



Progressive Education Society's  
Modern College of Arts, Science & Commerce Ganeshkhind, Pune – 16  
(Autonomous)

End Semester Examination: January 2023

Faculty: Science and Technology

Semester: I

Program: B.Sc. Blended      Program (Specific): B.Sc.Blended(Chemistry)      SET: C  
Course Type: Compulsory Credit (CC)      Class: F.Y.B.Sc.Blended  
Name of the Course: General Chemistry-Chemistry of Life      Credit: 3  
Course Code: CHM103      Time: 2½ hrs      Max.Marks: 50  
Paper: III

**Instructions to the candidate:**

- i) *There are 3 sections in the question paper. Write each section on separate page.*
- ii) *All Sections are compulsory.*
- iii) *Figures to the right indicate full marks.*
- iv) *Use of Scientific calculators is allowed.*
- v) *Draw diagrams wherever necessary.*
- vi) *Write appropriate unit wherever required.*
- vii) *Ask for graph paper if needed.*

**PHYSICAL CONSTANTS AND CONVERSION FACTORS**

Avogadro constant ( $N_A$ )	$6.0221 \times 10^{23} \text{ mol}^{-1}$
1 Atomic mass unit ( $u$ )	$1.6605 \times 10^{-27} \text{ kg}$
Gas constant ( $R$ )	$8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ or $0.08206 \text{ L atm K}^{-1} \text{ mol}^{-1}$
Speed of light ( $c$ )	$2.9979 \times 10^8 \text{ m s}^{-1}$
Planck constant ( $h$ )	$6.6261 \times 10^{-34} \text{ J s photon}^{-1}$
Rydberg constant ( $R_H$ )	$3.29 \times 10^{15} \text{ Hz}$
Mass of an electron ( $m_e$ )	$9.109 \times 10^{-31} \text{ kg}$
Bohr radius ( $a_0$ )	53 pm
1 Atmosphere (atm)	101 325 Pa = 760 mm Hg
1 Bar	100 kPa = 0.987 atm
Faraday constant ( $F$ )	$9.6485 \times 10^4 \text{ C mol}^{-1}$
$RT/F$ (at 298 K)	0.0257 V
2.303 $RT/F$ (at 298 K)	0.0592 V
Absolute zero, 0 K	-273.15 °C

### SELECTED CHEMICAL DATA

#### Molar Masses

Element	$M/g\ mol^{-1}$
H	1.008
He	4.00
C	12.01
N	14.01
O	16.00
Na	22.99
Mg	24.31
S	32.07
Cl	35.45
Ca	40.08
Cu	63.55
Pu	244.00

#### Standard Enthalpies of Formation

Substance and state	$\Delta_f H_{298}^\circ (kJ\ mol^{-1})$
H <sub>2</sub> O(l)	-285.8
CO <sub>2</sub> (g)	-393.5
MgO(s)	-602
Mg(OH) <sub>2</sub> (s)	-924.5
CaO(s)	-635.1
CaCO <sub>3</sub> (s)	-1206.9
SO <sub>2</sub> (g)	-296.83
SO <sub>3</sub> (g)	-395.72

#### Specific heat capacities

H <sub>2</sub> O(l)	$4.18\ J\ g^{-1}\ ^\circ C^{-1}$
Cu(s)	$0.387\ J\ g^{-1}\ ^\circ C^{-1}$

#### Densities

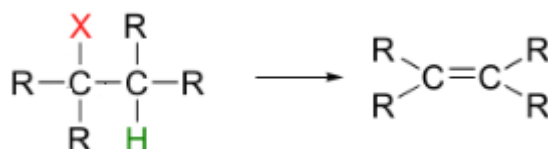
H <sub>2</sub> O(l)	$1.0\ g\ mL^{-1}$
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### PART A. - MULTIPLE CHOICE QUESTIONS

Solve all **TEN** multiple choice questions. (1 Mark each)

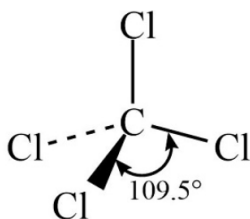
10 x1 =10 Marks

Q 1. Identify the following reaction



- A. Addition
- B. Elimination
- C. Substitution
- D. Rearrangement

Q 2. Identify the hybridisation in the given molecule.



