INDIAN ASSOCIATION OF CHEMISTRY TEACHERS

NATIONAL STANDARD EXAMINATION IN CHEMISTRY (NSEC) 2016-17

Examination Date : 27-11-2016   **Time: 2 Hrs.**   **Max. Marks : 240**

PAPER CODE : C322   HBCSE Olympiad (STAGE - 1)

Write the question paper code mentioned above on YOUR answer sheet (in the space provided), otherwise your answer sheet will NOT be assessed. Note that the same Q. P. Code appears on each page of the question paper.

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2. In addition to this question paper, you are given answer sheet along with Candidate's copy.
3. On the answer sheet, fill up all the entries carefully in the space provided, **ONLY In BLOCK CAPITALS**. Use only **BLUE or BACK BALL PEN** for making entries and marking answer.
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5. The question paper contain 80 multiple-choice question. Each question has 4 options, out of which only one is correct. Choose the correct alternative and fill the appropriate bubble, as shown

   Q. No. 22 (a) ● (c) (d)

6. A correct answer carries 3 marks and 1 mark will be deducted for each wrong answer.
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Only one out of four options is correct

1. For a gaseous reaction, A + B $\rightarrow$ products, the energy of activation was found to be 2.27 kJ mol^{-1} at 273 K. The ratio of the rate constant (k) to the frequency factor (A) at 273 K is

(A) 0.368 (B) 3.68 (C) 4.34 (D) 0.434

Ans. **(A)**

Sol. E_a= 2.27 KJ mol^{-1}

=2.27x10^3 J mol^{-1} .

According to Arrhenius equation

$$K = A\,e^{\frac{-E_a}{RT}}$$

$$\frac{K}{A} = e^{\frac{-2.27\times10^3}{8.314\times273}}$$

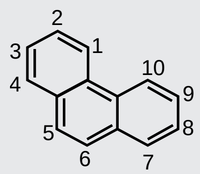
$$\Rightarrow \frac{K}{A} = e^{-1}$$

$$\Rightarrow \frac{K}{A} = \frac{1}{e}$$

$$\Rightarrow \frac{K}{A} == .368$$

Option A is Correct

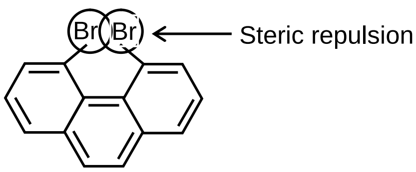
2. In the case of dibromo derivatives of the following compound, the derivative having highest energy has the bromo substituents in positions



(A) 1, 2 (B) 2, 3 (C) 4, 5 (D) 1, 10

Ans. **(D)**

Sol.

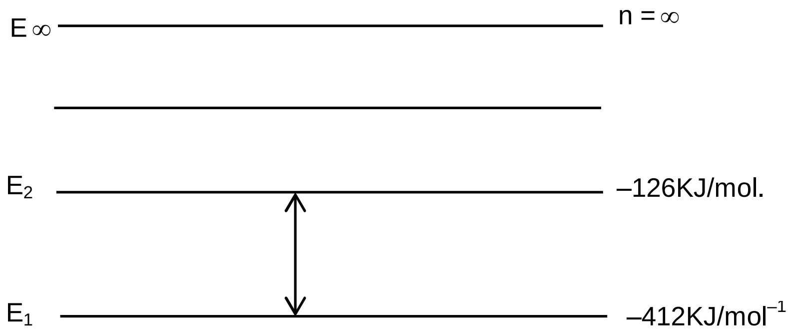


3. The ionization energy of a certain element is 412 kJ mol^{-1}. When the atoms of this element are in the first excited state, however, the ionization energy is only 126 kJ mol^{-1}. The region of the electromagnetic spectrum in which the wavelenght of light emitted in a transition from the first excited state to the ground state is

(A) Visible (B) UV (C) IR (D) X-ray

Ans. **(A)**

Sol. Ionization energy = 412 kJ mol $^{-1}$



$E_2 - E_1 = -126 + 412$

$\Delta E. = 286 \times 10^3 \text{ J} \quad \text{mol}^{-1}$

$\Delta E. = \dfrac{286 \times 10^3}{6.022 \times 10^{23}} = 47.49 \times 10^{-20} \quad \text{J}$

Energy in $\text{ev} = \dfrac{47.69 \times 10^{-19}}{1.6 \times 10^{-19} \times 10}$

$= 2.98 \quad \text{ev.}$

$\Rightarrow \lambda = \dfrac{12400 \text{ev} \overset{0}{\text{A}}}{\text{E}}$

$\Rightarrow \lambda(\overset{0}{\text{A}}) = \dfrac{12400}{2.98}$

$= 4161.0 \ \overset{0}{\text{A}}$

$\Rightarrow$ (a) visible region

4. The reaction of an olefin with HBr can proceed by ionic as well as radical mechanism. The reaction in the presence of light takes place by radical mechanism, as

(A) The free energy of the reaction in radical mechanism in higher than in ionic mechanism

(B) Ionic mechanism requires a catalyst while radical mechanism does not

(C) In the presence of light the activation energy of the reaction is lower than that for ionic mechanism.

(D) A radical reaction has very low activation energy as compared to that for the corresponding ionic reaction.

Ans. **(C) or (D) [Language of C and D is nearly similar]**

Sol. Refer theory

5. The correct statement/s is/are :

I. Soap is excellent for cleaning, 100% broken down by bacteria in rivers and hence has no further environmental damaging repercussions.

II. Soap forms an insoluble precipitate/scum when hard water containing calcium and magnesium ion is used.

III. Soaps can be used for cleansing under acidic solutions.

(A) Only I (B) Only II (C) Only III (D) I and III

Ans. **(B)**

Sol. The correct statement is (B) only II.

6. The kinetic data recorded at 278 K for the reaction

$NH_4^+ (aq) + NO_2^- (aq) \rightarrow N_2 (g) + 2H_2O (l)$ is

Set No.	**$[NH_4^+]$/M**	**$[NO_2^-]$/M**	**Rate of reaction/ Ms^{-1}**
1.	0.24	0.10	7.2×10^{-6}
2.	0.12	0.10	3.6×10^{-6}
3.	0.12	0.15	5.4×10^{-6}

The kinetic rate expression and the unit of rate constant (k) of the above reaction are respectively

(A) k $[NH_4^+] [NO_2^-]$ and M s^{-1} (B) k $[NH_4^+]$ and s^{-1}

(C) k $[NH_4^+] [NO_2^-]$ and $M^{-1} s^{-1}$ (D) k $[NO_2^-]$ and s^{-1}

Ans. **(C)**

Sol. It can be solved using initial rate law method

$\Rightarrow$ Rate = $K[NH_4^+]^x[NO_2^-]^y$

From set (1)

$7.2\times10^{-6} = K[.24]^x[.10]^y$ (1)

From set (2)

$3.6\times10^{-6} = K[.12]^x[.10]^y$ (2)

Divide (1) & (2)

$$\frac{7.2\times10^{-6}}{3.6\times10^{-6}} = K\frac{[.24]^x[.10]^y}{K[.12]^x[.10]^y}$$

$(2)^1=(2)^x$

$\Rightarrow$ x=1 $\Rightarrow$ order w. r. t NH_4^+ = 1

From set (2)

$3.6\times10^{-6} = K[.12]^x[.10]^y$ (3)

From set (3)

$5.4\times10^{-6} = K[.12]^x[.15]^{15}$ (4)

Divide (3 & (4)

$$\frac{3.6\times10^{-6}}{5.4\times10^{-6}}=\frac{K[.12]^x[.10]^y}{K[.12]^x[.15]^y}$$

$$\left(\frac{2}{3}\right)^1=\left(2/3\right)^y \Rightarrow y=1$$

order w.r.t NO_2^- is also (1)

$\Rightarrow$ Overall order 1+1 = 2 i.e. 2nd order

$\Rightarrow$ unit of $K=(\text{mol L}^{-1})^{1-n}s^{-1}\Rightarrow(M)^{-1}\sec^{-1}$

$\Rightarrow R=K[NH_4^+][NO_2^-]$

Ans. **(C)** Option

7. Which of the following statements is not true for Ce^{3+} and Yb^{3+} ?

(A) Both absorb in UV region
(B) Both show f-f transition
(C) Both show 4f to 5d transition
(D) Both ions are colorless

Ans. **(B)**

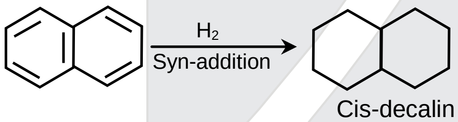
Sol. Both Ce^{3+} and Yb^{3+} are colored ions but donot show f-f transition.

