

1 What will be the mass of one atom of  $^{12}\text{C}$ :

- A. 1 amu
- B.  $1.9923 \times 10^{-23} \text{ g}$
- C.  $1.6603 \times 10^{-22} \text{ g}$
- D. 6 amu

Mass of one mole of  $^{12}\text{C} = 12 \text{ g}$

So, mass of 1 atom of  $^{12}\text{C}, = \frac{12}{6.022 \times 10^{23}} = 1.9923 \times 10^{-23} \text{ g}$

2 Bond order of  $\text{He}_2$ ,  $\text{He}_2^+$  and  $\text{He}_2^{2+}$  are respectively:

- A.  $1, \frac{1}{2}, 0$
- B.  $0, \frac{1}{2}, 1$
- C.  $\frac{1}{2}, 1, 0$
- D.  $1, 0, \frac{1}{2}$

Bond order (B.O.) =  $\frac{N_{BMO} - N_{ABMO}}{2}$

$\text{He}_2 \rightarrow (\sigma 1s)^2 (\sigma^* 1s)^2$

$\therefore \text{B.O.} = \frac{2-2}{2} = \frac{0}{2} = 0$

$\text{He}_2^+ \rightarrow (\sigma 1s)^2 (\sigma^* 1s)^1$

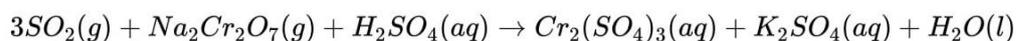
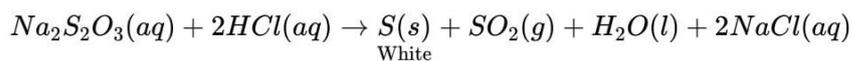
$\therefore \text{B.O.} = \frac{2-1}{2} = \frac{1}{2}$

$\text{He}_2^{2+} \rightarrow (\sigma 1s)^2 (\sigma^* 1s)^0$

$\therefore \text{B.O.} = \frac{2-0}{2} = 1$

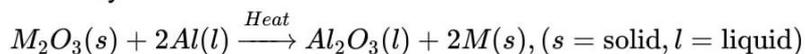
3 To a solution of a colourless efflorescent sodium salt, when dilute acid is added, a colourless gas is evolved along with formation of a white precipitate. Acidified dichromate solution turns green when the colourless gas is passed through it. The sodium salt is

- A.  $Na_2SO_3$
- B.  $Na_2S$
- C.  $Na_2S_2O_3$
- D.  $Na_2S_4O_6$



$Na_2SO_3$  and  $Na_2S_4O_6$  both produces  $SO_2$  on treatment with  $HCl$  but does not give white precipitate of sulphur.

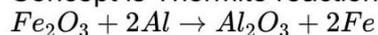
4 The reaction for obtaining the metal (M) from its oxide  $M_2O_3$  ore is given by



in that case, M is

- A. Copper
- B. Calcium
- C. Iron
- D. Zinc

Concept is Thermite reaction.

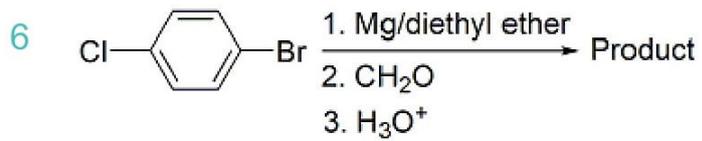


This reduction property of Aluminium is used in welding broken pieces of heavy iron objects like railway tracks.

5 In the extraction of  $Ca$  by electro reduction of molten  $CaCl_2$  some  $CaF_2$  is added to the electrolyte for the following reason:

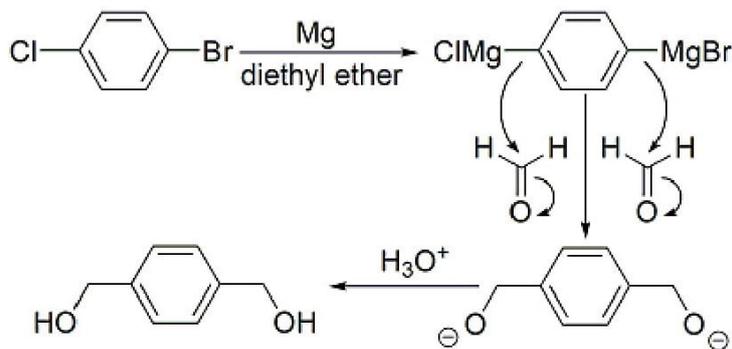
- A. To keep the electrolyte in liquid state at temperature lower than the melting point of  $CaCl_2$
- B. To effect precipitation of  $Ca$
- C. To effect the electrolysis at lower voltage
- D. To increase the current efficiency

To keep the electrolyte in liquid state at temperature lower than the m.p. of  $CaCl_2$ .

