INDIAN OLYMPIAD QUALIFIER IN CHEMISTRY (IOQC) 2020-21

(Held On Sunday 07th FEBRUARY , 2021)

Time allowed : 60 Minutes **Max. Marks : 120**

TEST PAPER WITH ANSWER (LEVEL-1)

Attempt All The Thirty Two Questions

A-1

- **ONLY ONE OUT OF FOUR OPTIONS IS CORRECT BUBBLE THE CORRECT OPTION.**

1. Two students did a set of experiments on ketones 'X' and 'Y' independently and obtained the following results.

Reaction /Experiment	X	Y
Optical rotation	Yes	Yes
Optical rotation after treatment with a base	Zero	Yes
NH_2NH_2, KOH, Heat	Formation of an optically inactive hydrocarbon C_6H_{12}	Formation of an optically inactive hydrocarbon C_6H_{12}

The ketones 'X' and 'Y' are respectively

(a) 2-ethylcyclobutanone and 3-ethylcyclobutanone

(b) 2-methylcyclopentanone and 3-methylcyclopentanone

(c) 3-methylcyclopentanone and 2-methylcyclopentanone

(d) 3-methyl-4-penten-2-one and 4-methyl-l-penten-3-one

1. Ans.(b)

Sol. In (a) option 3-ethylcyclobutanone opticaly inactive and in (d) option 4-methyl-l-penten-3-one opticaly inactive

2. Glycine ($C_2H_5O_2N$) is the simplest of amino acids. Molecular formula of the linear oligomer synthesized by linking ten glycine molecules together via a condensation reaction would be

(A) $C_{20}H_{32}O_{11}N_{10}$ (b) $C_{20}H_{68}O_{29}N_{10}$ (c) $C_{20}H_{40}O_{10}N_{10}$ (d) $C_{20}H_{50}O_{20}N_{10}$

2. Ans.(a)

Sol. From 10 unit of glycine [$10(C_2H_5.O_2N) = C_{20}H_{50}O_{20}N_{10}$] 9 molecule of H_2O [$9(H_2O) = H_{18}O_9$] will remove.

$\therefore \quad C_{20}H_{50}O_{20}N_{10} - H_{18}O_9 = C_{20}H_{32}O_{11}N_{10}$

3. If Ni^{2+} is replaced by Pt^{2+} in the complex ion $[NiCl_2Br_2]^{2-}$, which of the following would change?

I. Magnetic moment II. Geometry

III. Geometrical isomerism IV. Optical isomerism

(a) I, II, III (b) II, III (c) I, II (d) II, III, IV

3. Ans.(a)

Sol. $[NiCl_2Br_2]^{2-}$

$Ni^{2+} \rightarrow [Ar]3d^8 4s^0 4p^0$

[Ar] | ⇅ | ⇅ | ⇅ | ↑ | ↑ | | | | | |

WFL is present

sp^3 hybridisation

$\mu = \sqrt{8}$B.M.

Tetrahedral complex and chiral centre is absent, so G.I. and O.I. is not observed.

$[PtCl_2Br_2]^{2-}$

Pt^{2+} : $[Xe]5d^8 6s^0 6p^0$

For Pt^{2+} : Cl^-, Br^- behave as SFL

So all unpaired electrons are paired.

dsp^2 hybridisation

$\mu = 0$

Diamagnetic

$[PtCl_2Br_2]^{2-}$ is $[Ma_2b_2]$ type square planar complex, So G.I. is shown by complex but O.I. is not observed.

4. An inorganic compound 'X' of an alkali metal on heating gives a reddish-brown gas 'Y' and a binary solid 'Z'. This solid is less soluble in water and its solution is basic. 'X' does not give a positive silver nitrate test. 'X' can be identified as

(a) KIO_3 (b) $LiNO_3$ (c) $NaNO_3$ (d) KNO_2

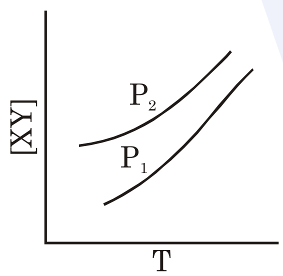
4. Ans.(b)

Sol. $\underset{(X)}{LiNO_3} \xrightarrow{\Delta} \underset{\substack{(Z)\\ \text{Binary solid} \\ \text{(Basic)}}}{Li_2O} + \underset{\substack{(Y) \\ \text{Reddish-brown}}}{NO_2(g)}$

$LiNO_3$ does not gives positive silver nitrate test.

5. The qualitative plots given represent the yield of the product, [XY], at equilibrium in the reaction $X(g) + Y(g) \rightleftharpoons XY(g)$, as a function of temperature, at total pressures P_1 and P_2.

The reaction is



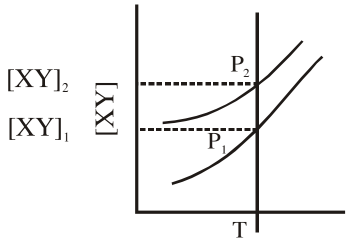
(a) endothermic and $P_1 < P_2$ (b) endothermic and $P_2 < P_1$

(c) exothermic and $P_1 > P_2$ (d) exothermic and $P_2 > P_1$

5. Ans.(a)

Sol. Fixing the temperature at T ;

$[XY]_2 > [XY]_1$ at

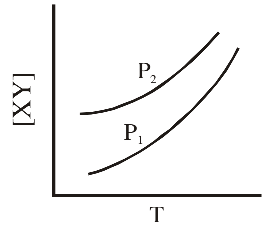


$\Rightarrow$ $\because$ $\Delta ng < 0$ for the reaction ;

$\therefore$ on increasing pressure ; reaction shifts in forward direction

$\therefore$ $p_2 > p_1$

from the graph ; upon increasing temperature the yield is increasing & hence reaction is endothermic .