8. Complete catalytic hydrogenation of naphthalene gives decalin ($C_{10}H_{18}$). The number of isomers of decalin formed and the total number of isomers of decalin possible are respectively

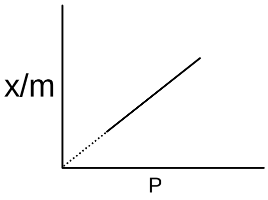
(A) 1, 2
(B) 2, 2
(C) 2, 4
(D) 3, 4

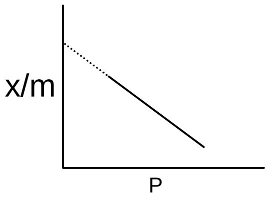
Ans. **(A)**

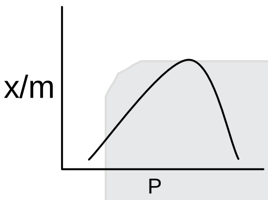
Sol.

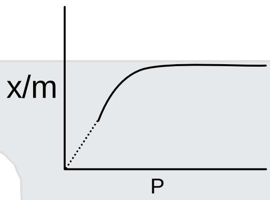


9. The mass of argon adsorbed per unit mass of carbon surface is plotted against pressure. Which of the following plots is correct if x and m represent the masses of argon and carbon respectively ? (........ represents extrapolated data)

(A) 

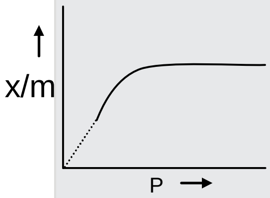
(B) 

(C) 

(D) 

Ans. **(D)**

Sol. Correct option is D.

i.e. 

10. In a process n-propyl chloride is reacted with sodium butanoate in an aqueous medium. After the reaction diethyl ether is added and the solution is shaken. The two layers are separated. The **incorrect** statement with respect to this procedure is

(A) The reaction gives a solid product which precipitates in the aqueous solution.

(B) The reaction takes place in the aqueous medium.

(C) The product is extracted in diethyl ether and the organic layer is the upper layer.

(D) The salt formed in the reaction remains in aqueous medium.

Ans. **(A)**

Sol. n-propylchloride + sodium butanoate $\rightarrow$ Ester

11. Which of the following statements about ammonium cerium (IV) nitrate, $(NH_4)_2[Ce(NO_3)_6]$ is **false**?

(A) NO_3^- acts as a monodentate ligand.

(B) The Ce atom has a coordination number of 12.

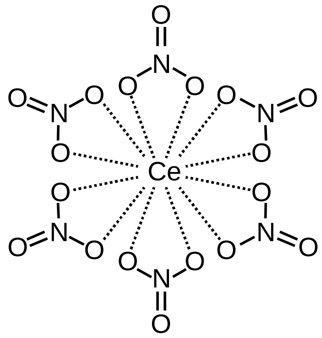
(C) The shape of the complex ion is icosahedron.

(D) The solution is used as oxidizing agent.

Ans. **(A)**

Sol. $(NH_4)_2[Ce(NO_3)_6] \longrightarrow 2NH_4^+ + [\overset{+4}{Ce}(NO_3)_6]^{-2}$

Oxidation number of Ce is +4



C.N. $\rightarrow$ 12

used as O.A. in organic synthesis.

So, statement (1) is incorrect.

Correct option is A.

12. The correct order of the magnitude of bondenergy (kJ/mol) of the central C–C bond in the following compounds is:

(i) CH_2=CH–CH=CH_2 (j) Me_3C–CPh_3 (k) MeCO–CO–Me (l) CH≡C–C≡CH

(A) k > i > l > j (B) j > k > l > i (C) i > j > k > l (D) l > i > k > j

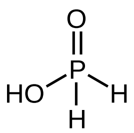
Ans. **(D)**

13. Which one of the following information about the compounds is correct ?

Compounds	Oxidation state of P	No. of P—OH bonds	No. of P—H bonds	No. of P=O bonds
[I] H_3PO_2 Hypophosphorous acid	1+	2	1	0
[II] $H_4P_2O_5$ pyropophosphorous acid	3+	2	2	2
[III] $H_4P_2O_6$ Hypophosphoric acid	4+	2	2	2
[IV] $H_4P_2O_7$ pyrophosphoric acid	5+	3	1	4

(A) I (B) III (C) IV (D) II

Ans. **(D)**

Sol. (I) $H_3PO_2 \rightarrow$ 

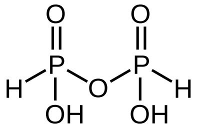
Oxidation state of P = +1

No. of P-OH bond = 1

No. of P–H bond = 2

No. of P=O bond = 0

$\Rightarrow$ option (A) is incorrect.

(II) $H_4P_2O_5 \rightarrow$ 

Oxidation state of P = +3

No. of P-OH bond = 2

No. of P–H bond = 2

No. of P=O bond = 2 $\Rightarrow$ correct option is (D) II.

14. The best method of preparation of 2-benzyloxynaphthalene is a base catalysed reaction of :

(A) benzyl chloride and 1-naphthol (B) 1-chloromethylnapthalene and phenol

(C) 1-chloronaphtalene and benzyl alcohol (D) benzyl alcohol and 1-naphthol

Ans. **(Bonus)**

Sol. Bonus [None of the option form 2-benzyloxynapthalene.]

15. The pair that is isostructural (i.e. having the same shape and hybridization) is

(A) NF_3 and BF_3 (B) BF_4^- and NH_4^+ (C) BCl_3 and $BrCl_3$ (D) NH_3 and NO_3^-

Ans. **(B)**

Sol. Correct option is (B) $BF_4^{\ominus}$ & $NH_4^{\oplus}$

16. A group which departs from the substrate in a nucleophilic substitution reaction is called a leaving group. The ease of departure is determined by the acidity of the conjugate acid of the leaving group ; higher the acidity better is the leaving group. The correct order of the reactivity of the following compounds in a given nucleophilic reaction is :

(A) R-Cl > R-$OCOCH_3$ > R-OSO_2CH_3 > RI (B) R-OSO_2CH_3 > R-Cl > R-$OCOCH_3$ > ROH

(C) R-I > RNH_2 > R-$OCOCH_3$ > R-OSO_2CH_3 (D) R-Br > R-OSO_2CH_3 > R-$OCOCH_3$ > $ROCH_3$

Ans. **(D)**

Sol. $R{-}Br > R{-}O{-}\overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle O}{\|}}{S}}{-}CH_3 > R{-}O{-}\overset{\overset{\displaystyle O}{\|}}{C}{-}CH_3 > ROH$

17. If a dilute solution of aqueous NH_3 is saturated with H_2S then the product formed is :

(A) $(NH_4)_2S$ (B) NH_4HS (C) $(NH_4)_2S_x$ (D) $NH_4OH + S$

Ans. **(B)**

Sol. Dilute solution of aqueous NH_3 saturated with H_2S, then the product formed is (B) NH_4HS.

