

# 4/CHE-252 (Th) Syllabus-2023

**2 0 2 5**

( May-June )

## **FYUP : 4th Semester Examination**

**CHEMISTRY**

**( Physical Chemistry—I )**

( CHE-252 )

**( Theory )**

*Marks : 75*

*Time : 3 hours*

*The figures in the margin indicate full marks  
for the questions*

1. (a) Describe  $P$ - $V$  isotherm of  $\text{CO}_2$  with the help of a diagram at varying temperatures.

6

- (b) Write the expression for—

(i) most probable velocity;

(ii) root mean square velocity.

Also mention the differences between them.

2+2+2=6

( 2 )

- (c) Write notes on the following :  $2 \times 2 = 4$   
(i) Collision diameter  
(ii) Collision number
- (d) Calculate the average velocity of  $\text{SO}_2$  at  $427^\circ\text{C}$ . [Given :  $R = 8.314 \text{ J-K}^{-1} \text{ mol}^{-1}$ ] 3

OR

2. (a) Derive mathematical equation to represent Maxwell's distribution of energies. 6  
(b) Discuss the principle of equipartition of energy. 4  
(c) Discuss the effect of temperature and pressure on the following :  $3+3=6$   
(i) Collision frequency  
(ii) Mean free path
- (d) Calculate the temperature at which the hydrogen molecules will have an average velocity of  $176400 \text{ cm s}^{-1}$ . [Given :  $R = 8.314 \text{ J-K}^{-1} \text{ mol}^{-1}$ ] 3
3. (a) State and explain Carnot theorem. How can the efficiency of a heat engine be increased?  $3+1=4$

( 3 )

- (b) Calculate the amount of heat supplied to Carnot's cycle working between  $368 \text{ K}$  and  $288 \text{ K}$  if the maximum work obtained is  $895 \text{ joules}$ . 3
- (c) Differentiate between the following :  $2 \times 2 = 4$   
(i) Helmholtz free energy  
(ii) Gibbs free energy
- (d) Derive Gibbs-Helmholtz equation. 5
- (e) State the first law of thermodynamics mentioning its limitations.  $1+2=3$

OR

4. (a) Prove that in a reversible process net entropy change for the system and surroundings is zero. 3  
(b) Calculate the maximum efficiency of a steam engine operating between  $110^\circ\text{C}$  and  $25^\circ\text{C}$ . 3  
(c) How does Gibbs' free energy vary with temperature and pressure? 5  
(d) Derive Clausius-Clapeyron equation. 5  
(e) State and explain Trouton's rule. 3

( 4 )

5. (a) Write three points of differences between metallic and electrolytic conductors. 3
- (b) If molar conductivities at infinite dilution of NaCl, HCl and  $\text{CH}_3\text{COONa}$  are—  
126.4, 426.1 and  $91.0 \Omega^{-1}\text{cm}^2\text{mol}^{-1}$   
respectively, what will be that of  $\text{CH}_3\text{COOH}$ ? 3
- (c) What are specific conductance and equivalent conductance? Explain how they vary with dilution for strong and weak electrolyte. 3+4=7
- (d) Derive Ostwald's dilution law. What are its uses and limitations? 3+2=5

OR

6. (a) Describe the moving boundary method for the determination of transport numbers. 4
- (b) Discuss the curves obtained by conductometric titration of—  
(i) a strong acid with a weak base;  
(ii) a weak acid with a strong base. 3+2=6

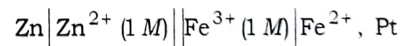
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( 5 )

- (c) The equivalent conductance of a very dilute solution of  $\text{NaNO}_3$  at  $18^\circ\text{C}$  is  $105.2 \Omega^{-1}\text{cm}^2$ . If the ionic conductance of  $\text{NO}_3^-$  ion in the solution is  $61.7 \Omega^{-1}\text{cm}^2$ , calculate the transport number of  $\text{Na}^+$  ions in the solution. 2
- (d) Explain the following : 3+2=6  
(i) Asymmetric effect  
(ii) Electrophoretic effect
7. (a) What is meant by electrochemical series? Explain why zinc (Zn) reacts with  $\text{H}_2\text{SO}_4$  to give  $\text{H}_2$  but silver does not. 2+2=4
- (b) Briefly explain the different types of reversible electrodes. 4

- (c) Write the cell reaction and calculate  $E^\circ$  for the cell



Given,

$$E^\circ_{\text{Fe}^{3+}/\text{Fe}^{2+}} = +0.77 \text{ V}$$

$$E^\circ_{\text{Zn}^{2+}/\text{Zn}} = -0.76 \text{ V}$$

2+3=5

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( Turn Over )

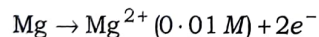
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- (d) Derive the relation between e.m.f. of a cell with the following thermodynamic parameters of a cell reaction :  $2+2+2=6$

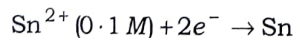
- (i) Free energy  
(ii) Enthalpy  
(iii) Entropy

OR

8. (a) Derive Nernst equation for measuring the e.m.f. of the cell. 3
- (b) What is an electrochemical cell? Write a representation of an electrochemical cell, using important sign conventions, taking the example of Zn-Cu cell.  $2+3=5$
- (c) Represent schematically the cell made up of the following half-cell reactions :



$$E^{\circ} = +2.34 \text{ V}$$



$$E^{\circ} = -0.136 \text{ V}$$

Calculate the e.m.f. of the above cell at 25 °C.  $2+3=5$

( 7 )

- (d) What is liquid junction potential? How can it be minimized?  $2+1=3$
- (e) What are concentration cells? Mention different types of concentration cells.  $1+2=3$

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