6. Thc Galvanic cell can be represented as Zn / Zn^{2+} (0.1M) // Cu^{2+} (0.1 M)/Cu. Among the following, the cell that can produce an EMF more than that of the Galvanic cell is

(E° of Zn^{2+} / Zn and Cu^{2+} / Cu are –0.763V and 0.337V respectively)

(a) Zn / Zn^{2+} (0.1M) // Cu^{2+}(0.01M)/Cu
(b) Zn / Zn^{2+} (1M) // Cu^{2+} (0.01M) / Cu
(c) Zn/Zn^{2+}(0.01M) // Cu^{2+}(1M) / Cu
(d) Zn / Zn^{2+} (0.01M) // Cu^{2+} (0.01M)/Cu

6. Ans.(c)

Sol. Anode : $Zn(s) \longrightarrow Zn^{2+}_{(aq.)} + 2e^-$

Cathode : $Cu^{2+}_{(aq.)} + 2e^- \longrightarrow Cu(s)$

Overall cell reaction : $Zn(s) + Cu^{2+}_{(aq.)} \longrightarrow Cu(s) + Zn^{2+}_{(aq.)}$

$$E_{cell} = E^0_{cell} - \frac{RT}{nF}\ln\frac{[Zn^{2+}]}{[Cu^{2+}]}$$

from the values given in question ; $E = E^0_{cell}$

checking value of reaction quotient from options. A lower value of reaction quotient would reflect a higher tendency to shift the reaction forward & hence increase the EMF.

(a) $Q = \frac{[Zn^{2+}]}{[Cu^{2+}]} = \frac{0.1}{0.01} = 10$

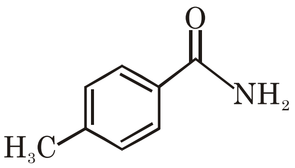
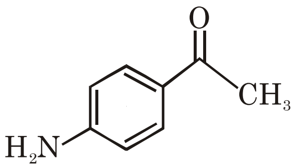
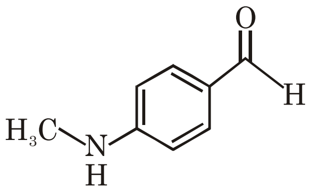
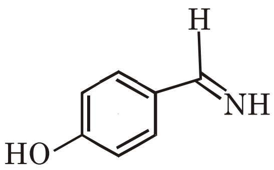
(b) $Q = \frac{[Zn^{2+}]}{[Cu^{2+}]} = \frac{1}{0.01} = 100$

(c) $Q = \frac{[Zn^{2+}]}{[Cu^{2+}]} = \frac{0.01}{1} = 0.01$

(d) $Q = \frac{[Zn^{2+}]}{[Cu^{2+}]} = \frac{0.01}{0.01} = 1$

$\therefore$ Lowest value of Q is in option (c)

7. Thc correct match of the molecules in column I and reactions in column II is

Column I	Column II
(i) 	(L) Coloration with $FeCl_3$
(ii) 	(M) Effervescence with $NaHCO_3$
(iii) 	(N) Yellow precipitate with NaOH and I_2
(iv) 	(O) Yellow oil with $NaNO_2$, HCl at 0 °C
	(P) Heating with NaOH gives out a gas that turns moist turmeric paper brown

(a) i–N ii–L iii–O iv–M
(b) i–O ii–N iii–L iv–P
(c) i–P ii–O iii–L iv–M
(d) i–P ii–N iii–O iv–L

7. **Ans.(d)**

Sol. (i) Gives NH_3 when react with NaOH which turn turmaric paper brown
(ii) Gives Iodoform test
(iii) 2° amine gives yellow oil with $NaNO_2$, HCl
(iv) Phenol derivative give $FeCl_3$ test

8. When 6.8 g of $AgNO_3$ completely reacts with H_3PO_2, metallic silver produced (g) and H_3PO_2 consumed (mole) are respectively
(a) 4.32 and 0.1 (b) 1.08 and 0.01 (c) 4.32 and 0.01 (d) 2.16 and 0.01

8. **Ans.(c)**

Sol. $AgNO_3 + H_3\overset{+1}{P}O_2 \rightarrow H_3\overset{+3}{P}O_3 + 2Ag + 2HNO_3$

$2Ag^+$ gets reduced & phosphorous gets oxidised
n-factor of $AgNO_3$ = 1
n-factor of H_3PO_2 = 2
Equivalents of $AgNO_3$ reacted = Equivalents of Ag produced = Equivalents of H_3PO_2 reacted

$$\Rightarrow \left(\frac{6.8}{170}\right)\times 1 = (n_{Ag}\times 1) = n_{H_3PO_2}\times 2$$

$\Rightarrow$ n_{Ag} produced = 0.04 $\Rightarrow$ wt. of Ag = 0.04 mol × 108 g/mol = 4.32 gm

$\Rightarrow$ $n_{H_3PO_2}$ reacted = 0.02

9. A chemical reaction is carried out at two different temperatures T_1 and T_2 ($T_2 > T_1$) and also with and without a catalyst.