18. Three Faradays of electricity are passed through aqueous solutions of $AgNO_3$, $NiSO_4$ and $CrCl_3$ kept in three vessels using inert electrodes. The ratio (in moles) in which the metals Ag, Ni and Cr are deposited is:

(A) 1 : 2 : 3 (B) 3 : 2 : 1 (C) 6 : 3 : 2 (D) 2 : 3 : 6

Ans. **(C)**

Sol. $AgNO_3$, $NiSO_4$, $CrCl_3$

$$AgNO_3 \rightarrow Ag^{+} + NO_3^{-}$$
$$\downarrow$$
Ag (requires 1 mole electron i.e. 1 Farad charge.)

$$NiSO_4 \rightarrow Ni^{2+} + SO_4^{2-}$$
$$\downarrow$$
Ni (requires 2 mole electron i.e. 2 Farad charge.)

$$CrCl_3 \rightarrow Cr^{3+} + 3Cl^{-}$$
$$\downarrow$$
Cr (requires 3 mole electron i.e. 3 Farad charge.)

But the charge passed is 3F.

$$\left.\begin{array}{l}\text{1F charge deposit 1 mole Ag}\\ \text{3F charge deposit 3 mole Ag}\end{array}\right\} \ldots (1)$$

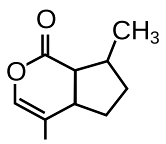
$$\left.\begin{array}{l}\text{2F charge deposit 1 mole } NI^{2+}\\ \text{1F charge deposit } \frac{1}{2} \text{ mole } Ni^{2+}\\ \text{3F charge deposit } \frac{3}{2} \text{ mole } Ni^{2+}\end{array}\right\} \ldots (2)$$

3F charge deposit 1 mole Cr^{3+} } ….(3)

$$\Rightarrow \quad Ag : Ni : Cr = 3 : \frac{3}{2} : 1 \quad \Rightarrow \quad 6 : 3 : 2$$

Correct option is (C).

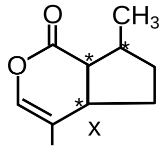
19. Nepetalactone (X) is isolated as an oil from Catnip.



The number of chiral carbon atoms and the amount of KOH consumed by 83 mg of Nepetalactone are respectively

(A) 3, 50 mg (B) 2, 56 mg (C) 3, 56 mg (D) 3, 28 mg

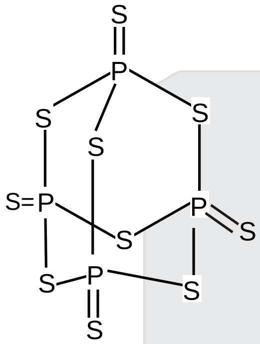
Ans. **(D)**

Sol.  KOH will attack at ester only.

20. Number of P–S single bonds and P–S double bonds (P=S) in P_4S_{10} are respectively

(A) 10, 6 (B) 16, 0 (C) 14, 2 (D) 12, 4

Ans. **(D)**

Sol. 

Number of single P-S bond = 12

Number of double P-S bond = 4

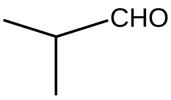
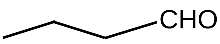
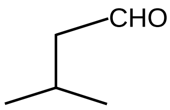
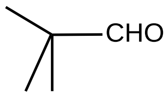
Correct option is (D)

21. If the solubility product of iron(III) hydroxide is 1.8×10^{-37}, the pH of a saturated solution of iron(III) hydroxide in distilled water is close to

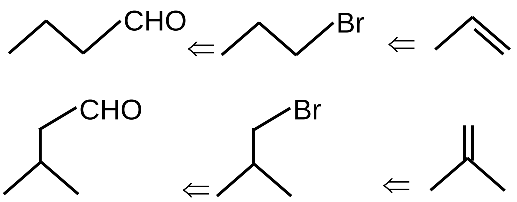
(A) 4 (B) 5 (C) 7 (D) 9

Ans. **(C)**

22. An alkyl halide (X) on reaction with ethanolic sodium hydroxide forms an alkene (Y) which on further reaction with HBr gives the same alkyl halide. The alkene (Y) on reaction with HBr/peroxide followed by reaction with Mg metal followed by reaction with HCN produces an aldehyde (Z). Z is :

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

Ans. **(B & C)**

Sol. 

23. $HClO_4$ is stronger acid than HClO. The correct statement is :

(A) ClO_4^- ion is more stabilized than ClO^-

(B) ClO_4^- ion has higher hydration energy than ClO^-

(C) $HClO_4$ is better solvated in water than HClO

(D) In $HClO_4$, H is attached to Cl, while in HClO it is attached to O.

Ans. (A)

24. For an elementary rearrangement reaction A $\rightleftharpoons$ P, the following data were recorded at 303 K, when $[P]_0 = 0$.

Set No.	$[A]_0$/mol L^{-1}	Rate of conversation of A/mol L^{-1} min^{-1}
1	0.340	0.100
2	0.170	0.050
3	0.085	0.025

If the equilibrium constant of the reaction is 1.12 at 303 K, the rate constant for the reaction P$\rightarrow$ A is :

(A) 0.263 min^{-1} (B) 0.294 min^{-1} (C) 0.526 min^{-1} (D) 0.588 min^{-1}

Ans. (A)

Sol. $A \underset{K_b}{\overset{K_f}{\rightleftharpoons}} P$

for forward reaction let $-\frac{dA}{dt} = K_f(A)^x$

from experimental data,

$0.1 = K_f(0.34)^x \Rightarrow \quad 2 = (2)^x$

$0.05 = K_f(0.17)^x \quad$ so x = 1

so $K_f = \frac{0.1}{0.34}$

Now $K_{eq} = \frac{K_f}{K_b} = 1.12 = \frac{0.1}{0.34 \times K_b}$

so $K_b = 0.263\ min^{-1}$.

Ans. (A)

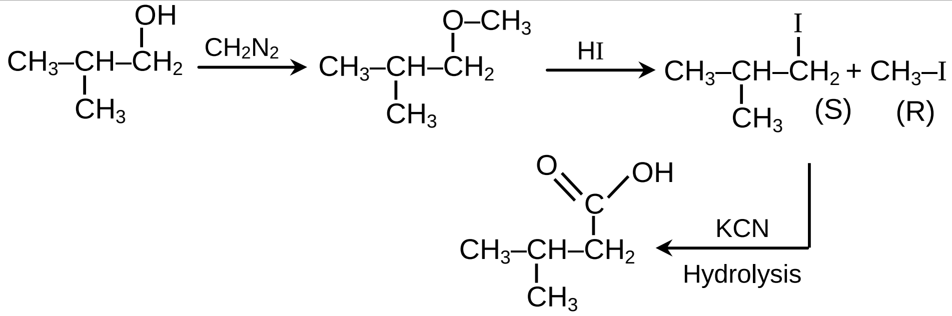
25. Compound P on treatment with CH_2N_2 (diazomethane) produces compound Q. Compound Q on reaction with HI produces two alkyl iodides R and S. Alkyl iodide S with higher number of carbon atoms on reaction with KCN followed by hydrolysis gives 3-methylbutanoic acid. The compound P is :

(A) 2-butanol (B) 1-butanol

(C) 2-methyl-2-propanol (D) 2-methyl-1-propanol

Ans. (D)

Sol.