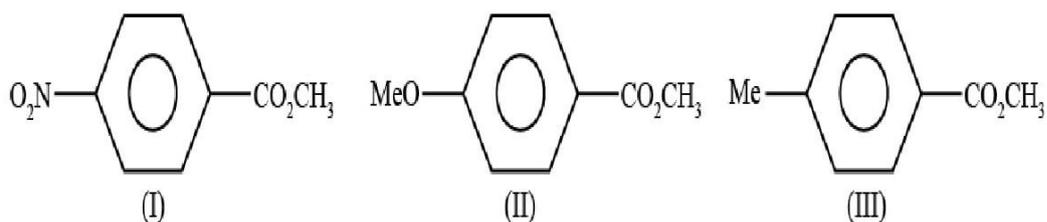


This product in the above reaction is

- A. BrC1=CC=C(CO)C=C1
- B. ClC1=CC(CO)=C(CO)C=C1
- C. ClC1=CC(CO)=C(CO)C=C1
- D. OC1=CC=C(CO)C=C1



7



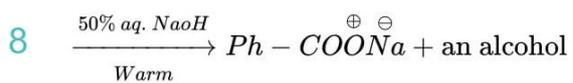
For the above three esters, the order of rates of alkaline hydrolysis is

- A. I > II > III
- B. II > III > I
- C. I > III > II
- D. III > I > II

Under alkaline condition, hydroxide attacks on carbonyl carbon of esters to furnish respective acids.

So when the  $\delta+$  charge on carbonyl carbon increases, attack of  $OH^-$  becomes more favourable and the rate of hydrolysis increases.

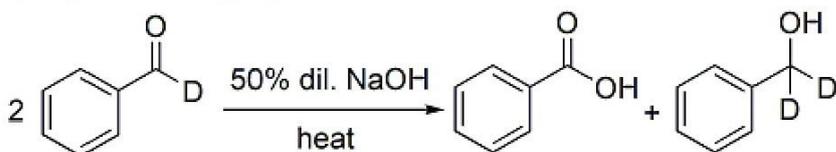
$NO_2$  showing strong  $-I$  effect will increase the  $\delta+$  charge.  $OCH_3$  shows  $+M$  effect and  $CH_3$  shows  $+I$  effect so they diminishes  $\delta+$  charge. Since  $+M$  is more effective than  $+I$ , hence rate will be least for compound (II).



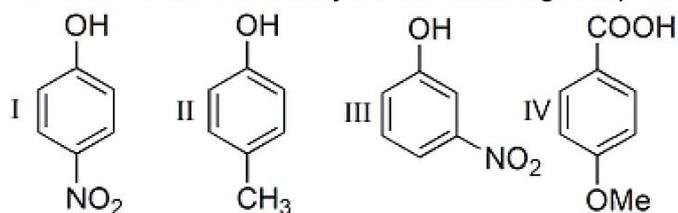
This alcohol is

- A.  $\text{Ph} - \text{CHD} - \text{OH}$
- B.  $\text{Ph} - \text{CHD} - \text{OD}$
- C.  $\text{Ph} - \text{CD}_2 - \text{OH}$
- D.  $\text{Ph} - \text{CD}_2 - \text{OD}$

This is an application of Cannizzaro reaction in which a non-enolized aldehyde undergoes disproportionation to give a carboxylic acid and a primary alcohol under basic condition.

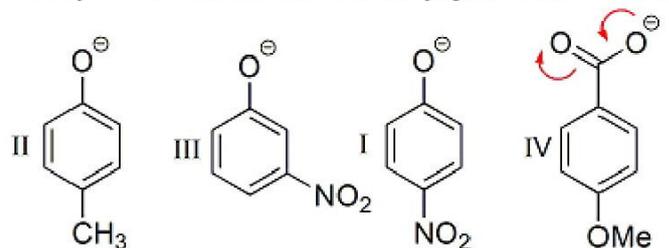


9 The correct order of acidity for the following compounds is:



- A. II < IV < III < I  
 B. II < III < I < IV  
 C. II < III < IV < I  
 D. III < II < I < IV

Acidity will be most when the conjugate base is most stabilised.