The statement that is correct among the following is.

(a) Lowering in the activation energy of the reaction due to catalyst would be higher at T_2 than at T_1

(b) Lowering in the activation energy of the reaction due to catalyst would be higher at T_1 than at T_2

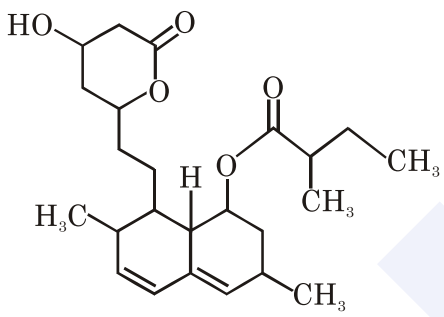
(c) The factor by which the rate of the reaction is increased by the catalyst would be lower at T_2 than at T_1

(d) The factor by which the rate of the reaction is increased by the catalyst would be higher at T_2 than at T_1

9. **Ans.(c)**

Sol. Increasing temperature would result in an increase in rate of reaction & the same effect will be due to addition of catalyst.

10. Lovastatin, a drug used to reduce the risk of cardio vascular diseases has the following structure



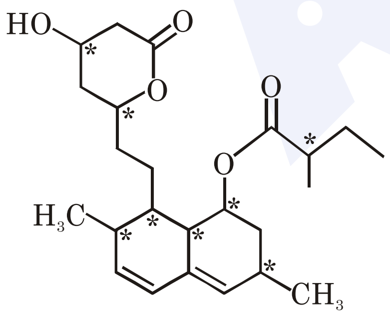
Lovastatin

The number of stereogenic centers present in lovastatin is

(a) 8 (b) 3 (c) 4 (d) 6

10. **Ans.(a)**

Sol.

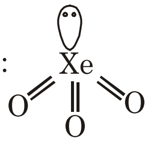


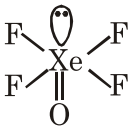
11. Among the following sets, the one in which all the molecules are non polar is

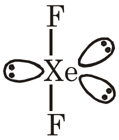
(a) XeF_4, XeO_3, XeO_4 (b) XeF_2, XeO_4, $XeOF_4$

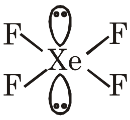
(c) XeF_2, XeF_4, XeO_4 (d) XeF_2, XeO_3, $XeOF_4$

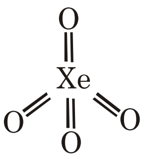
11. **Ans.(c)**

Sol. (a) XeO_3 :  Polar

(b) $XeOF_4$:  Polar

(c) XeF_2 :  Non polar

XeF_4 :  Non polar

XeO_4 :  Non polar

(d) XeO_3 and $XeOF_4$ are polar

12. Gas phase reactions (i) and (ii) are of first and second order respectively :

$2N_2O_5 \rightarrow 4NO_2 + O_2$ ....(i)

$2NO + O_2 \rightarrow 2NO_2$ ....(ii)

Under certain conditions, the rate constants (k_1, k_2) of (i) and (ii) respectively, have the same numerical value, when the concentrations of the reactants are expressed in mol/dm^3. If the concentrations are expressed in mol/mL, the correct relationship between k_1 and k_2 is -

(a) $k_2 \times 10^{-3} = k_1$ (b) $k_2 \times 10^3 = k_1$ (c) $k_1 = k_2$ (d) $k_1 \times 10^6 = k_2$

12. Ans.(a)

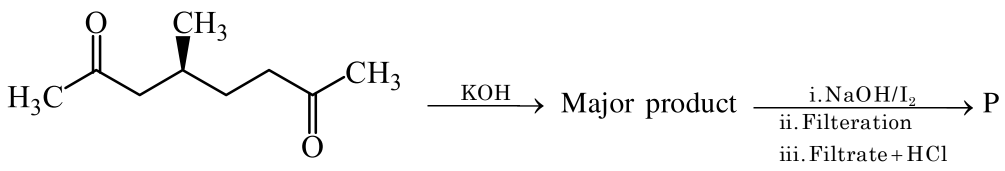
Sol. Assuming k_1 & k_2 have same numerical value 'x' when the concentration of reactans are reported as mol / dm^3

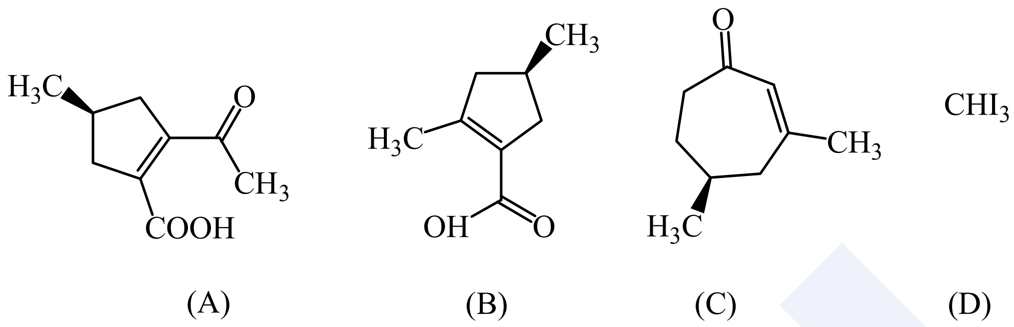
$\Rightarrow k_1 = x\ (\text{time})^{-1}$