26. I_2 reacts with aqueous $Na_2S_2O_3$ to give $Na_2S_4O_6$ and NaI. The products of reaction of Cl_2 with aqueous $Na_2S_2O_3$ are

(A) $Na_2S_4O_6$ + NaCl (B) $NaHSO_4$ + HCl (C) $NaHSO_3$ + HCl (D) $NaHSO_3$ + NaCl

Ans. **(B)**

27. The standard potentials (E°) of MnO_4^-/Mn^{2+} and MnO_2/Mn^{2+} half cells in acidic medium are 1.51 V and 1.23 V respectively at 298 K. The standard potential of MnO_4^-/MnO_2 half-cell in acidic medium at the same temperature is :

(A) 5.09 V (B) 1.70 V (C) 0.28 V (D) 3.34 V

Ans. **(B)**

Sol. $MnO_4^-/ Mn^{+2} \rightarrow 1.51$ V

$MnO_2/ Mn^{+2} \rightarrow 1.23$ V

$[3e^- + 4H^+ + MnO_4^- \rightarrow MnO_2 + 2H_2O]$

$5e^- + 8H^+ + MnO_4^- \rightarrow Mn^{2+} + 4H_2O$, $E°_1$ =1.5eV.

$2H_2O + Mn^{+2} \rightarrow MnO_2 + 4H^+ + 2e^-$, $E°_2 = -1.23$V

$3e^- + 4H^+ + MnO_4^- \rightarrow MnO_2 + 2H_2O$, E° = ?

As $\Delta G° = -nF\, E°_{Cell}$

$-3\times F \times E°_3 = -5\times F \times 1.51 + 2\times F + \times 1.23$

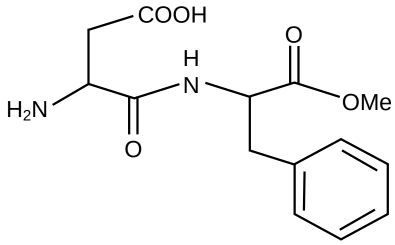
$-3E_3° = -7.55 + 2.46$

$-3F_3° = -5.09$

$\Rightarrow E_3° = \dfrac{5.09}{3} \quad \Rightarrow \quad E_3° = 1.699 = 1.70$V

Correct option is (B) 1.70 V

28. Aspartame (X) is an artificial sweetening agent and is 200 times sweeter than sugar. It is an ester of the dipeptide of :



(A) alanine and phyenylalanine (B) aspartic acid and alanine
(C) phenylalanine and glycine (D) aspartic acid and phenylalanine

Ans. (D)

29. Which one of the following reactions is correct ?

(A) $[Fe(CO)_5] + 2NO \rightarrow [Fe(CO)_2(NO)_2] + 3CO$ (B) $[Fe(CO)_5] + 2NO \rightarrow [Fe(CO)_3(NO)_2] + 2CO$
(C) $[Fe(CO)_5] + 3NO \rightarrow [Fe(CO)_2(NO)_3] + 3CO$ (D) $[Fe(CO)_5] + 3NO \rightarrow [Fe(CO)_3(NO)_3] + 2CO$

Ans. (A)

30. Standard molar enthalpy of formation of $CO_2(g)$ is equal to

(A) Zero
(B) The standard molar enthalpy of combustion of carbon (graphite)
(C) The standard molar enthalpy of combustion of C(g)
(D) The standard molar enthalpy of combustion of CO(g)

Ans. (B)

31. The reaction of 1-phenylpropane with limited amount of chlorine in the presence of light gives mainly.

(A) 4-chloropropylbenzene (B) 1-chloro-1-phenylpropane
(C) 3-chloro-1-phenylpropane (D) 2-chloro-1-phenylpropane

Ans. (B)

Sol. $CH_3–CH_2–CH_2–Ph \xrightarrow[h\nu]{Cl_2} CH_3–CH_2–\underset{}{\overset{Cl}{\overset{|}{C}}}H–Ph$

32. An ionic solid LaI_2 shows electrical conduction due to presence of :

(A) La^{2+} and $2I^–$ (B) La^{3+}, $2I^–$ and $e^–$ (C) La^{2+}, I_2 and $2e^–$ (D) La^{3+}, I_2 and $3e^–$

Ans. (B)

33. The kinetic energy of an electron that has a wavelength of 10 nm is

(A) $2.4 \times 10^{–21}$ J (B) $4.8 \times 10^{–21}$ J (C) $2.4 \times 10^{–29}$ J (D) $4.8 \times 10^{–29}$ J

Ans. (A)

Sol. $\lambda = \left(\frac{150}{v}\right)^{1/2} \overset{0}{A}$

$100 = \left(\frac{150}{v}\right)^{1/2} \Rightarrow v = \frac{150}{10000} \Rightarrow v = 15 \times 10^{-3}$

$\Rightarrow K.E = 15 \times 10^{-3} ev \Rightarrow K.E = 15 \times 10^{-3} \times 1.6 \times 10^{-19}$ J

$= 24 \times 10^{-22} J = 2.4 \times 10^{-21} J$

Correct option is **(A)**

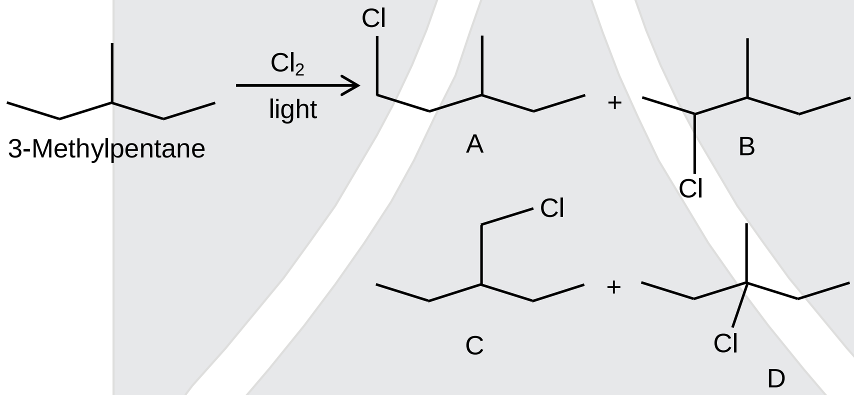
34. Which of the following compounds contain 3-centered 2-electron bonding ?

(i) $[BeF_2]_n$ (ii) $[Be(CH_3)_3]_n$ (iii) $[BeCl_2]_n$ (iv) $[BeH_2]_n$

(A) (i) and (ii) (B) (ii) and (iii) (C) (ii) and (iv) (D) (iii) and (iv)

Ans. **(C)**

35. 3-Methylpentane on monochlorination gives four possible products. The reaction follows free radical mechanism. The relative reactivities for replacement of –H are 3º : 2º : 1º = 6 : 4 : 1.



Relative amounts of A, B, C and D formed are

(A) 6/31, 16/31, 6/31, 3/31 (B) 16/31, 6/31, 6/31, 3/31

(C) 6/31, 16/31, 3/31, 6/31 (D) 6/31, 3/31, 6/31, 16/31

Ans. **(C)**

36. White phosphorous on reaction with NaOH gives PH_3 and

(A) Na_2HPO_3 (B) NaH_2PO_2 (C) NaH_2PO_3 (D) Na_3PO_4

Ans. **(B)**

37. Given the E_0 values for the half reactions :

$Sn^{4+} + 2e^- \rightarrow Sn^{2+}$, 0.15 V

$2Hg^{2+} + 2e^- \rightarrow Hg_2^{2+}$, 0.92V

$PbO_2 + 4H^+ + 2e^- \rightarrow Pb^{2+} + 2H_2O$, 1.45V

Which of the following statements is true?

(A) Sn^{2+} is a stronger oxidizing agent than Pb^{4+} (B) Sn^{2+} is a stronger reducing agent than Hg_2^{2+}

(C) Hg^{2+} is a stronger oxidizing agent than Pb^{4+} (D) Pb^{2+} is a stronger reducing agent than Sn^{2+}

Ans. **(B)**

Sol. S.R.P $\rightarrow Pb^{+4} > Hg^{+2} > Sn^{+4}$

1.45V 0.92V 0.15V

S.O.P $Sn^{+2} \rightarrow -0.15$V . Maximum

$Hg_2^{+2} \rightarrow -0.92$ V

$Pb^{+2} \rightarrow -1.45$ V

$\Rightarrow Sn^{+2}$ is a strong reducing agent than Hg_2^{+2}.

