SET 2

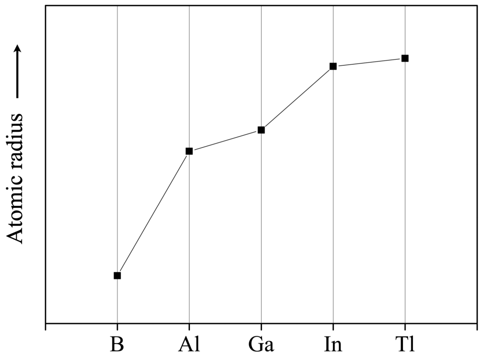
Section A: 2.5 Marks

1. The correct statement regarding the halides and monoxides of the alkaline earth metals is:
   A. All the oxides and halides are ionic in nature.
   B. All the halides are always monomeric.
   C. Hydrated chlorides of all the alkaline earth metals give dehydrated products at high temperature.
   D. Beryllium monoxide reacts with water to give beryllium hydroxide which further reacts with an alkali metal hydroxide to give $[Be(OH)_4]^{2-}$.

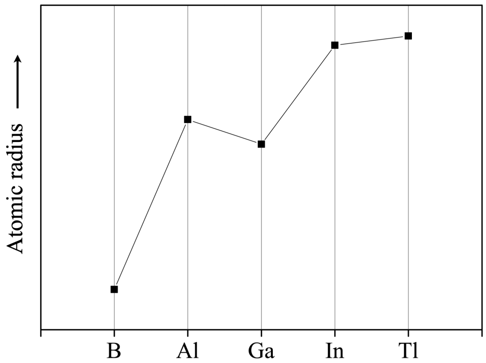
2. The reaction of methyl chloride with silicon at 573 K in the presence of copper as a catalyst produces substituted chlorosilanes. Hydrolysis of chlorosilanes produces silanols. The silanols with appropriate substitution, thus formed, are used to make silicone polymers. The correct statement in this context is:
   A. Only two different chlorosilanes are produced in the reaction of methyl chloride with silicon.
   B. A silicate is formed on condensation polymerization of silanols.
   C. The chain length of the silcone polymer can be controlled by adding trimethylchlorosilane.
   D. Trimethylsilanol upon condensation yields a straight chain polymer.

3. The correct graph representing the trend in the atomic radius of the boron family is

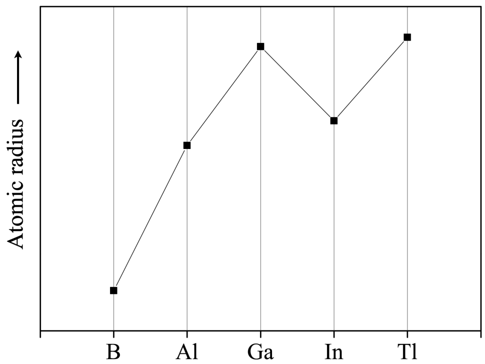
A.



B.



C.



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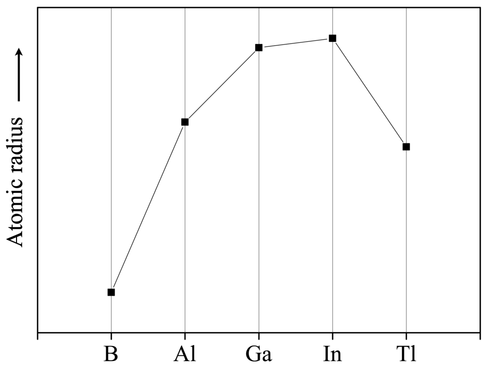


4. The largest crystal field stabilization energy is for

   A. $[Cr(H_2O)_6]^{3+}$

   B. $[Ti(H_2O)_6]^{3+}$

   C. $[V(H_2O)_6]^{3+}$

   D. $[Fe(H_2O)_6]^{3+}$

5. The equation appropriate for the exact calculation of pH of an aqueous solution of HCl at a concentration (c_{HCl}), close to 10^{-6} M, is given by

   A. $[H^+] = c_{\text{HCl}}$

   B. $[H^+] = c_{\text{HCl}} + K_w/[H^+]$

   C. $[H^+] = c_{\text{HCl}} + \sqrt{K_w}$

   D. $[H^+] = c_{\text{HCl}} + K_w/(2c_{\text{HCl}})$

6. Consider a hypothetical one-electron atom, where the nucleus and the electron interact with a force $F = -kr$. Here, r is the distance between the electron and the nucleus, and k is a constant. If this atom is studied using the Bohr model, the electron is assumed to move around the nucleus in selected stable orbits of fixed radii, characterized by quantum number n. The radius of the orbiting electron (of mass m_e) is