$$k_2 = x\left(\frac{dm^3}{mol}\right)(\text{time})^{-1}$$

$\Rightarrow k_2 = k_1 \times 1000$

13. The product **'P'** in the following sequence of reactions is -

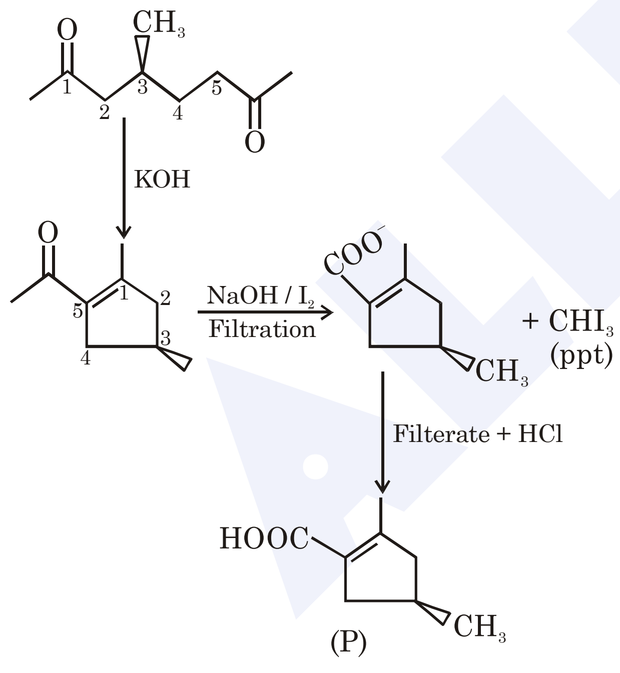




(a) (A) (b) (B) (c) (C) (d) (D)

13. Ans.(b)

Sol.



14. Among the following, maximum number of resonance structures is possible for -

(a) PO_4^{-3} (b) SO_4^{-2} (c) CO_3^{-2} (d) MnO_4^{-}

14. Ans.(b)

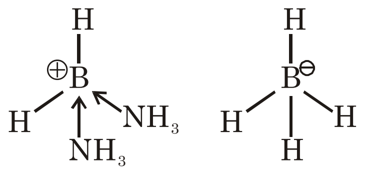
Sol. In SO_4^{2-}, maximum six resonating structures are possible.

15. Reaction of ammonia with diborane gives an ionic product ($B_2H_6.2NH_3$). The hybridization of boron in the cation and anion of this product are respectively

(a) sp^3 in both (b) sp^3 and sp^2 (c) sp^2 & sp^3 (d) sp^2 in both

15. Ans.(a)

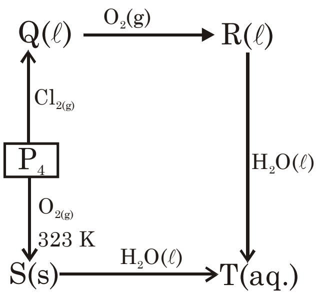
Sol. $B_2H_6 + 2NH_3 \longrightarrow [BH_2(NH_3)_2]^+ [BH_4]^-$



In both cationic and anionic part 'B' atom is sp^3 hybrid.

16. The sequence of reactions of phosphorous (P_4) is given below

The correct set of products (Q, R, S and T) among the following is-



(a) $Q = PCl_3$; $R = POCl_3$; $S = P_2O_3$; $T = H_3PO_3$

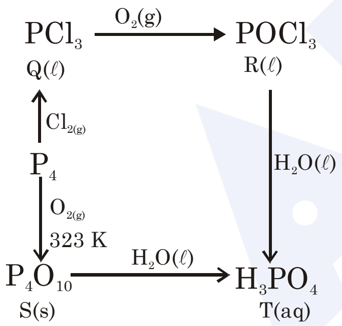
(b) $Q = PCl_5$; $R = P_2O_5$; $S = P_4O_6$; $T = H_3PO_3$

(c) $Q = PCl_3$; $R = POCl_3$; $S = P_4O_{10}$; $T = H_3PO_4$

(d) $Q = PCl_5$; $R = P_4O_{10}$; $S = P_4O_{10}$; $T = H_3PO_4$

16. Ans.(c)

Sol.



17. In the gaseous state of $Fe(CO)_5$, the 'd' orbital that would be participate in hybridization is -

(a) $d_{x^2-y^2}$ (b) d_{z^2}

(c) d_{xz} (d) any one of the 'd' orbitals

17. Ans.(b)

Sol. $Fe(CO)_5$ having triagonal bipyramidal geometry. So d_{z^2} orbital involve in hybridization.

18. Among the following, the **CORRECT** statement/s about 'p' block elements, is/are

I. The valence shell electronic configuration of all of them is $ns^2\ np^{1-6}$

II. Only in p block, metals, nonmetals and metalloids are present

III. Halogens have the lowest negative electron gain enthalpy in the respective period.

IV. Noble gases have no tendency to accept an electron and hence they have large negative values of electron gain enthalpy .