+I effect  
of  $\text{CH}_3$

-I effect  
of  $\text{NO}_2$

-R effect  
of  $\text{NO}_2$

Resonance  
effect

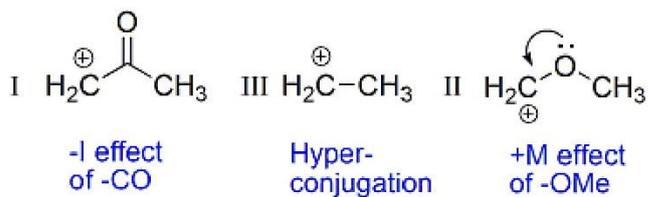
Carboxylic acid is more acidic than phenol.

For nitro substituted phenol,  $\text{NO}_2$  when present at para position will show maximum acidity due to -R effect while at meta position it shows only -I effect. Since -R effect is more pronounced over -I therefore (I) will be more acidic than (iii).

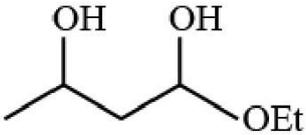
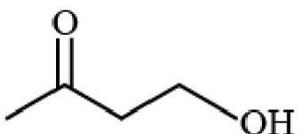
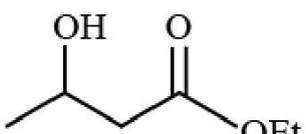
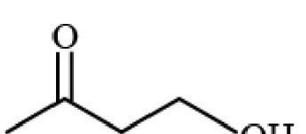
Methyl group destabilises the conjugate base through +I effect and hence (II) will be least acidic.

10 For the following carbocations the correct order of stability is  
 I :  $\oplus\text{CH}_2 - \text{COCH}_3$     II :  $\oplus\text{CH}_2 - \text{OCH}_3$     III :  $\oplus\text{CH}_2 - \text{CH}_3$

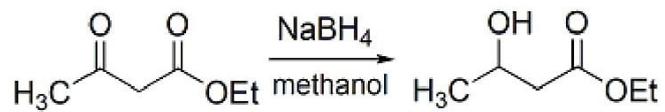
- A. III < II < I
- B. II < I < III
- C. I < II < III
- D. I < III < II



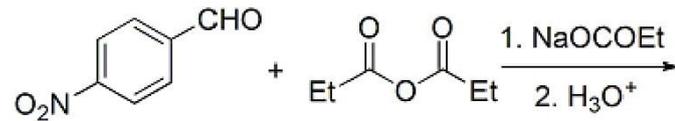
11 The reduction product of ethyl-3-oxobutanoate by  $\text{NaBH}_4$  in methanol is

- A. 
- B. 
- C. 
- D. 

Ethyl-3-oxobutanoate has two functional groups a ketone and an ester.  $\text{NaBH}_4$  does not reduce esters.

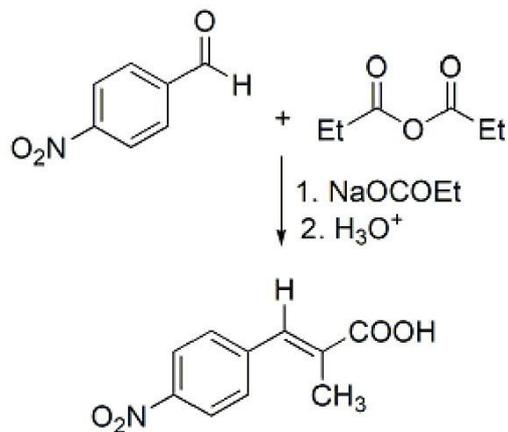


12 What is the major product of the following reaction?



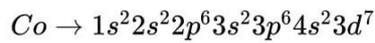
- A.
- B.
- C.
- D.

This is Perkin reaction which produces an  $\alpha,\beta$ -unsaturated aromatic acid by the aldol condensation of an aromatic aldehyde and an acid anhydride, in the presence of an alkali salt of the acid.



13 The maximum number of electrons in an atom in which the last electron filled has the quantum numbers  $n = 3, l = 2$  and  $m = -1$  is

- A. 17
- B. 27
- C. 28
- D. 30

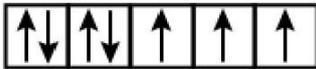


$$\therefore 3d^7$$

$$n = 3$$

$$l = 2$$

$$m = -1$$



14 In the face-centred cubic lattice structure of gold the closest distance between gold atoms is: ('a' being the edge length of the cubic unit cell)

- A.  $a\sqrt{2}$
- B.  $\frac{a}{\sqrt{2}}$
- C.  $\frac{a}{2\sqrt{2}}$
- D.  $2\sqrt{2}$

For, FCC, the closet distance between two atoms is  $2R$ .

