(6)

[This question paper contains 7 printed pages]

Your Roll No. : 2019

Sl. No. of Q. Paper : **7392** **J**

Unique Paper Code : 32171102 - OC

Name of the Course : **B.Sc.(Hons.) Chemistry**

Name of the Paper : Physical Chemistry - I

Semester : I

Time : 3 Hours ***Maximum Marks : 75***

Instructions for Candidates :

(i) Write your Roll No. on the top immediately on receipt of this question paper.

(ii) Attempt **six** questions in all.

(iii) Question No. **1** is compulsory.

(iv) Use of scientific calculator is permitted.

Physical constants :

$R = 8.314\ J\ K^{-1}mol^{-1}$

$R = 0.082$ lit atm $K^{-1}\ mol^{-1}$

$k = 1.38 \times 10^{-23} J\ K^{-1}$

P.T.O.

1. Explain any **five** of the following : 3×5=15

(a) Mean free path of gas molecules increases and number of collisions per unit time decreases with lowering of temperature.

(b) Boyle temperatures of different gases are different.

(c) pH of pure water is 6.63 at 50°C, but it is not acidic.

(d) On passing H_2S, Cus precipitates in acidic medium, but CoS precipitates in alkaline medium.

(e) A crystal cannot have fivefold axis of symmetry.

(f) Viscosity of liquids decreases and that of gases increases with increase in temperature.

2. (a) Draw the compressibility factor Z vs pressure curves for different gases at room temperature and for a particular gas at different temperatures. Describe the variation in Z as a function of nature of gas, temperature and pressure. 5

(b) Why does the Maxwell distribution curve of a gas show a maximum ? Derive the expression for average velocity of a gas using Maxwell distribution expression. 3

(c) Calculate the fraction of molecules of N_2 at 1 atm pressure and 315 K, when speeds are in the range of most probable speeds ± 0.006 cm per second. 4

3. (a) Derive the expression for kinetic theory of gases $pv = \frac{1}{3}mNc^2$. Why is this theory called kinetic theory ? 5

(b) What is equilibrium vapour pressure ? Why does it increase with the increase in temperature ? Why is it not possible to liquefy a gas above critical temperature ? 3

(c) What is the mean free path λ for oxygen molecules at temperature T= 300 K and P=1.00 atm ? Assume that the molecular diameter d= 290 pm and the gas is ideal. 4

4. (a) Starting from the Vander Waals equation, derive the relations $a = \frac{27R^2T_c^2}{64P_c}$, $b = \frac{RT_c}{8P_c}$. Where T_c, P_c are critical temperature and critical pressure of the gas and 'a' and 'b' are Vander Waals constants. 4

(b) Using Vander Waal's equation find the temperature at which 3 moles of SO_2 will occupy a volume of 20 liters at a pressure of 2.1 M Pa. Given a=678.88 kPa $dm^6 mol^{-2}$ and b=$5.6\times10^{-2} dm^3 mol^{-1}$. 4

(c) Using the law of equipartition of energies, estimate the C_v and C_p of CCl_4 and CO_2 molecules. 4

5. (a) Derive the expressions for $[H^+]$ for dilute solutions of strong monoprotic acid and concentrated solutions of weak monoprotic acids. 6

(b) Calculate the pH of a 10^{-8} N solution of NaOH at room temperature. 4

(c) Degree of dissociation of Acetic acid in N/32 solution is 0.0236. What will be its degree of dissociation in 0.01N solution ? 2

6. (a) Derive relationships for the hydrolysis constant, degree of hydrolysis and the pH of a salt of strong acid and weak base. 3

(b) How does a solution of a weak acid and its salts act as a buffer ? Derive the expression for the pH of such a buffer and also derive the expression for the pH of this solution when some base is added to it. 3

(c) How can the pH of solutions be calculated before, at and after the equivalent point for the titration of strong acid with weak base ? Why is Phenolphthalein not a suitable indicator for this titration ? 4

(d) Calculate the pH of a solution containing 20ml 0.1N HCl and 25 ml 0.1 M NH_4OH ? 2

7. (a) Solubility of $BaSO_4$ at 25°C is 0.0023 g/lit. Calculate its solubility product. What will be its solubility in a solution containing 10 gm of $(NH_4)_2SO_4$ is added to it. Molecular Weight of $BaSO_4$ is 233 gm/mol. 4