(a) I, IV (b) II, III (c) IV only (d) II only

18. Ans.(d)

Sol. → In p-block, metals, non metals and metalloids are present

→ Halogen having most negative electron gain enthalpy in respective period.

→ Noble gases have no tendency to accept an electron, so energy is required when electron is added in noble gas. So their electron gain enthalpy is positive.

19. A mixture of sodium (Na) and potassium (K) metals weighing 32 g was reacted with water and the solution obtained could be neutralized with 517.3 mL of 1.0 M H_2SO_4(aq.) The mass of sodium that was present in the mixture is -

(a) 20g (b) 16 g (c) 10 g (d) 12 g

19. Ans.(d)

$$\underset{xg}{Na} + H_2O \longrightarrow NaOH + \frac{1}{2}H_2$$

$$\underset{(32-x)g}{k} + H_2O \longrightarrow KOH + \frac{1}{2}.H_2$$

$$n_{NaOH} \text{ produced} = n_{Na} \text{ reacted} = \left(\frac{x}{23}\right)$$

$$n_{KOH} \text{ produced} = n_{K} \text{ reacted} = \left(\frac{32-x}{39}\right)$$

$$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$$

$$2KOH + H_2SO_4 \longrightarrow K_2SO_4 + 6H_2O$$

$$\frac{n_{NaOH} \text{ reacted}}{2} + \frac{1}{2} \times n_{KOH} \text{ reacted} = n_{H_2SO_4} \text{ reacted}$$

$$\left(\frac{x}{23}\right) + \left(\frac{32-x}{39}\right) = 0.5173 \times 1 \times 2$$

$$(0.0179x) = 0.214 \Rightarrow x \simeq 12 \text{ gm}$$

20. The mass ratio of steam and hydrogen is found to be 1 : 1.5 at equilibrium in the following reaction

$$3Fe(s) + 4H_2O(g) \rightleftharpoons Fe_3O_4(s) + 4H_2(g)$$

The value of the equilibrium constant (K_c) of the above reaction is.

(a) 3.0×10^{-5} (b) 3.3×10^4 (c) 3.3×10^6 (d) 1.3×10^3

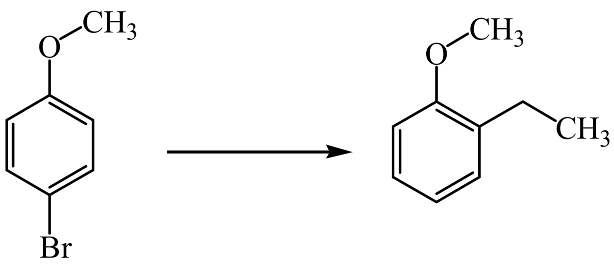
20. Ans.(b)

Sol. $w_{H_2O} : w_{H_2} = 1 : 1.5 = 2 : 3$

$\Rightarrow \quad n_{H_2O} : n_{H_2} = \left(\frac{2}{18}\right) : \left(\frac{3}{2}\right) = 2 : 27$

$\Rightarrow \quad \text{Now, } K_C = \frac{\left(\frac{n_{H_2}}{V}\right)^4}{\left(\frac{n_{H_2}}{V}\right)^4} = \left(\frac{27}{2}\right)^4 = 33215.0625 = 3.3 \times 10^4$

21. The correct sequence of reactions to get 'Q' as the only product from 'P' is -



P **Q**

(a) (i) H_2 & Pt catalyst (ii) C_2H_5Cl & $AlCl_3$

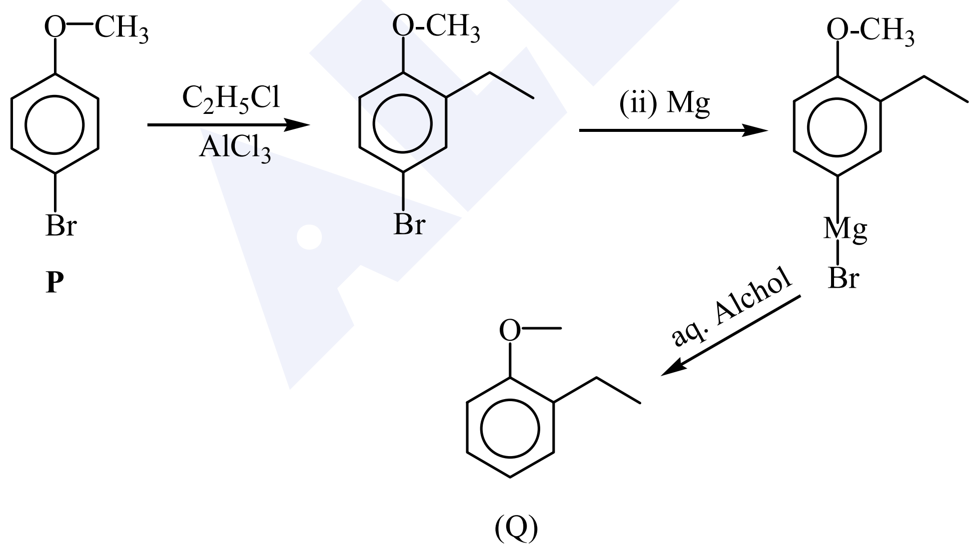
(b) (i) Mg in ether (ii) aqueous alcohol (iii) C_2H_5Cl & $AlCl_3$

(c) (i) Mg in ether (ii) C_2H_5Cl & $AlCl_3$

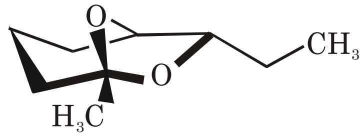
(d) (i) C_2H_5Cl & $AlCl_3$ (ii) Mg in ether (iii) aqueous alcohol

21. Ans.(d)

Sol.



