



Eastern University Sri Lanka  
First Year Second Semester Examination in Science  
2021/2022 (2024)  
CH1033 Principles of Chemistry II

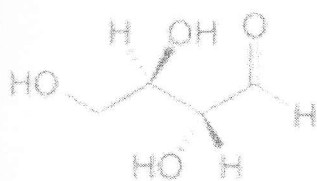
Answer all questions

Time: 3 Hours

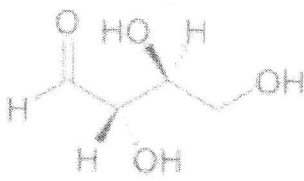
You may find the following data useful.

Universal gas constant,  $R = 8.3144 \text{ J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$ , Boltzmann constant,  $k = 1.381 \times 10^{-23} \text{ J}\cdot\text{K}^{-1}$ ,  
Avogadro constant  $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$ , Faraday constant  $F = 96485 \text{ Cmol}^{-1}$ , Rest mass of  
electron ( $m_e$ ):  $9.1 \times 10^{-31} \text{ kg}$ , Velocity of light ( $c$ ):  $3 \times 10^8 \text{ ms}^{-1}$ , Electron charge ( $e$ ):  $1.602 \times 10^{-19} \text{ C}$

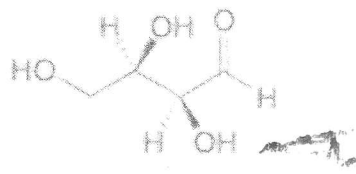
1. a) Consider the following three organic molecules **P**, **Q** and **R** and answer the questions given below.



**P**



**Q**

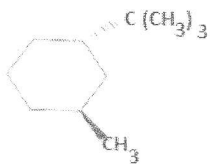


**R**

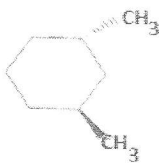
- Draw Fischer projections of **P**, **Q** and **R**.
- Identify their R, S representations for the stereo centres present in the above structures and explain how you have obtained the configurations.
- Write the relationships between **P** & **Q**, **Q** & **R** and **P** & **R**.

(30 marks)

b) Consider the following *trans*-1,3-disubstituted cyclohexane compounds given below:



**M**

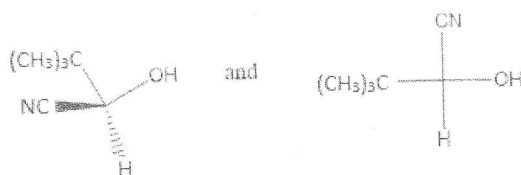
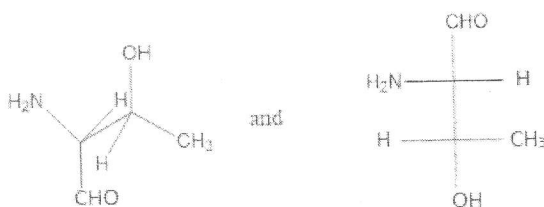
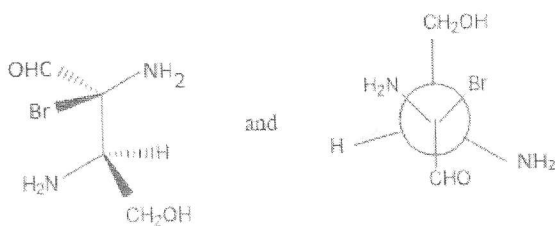


**N**

- Draw all the possible chair conformations of the above compounds **M** and **N**.
- Give reasons and indicate the most stable conformation of the above possible chair forms (Your answer should include the various destabilising interactions that contribute to the total strain of each conformation).
- Explain why there is only one chair conformation is found as the major in **M** while there are equal percentage of conformations found in **N**.

(30 marks)

c) i) Determine whether the following pairs of compounds are enantiomers, diastereomers or the identical compound?

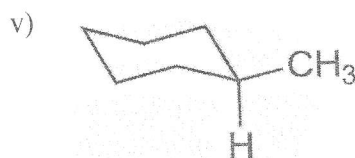
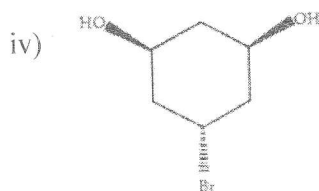
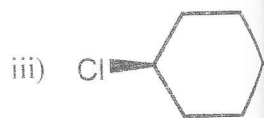
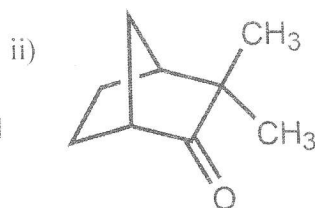
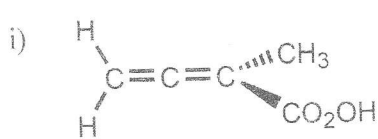


(30 marks)

ii) The specific rotation of (*S*)-carvone is  $+61^\circ$ . The optical rotation of a sample of a mixture of *R* and *S* carvone is  $-23^\circ$ . Which enantiomer is in excess? Calculate the percentage of (*R*)- and (*S*)-carvone in the sample.