(b) What are Millar indices ? Why are these preferred over the Weiss indices for the designation of planes in a crystal ? Write the Millar indices of the planes with intercepts : 6

(i) 1a, 3b, -1c (ii) 2a, 3b, 4c

(c) List and describe the symmetry elements of C_6H_6. 2

8. (a) Describe different planes in primitive, face centered and body centered cubic crystals. Compute their interplanar distances. 6

(b) Following θ values obtained when a cubic crystal is subjected to X rays of wave length 153.9pm. 4

θ /degree 13.70 15.89 22.75 26.91 28.25 33.15 37.00 37.60 41.95

Identify the type of cubic lattice, determine edge length and index the lines.

(c) Why are the X rays suitable for determining the crystal structure ? 2

9. (a) Explain how some liquids including water rise in a capillary ? Derive the formula for the rise of a liquid in a capillary. 3

(b) The radius of a given capillary is 1.05×10^{-4} m. A liquid whose density is 0.80 g/cm^3 rises up to a height of 6.25×10^{-2} m, calculate the surface tension of liquid assuming the contact angle to be zero. 2

(c) Derive the formula for the coefficient of viscosity of liquid. What will happen to the viscosity of a liquid if the radius of the capillary of the viscometer used for its measurement is doubled ? 3

(d) Why does the boiling point of a liquid vary with external pressure ? Derive the relation

$$\ln\frac{p_2}{p_1} = \Delta H_{vap}\left(\frac{T_2 - T_1}{T_1T_2}\right)$$ 4

[This question paper contains 3 printed pages.]

7 **Your Roll No...2019**

Sr. No. of Question Paper : 8590 J

Unique Paper Code : 32171101

Name of the Paper : Inorganic Chemistry

Name of the Course : **B.Sc. (H) Chemistry**

Semester : **I**

Duration : 3 Hours Maximum Marks : 75

1. Write your roll number on the top immediately e on receipt of this question paper
2. Attempt six questions in all.
3. Question number one is compulsory.
4. The questions should be numbered in accordance with the number in the question paper.
5. Calculator and lock tables may be used.

1. Explain any five of the following

(I) Ionic radii of Na^+ and Cu^{2+} ions are almost similar.

(II) An electron moving in an orbital dose not slow down gradually.

(III) Electron affinity of Nitrogen is lower than Oxygen.

(IV) HF is liquid whereas HCl is a gas.

(V) H_2 is known while He_2 is not.

(VI) $BeCl_2$ has zero dipole movement while H_2S has some.

(3x5=15)

2. (I) Draw radial probability distribution curve for 1s,4p,5s,4d. What are radial and angular wave functions ?

(II) Drive the Born-Lande's equation for lattice energy of a crystal lattice.

(III) Explain significance of Azimuthal quantum number. (6, 4,2)

3. (I) Calculate Z* (effective nuclear charge- Slater's rule) for 2s and 4s electrons.

(II) During ionization of atoms having ns and (n-1)d electrons, the electron of ns orbital lost first. Why?

(III) Find out electron gain enthalpy using following data:

Enthalpy of formation :382 KJ mol^{-1}

Lattice Energy :759 KJ mol^{-1}

Ionization Enthalpy : 494 KJ mol^{-1}

Dissociation Energy Cl_2 : 121 KJ mol^{-1}

Sublimation Energy (Na) : 108 KJ mol^{-1} (3,3,6)

4. (I) Draw molecular orbital energy level diagram of O_2^- and NO^+ . Which has higher bond energy?

or

Draw molecular orbital energy level diagram of NO^- and HCl. Which has higher bond energy?

(II) Using VSEPR theory give the shape of $POCl_3$, SF_6, BrF_4^-,NH_3.

(III) What is Fajan's Rule ? Explain why lithium halides are covalent in spite of the fact that Li is an alkali metal. (4X3)

5. (I) First ionization energy of Be is greater than Li but position is reversed in case of second ionization energy of Be and Li. Why?

(II) Why P-Nitrophenol has higher boiling point than O-nitrophenol phenol?

(III) Write short note on following (any three)

a. Londen or dispersion forces b. Diple-dipole interaction

c. HF is liquid HCl is gas d. Hybridization (3,3,2x3)

6. (I) Explain Conductivity of metals and semiconductors using band theory.