22. Pheromones are chemicals that animals produce for social response. The structure of brevicomin, a pheromone, is shown below. The open chain ketodiol that would form brevicomin is



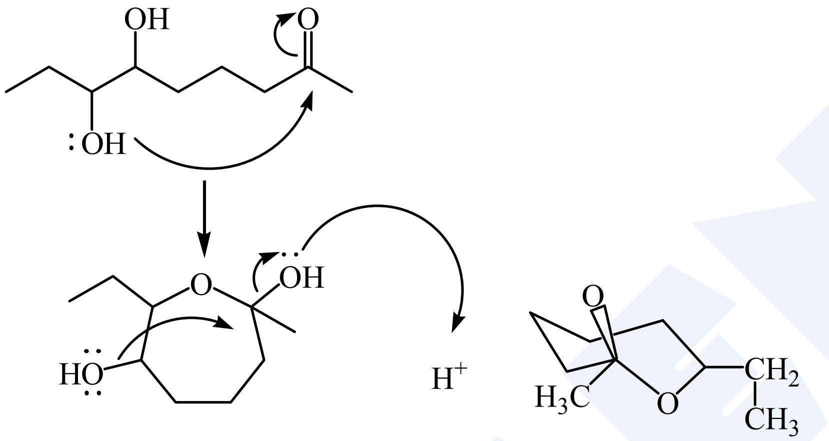
Brevicomin

(a) 7,8-dihydroxynonan-3-one (b) 6,7-dihydroxynonan-3-one

(c) 7,8-dihydroxynonan-2-one (d) 6,7-dihydroxynonan-2-one

22. Ans.(d)

Sol.



23. While doing titration, a student recorded a burette reading of 10.0 mL for the neutralization of 10.0 mL $NaHC_2O_4$ (aq) with 0.1 M NaOH (aq). In a separate experiment, 10.0 mL of this $NaHC_2O_4$ (aq) solution could be completely oxidized by 10.0 mL of $KMnO_4$ in an acidic medium.

What would be the molarity of $KMnO_4$ used by this student?

(a) 0.02 M (b) 0.04 M (c) 0.1 M (d) 0.2 M

23. Ans.(b)

Sol. $NaHC_2O_4$ would give an acid-base neutralisation reaction with NaOH ; while acting as a base (n-factor=1) & with $KMnO_4$, it gives a redox reaction ,where it acts like a reducing agent (n-factor = 2)

$\Rightarrow$ Equivalents of $NaHC_2O_4$ = equivalents of NaOH

$$\Rightarrow \quad 1\times\left(\frac{10}{1000}\right)\times M_{NaHC_2O_4} = 1\times 0.1\times\frac{10}{1000} \quad ..... (1)$$

$\Rightarrow$ Equivalents of $NaHC_2O_4$ = equivalents of $KMnO_4$

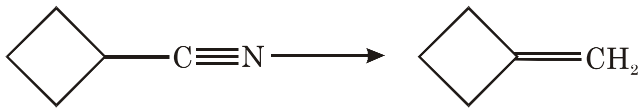
(n-factors of $KMnO_4$ in acidic medium = 5)

$$\Rightarrow \quad 2\times\frac{10}{1000}\times M_{NaHC_2O_4} = 5\times\frac{10}{1000}\times M_{KMnO_4} \quad ..... (2)$$

divide (1) & (2) ;

$$\frac{5}{0.1}\times M_{KMnO_4} = 2 \; ; \Rightarrow M_{KMnO4} = 0.04M$$

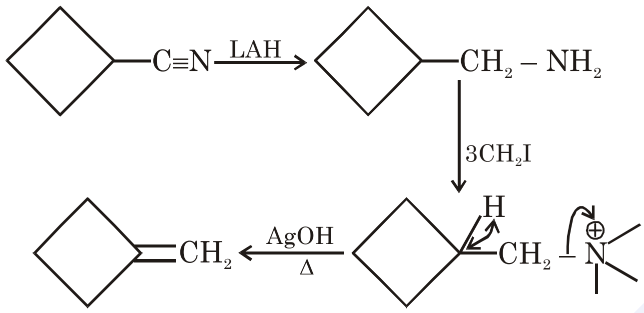
24. The best reagents and conditions to accomplish the following conversion is



(a) (i) $LiAlH_4$ in ether , (ii) 3 moles of CH_3I followed by heating with AgOH
(b) (i) $LiAlH_4$ in ether ; (ii) P_2O_5 and heat
(c) (i) 20 % H_2SO_4 & heat, (ii) P_2O_5 and heat
(d) H_2 and Lindlar catalyst

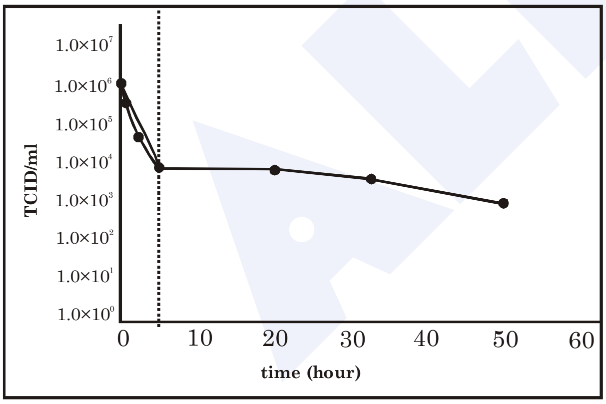
24. **Ans.(a)**

Sol.

