

B. SC. (CHEMISTRY) EXAMINATION, 2022

(1st Year, 2nd Semester)

CHEMISTRY (CORE)

PAPER – CORE/CHEM/TH/03

Time : Two hours

Full Marks : 40

(20 marks for each unit)

(Use a separate Answer script for each Unit)

UNIT: 2031-I

1. Answer *any five* questions: 2×5
 - a) From its position in the periodic table, if it is realized that a newly discovered short-lived radioactive element is a metal, then using the Born-Haber cycle, the Born-Landé equation, radius-ratio calculations and any other aspect necessary, how can you predict if this element would form an oxide or not? 2
 - b) Derive the Born-Landé equation for determining the lattice energy of NaCl. 2
 - c) Use suitable calculations to derive the limiting condition for radius-ratio of cation to anion for a body-centred cubic lattice having coordination number eight. 2
 - d) Melting points of the following fluorides, provided in parentheses, are not in accordance with the Fajan's rules. Justify or contradict highlighting

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essential features of Fajan's rules.

LiF (845°C); NaF (993°C); KF (858°C); RbF (795°C); CsF (682°C). 2

e) Using *either* the concept of hybridization *or* VSEPR explain shape of BrF₃. 2

f) The radii of Sr²⁺ and F⁻ are 113 pm and 136 pm respectively. Using radius ratio calculations predict its structure. What is such a structure called?

$$1\frac{1}{2} + \frac{1}{2}$$

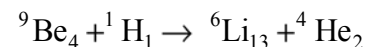
g) In your own words, explain how percentage ionic character is determined across a covalent bond. If the bond length of HF is 0.91 Å and its dipole moment 1.98 debye. Calculate percentage ionic character present. 1

$$1\frac{1}{2} + \frac{1}{2}$$

2. a) Define half life and mean life. One microgram of phosphorous-32 was injected into a living system for biological tracer studies. The half-life of ³²P₁₅ is 14.3 days. How long will it take for the radioactivity to fall to 10% of the initial value? 3

b) What is nuclear shell model? Give two examples for doubly magic nucleus to explain the fact. 2

c) Red giant stars, which are cooler than the Sun, produce energy by means of the reactions,

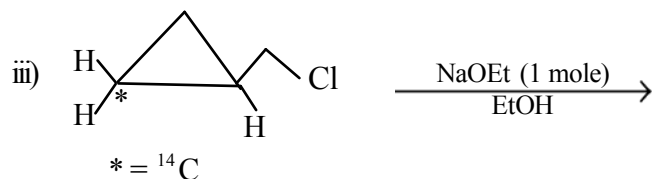


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ii) Predict the products of the following reaction and explain the mechanism. 1



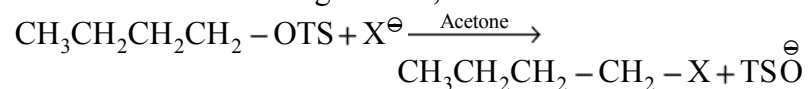
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6. Answer **any two** of the following questions: $2\frac{1}{2} \times 2$

a) Account for the following observations:

In the following reaction,



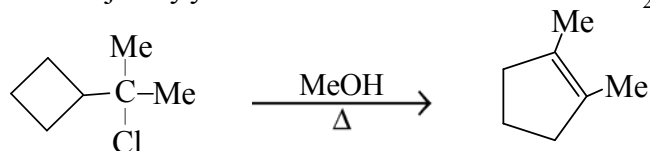
The order of nucleophilicity for various halide is

$\text{Cl}^\ominus > \text{Br}^\ominus > \text{I}^\ominus$ when $\text{Bu}_4\text{N}^\oplus\text{X}^\ominus$ is used, but the

order is $\text{I}^\ominus > \text{Br}^\ominus > \text{Cl}^\ominus$ when LiX is used as reagent.

b) Write down the structures of all monochlorinated products when 2-methylbutane is chlorinated at 300°C . What would be the anticipated percent yield of the major product?

c) i) Propose a mechanism for the following reaction and justify your answer. $1\frac{1}{2}$



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From the nuclidic mass ^9Be (9.0154) and ^6Li (6.01702), calculate the energy released in MeV and compare it with the energy released in carbon cycle (30 MeV) and in solar-hydrogen cycle (26.6 MeV).