(II) What was the velocity of a beam of electron if they are display a de-Broglie wavelength of 100 A°

(III) ψ has no physical significance and ψ^2 has. Explain.

(IV) Be and N in second period and Mg and P in third period of the periodic table have higher ionization energy than expected. Justify

(V) What do you understand by equivalent and non-equivalent hybrid orbital's give one example of each

(VI) Bond angle of CH_4 is higher than NH_3.Explain. (2X6)

7. (I) Draw neatly labelled molecular orbital diagram of N_2^- and O_2^{2+} with bond order and magnetic behaviour .

(II) Write Schrödinger equation for Hydrogen atom. Explain terms involved in it and write conditions for physical significance of the equation.

(III) What are Slater rules, calculate the Z* effective nuclear charge for the valence electrons in G, Z is equal to 31. (4X3)

8. (I) First ionization enthalpy of Oxygen is less than that of Nitrogen. Give reason.

(II) Which of following is more covalent and why?

CuCl or KCl

(III) Define electro negativity according to Mullikan Scale.

(IV) If a solid "A^+B^-" has a structure similar to NaCl. Consider the radius of anion as 250 pm. Find the ideal radius of the cation in the structure. Is it possible to fit a cation C^+ of radius 180 pm in the tetrahedral site of the structure "A^+B^-"?

(3,2,2,5)

This question paper contains **4+2** printed pages]

Roll No. | | | | | | | | 2 | 0 | 1 | 9 |

S. No. of Question Paper : **8610**

Unique Paper Code : **32171102**

Name of the Paper : **Physical Chemistry - I**

Name of the Course : **B.Sc. (Hons.) Chemistry**

Semester : **I**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt *six* questions in all.

Question No. **1** is compulsory.

Use of scientific calculator and log tables is permitted.

1. Explain briefly, any *five* statements of the following :

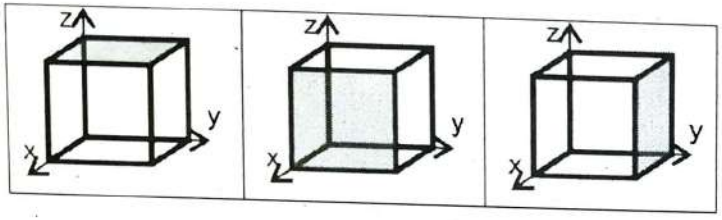
   (*a*) An ideal gas is not expected to show any cooling on free expansion.

   (*b*) Addition of detergents decreases the surface tension of water.

P.T.O.

(*c*) K^+ ions and Cl^- ions are indistinguishable by X-ray diffraction.

(*d*) Identify the type of lattice planes shown in the following figures :



i ii iii

(*e*) The viscosity of gas increases with temperature while that of liquid decreases with temperature.

(*f*) Can pH of an aqueous solution be less than 0 or more than 14 at 25°C ?

(*g*) Phenolphthalein is not a suitable indicator for a strong acid-weak base titration. 5×3

2. (*a*) Starting from the postulates of kinetic theory of gases, derive the Kinetic Gas Equation $pV = \frac{1}{3}mN\hat{u}^2$, where symbols have their usual meaning.

(*b*) What is law of corresponding states ? Derive the reduced equation of state for van der Waals equation of state.

(*c*) The critical constants for water are 647 K, 22.09 MPa and 0.0566 $dm^3\ mol^{-1}$. Calculate the values of van der Waals constants *a*, *b* and R and also explain the abnormal value of R. 4,4,4

3. (*a*) Write the mathematical expression for the Maxwell distribution of molecular speeds for a gas and explain briefly the terms involved. Derive the mathematical expression for the most probable speed of a gas molecule.

(*b*) The mean free path of molecules in a gas increases and the number of collisions per unit time decreases with lowering of pressure if temperature is kept constant. Explain.

(*c*) The average speed at T_1K and most probable speed at T_2 K of CO_2 is $9 \times 10^2 m\ s^{-1}$. Calculate the value of T_1 and T_2. 5,3,4

4. (*a*) Describe the powder diffraction method to determine crystal structure. Explain the significance of missing lines in the analysis of crystal structure using powder diffraction method.

(*b*) Evaluate the Miller indices for the planes with the following intercepts :

(*i*) $0a, 2b, 2c$

(*ii*) $a, 1/3b, 1/4c$

(*iii*) $-2a, 3b, 4c$

(*c*) Show that a 5-fold rotation axis of symmetry cannot exist in a crystal. 5,3,4

5. (*a*) How does viscosity of a liquid vary with temperature ? Give the mathematical expression of the same and define each term.