- A.  $sp^3$
- B.  $sp^2$
- C.  $sp$
- D.  $dsp^2$

Q3. Consider the following species:  $S^{2-}$ ,  $F^-$ ,  $Cl^-$ ,  $Na^+$  and  $Al^{3+}$ . The size of these species increases in the order:

- A.  $S^{2-} < F^- < Cl^- < Na^+ < Al^{3+}$
- B.  $Al^{3+} < Na^+ < Cl^- < F^- < S^{2-}$
- C.  $Na^+ < Al^{3+} < F^- < Cl^- < S^{2-}$
- D.  $Al^{3+} < Na^+ < F^- < Cl^- < S^{2-}$

Q4. Identify the correct balanced chemical reaction among the following

- A.  $Fe_2O_3 + 3C \rightarrow 2Fe + 3CO_2$
- B.  $FeO_3 + 4C \rightarrow Fe + 4CO_2$
- C.  $2Fe_2O_3 + 3C \rightarrow 4Fe + 3CO_2$
- D.  $2Fe_2O_3 + 4C \rightarrow 4Fe + 4CO_2$

Q5. The concept of engine with 100% efficiency is as per the ----- law of thermodynamics.

- A. First
- B. Zeroth
- C. Third
- D. Second

Q6. pH of  $10^{-12}$  M HCl solution is

- A. 12
- B. between 6 to 7
- C. between 7 to 8
- D. 2

Q 7. In which case must a reaction be spontaneous at all temperatures?

- A.  $\Delta H$  is positive,  $\Delta S$  is negative
- B.  $\Delta H = 0$ ,  $\Delta S$  is negative
- C.  $\Delta H$  is positive,  $\Delta S = 0$
- D.  $\Delta H$  is negative,  $\Delta S$  is positive

Q 8. Which of the following statements about the kinetic theory of gases is **incorrect**?

- A. gases are made up of tiny particles in constant chaotic motion
- B. gas particles are very small compared to the average distance between them
- C. gases collide with the walls of their container in elastic collisions
- D. the average velocity of gas particles is directly proportional to the absolute temperature

Q 9. A gas absorbs 2.8 J of heat and then performs 12.4 J of work. The change in internal energy of the gas is

- A. -9.6 J
- B. 15.2 J
- C. 9.6 J
- D. -15.2 J

Q 10. What is the amount of heat absorbed by 15.0 g of water when it is heated from  $20^\circ C$  to  $50^\circ C$ ? [The specific heat capacity of water is  $4.18 Jg^{-1}C^{-1}$ ]

- A. 1.00 kJ
- B. 1.29 kJ
- C. 1.41 kJ
- D. 1.88 kJ

## PART B. - SHORT WRITTEN ANSWERS

Answer any **TEN** out of 12. (2 marks each)

10 x 2 = 20 Marks

**Q 1.** Calculate the half-life of the first order reaction having rate constant of  $5 \times 10^{-3} \text{ min}^{-1}$

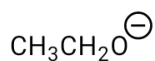
**Q 2.** Identify radical species among the following and justify your answer.



**Q 3.** An ethanoic acid/ethanoate buffer has a pH of 5.24.

What is the ratio of ethanoate ( $\text{CH}_3\text{COO}^-$ ) to ethanoic acid ( $\text{CH}_3\text{COOH}$ ) in the buffer solution? [ $\text{pK}_a(\text{CH}_3\text{COOH}) = 4.76$ ]

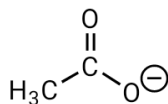
**Q4.** Rank the following chemical species (F-I) from best leaving group to poorest leaving group. Explain your answer.



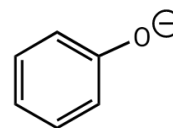
F



G



H



I

( $\text{pK}_a$  values:  $\text{CH}_3\text{CO}_2\text{H} = 4.7$ ;  $\text{H}_2\text{O} = 15.7$ ;  $\text{CH}_3\text{CH}_2\text{OH} = 16$ ;  $\text{C}_6\text{H}_5\text{OH} = 10$ )

**Q5.** Calculate the isothermal reversible work done by 2 moles of an ideal gas expansion from 1 L to 10 L at 500K.

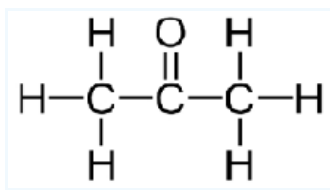
**Q6.** Calculate the amount of carbon dioxide released when 25 grams of  $\text{CaCO}_3$  is decomposed. (Given: molecular weight of  $\text{CaCO}_3$  100.0869 g/mol,  $\text{CaO}$  56.0774 g/mol, and  $\text{CO}_2$  44.01 g/mol)