(10 marks)

2. a) State whether the following molecules are chiral or achiral.



(35 marks)

b) Show how a racemic mixture of 1-phenylethanol could be resolved. Draw all the steps involved.

(35 marks)

c) i) What do you mean by significant figures.

ii) Write the significant figures rules that govern the determination of significant figures.

iii) How many significant figures are in following measurements.

I) 4308

II) 40.05

III) 470,000

IV) 4.00

V) 0.00500

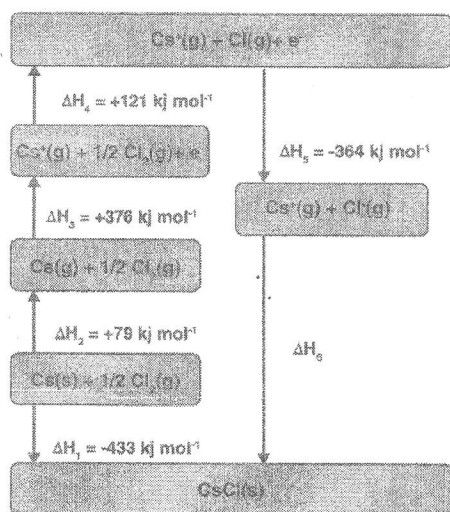
(40 marks)

6. a) i) What is the 'Born Haber' cycle.

ii) Define the term lattice enthalpy of dissociation.

iii) The energy level diagram (Born-Haber cycle) for Caesium chloride is shown below.

Write the names of the enthalpy changes represented by  $\Delta H_1$  to  $\Delta H_6$ . Calculate the value of the lattice energy  $\Delta H_6$  by using the values given in the diagram.



(40 marks)

b) How does catalyst affect activation energy for a reaction? Briefly explain it using the Maxwell-Boltzmann distribution curve.

(30 marks)

c) Differentiate the following,

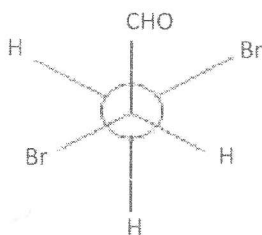
i) A back titration and a direct titration

ii) An end point and an equivalence point

(30 marks)

.....End.....

c) Draw the potential energy vs dihedral angle diagram for the following molecule and explain the variations of potential energies of the corresponding conformers for different rotational angles.



(30 marks)

3. a) The Kinetic Theory of Gases provides a framework for explaining the properties and behavior of gas particles in motion.

i. Discuss two primary assumptions of the Kinetic Molecular Theory and how they contribute to the understanding of ideal gases.

(20 marks)

ii. Explain the limitations of above-mentioned assumptions when applied to real gases.

(20 marks)

b)

i. Derive Van der Waals Equation of State for Real Gases.

(20 marks)

ii. Derive the relationship between the average kinetic energy of gas molecules and the absolute temperature.

(20 marks)

iii. Draw the Maxwell-Boltzmann distribution curves for molecular velocities of a gas at two different temperatures ( $T_1 > T_2$ ). On the graph, clearly indicate the positions of the root mean square (RMS) velocity, the average velocity, and the most probable velocity.

(20 marks)

4. a)

i) Define the half-life of a reaction rate.

(10 marks)

ii) Write two factors that can affect on the half-life of a reaction rate.

(10 marks)

iii) A first-order decomposition reaction is observed to have the following constants at the indicated temperature. Estimate the activation energy.

$k_r / (10^{-3} \text{ s}^{-1})$	2.46	45.1	576
$\theta / ^\circ\text{C}$	00	20.0	40.0

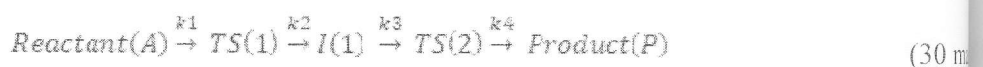
Assume that the rate constant obeys the Arrhenius equation.

(30 marks)

b)

i) Draw a potential energy diagram illustrating the energy changes throughout the reaction pathway, from reactants (A) to products (P). Include all intermediates (I) and transition states (TS). Label the axes appropriately and indicate the relative energies of each species.

Consider:  $k_3 < k_4 < k_1 < k_2$



(30 marks)

ii) Identify and explain which step in the mechanism is likely the rate-determining step.

(20 marks)

5. a) What is the atomic radius. How do you think chemists measure it.

(20 marks)

b) Briefly explain the followings.

i) Shielding effect and Screening effect

ii) Accuracy and precision

(40 marks)