(*b*) Define surface tension of liquid and give its SI units, and describe a method for its experimental determination.

(*c*) If the flow time for the two liquids A and B through the same capillary is in the ratio of 4 : 5 and the densities in the ratio of 2 : 1. What is the ratio of their viscosities ? 4,4,4

6. (*a*) Show that the concentration of H_3O^+ in an aqueous solution of a monoprotic acid HA can be computed from the following expression :

$$K_a = \frac{[H_3O^+]^3 - [H_3O^+]K_w}{[H_3O^+][HA]_o - [H_3O^+]^2 + K_w}$$

Under what conditions can the following expressions be used :

$$K_a = \frac{[H_3O^+]^2}{[HA]_o - [H_3O^+]}$$

$$K_a = \frac{[H_3O^+]^2}{[HA]_o}$$

(*b*) Define different types of buffer solutions. Derive Henderson-Hasselbalch equation for pH of acidic and basic buffer.

(*c*) What is pH of a solution obtained by mixing 50 mL, 0.1M HCl with 50 mL, 0.1 M NH_4OH. (Given : pK_b of NH_4OH = 4.74). 4,4,4

7. (*a*) Define solubility and solubility product. Express solubility product of the given salts in terms of the solubility of ions :

(*i*) $PbCl_2$ and

(*ii*) $Fe_3(PO_4)_2$

(*b*) Show that the pH of an aqueous solution of salt formed from a strong acid and weak base is given by :

$$pH = 7 - \frac{1}{2}(pK_b + \log c)$$

(*c*) Will a precipitate form if equal volumes of 0.01 M $AgNO_3$ and 0.0004 M NaCl are mixed ? Given K_{sp} of AgCl = 1.7×10^{-10} M^2. 4,4,4

8. (*a*) Write the van der Waals equation in the virial form and evaluate the second virial coefficient.

(*b*) Calculate the volume occupied by 2.0 mol of N_2 at 400 K and 10.1325 MPa pressure if p_rV_r/T_r is equal to 2.21.

(*c*) Calculate at 25°C the exact pH of a solution of (*a*) 0.001 M NaOH, and (*b*) 10^{-7} M NaOH. 4,4,4]

9. Write short notes on any *four* :

(*i*) Law of equipartition of energy

(*ii*) Rotating crystal method

(*iii*) Theory of Acid-base indicators

(*iv*) Continuity of States

(*v*) Cleansing action of detergents. 4×3

(9)

Roll No. | | | | | | | | 2 | 0 | 1 | 9 |

S. No. of Question Paper : 8842

Unique Paper Code : 217103

Name of the Paper : **Organic Chemistry-I (CHHT-102)**

Name of the Course : **B.Sc. (H) Chemistry**

Semester : **I**

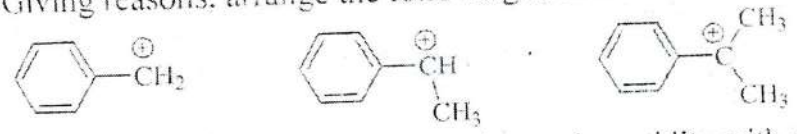
Duration : **3 Hours**

Maximum Marks : 75

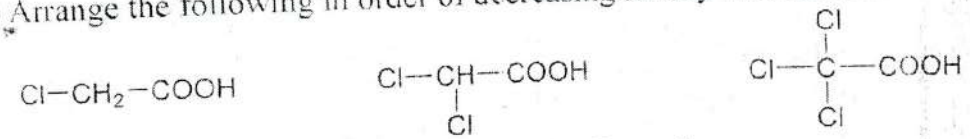
Instructions for Candidates:

- Write your Roll No. on the top immediately on receipt of this question paper.
- Answer **any six** questions.
- Attempt all the parts and sub parts of a question together.
- Question **No. 1** carries **15** marks (Question Nos. 2 to 8 carry 12 marks each).

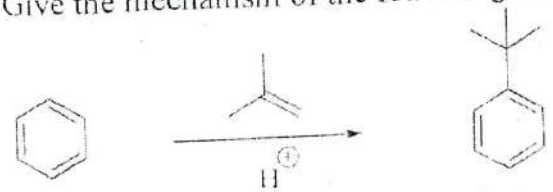
1. (a) Giving reasons, arrange the following in order of increasing stability.