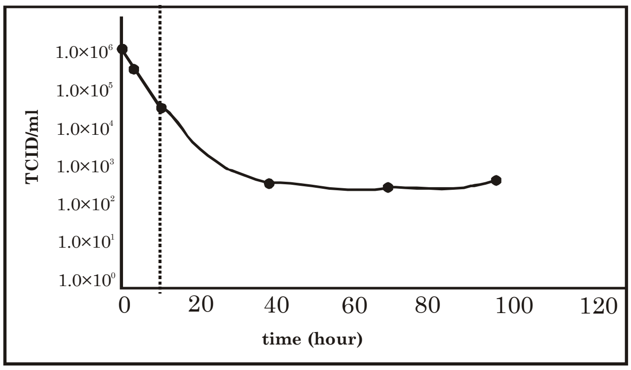


25. Viruses are nonliving complex chemical entities. They undergo inactivation and hence lose the ability to infect a host, with time. Concentration (expressed as 'median tissue culture infectious dose', TCID/ml, a unit used in expressing virus concentrations) vs. time plots of a corona virus on the surfaces of a paper currency note and a plastic currency note are shown below. Both these plots have two separate regions (shown by vertical lines in the plols), indicating two time zones.

I. Paper currency note



II. Plastic currency note



The correct option/s among the following is/are

(a) Inactivation of the virus follows zero order kinetics in Ist zone and first order kinetics in 2nd zone

(b) The rate of inactivation is independent of the surface material

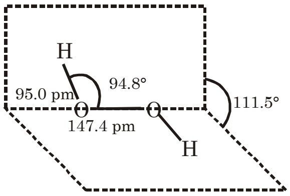
(c) The virus reacts with different chemical entities/substances in 1st zone and 2nd zone

(d) On both the surfaces, at least 95 % of the virus is inactivated within 10 h

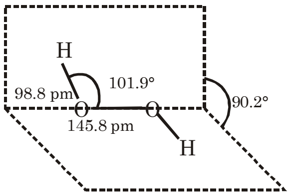
25. Ans.(c,d)

Sol. In Ist and IInd zone, the rate of reaction changes sharply and hence the virus reacts with different substances.

26. The structures of hydrogen peroxide (H_2O_2) in the solid and gaseous states are given below. H_2O_2 (ℓ) is slightly more viscous than H_2O (ℓ). The correct option/s among the following is/are



Gas



Solid (Crystal)

(a) Both O atoms are near enough to cause repulsion between the electron lone pairs thus making the O-O bond susceptible for cleavage

(b) The strong intermolecular H-bonding along with restricted rotation present in the liquid state of H_2O_2 make it more viscous than H_2O(ℓ)

(c) The molecule gets twisted to minimize the repulsion between the lone pair and bond pair of electrons

(d) The difference in the dihedral angles in the solid and gaseous states is a consequence of hydrogen bonding between the molecules

26. Ans.(a,b,c,d)

Sol. (a) All statements are correct.

27. Which of the following aqueous solution/s will have a pH value between 4.0 and 5.0 at 25°C?

(a) 0.01 M solution of benzoic acid (K_a= 6.6 x 10^{-5} at 25°C)

(b) 0.02 mol benzoic acid and 0.05 mol sodium benzoate dissolved in appropriate amount of water to make a solution of 1L

(c) A mixture of 999 mL water and 1 mL 0.2 M HCl

(d) 499 mL of 0.01 M NaOH and 501 mL of 0.01 M HCl mixed together

27. Ans.(b, d)

Sol. Checking for option (a)

$$C_6H_5COOH \rightleftharpoons C_6H_5COO^- + H^+$$

$$t_{eq} \quad 0.01(1-\alpha) \qquad 0.01\alpha \qquad 0.01\alpha$$

$$k_\alpha = 6.6\times10^{-5} = \frac{0.01\alpha^2}{1-\alpha} \quad \Rightarrow \quad \frac{\alpha^2}{1-\alpha} = 6.6\times10^{-3}$$

$$\Rightarrow \quad \alpha = \sqrt{6.6\times10^{-3}} = 0.0812$$

$$\Rightarrow \quad [H^+] = 0.01 \times 0.0812 \text{ M}$$

$$\Rightarrow \quad pH \simeq 3$$

Checking for option (b)

$C_6H_5COOH + C_6H_5COO^{\ominus}Na^+$

0.02 M 0.05 M

$$k_\alpha = \frac{[C_6H_5COO^-][H^+]}{[C_6H_5COOH]} = \frac{[H^+](0.05)}{0.02} = 6.6\times10^{-5}$$

$\Rightarrow$ pH = 4.48

Checking for option (c)

molarity of HCl after dilution $= \frac{0.2\times1}{1000} = 2\times10^{-4}$

$\Rightarrow$ pH = 4–log2 $\simeq$ 3.7

checking for option (d)