Taking 'a' is the edge length

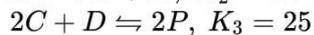
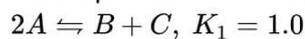
$$(4R)^2 = a^2 + a^2$$

$$\Rightarrow 16R^2 = 2a^2$$

$$\Rightarrow R = \frac{a}{2\sqrt{2}}$$

$$\Rightarrow 2R = \frac{a}{\sqrt{2}}$$

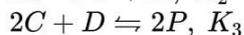
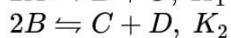
15 The equilibrium constant for the following reaction are given at 25 °C



The equilibrium constant for the reaction  $P \rightleftharpoons A + \frac{1}{2}B$  at 25 °C is

- A.  $\frac{1}{20}$
- B. 20
- C.  $\frac{1}{42}$
- D. 21

Given,

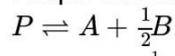


$$\therefore K_1 = \frac{[B][C]}{[A]^2}$$

$$K_2 = \frac{[C][D]}{[B]^2}$$

$$K_3 = \frac{[P]^2}{[C]^2[D]}$$

Required reaction is



$$K_4 = \frac{[A][B]^{\frac{1}{2}}}{[P]}$$

$$\therefore K_4 = \sqrt{\frac{1}{K_3} \times \frac{1}{K_2} \times \frac{1}{K_1}}$$

$$\Rightarrow K_4 = \sqrt{\frac{1}{25} \times \frac{1}{16} \times \frac{1}{1.0}}$$

Solving these we get  $K_4 = \frac{1}{20}$

16 Among the following, the ion which will be more effective for flocculation of  $Fe(OH)_3$  sol is:

- A.  $PO_4^{3-}$
- B.  $SO_4^{2-}$
- C.  $SO_3^{2-}$
- D.  $NO_3^-$

Based on Hardy & Schulze rule greater the valency on oppositely charged ions, greater is the flocculation.

17 The mole fraction of ethanol in water is 0.08. Its molality is:

- A.  $6.32 \text{ mol kg}^{-1}$
- B.  $4.83 \text{ mol kg}^{-1}$
- C.  $3.82 \text{ mol kg}^{-1}$
- D.  $2.84 \text{ mol kg}^{-1}$

Given, mole fraction of ethanol is 0.08

$\therefore$  mole fraction of water =  $1 - 0.08 = 0.92$

Again, 0.92 mol of water =  $\frac{0.92 \times 18}{1000} = 0.0165 \text{ Kg}$

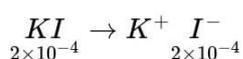
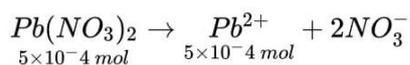
So, the molality of the solution is  $\frac{0.08}{0.0165} = 4.848 \text{ mol/kg}$

18 5 ml of 0.1M  $Pb(NO_3)_2$  is mixed with 10 ml of 0.02 M  $KI$ . The amount of  $PbI_2$  precipitated will be about:

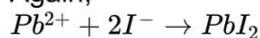
- A.  $10^{-2}$  mol
- B.  $10^{-4}$  mol
- C.  $2 \times 10^{-4}$  mol
- D.  $10^{-3}$  mol

$$5 \text{ ml of } 0.1 \text{ M } Pb(NO_3)_2 = 5 \times 0.1 \times 10^{-3} = 5 \times 10^{-4} \text{ mol}$$

$$10 \text{ ml of } 0.02 \text{ M } KI = 10 \times 0.02 \times 10^{-3} = 2 \times 10^{-4} \text{ mol}$$



Again,



$\therefore$  Limiting reagent is  $I^-$ , hence amount of  $PbI_2$  precipitated will be  $10^{-4}$  mol.

19 At 273 K temperature and 76 cm Hg pressure, the density of a gas is  $1.964 \text{ gL}^{-1}$ . The gas is :

- A.  $CH_4$
- B.  $CO$
- C.  $He$
- D.  $CO_2$

We know,

$$PV = nRT$$

$$\Rightarrow PV = \frac{W}{M}RT$$

$$\text{Or, } M = \frac{dRT}{P}$$

$$\text{Given, } d = 1.964 \text{ g/l}$$

$$P = 76 \text{ cm} = 760 \text{ mmHg} = 1 \text{ atm}$$

$$R = 0.0821 \text{ l atm K}^{-1} \text{ mol}^{-1}$$

$$T = 273 \text{ K}$$

$$\therefore M = \frac{1.964 \times 0.0821 \times 273}{1} \approx 44$$

So, gas is  $CO_2$

20 Equal masses of ethane and hydrogen are mixed in an empty container at 298 K. The fraction of total pressure exerted by hydrogen is