(b) Arrange the following in order of decreasing acidity with suitable reason.

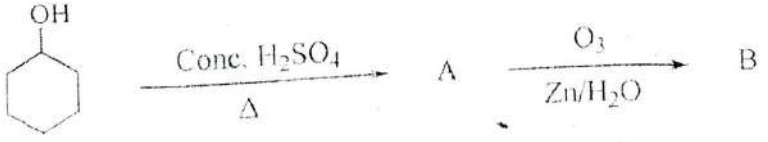


(c) Give the mechanism of the following transformation.

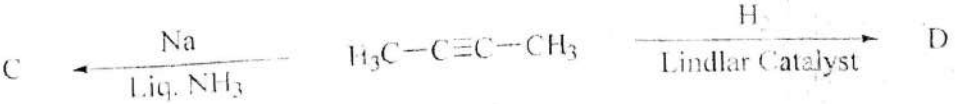


(d) Predict the structures of major products A to F in the following reactions.

(i)



(ii)

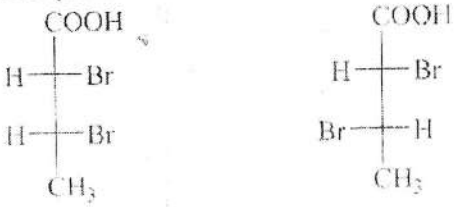


(iii) E ← HBr — $H_3C-CH=CH_2$ — HBr / Benzoyl peroxide → F

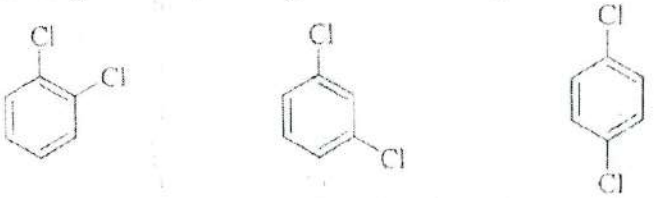
(3,3,3,6)

2. (a) Assign the following as aromatic/antiaromatic with suitable explanation.

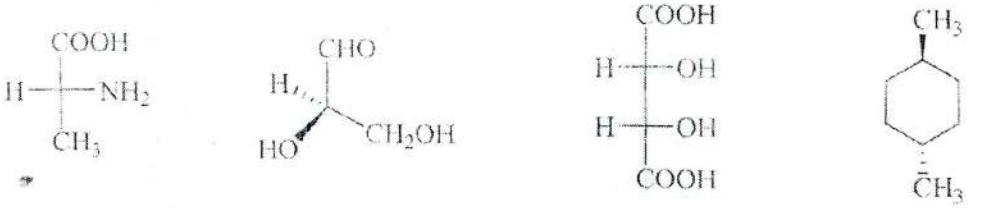
(b) Assign the *R/S* configurations and stereochemical relationship to the following compounds.



(c) Giving reasons, arrange the following in order of increasing dipole moment.

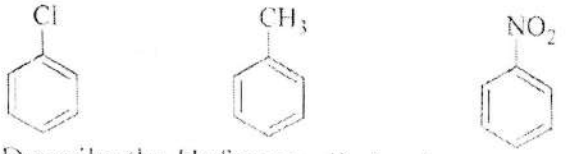


(d) What do you mean by "optically active substance"? Assign the following compounds as optically active/inactive.



(3,3,3,3)

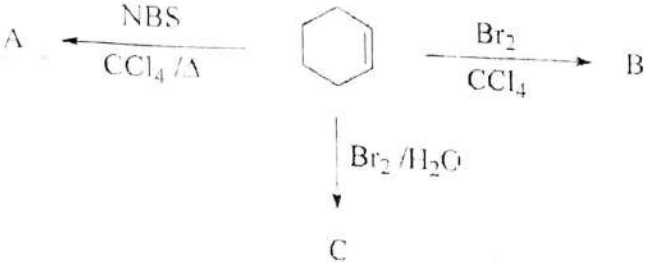
3. (a) Giving reasons, arrange the following in order of increasing rate towards aromatic electrophilic substitution reactions.



(b) Describe the Hofmann-elimination reaction with suitable example.

