}}$

$\Rightarrow n_{CuSO_4} = 0.2 \times \frac{500}{1000} = 0.1$

mass of solution = 1.25 × 500 = 625 g

mass of solvent = 625 – 0.1 × (159.5)

= 609.05 g

$$\text{Molality} = \frac{n_{CuSO_4}}{m_{solvent}\,(\text{In kg})}$$

$$= \frac{0.1 \times 1000}{609.05}$$

$$= 0.164$$

$$= 16.4 \times 10^{-2}$$

So, $x \simeq 16$

25. Given $E^{\circ}_{MnO_4^-/Mn^{2+}} = 1.33\,V$

How many of the given species can be oxidised by MnO_4^- in aqueous solution among the following?

(a) Cu [Given $E^{\circ}_{Cu^{2+}/Cu} = 0.34\,V$]

(b) Cr [Given $E^{\circ}_{Cr^{3+}/Cr} = -0.74\,V$]

(c) Ag [Given $E^{\circ}_{Ag^{+}/Ag} = 0.80\,V$]

(d) Au [Given $E^{\circ}_{Au^{+}/Au} = 1.68\,V$]

Answer (3)

Sol. If the standard cell potential is positive, then the reaction is feasible.

(a) $E^{\circ}_{cell} = (-0.34 + 1.33)\,V = 0.99\,V$

(b) $E^{\circ}_{cell} = (0.74 + 1.33)\,V = 2.07\,V$

(c) $E^{\circ}_{cell} = (-0.80 + 1.33)\,V = 0.53\,V$

(d) $E^{\circ}_{cell} = (-1.68 + 1.33)\,V = -0.35\,V$

26. Rate of a reaction is given as : rate = $k[A]^2[B]$. If concentration of both reactants is doubled then rate becomes x times the previous and the overall order of reaction is y, then what is the value of (x + y)?

Answer (11)

Sol. rate = $k[A]^2[B]$

order of reaction = 2 + 1 = 3

So, y = 3

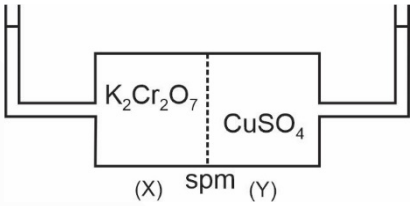
on doubling the concentration

rate becomes $2^2 \cdot 2 = 8$ times

So, x = 8

x + y = 8 + 3 = 11

27. Equimolar solution of $K_2Cr_2O_7$ and $CuSO_4$ are separated by a semi-permeable membrane. How many of the following statements are incorrect?



(i) Green colour of $CuCr_2O_7$ is observed as side (Y)

(ii) Green colour of $CuCr_2O_7$ is observed as side (X)

(iii) Molarity of $K_2Cr_2O_7$ will decrease

(iv) Molarity of $CuSO_4$ will decrease

Answer (3)

Sol. $K_2Cr_2O_7 \rightarrow 2K^+ + Cr_2O_7^{2-}$

$CuSO_4 \rightarrow Cu^{2+} + SO_4^{2-}$

van't Hoff factor for $K_2Cr_2O_7 = 3$

van't Hoff factor for $CuSO_4 = 2$

Therefore, solvent molecules will migrate from (Y) to (X) resulting in decrease of molarity of $K_2Cr_2O_7$.

$\therefore$ (i), (ii) and (iv) are incorrect.

28.

29.

30.