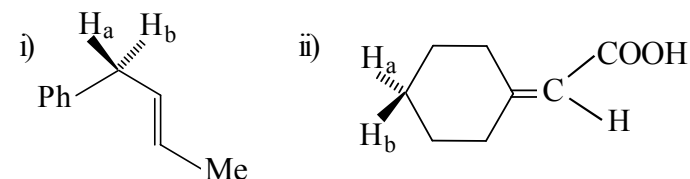
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d) It is well known that the ratio of the number of neutrons to protons decide the so called belt of nuclear stability which can be shown by drawing a graph. Using this, explain the decay process involving $^{14}\text{C}_6$, $^{23}\text{Mg}_{12}$ and $^{214}\text{Po}_{84}$. $1\frac{1}{2}$

e) $^{246}\text{Cf}_{90}$ was emitted along with neutrons, when an unknown radioactive substance was bombarded using ^{12}C as projectile. Predict the unknown radioactive substance and the type of nuclear reaction involved. $1\frac{1}{2}$

UNIT: 2032-O

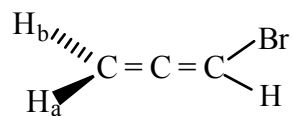
3. a) Identify \mathbf{H}_a and \mathbf{H}_b in the following molecules as homotopic, enantiotopic and diastereotopic. 1



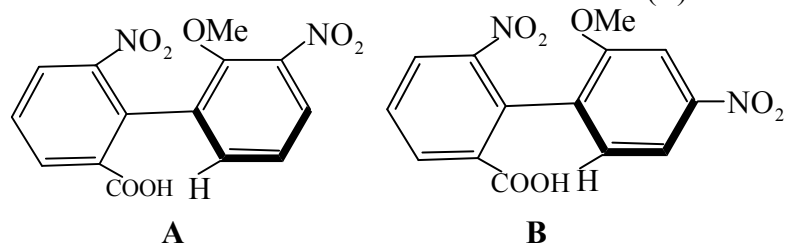
b) Designate \mathbf{H}_a and \mathbf{H}_b in the following compound by *pro-R* / *pro-S* configuration. 1

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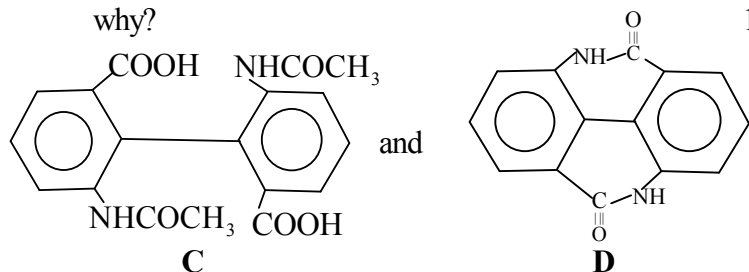
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- c) The rate of racemisation of 3'-nitro derivative (A) is much lower than that of 5'-nitro derivative (B). 1



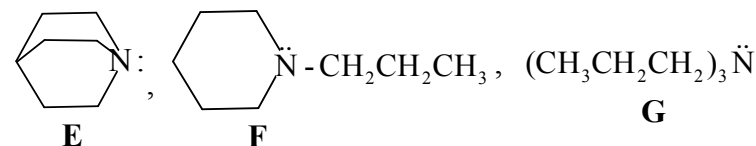
- d) Which of the following compound is non-resolvable and why? 1



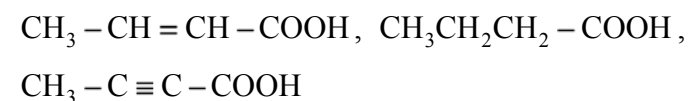
- e) Find the absolute configuration of the product/s obtained when benzaldehyde undergoes nucleophilic attack by CH_3MgBr on the Re-face. 1
4. a) Butan-2,3-dione $\left(\text{CH}_3 - \overset{\text{O}}{\parallel}{\text{C}} - \overset{\text{O}}{\parallel}{\text{C}} - \text{CH}_3 \right)$ exists almost exclusively in the Keto form whereas cyclopentan-1,2-dione exist exclusively in the enol form – explain. 1

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- b) Predict the increasing rate of reaction rate of the following bases with Me_3B and explain your response. 1 ½

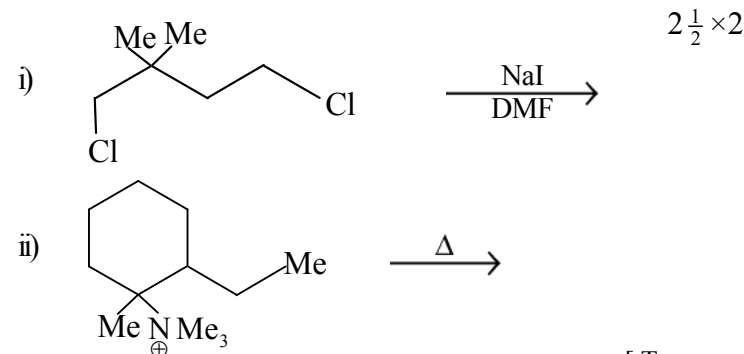


- c) Arrange the following compounds in order of increasing acidity. 1



- d) The photochemical chlorination of n-propane is less selective than photochemical bromination of n-propane. Explain the above reactions on the basis of Hammond's postulate. 1 ½

5. Predict the product(s) of the following reactions and explain with plausible mechanism. Identify the major product resulting from each of the following reactions (Answer *any two*). 2 ½ × 2



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