- A. 15 : 16
- B. 1 : 1
- C. 1 : 4
- D. 1 : 6

$$P_{H_2} \propto x_{H_2}$$

$$\frac{P_{H_2}}{P_T} = x_{H_2} = \frac{x_{H_2}}{x_2 + x_{ethane}}$$

$$x_{H_2} = \frac{w/2}{(w/2) + (w/30)} = \frac{15}{16}$$

21 An ideal gas expands adiabatically against vacuum. Which of the following is correct for the given process?

- A.  $\Delta S = 0$
- B.  $\Delta T = -ve$
- C.  $\Delta U = 0$
- D.  $\Delta P = 0$

$$W = -p_{ext} \Delta V$$

since it working against the vacume so  $-P_{ext} = 0$

$$W = 0 \times \Delta V = 0$$

For adiabatic process:

$$q = 0$$

$$\Delta U = q + W$$

$$\Delta U = 0 + 0 = 0$$

22  $K_f$  (water) =  $1.86 \text{ K kg mol}^{-1}$ . The temperature at which ice begins to separate from a mixture of 10 mass % ethylene glycol is

- A.  $-1.86 \text{ }^\circ\text{C}$
- B.  $-3.72 \text{ }^\circ\text{C}$
- C.  $-3.3 \text{ }^\circ\text{C}$
- D.  $-3 \text{ }^\circ\text{C}$

$\Delta T_f = T_f^\circ - T_f$  and 10 mass % means  
 $100 \text{ g sol}^n \rightarrow 10 \text{ g of ethylene glycol and } 90 \text{ g } H_2O$

$$\text{Also, } \Delta T_f = \frac{K_f \times W_B \times 1000}{M_B \times W_A}$$

Substituting the values, we get

$$T_f = -3.3 \text{ }^\circ\text{C}$$

23 The radius of the first Bohr orbit of a hydrogen atom is  $0.53 \times 10^{-8} \text{ cm}$ . The velocity of the electron in the first Bohr orbit is:

- A.  $2.188 \times 10^8 \text{ cm s}^{-1}$
- B.  $4.376 \times 10^8 \text{ cm s}^{-1}$
- C.  $1.094 \times 10^8 \text{ cm s}^{-1}$
- D.  $2.188 \times 10^9 \text{ cm s}^{-1}$

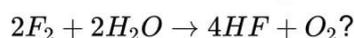
We know,

$$mvr = \frac{nh}{2\pi}$$

$$\Rightarrow v = \frac{nh}{2\pi mr}$$

$$\Rightarrow v = \frac{1 \times 6.6 \times 10^{-34}}{2 \times 3.14 \times 9.1 \times 10^{-31} \times 0.53 \times 10^{-10}} = 2.18 \times 10^6 \text{ m s}^{-1} = 2.18 \times 10^6 \text{ cm s}^{-1}$$

24 Which of the following statements is not true for the reaction:



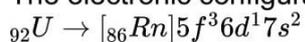
- A.  $F_2$  is more strongly oxidising than  $O_2$
- B.  $F - F$  bond is weaker than  $O = O$  bond
- C.  $H - F$  bond is stronger than  $H - O$  bond
- D.  $F$  is less electronegative than  $O$

Fluorine is the most electronegative element in the periodic table. So the statement  $F$  is less electronegative than  $O$  is incorrect.

25 The number of unpaired electrons in the uranium ( ${}_{92}U$ ) atom is:

- A. 4
- B. 6
- C. 3
- D. 1

The electronic configuration of uranium atom is,



$\therefore$  No. of unpaired electrons is  $3 + 1 = 4$

26 The difference between orbital angular momentum of an electron in a  $4f$  orbital and another electron in a  $4s$  orbital is:

- A.  $2\sqrt{3}$
- B.  $3\sqrt{2}$
- C.  $\sqrt{3}$
- D. 2

Orbital angular momentum is given by the formula,

$$\sqrt{l(l+1)} \cdot \frac{h}{2\pi}$$

$\therefore$  For  $4f$ ,  $l = 3$

$$\Rightarrow \text{orbital angular momentum} = \sqrt{12} \cdot \frac{h}{2\pi}$$

For  $4s$ ,  $l = 0$ ,

$$\Rightarrow \text{orbital angular momentum} = 0$$

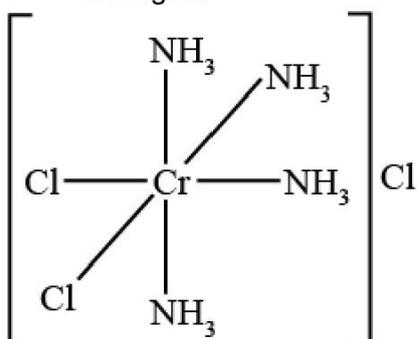
$$\therefore \text{Difference} = \sqrt{12} - 0 = \sqrt{12} = 2\sqrt{3}$$