Correct answer is option (B).

38. For the conversion $CCl_4(\ell) \rightarrow CCl_4(g)$ at 1 bar and 350 K, the correct set of thermodynamic parameters is (Boiling point of CCl_4 is 77ºC)

(A) $\Delta G = 0$, ΔS = +ve (B) $\Delta G = 0$, ΔS = –ve

(C) ΔG = –ve, $\Delta S = 0$ (D) ΔG = –ve, ΔS = +ve

Ans. **(A)**

39. How many isomers are possible for complex $[Co(ox)_2Cl_2]^+$?

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

Ans. **(B)**

40. The compound that will not react with silver perchlorate under normal condition is :

(A) 3-bromocyclopropene (B) tetraethyl ammonium chloride

(C) tetramethylammonium hydroxide (D) polyvinyl chloride

Ans. **(D)**

41. The conductivity of 0.10 M KCl solution at 298 K is 1.29×10^{-2} S cm^{-1}. The resistance of this solution is found to be 28.44 Ω. Using the same cell, the resistance of 0.10 M NH_4Cl solution is found to be 28.50 Ω. The molar conductivity of NH_4Cl solution in S cm^2 mol^{-1} is :

(A) 0.130 (B) 13 (C) 130 (D) 1300

Ans. **(C)**

Sol. C = 10 M (KCl)

$K = 1.29 \times 10^{-2}$ S cm^{-1}

R = 28.44 Ω

$K = \frac{1}{R} \times \frac{\ell}{A} \Rightarrow \frac{\ell}{A} = K \times R \Rightarrow \frac{\ell}{A} = 1.29 \times 10^{-2} \times 28.44$

For II Case :

$K = 1.28 \times 10^{-2}$ S cm^{-1}

$\wedge_{NH_4Cl} = \frac{K \times 1000}{C} = 1.28 \times 10^2 = 128 = 130$

Correct option is (C) 130

42. Consider a compound $CsXY_2$ where X and Y are halogens. Which of the following statement/s is/are correct ?

(i) X and Y have different oxidation states.

(ii) For Y with lower atomic number than X, X can assume oxidation states higher than normal.

(iii) Such compounds exist because Cs^+ has a high charge to size ratio.

(A) Only (i) (B) (i) and (ii) (C) Only (ii) (D) (i) and (iii)

Ans. (B)

43. Match the compounds given in list I with their characteristic reactions in list II

List-I (Compound)		List-II (Reaction)	
1	Tert-butyl amine	a	Liberation of ammonia on heating with aq.NaOH
2	2-methyl-2-pentanol	b	Effervescence with $NaHCO_3$
3	2,4,6-trinitrophenol	c	Foul smell with chloroform in alkaline condition
4	Cyclohexane carboxamide	d	Formation of an water insoluble compound on treatment with conc. HCl and $ZnCl_2$

(A) 1-a, 2-c, 3-d, 4-b (B) 1-c, 2-d, 3-b, 4-a (C) 1-a, 2-b, 3-c, 4-d (D) 1-d, 2-a, 3-b, 4-c

Ans. (B)

44. Which of the following statements is not correct regarding the galvanic cells ?

(A) Oxidation occurs at the anode.

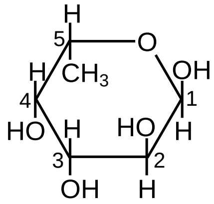
(B) Ions carry current inside the cell.

(C) Electrons flow in the external circuit from cathode to anode.

(D) When the cell potential is positive, the cell reaction is spontaneous.

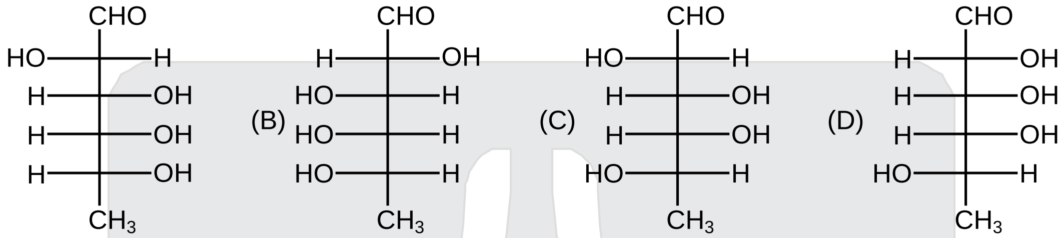
Ans (C)

45. L-Fucose with the following planar representation is a sugar component of the determinants of the A, B, O blood group typing



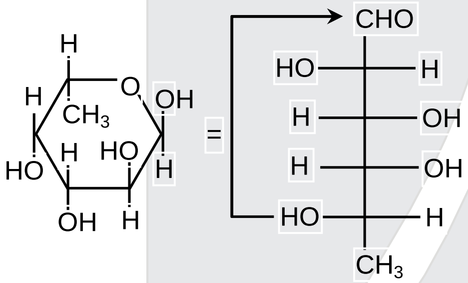
The open chain structure of L-Fucose can be represented as

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



Ans. **(C)**

Sol.



46. In ammonia the bond angle is 107º 48’ while in SbH_3 the bond angle is about 91º 18’. The correct explanation among the following is/are

(A) The orbitals of Sb used for the formation of Sb-H bond are almost pure p-orbitals.

(B) Sb has larger size compared to N.

(C) Sb has more metallic character than N.

(D) All the statements are correct.

Ans. **(A)**

47. Equal masses of ethane and hydrogen gas are present in a container at 25ºC. The fraction of the total pressure exerted by ethane gas is :

(A) 1/2 (B) 1/16 (C) 15/16 (D) 1/8

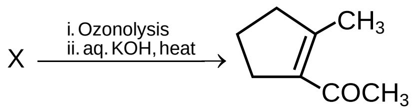
Ans. **(B)**

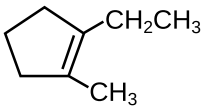
48. The volume of nitrogen evolved on complete reaction of 9 g of ethylamine with a mixture of $NaNO_2$ and HCl at 273ºC and 1 atm pressure is :

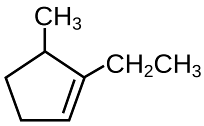
(A) 11.2 dm^3 (B) 5.6 cm^3 (C) 4.48 dm^3 (D) 22.4 cm^3

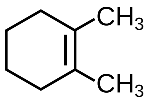
Ans. **(C*)** It is the best options assuming 273 K. Otherwise it is bonus.

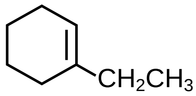
49. Compound 'X' in the following reaction is



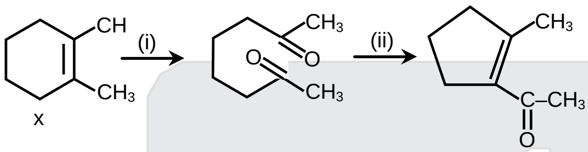
(A) 

(B) 

(C) 

(D) 

Ans. **(C)**

Sol. 

50. A toxic element is to be removed from drinking water by adsorption on activated charcoal. At low concentrations, the rate constant for adsorption is 1.8×10^{-5} s^{-1}. The time required to reduce the concentration of the toxic element to 10% of its initial concentration is

(A) 1.28×10^{5} s
(B) 5.85×10^{3} s
(C) 1.28×10^{6} s
(D) cannot be calculated from the given data.