**Q7** Give an example of Friedel Crafts acylation. Propose the reaction mechanism.

**Q8.** Compare the change in hybridization, planarity and bond angles in the following reaction.

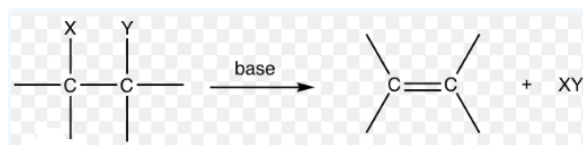
$$\text{C}_2\text{H}_4(\text{g}) + \text{H}_2(\text{g}) \longrightarrow \text{C}_2\text{H}_6(\text{g})$$

**Q9.** What alcohol is produced in the reduction of the following molecule?

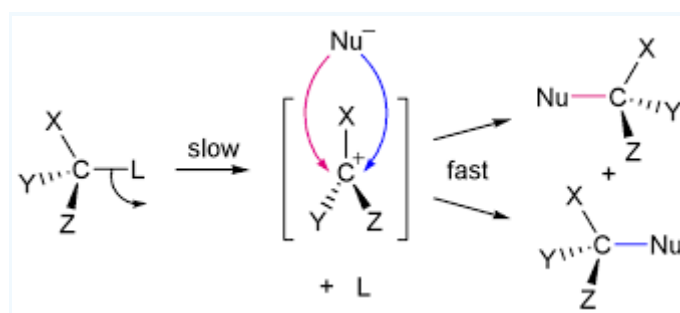


Q10. What is second law of thermodynamics? Based on that comment on the spontaneity of the reaction.

Q11. Identify the following reaction and write its mechanism.



Q12. Identify the following reaction mechanism and draw the potential energy profile.

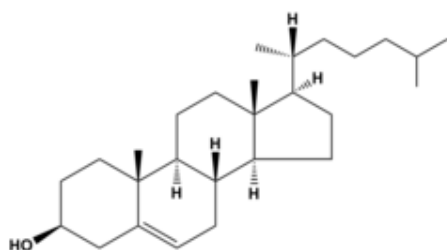


### PART C - LONG WRITTEN ANSWERS

Answer any **FOUR** out of 6. (5 Marks each)

4 x 5 = 20 Marks

Q1. Cholesterol is a type of lipid found in cells. The structure is given below.



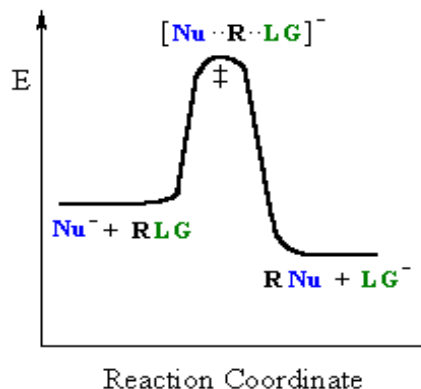
Based on the above structure, answer the following questions.

- Name the functional groups present.
- How many asymmetric carbon centres are there?
- How many  $sp^3$  hybridised carbon atoms are present?
- How many  $sp^2$  hybridised carbon atoms are present?
- is the molecule planar?

**Q 2.** Derive Hinderson's equation and explain the concept of pKa with suitable example.

**Q3.** Based on the given potential energy profile, write

- Type of the reaction
- Reaction mechanism
- Geometry of the reactant and the product
- Configuration of the reactant and the product
- Suitable example

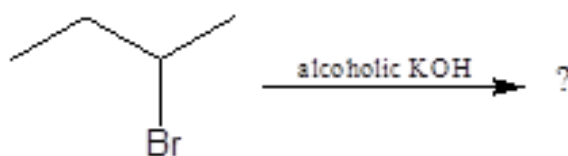


**Q 4.** Sodium metal (2.95 g) is brought into contact with bromine liquid (8.45 g) and they react according to the equation:  $2\text{Na}_{(s)} + \text{Br}_{2(l)} \rightarrow 2\text{NaBr}_{(s)}$

Determine which reagent is in excess and by what mass. Calculate the mass of sodium bromide produced.

(Given: Atomic Masses. Na: 23.0 M/g mol<sup>-1</sup>; Br 79.9 M/g mol<sup>-1</sup>)

**Q5.** Predict the product



**Q 6.** A first order reaction has initial concentration of 0.1M. After 8 hours, 0.02M reactant is remaining. Calculate the rate constant and half-life of the reaction.

-X-