27 Which of the following has the largest number of atoms?

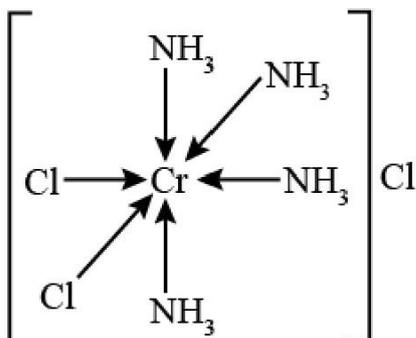
- A. 1 g of Ag
- B. 1 g of Fe
- C. 1 g of Cl<sub>2</sub>
- D. 1 g of Mg

The more is the number of mole, the more is the number of atoms.  
Since among the following Mg has the smallest atomic number so it will have the highest number of mole and thus also has highest number of atoms.

28 Indicate the correct IUPAC name of the co-ordination compound shown in the figure.



- A. Cis-dichlorotetraminochromium (III) chloride
- B. Trans-dichlorotetraminochromium (III) chloride
- C. Trans-tetraminedichlorochromium (III) chloride
- D. Cis-tetraamminedichlorochromium (III) chloride



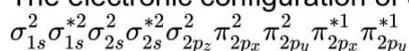
Name of ligands should be in alphabetical order while naming the complex.

29 A homonuclear diatomic gas molecule shows 2 electron magnetic moment. The one-electron and two-electron reduced species obtained from above gas molecule can act as both oxidizing and reducing agents. When the gas molecule is one-electron oxidized the bond length decreases compared to the neutral molecule. The gas molecule is:

- A.  $N_2$
- B.  $Cl_2$
- C.  $O_2$
- D.  $B_2$

Oxygen ( $O_2$ )

The electronic configuration of  $O_2$  is

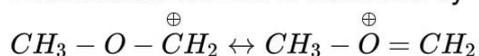


Since it has 2 unpaired electrons so it shows two-electron magnetic moment. The one-electron and two-electron reduced species of  $O_2$  can lose as well as gain electrons, hence, acts as both reducing as well as oxidizing agent. When the gas molecule is one-electron oxidized the bond length decreases compared to the neutral molecule since the electron goes from the antibonding orbital.

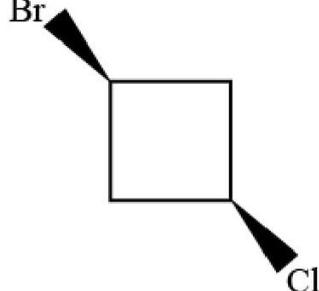
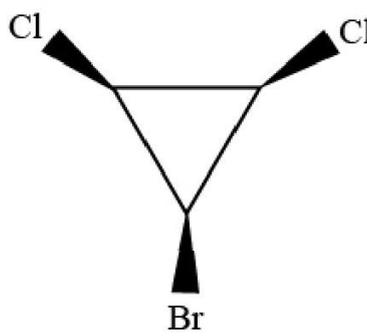
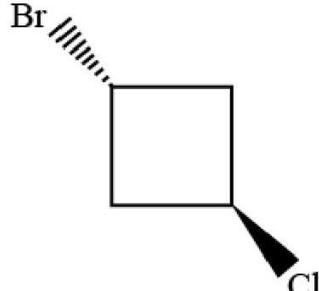
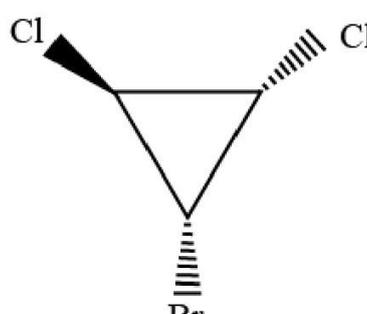
30  $CH_3 - O - CH_2 - Cl \xrightarrow[\Delta]{aq. \ominus OH} CH_3 - O - CH_2 - OH$  Which information below regarding this reaction is applicable?

- A. It follows  $S_N2$  pathway, because it is a primary alkyl chloride
- B. It follows  $S_N1$  pathway, because the intermediate carbocation is resonance stabilized
- C.  $S_N1$  pathway is not followed, because the intermediate carbocation is destabilised by -I effect of oxygen.
- D. A mixed  $S_N1$  and  $S_N2$  pathway is followed

Reaction proceeds via  $S_N1$  pathway having a stable intermediate. Here the intermediate formed is stabilised by the +M effect of the  $OCH_3$  group.