   A. $\left(\frac{n^2h^2}{4\pi^2 k m_e}\right)^{1/4}$

   B. $\left(\frac{n^2h^2}{4\pi^2 k m_e}\right)$

   C. $\left(\frac{n^2h^2}{4\pi^2 k m_e}\right)^{1/3}$

   D. $\left(\frac{n^2h^2}{4\pi^2 k m_e}\right)^{1/2}$

7. Biological standard potential (E^*) is defined as the potential measured at pH = 7.0. The species nicotinamide adenine dinucleotide (NADH) and its oxidised form NAD^+ play an important role in respiratory process. Given, the standard potential $E^0 = -0.099$ V for the reaction NAD^+ (aq) + H^+(aq) + $2e^-$ $\rightarrow$ NADH (aq), the value of E^* for the conversion of NAD^+ (aq) to NADH (aq) in 1.0 M NAD^+ solution, at room temperature (25° C), is

   A. −0.31 V

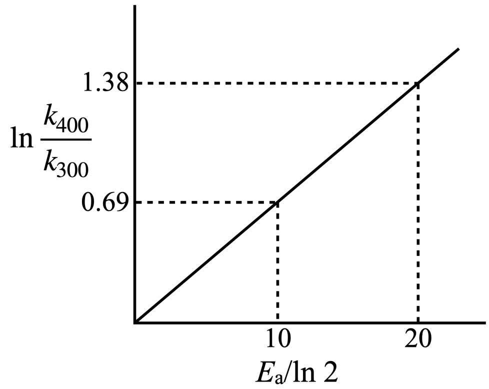
   B. −0.99 V

   C. −0.51 V

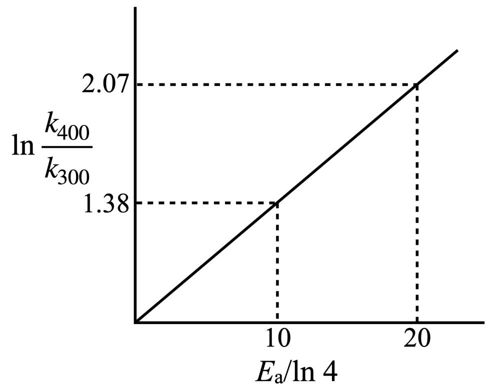
   D. −0.41 V

8. The temperature dependence of the rate constants (k) of a chemical reaction can be expressed in terms of Arrhenius equation, which contains the corresponding activation energy (E_a) term. The correct plot of the ratio of the rate constants (not drawn to scale) of different chemical reactions, at two temperatures 300 K and 400 K, as a function of their E_a values (in kJ mol^{-1}) is

A.



B.



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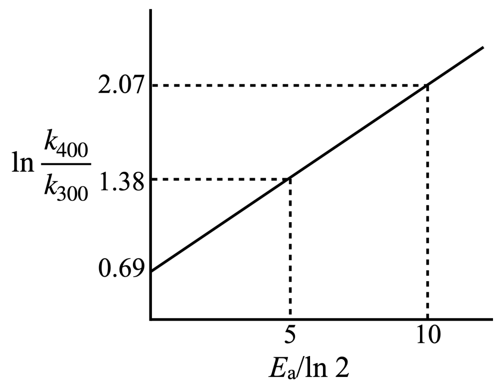

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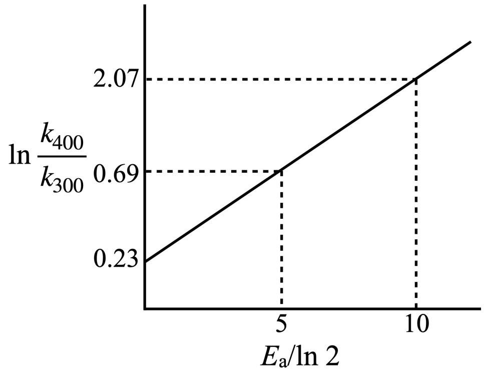
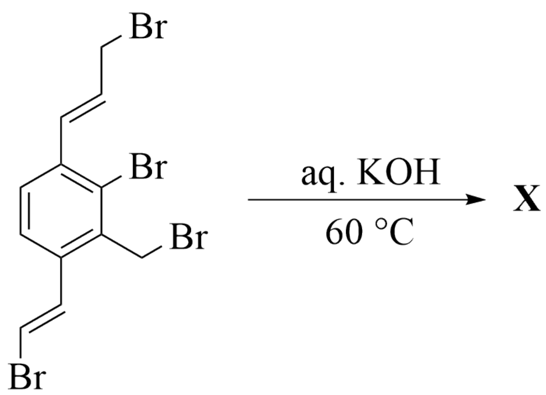
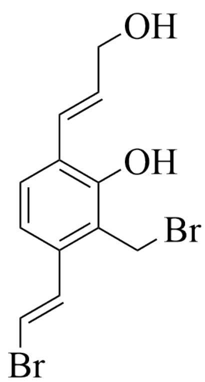


9. In the reaction shown below,



the major product **X** is

A.