$NaOH + HCl \longrightarrow NaCl + H_2O$

4.99 m mol 5.01 m mol

0 0.02 m mol

$\Rightarrow$ $[HCl] = \frac{0.02 \text{ m mol}}{1000 \text{ mol}} = 2\times10^{-5}$ M

$\Rightarrow$ pH = 5–log2 = 4.7

$\Rightarrow$ correct ans (b) and (d)

28. Which of the following option/s is/are correct?

(a) C_2 is paramagnetic

(b) He_2^+ has the same energy as that of two isolated He atoms

(c) S_2 is paramagnetic and S_2^{2-} is diamagnetic

(d) N_2^+ and N_2^- have the same bond order

28. Ans.(c,d)

Sol. (a) C_2 is diamagnetic

(b) He_2^+ does not have same energy as that of two isolated He atom

(c) In S_2, unpaired electrons are present in π_{3p} orbitals, so it is paramagnetic but in S_2^{2-} electrons are paired just like O_2^{2-}, so it is diamagnetic

(d) Bond order of $N_2^+ = 2.5$

Bond order of $N_2^- = 2.5$

29. The energy required to remove an electron from a gaseous species 'X' to form 'X^+' is known as first ionization energy (IE) of X. The energy required to remove an electron from a gaseous species 'X^+' to form 'X^{++}' is called the second IE of X. Similarly, the energy required to remove an electron from a gaseous species X^- to form X is called the IE of X^-.

Identify the correct statement/s from the following

(a) The second IE of the He atom is four times that of the (first) IE of the H atom

(b) The first IEs of F, Ne and Na atoms follow the order IE(Na) < IE(Ne) < IE(F)

(c) The second IE of the H^- ion is much less than the (first) IE of the H atom

(d) The IEs of Li, Na and K atoms follow the order IE(K) < IE(Na) < IE(Li)

29. (a,d)

Sol. (a) For single electron system.

$$I.E. = +13.6 \times \frac{z^2}{n^2}$$

so second I.E. of He atom is four times that of first I.E. of H-atom.

(b) IE_1 order : Na < F < Ne

(c) H-atom having only one electron, so second I.E. is not valid for H-atom

(d) I.E. order : K < Na < Li

(Down the group I.E. decreases for alkali metals)

30. The correct statement/s among the following is/are

(a) Intermolecular forces in n-heptane are stronger than those in 2-methylheptane

(b) Boiling point of 2,2-dimethylpentane is higher than that of 2, 2-dimethylbutane

(c) Both hydrogen bonding and van der Waals forces exist between molecules of 2-methylbutan-2-ol

(d) In 2,2-dimethylbutane, 1°, 2° and 3° types of carbon atoms are present

30. Ans.(b, c)

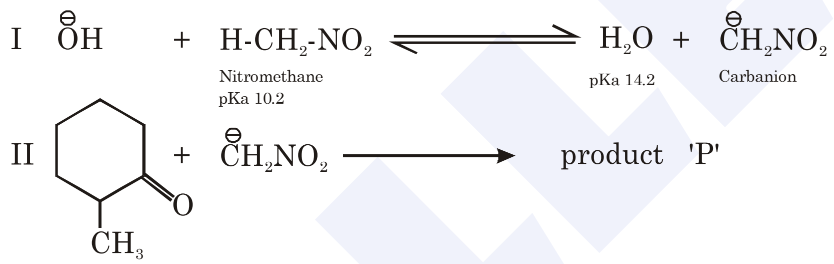
*Boiling point α molecular mass

* H-bonding and vanderwaal force

exist in 2-methyl butan-2-ol

31. Nitromethane undergoes an aldol type reaction with a racemic mixture of 2-methylcyclohexanone in presence of aqueous NaOH in two steps (I, II) to give the product 'P'.

The statement/s NOT correct among the following is/are



(a) The equilibrium in step I will be more towards the right as water is a stronger acid than nitromethane

(b) The carbanion formed in reaction I can be stabilized due to resonance

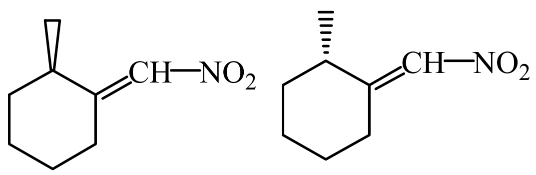
(c) The product formed will a mixture of four stereoisomers in the form of two pairs of enatiomers

(d) The mixture of products formed can be readily dehydrated to give a single product

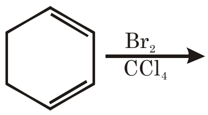
31. Ans.(a,d)

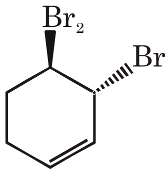
Sol. *water is weak acid than CH_3–NO_2

* (d)

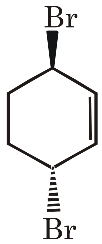


32. The product/s formed in the following reaction is/are.

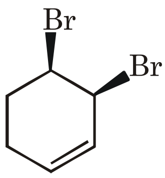




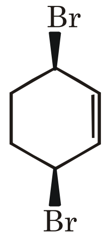
(A)



(B)



(C)



(D)

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

32. Ans.(a,b,d)

Sol.