31 Which of the following compounds is asymmetric?

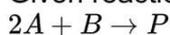
- A. 
- B. 
- C. 
- D. 

Asymmetric compound does not contain any mirror plane and are non-superimposable on its mirror image.

32 For a reaction  $2A + B \rightarrow P$ , when concentration of B alone is doubled,  $t_{\frac{1}{2}}$  does not change and when concentrations of both A and B is doubled, rate increases by a factor of 4. The unit of rate constant is,

- A.  $s^{-1}$
- B.  $L \text{ mol}^{-1} s^{-1}$
- C.  $\text{mol L}^{-1} s^{-1}$
- D.  $L^2 \text{ mol L}^{-2} s^{-1}$

Given reaction is,



$$\therefore r = K[A]^2[B]$$

$$\text{For first order reaction, } t_{\frac{1}{2}} = \frac{0.693}{k}$$

So  $t_{\frac{1}{2}}$  does not depend on the concentration of the reactant for first order reaction.

Hence the order of the reaction with respect to  $[B]$  is one.

Again since when concentrations of both A and B is doubled, rate increases by a factor of 4, so the the order of the reaction with respect to  $[A]$  is also one.

Hence the overall order of the reaction is 2.

$\therefore$  the unit of rate constant is  $L \text{ mol}^{-1} s^{-1}$

33 A solution is saturated with  $SrCO_3$  and  $SrF_2$ . The  $[CO_3^{2-}]$  is found to be  $1.2 \times 10^{-3} M$ . if the value of solubility product of  $SrCO_3$  and  $SrF_2$  are  $7.0 \times 10^{-10}$  and  $7.9 \times 10^{-9}$  respectively. The concentration of  $F^-$  in the solution would be

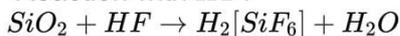
- A.  $3.7 \times 10^{-6} M$
- B.  $3.2 \times 10^{-3} M$
- C.  $5.1 \times 10^{-7} M$
- D.  $3.7 \times 10^{-2} M$

It is  $AB_2$  type salt,  
 $\therefore K_{SP} = 4S^3$   
 $(7.9 \times 10^{-9} = 1.2 \times 10^{-3} \times [F^-]^2) \therefore [Sr^{2+}] = [CO_3^{2-}] = 1.2 \times 10^{-3} M$   
 $\therefore [F^-] = 3.7 \times 10^{-2} M$

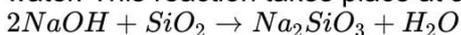
34  $SiO_2$  is attacked by which one/ones of the following?

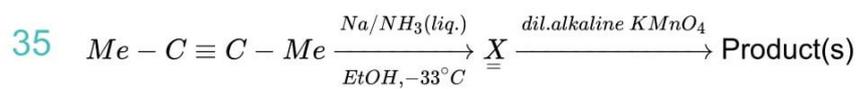
- A HF
- B conc. HCl
- C hot NaOH
- D Fluorine

Reaction with HF:

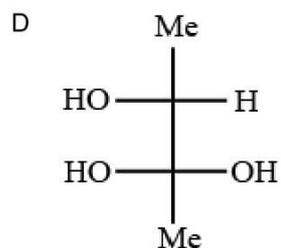
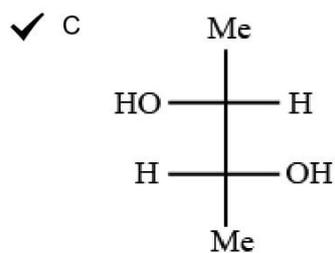
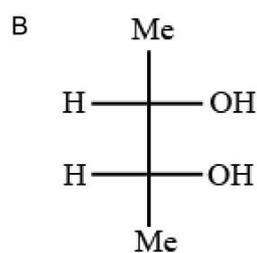
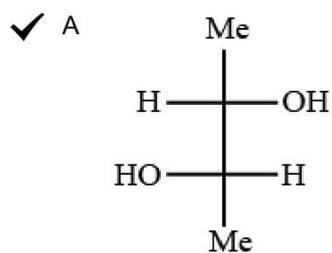


Sodium hydroxide reacts with silicon dioxide to produce sodium silicate and water. This reaction takes place at a temperature of  $900 - 1000^\circ C$ .