Ans. **(A)**

51. Assuming that Hund's rule is violated by the diatomic molecule B_2, its bond order and magnetic nature will be respectively

(A) 1, diamagnetic (B) 1, paramagnetic (C) 2, diamagnetic (D) 2, paramagnetic

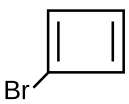
Ans. **(A)**

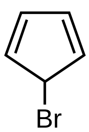
52. In a cubic crystal structure, divalent metal-ion is located at the body-centered position, the smaller tetravalent metal ions are located at each corner and the O^{2-} ions are located half way along each of the edges of the cube. The number of nearest neighbors for oxygen is

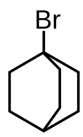
(A) 4 (B) 6 (C) 2 (D) 8

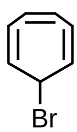
Ans. **(C)**

53. Organic compounds sometimes adjust their electronic as well as steric structures to attain stability. Among the following, the compound having highest dipole moment is :

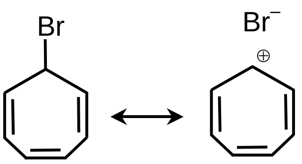
(A) 

(B) 

(C) 

(D) 

Ans. **(D)**

Sol. 

54. Cyanide ion is a very good complexing agent and also functions as a reducing agent. Hence may cyanide complexes of metals are known. Addition of an aqueous solution of KCN to a solution of copper sulphate yields a white precipitate which is soluble in excess of aqueous KCN to form the complex :

(A) $[Cu(CN)_4]^{1-}$ (B) $[Cu(CN)_4]^{2-}$ (C) $[Cu(CN)_4]^{3-}$ (D) $[Cu(CN)_4]^{4-}$

Ans. **(C)**

55. When a certain metal was irradiated with light of frequency 3.2×10^{16} Hz, the photoelectrons emitted had twice the kinetic energy as did the photoelectrons emitted when the same metal was irradiated with light of frequency 2.0×10^{16} Hz. The v_0 of the metal is :

(A) 2.4×10^{16} Hz (B) 8.0×10^{16} Hz (C) 8.0×10^{15} Hz (D) 7.2×10^{16} Hz

Ans. **(C)**

Sol. $h \times 3.2 \times 10^{-6} = h\nu_0 + K.E_1$ ....(i)

$h \times 2 \times 10^{16} = h\nu_0 + K.E_2$ ....(ii)

$K.E_1 = 2 \times K.E_2$.

$h \times 3.2 \times 10^{16} = h\nu_0 + 2K.E_2$

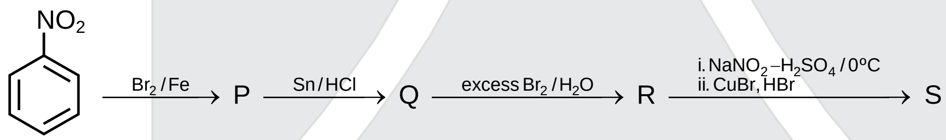
$h \times 2 \times 10^{16} = h\nu_0 + K.E_2$

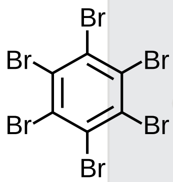
$-$ $-$ $-$

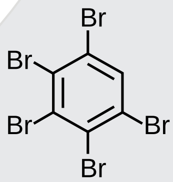
$1.2 \times 10^{16} \times h = K.E_2$

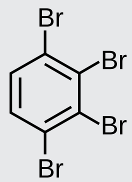
$\Rightarrow$ $K \times 2 \times 10^{16} = h\nu_0 + 1.2 \times 10^{16} \times h$ $\Rightarrow$ $\nu_o = 0.8 \times 10^{16}$ $\Rightarrow$ $\boxed{\nu_0 = 8 \times 10^{15} HZ}$

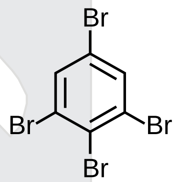
56. The major product 'S' of the following reaction sequence is :



(A) 

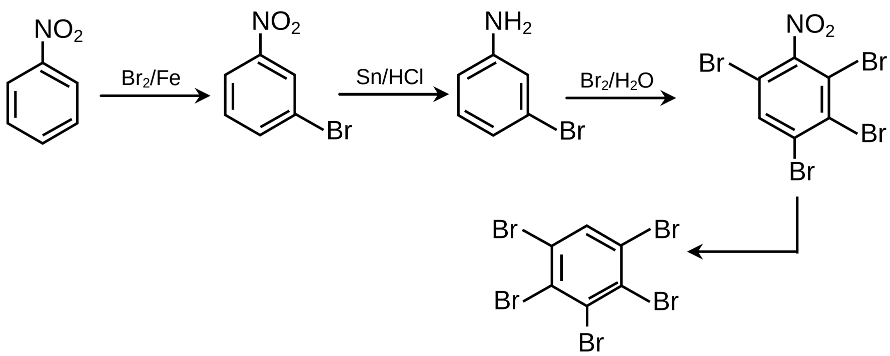
(B) 

(C) 

(D) 

Ans. **(B)**

Sol.



57. 1.250 g of metal carbonate (MCO_3) was treated with 500 mL of 0.1 M HCl solution. The unreacted HCl required 50.0 mL of 0.500 M NaOH solution for neutralization. Identify the metal M

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

Ans. **(B)**

Sol. For HCl

$M_1 = 0.1$ M

$V_1 = 500$ ml

$n = M_1V_1 = 500 \times \frac{0.1}{10} = 50$ millimoles

for NaOH

$M_2 = 0.5$ M

$V_2 = 50$ ml

$n = M_2V_2 = 0.5 \times 50 = 25$ millimoles

$\Rightarrow$ millimoles of carbonate = 25 millimoles

$\Rightarrow$ millimoles of $CaCO_3$ = 12.5

Correct option is (B).

58. An electron beam can undergo diffraction by crystals which proves the wave nature of electrons. The potential required for a beam of electrons to be accelerated so that its wavelength becomes equal to 0.154 nm is :

(A) 63.5 V (B) 31.75 V (C) 635 V (D) 127 V

Ans. **(A)**

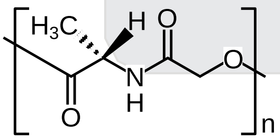
Sol. $\lambda = 1.54$ Å

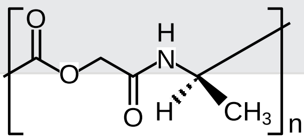
$\lambda = \frac{12.27}{V^{1/2}}$

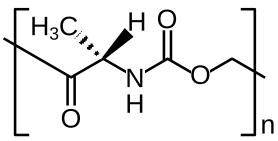
$V = \frac{12.27 \times 12.27}{1.54 \times 1.54} = 63.48$ V

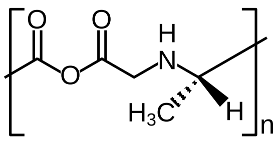
Correct option is (A).

59. A biodegradable alternating copolymer of L-alanine and glycolic acid (HO–CH_2–COOH) is :

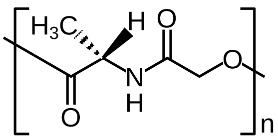
(A) 

(B) 

(C) 

(D) 

Ans. **(A)**

Sol. 

60. In which of the following complexes the metal ion has the lowest ionic radius ?

(A) $[Ti(H_2O)_6]^{2+}$ (B) $[V(H_2O)_6]^{2+}$ (C) $[Cr(H_2O)_6]^{2+}$ (D) $[Mn(H_2O)_6]^{2+}$

Ans. **(B)**

61. In cold climate, the water in a radiator of car gets frozen causing damage to the radiator. Ethylene glycol is used as an antifreezing agent. The amount of ethylene glycol that should be added to 5 kg of water to prevent it from freezing at –7ºC is :

(Given : K_f for water = 1.86 K mol^{-1} kg ; Molar mass of ethylene gycol = 62 g mol^{-1})

(A) 1165 g (B) 46.7 g (C) 116.7 g (D) 93.4 g

Ans. **(A)**

Sol. $\Delta T_f = K_b \times$ molality

7 = 1.86 × molality

molality = $\frac{7}{1.86} = 3.76 = \left(\frac{\text{mass in 1kg solvent}}{62}\right)$

mass in 1 kg water = 3.76 × 62 gm = 233.33 gm

so mass to be added in 5kg water = 1166 gram

Correct option is (A).