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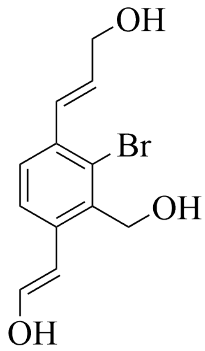
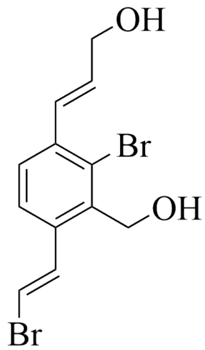


C.



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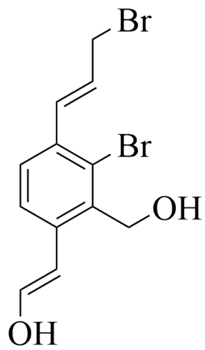
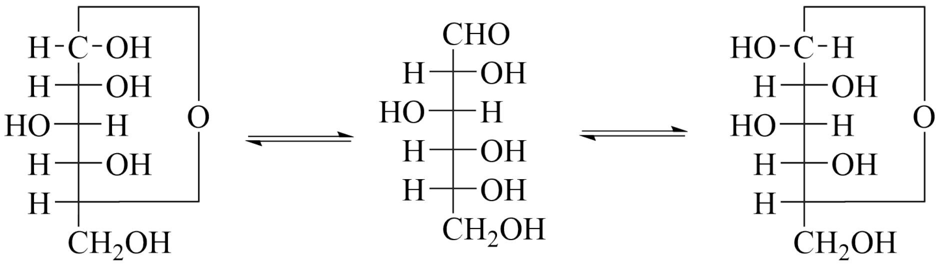


10. In an aqueous solution, glucose exists in cyclic and open-chain forms, in equilibrium, as shown below. Glucose solution does not give positive Schiff test.



α-D (+) - Glucose β-D (+) - Glucose

The correct statement is:

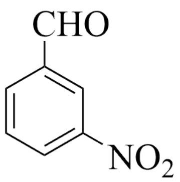
A. α-D(+)-glucose and β-D(+)-glucose are enantiomers.

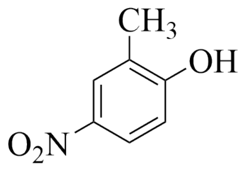
B. α-D(+)-glucose and β-D(+)-glucose are anomers.

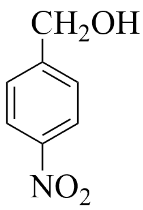
C. In solution, the open-chain form predominates over the cyclic forms.

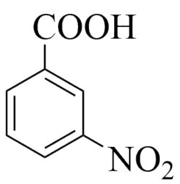
D. Glucose reacts with sodium bisulphite to form an addition product.

11. One mole of toluene on reaction with 2 moles of Cl_2 in the presence of light gives **X**, which on hydrolysis at 100° C gives **Y**. **Y** on reaction with conc.HNO_3/H_2SO_4 at 0-10° C provides **Z** as the major product. The compound **Z** is

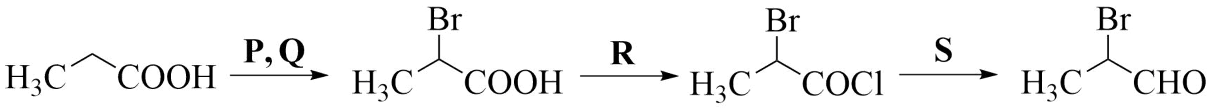
A. 

B. 

C. 

D. 

12. Consider the following sequence of reactions.



The correct reagents (**P**, **Q**, **R** and **S**) required are:

A. **P** = Br_2/red phosphorous; **Q** = H_2O; **R** = $SOCl_2$; **S** = H_2, Pd-$BaSO_4$

B. **P** = Br_2/red phosphorous; **Q** = H_3O^+; **R** = $SOCl_2$; **S** = $LiAlH_4$

C. **P** = Br_2/NaOH; **Q** = H_2O; **R** = PCl_3; **S** = DIBAL-H

D. **P** = PBr_3; **Q** = H_3O^+; **R** =Cl_2/$FeCl_3$; **S** = Pd-$BaSO_4$

Section B: 4 Marks

13. Ammonium sulfate on reaction with sodium hydroxide produces compounds **Q** and **R** along with water. Catalytic oxidation of **Q** by atmospheric oxygen yields **T** (an oxide of nitrogen) and water. **T** reacts with oxygen to produce compound **X**, which dissolves in water giving **Y** and **T**. The correct statement(s) is(are):

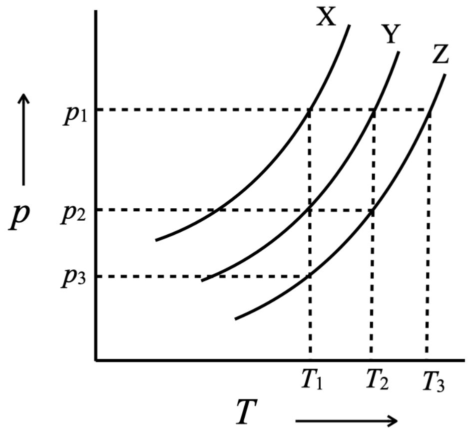
A. The geometry of compound **X** is bent.