(c) Draw the conformations of cyclohexane and relate their energies through potential energy diagram.

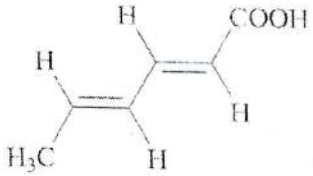
(d) Predict the structures of major products A to C in the following reactions.



(2.3,4.3)

4. (a) Explain the reaction and mechanism involved in the hydroboration-oxidation of 1-propene.

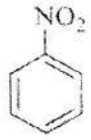
(b) Give the *E*/*Z* notation in the following compound.



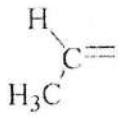
(c) Explain the mechanism of free radical halogenations of an alkane.

(d) Predict the structures of major products in the following reactions.

(i) $H_3C-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_3 \xrightarrow[h\nu]{Br_2}$

(ii)  $\xrightarrow[Fe\ /\Delta]{Br_2}$

(iii) $H_3C-CH_2-\underset{\displaystyle Br}{\underset{|}{CH}}-CH_3 \xrightarrow[\Delta]{KOH\ (alc.)}$

(iv)  $\xrightarrow[\overset{\ominus}{OH}]{Dil.\ KMnO_4}$

(3.2,3,4)

5. (a) Giving reason, arrange the following in order of increasing boiling point.

$H_3C-CH_2-CH_2-CH_2-CH_3$ $\qquad$ $H_3C-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2-CH_3$ $\qquad$ $H_3C-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}}-CH_3$

(b) Classify the following into electrophiles and nucleophiles with explanation.

$H_3C-C\equiv\overset{\oplus}{O}$, H_3C-NH_2 , $:CBr_2$, CO_2 , $\overset{\ominus}{NO_2}$, $\overset{\ominus}{NH_2}$

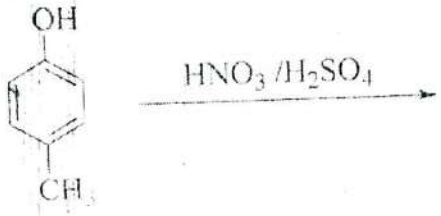
(c) Giving reasons, arrange the following in order of increasing stability.



(d) Predict the structures of major products A to D in the following reactions.

(i) $Ph-C\equiv CH \xrightarrow[H_2SO_4]{HgSO_4/H_2O} A$

(ii) $H_3C-\underset{Br}{CH}-\underset{Br}{CH_2} \xrightarrow[\Delta]{KOH\ (alc.)} B \xrightarrow{NaNH_2} C$

(iii) 

(2,3,3,4)

6. Explain the following:

(a) 1-Propyne is less reactive than 1-propene towards electrophilic addition reactions.

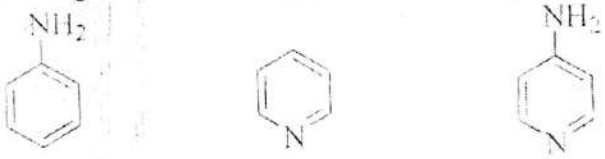
(b) Iodoethane is less reactive than chloroethane in Friedel-Craft's alkylation of benzene.

(c) Ethane-1,2-diol is more stable in *Gauche* conformation than its *Anti* conformation.

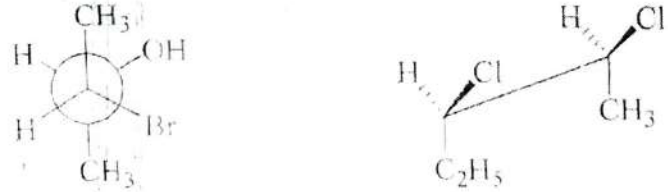
(d) Dipole moment of chloroethane is higher than chloroethene.

(3,3,3,3)

7. (a) Giving reasons, arrange the following in order of increasing stability.



(b) Draw the Fischer projection formulae of the following.



(c) Give the reaction and mechanism of the following:
(i) Ozonolysis of 2-butene.
(ii) Friedel-Craft's acylation of benzene.

(3,3,6)

8. Write shot notes on the following (***any four***).

(a) Baeyer strain theory.

(b) Markovnikov's addition to alkenes.

(c) Wurtz reaction.

(d) Optical Isomerism.

(e) Inductive and electromeric effects.

(3,3,3,3)