62. The ratio of the energy of the electron in ground state of hydrogen atom to that of the electron in the first excited state of Be^{3+} is

(A) 1 : 4 (B) 1 : 8 (C) 1 : 16 (D) 4 : 1

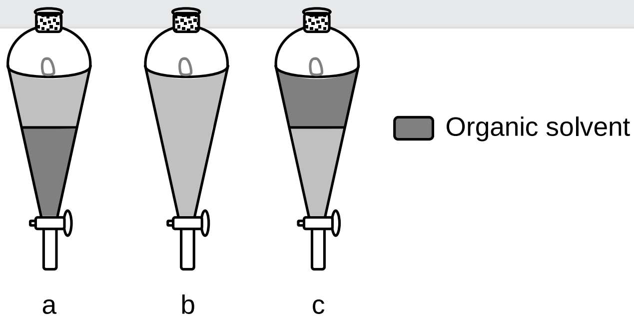
Ans. **(A)**

Sol. Energy of ground state of hydrogen atom = –13.6 × 1 eV

Energy of electron in first excited state of Be^{+3} = – 54.4 eV.

$\Rightarrow$ ratio = 1 : 4

63. Water insoluble, but organic solvent soluble, dye is dissolved in three organic solvents and taken in three separating funnels, a b, and c. To each solution, water is added, shaken, and kept undisturbed. The solvents in separating funnels a, b and c from the following figures are respectively :



(A) a : EtOH; b: CCl_4; c: EtOAc (B) a: CCl_4; b: EtOH; c: EtOAc

(C) a: EtOAc; b: CCl_4; c: EtOH (D) a: CCl_4; b : EtOAc; c : EtOH

Ans. **(B)**

64. P,Q, R and S are four metals whose typical reactions are given below :

(I) Only Q and R react with dilute HCl to give H_2 gas.

(II) When Q is added to a solution containing the ions of the other metals, metallic P,R and S are formed.

(III) P reacts with concentrated HNO_3 but S does not

The correct order of their reducing character is :

(A) S < P < R < Q (B) S < R < P < Q (C) R < Q < P < S (D) Q < P < S < R

Ans. (A)

65. The electrons identified by quantum number n and l, (i) n = 4, l =1, (ii) n = 4, l =0, (iii) n = 3, l=2, (iv) n = 3, l = 1 can be placed in order of increasing energy from lowest to highest as

(A) (iv) < (ii) < (iii) < (i) (B) (ii) < (iv) < (i) < (iii)

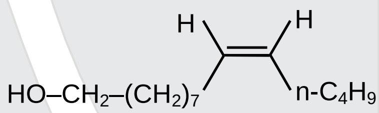
(C) (i) < (iii) < (ii) < (iv) (D) (iii) < (i) < (iv) < (ii)

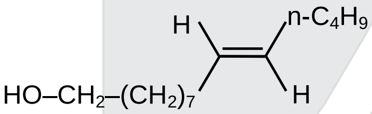
Ans. (A)

66. Spodoptol, a sex attractant, produced by a female fall armyworm moth, can be prepared as follows. The structure of Spodoptol is (pK_a : terminal alkynes ~ 25, alcohols ~ 17)

$$HO—CH_2(CH_2)_7C\equiv CH \xrightarrow{\text{i. } NaNH_2 \text{ (excess)} \quad \text{ii. n-}C_4H_9Br \text{ (1eq)} \quad \text{iii. } H_2\text{/Lindlar cat}} \text{Spodoptol}$$

(A) $n\text{-}C_4H_9–O–CH_2–(CH_2)_7—HC=CH_2$

(B) 

(C) 

(D) $HO–CH_2–(CH_2)_{12}–CH_3$

Ans. (B)

67. Passing H_2S gas into a mixture of Mn^{2+}, Ni^{2+} , Cu^{2+} and Hg^{2+} in an acidified aqueous solution precipitates.

(A) CuS and HgS (B) MnS and CuS (C) MnS and NiS (D) NiS and HgS

Ans. (A)

68. Battery acid (H_2SO_4) has density 1.285 g cm^{-3}. 10.0 cm^3 of this acid is diluted to 1L. 25.0 cm^3 of this diluted solution requires 25.0 cm^3 of 0.1 N sodium hydroxide solution for neutralization. The percentage of sulphuric acid by mass in the battery acid is :

(A) 98 (B) 38 (C) 19 (D) 49

Ans. (B)

Sol. Let the normality of H_2SO_4 in battery acid be = 'x' N

then number of mol of H_2SO_4 in 10 cm^3 of acid = (10 x)

After dilution to 1 L only 25 cm^3 of this is taken so number of mol in 25 cm^3 of diluted acid

$$= \left(\frac{10x}{1000}\times 25\right) = \left(\frac{x}{4}\right)\text{mol}$$

So number of mol of NaOH = 0.1 × 25 = 2.5

So $\frac{x}{4} = 2.5 \quad \Rightarrow \quad x = 10$ N

So molarity of H_2SO_4 in battery acid = 5 M

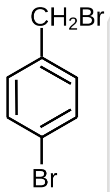
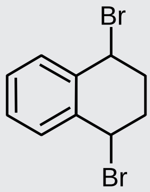
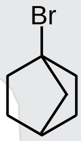
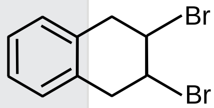
mass of H_2SO_4 = 5 × 98 gm

Total mass of solution = 1.285 × 1000 gm = 1285 gm

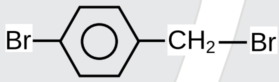
so % of H_2SO_4 = $\frac{5 \times 98}{1285} \times 100\% = 38.13\%$

Answer is (B).

69. The compound that reacts fastest with methylamine is

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

Ans. **(A)**

Sol. Given reaction in S_N2 

70. HgO is prepared by two different methods : one shows yellow colour while the other shows red colour. The difference in colour is due to difference in

(A) electronic d-d transitions
(B) particle size
(C) Frenkel defect
(D) Schottkey defect

Ans. **(B)**

71. The pH of a 1.0×10^{-3} mol L^{-1} solution of weak acid HA is 3.60 . The dissociation constant of the acid is

(A) 8.4×10^{-8}
(B) 8.4×10^{-6}
(C) 8.4×10^{-5}
(D) 8.4×10^{-2}

Ans. **(C)**

Sol. $XA \rightleftharpoons X^+ + A^-$

C 0 0

$C(1-\alpha)$ $c\alpha$ $c\alpha$

$$\alpha = \frac{C\alpha^2}{(1-\alpha)}$$

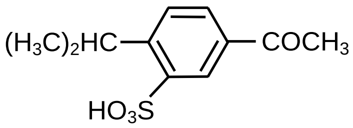
Now, $pH = 3.60 \;\&\; (H^+) = 2.5 \times 10^{-4}$

$10^{-3}\alpha = 2.5 \times 10^{-4}$

So $\alpha = \frac{0.25 \times 10^{-3}}{10^{-3}} = 0.25$ So $K_a = \frac{10^{-3}(1/16)}{(3/4)} = \frac{1}{12} \times 10^{-3} = 0.084 \times 10^{-3} = 8.4 \times 10^{-5}$