B. Compound **T** on reaction with hexaaqua iron(II) complex gives brown color.

C. The conversion of **X** to **Y** is a reduction process.

D. Compound **Y** on reaction with carbon yields compound **X**, CO_2 and water.

14. Consider three liquids: water, dilute aqueous solution of glucose, and dilute aqueous solution of NaCl. The aqueous solutions of glucose and NaCl are of the same molal concentrations. The vapour pressures (p) of the three liquids are plotted (not drawn to scale) as a function of temperature (T) in the figure below.



The three values of pressure, p_1 (= 1 atm), p_2 and p_3 and three temperatures T_1, T_2 and T_3 are indicated in the figure. The correct statement(s) is (are):

A. Curves X , Y and Z correspond to pure water, glucose solution and NaCl solution respectively.

B. The temperatures T_1, T_2 and T_3 represent the boiling points of the solutions corresponding to the curves X, Y and Z, respectively.

C. The pressures, p_1, p_2 and p_3 are related as $2p_2 = p_1 + p_3$.

D. The temperatures, T_1, T_2 and T_3 are related as $3T_2 = 2T_1 + T_3$.

15. Consider the three electrodes Fe/Fe^{2+}, Fe/Fe^{3+}, and Fe^{2+}/Fe^{3+}, for which the standard electrode (oxidation) potentials are: E_1^0, E_2^0, and E_3^0, respectively. The standard EMF of the cell, $Fe/Fe^{2+}||Fe^{3+}/Fe$, is E_4^0. The correct expression(s) is (are):

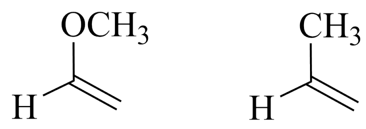
A. $E_3^0 = (3E_2^0 - 2E_1^0)$

B. $E_3^0 = (E_2^0 - E_1^0)$

C. $E_4^0 = (2E_1^0 - 3E_2^0)$

D. $E_4^0 = (E_1^0 - E_2^0)$

16. In an electrophilic addition reaction of olefins, the stability of carbocations plays a crucial role. Consider the compounds **P** and **Q** that can undergo such reactions with different reagents.



P **Q**

With reference to the above reactions, the correct statement(s) is(are):

A. In the HBr addition, the rate of the reaction is faster for **Q** than for **P**.

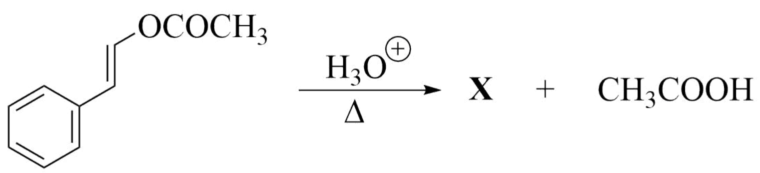
B. HBr addition to P gives an equal mixture of enantiomers as a major product.

C. **P** reacts with diborane followed by oxidation with H_2O_2/NaOH gives racemic alcohol as a major product.

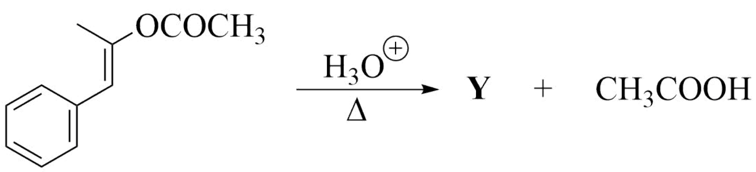
D. Reaction of **P** with O_3 followed by treatment with Zn/H_2O gives methyl formate and formaldehyde.

17. Consider the following acid hydrolysis of esters.

Reaction I:



Reaction II:



The correct statement(s) about **X** and **Y** is(are):

A. Both **X** and **Y** on reaction with Lucas reagent ($ZnCl_2$ + conc. HCl) give turbid solutions.

B. **Y** on reaction with Br_2/NaOH gives sodium salt of phenyl acetic acid.

C. **X** forms silver mirror with ammonical silver nitrate solution.

D. The reaction of **Y** with NH_2NH_2 followed by heating with KOH in ethylene glycol gives n-propylbenzene.