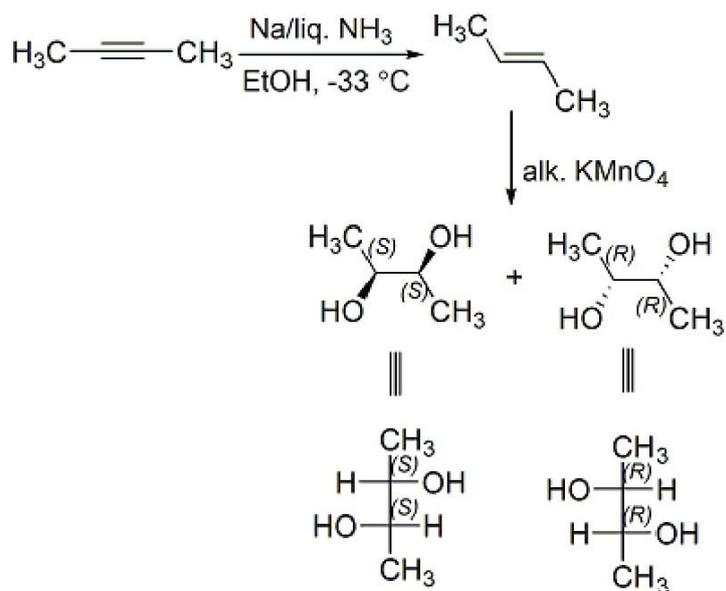




The product(s) from the above reaction will be



*Na* in *liq. NH<sub>3</sub>* reduces alkynes to trans alkenes. Cold alkaline *KMnO<sub>4</sub>* does syn dihydroxylation on alkene to produce vicinol diols. Here trans alkenes give pair of enantiomers while cis alkenes give meso compound.



36 Which of the following give(s) a meso-compound as the main product?

- ✓ A
- ✓ B
- C
- D

Hex-3-ene reacts with  $\text{Br}_2$  in presence of  $\text{CCl}_4$  gives 3, 4 - dibromohexane (meso-compound) and 3, 4 - dimethylhex-3-ene undergoes reduction with  $\text{Pd} - \text{C}$  to give meso compound.

37 For spontaneous polymerization, which of the following is (are) correct?

- ✓ A  $\Delta G$  is negative
- ✓ B  $\Delta H$  is negative
- C  $\Delta S$  is positive
- ✓ D  $\Delta S$  is negative

For spontaneity,  $\Delta G$  should be -ve. In polymerisation reaction lot of heat is generated, so  $\Delta H$  is -ve. And the final product from monomer i.e. polymer is well defined structure (orderly manner), so  $\Delta S$  is -ve.

38 Which of the following statement(s) is/are incorrect:

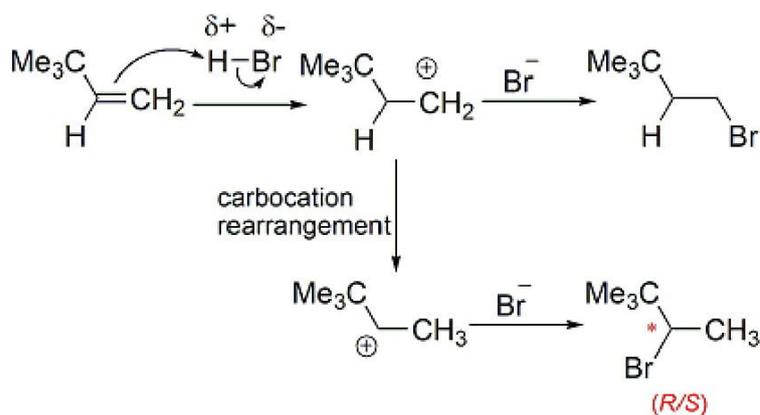
- A A sink of  $SO_2$  pollutant is  $O_3$  in the atmosphere
- ✓ B FGD is a process of removing  $NO_2$  from atmosphere
- ✓ C  $NO_x$  in fuel gases can be removed by alkaline scrubbing
- D The catalyst used to convert  $CCl_4$  to  $CF_4$  by HF is  $SbF_5$ .

FGD is a set of technologies used to remove  $SO_2$  from exhaust flue gases of fossil-fuel power plants and from the emissions of other  $SO_2$  emitting processes.

$NO_x$  in fuel gases can be removed by pyrolusite slowly.

39 The total number of alkyl bromides (including stereoisomers) formed in the reaction  $\text{Me}_3\text{C}-\text{C}=\text{CH}_2 + \text{HBr} \rightarrow$  will be

- A. 1
- B. 2
- C. 3
- D. No bromide forms



So total number of isomers (including stereoisomer) formed is 3.