Ans. (C) Correct

72. The best sequence of reactions for preparation of the following compound from benzene is



(A) (i) $CH_3COCl/AlCl_3$ (ii) Oleum (iii) $(CH_3)_2CH–Cl$ (1 mole)/$AlCl_3$

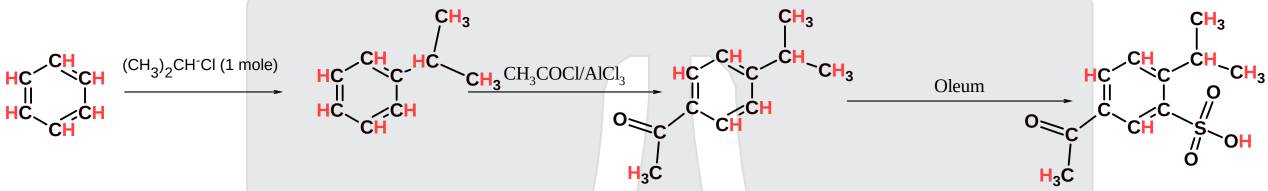
(B) (i) $(CH_3)_2CH–Cl$(1 mole)/$AlCl_3$ (ii) $CH_3COCl/AlCl_3$ (iii) Oleum

(C) (i) Oleum (ii) $CH_3COCl/AlCl_3$ (iii) $(CH_3)_2CH–Cl$ (1 mole)/$AlCl_3$

(D) (i) $(CH_3)_2CH–Cl$(1 mole)/$AlCl_3$ (ii) Oleum (iii) $CH_3COCl/AlCl_3$

Ans. **(B)**

Sol.



73. Which reaction is spontaneous at all temperatures at standard pressure and concentration ?

(A) exothermic reaction with a decrease in entropy

(B) exothermic reaction with an increase in entropy

(C) endothermic reaction with a decrease in entropy

(D) endothermic reaction with an increase in entropy

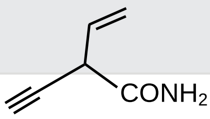
Ans. **(B)**

Sol. As, $\Delta G° = \Delta H° – T\Delta S°$

For on spontaneous process, $\Delta G°$ must be negative.

if correct option is (B)

74. The IUPAC name of the following compound is



(A) 3-Aminocarbonylpent-1-en-4-yne

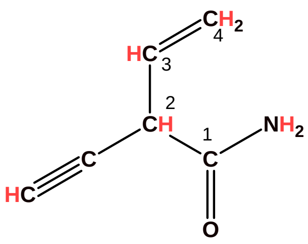
(B) 2-Ethenylbut-3-yn-1-amide

(C) 2-Ethynylbut-3-en-1-amide

(D) 3-Aminocarbonylpent-4-en-1-yne

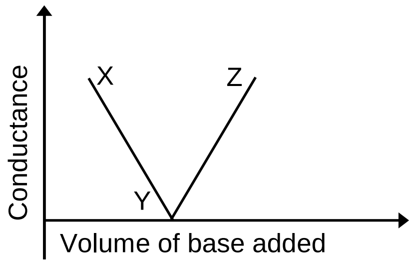
Ans. **(C)**

Sol.



2-ethynylbut-3-enamide

75. NaOH solution is added dropwise to HCl solution and the conductance of the mixture is measured after addition of each drop. The variation of conductance with volume of NaOH added is as shown below.



The statement that is not true for the above is

(A) decrease in conductance from X$\rightarrow$ Y is due to decrease in $[H^+]$

(B) point Y represents the equivalence point of titration.

(C) Na^+ has the higher equivalence conductance than H_3O^+

(D) segment YZ represents the conductance due to ions from NaCl and NaOH in solution.

Ans. **(C)**

Sol. (A) correct statement.

(B) correct statement.

(C) incorrect statement.

as H_3O^+ has greater equivalence conductance than Na^+.

(A) Correct statement.

76. A colorless water-soluble compound on strong heating liberates a brown colored gas and leaves a yellow residue that turns white on cooling. An aqueous solution of the original solid gives a white precipitate with $(NH_4)_2S$. The original solid is :

(A) $Zn(NO_3)_2$ (B) $Ca(NO_3)_2$ (C) $Al(NO_3)_3$ (D) $NaNO_3$

Ans. **(A)**

77. The following compounds are heated (i) KNO_3, (ii) $Cu(NO_3)_2$ (iii) $Pb(NO_3)_2$, (iv) NH_4NO_3 . Which of the following statement/s is/are correct ?

(A) (ii) and (iii) liberate NO_2 (B) (iv) liberates N_2O

(C) (i), (ii) and (iii) liberate O_2 (D) All statements are correct.

Ans. **(D)**

Sol. $KNO_3 \longrightarrow$ Liberates O_2

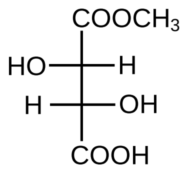
$$\left.\begin{array}{l} Cu(NO_3)_2 \\ Pb(NO_3)_2 \end{array}\right] \text{Liberates } NO_2$$

NH_4NO_3 liberates N_2O

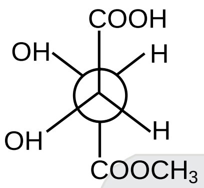
$\Rightarrow$ All options are correct.

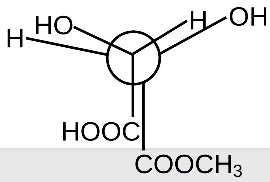
$\Rightarrow$ Correct answer is option (D) All statements are correct.

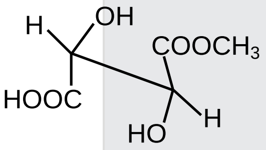
78. The diastereoisomer (Stereoisomer that is not a mirror image) of 'X' is

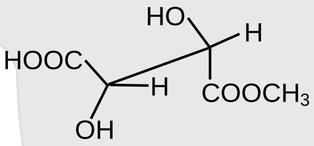


'X'

(A) 

(B) 

(C) 

(D) 

Ans. (C)

79. Given $\Delta_r H^o = -54.08 kJ\ mol^{-1}$ and $\Delta_r S^o = 10.0\ J\ mol^{-1}$ at 25ºC, the value of $\log_{10}K$ for the reaction $A \rightleftharpoons B$ is

(A) 3.4 (B) 10 (C) 0.53 (D) 113

Ans. (B)

Sol. $\Delta G^o = \Delta H^o - T\Delta S^o$

$= -54.08 \times 10^3 - 298 \times 10 = -54080 - 2980$

$= -57060\ J = -57.06\ KJ$

$\Delta G^o = -RT\ell nk$

$-57.06 \times 10^3 = -8.314 \times 2.303 \log_{10}K \times 298 \Rightarrow \log_{10}K = \dfrac{57.06 \times 10^3}{8.314 \times 2.303 \times 298} = 10$

$\Rightarrow$ Correct option is (B) 10.

80. Which of the complex has the magnetic moment of 3.87 B.M. ?

(A) $[Co(NH_3)_6]^{3+}$

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

(C) $[CoCl_4]^{2-}$

(D) $[Co(dmg)_2]$ square planar complex (dmg = dimethyl glyoxime)

Ans. (C)

Sol. (a) $[Co(NH_3)_6]^{+3}$

Oxidation state of cobalt is +3 and NH_3 is a strong field ligand. Therefore pairing will occur. There will be no unpaired electron.

Therefore $\mu = 0$.

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

Oxidation state of cobalt is +3 and F^- is a weak field ligand. Therefore pairing will not occur. There will be 4 unpaired electron.

Therefore μ = 4.92 BM.

(c) $[CoCl_4]^{-2}$

Oxidation state of cobalt is +2 and Cl^- is a weak field ligand. Therefore pairing will not occur. There will be 3 unpaired electron.

Therefore μ = 3.87 BM.