

1<sup>st</sup> Sessional Examination  
Odd Semester, 2022  
I (M)  
**PHYSICAL CHEMISTRY C-102**

**Total marks = 40**

**Time allotted = 90 min**

1. Choose the correct answer: 1+1=2
- a. Which of the following is incorrect?
- i. The rate of condensation is equal to the rate of evaporation at equilibrium
- ii. The concentration of the molecule in vapour phase decreases continuously.
- iii. The concentration of molecule in vapour phase remains unchanged at equilibrium.
- iv. None of the above
- b. For anionic hydrolysis,  $pH$  is given by
- i.  $pH = \frac{1}{2} pK_w - \frac{1}{2} pK_b - \frac{1}{2} \log C$
- ii.  $pH = \frac{1}{2} pK_w + \frac{1}{2} pK_a - \frac{1}{2} \log C$
- iii.  $pH = \frac{1}{2} pK_w + \frac{1}{2} pK_b + \frac{1}{2} \log C$
- iv. None of the above
2. Answer the following (*any six*). 2×6=12
- a. Define coefficient of viscosity.
- b. What is meant by surface tension of liquid?
- c. Describe the cleansing action of soaps and detergents.
- d. What is a buffer solution?
- e. Find the relationship between solubility and solubility product.
- f. Define common ion effect.
- g. What are the factors effecting ionization of an electrolyte?
- h. Write about the application of common ion effect in systematic group analysis of basic radicals?
- i. Write a note on acid-base indicator.
3. Answer the following (*any one*). 3
- a. Describe one method of determination of surface tension of a liquid.
- b. Derive an expression for pH of an aqueous solution of salts of strong acid and weak base.
4. What do you mean by standardization of a solution? What is end point of an acid-base titration? 3
5. a) What is expansivity and compressibility?  
b) Show that for an ideal gas  $\alpha = 1/T$  and  $\beta = 1/P$  1+1=2
6. The van der Waals constants of a gas are  $a = 0.751 \text{ dm}^6 \text{ atm mol}^{-2}$  and  $b = 0.0226 \text{ dm}^3 \text{ mol}^{-1}$ . Calculate the critical constants. 2
7. Calculate the temperature and pressure that 1 mole of ammonia has in corresponding state to 1 mole of  $H_2$  at  $25^\circ\text{C}$  and 1 atm pressure. The critical constants are:  
For  $H_2$ :  $T_c = 33.0 \text{ K}$  and  $P_c = 12.8 \text{ atm}$  2  
For  $NH_3$ :  $T_c = 405.0 \text{ K}$  and  $P_c = 111.5 \text{ atm}$
8. a) Define F-centre? 1  
b) State and explain Bragg's law 1  
c) Give an account of rotating crystal method and powder pattern method 2
9. State the causes of deviation from ideal behaviour of gases? Derive van der Waals equation of state and state its application in explaining real gas behaviour 1+3=4
10. For BCC Fe, calculate the interplanar spacing between the parallel planes of (220). The lattice parameter of iron is 0.2866 nm. 1+2=3
11. How does vacancy defect affect the stability of a crystal? List the differences between Frenkel and Schottky defects. 1+2=3

1<sup>st</sup> Sessional Examination  
Odd Semester, 2022  
III (M)  
PHYSICAL CHEMISTRY C-303

**Total marks = 40**

**Time allotted = 90 min**

1. Answer the following (any four).  $3\frac{1}{2} \times 4 = 14$ 
  - a. Write the rate expression for first order reaction.
  - b. Describe one method of determination of the order of a chemical reaction.
  - c. What is meant by *half-life period* of a chemical reaction? How is it related to the initial concentration of a second order reaction?  $1 + 2\frac{1}{2} = 3\frac{1}{2}$
  - d. What is the effect of temperature on reaction rate? Explain the Arrhenius equation.  $1\frac{1}{2} + 2 = 3\frac{1}{2}$
  - e. Describe the kinetics of consecutive reaction.
  - f. Write down the reaction steps of hydrogen-bromine chain reaction.
2. Write short notes on (any two):  $3 \times 2 = 6$ 
  - a. Order and molecularity of chemical reaction
  - b. Steady state approximation
  - c. Activated complex
3. State the Phase Rule. Define components, phase and degree of freedom? 2
4. Elaborate the following using appropriate phase diagram: 3
5. (a). What are the solid states in sulphur?  
(b) A triple point is defined as a temperature and pressure where three phases are in equilibrium. How many triple points does sulphur have?
6. (c) Which physical states are present at equilibrium under these conditions?
7. What is peritectic change? Discuss the labelled phase diagram of Na<sub>2</sub>SO<sub>4</sub>-H<sub>2</sub>O system  $1 + 3 = 4$
8. Derive and explain Nernst distribution law 3
9. What is Clausius- Clapeyron equation? Why the fusion curve gives a negative slope but vapour pressure curve gives a positive slope in the phase diagram of water system? 2
10. Derive Michaelis-Menten equation for enzyme catalysis. Why finely divided Ni is used as catalyst in heterogeneous catalysis?  $3 + 1 = 4$
11. What is the effect of temperature on (a) surface reactions (b) enzyme catalysis 2

**PHYSICAL CHEMISTRY C-502****Total marks = 40****Time allotted = 90 min**

1. What is Born and Oppenheimer approximation? 2
  2. Which of the following show rotational spectra and why? 2  
HCl, H<sub>2</sub>, O<sub>2</sub>, CO
  3. Which of the following show vibrational spectra and why? \ 2  
HCl, H<sub>2</sub>, O<sub>2</sub>, H<sub>2</sub>O
  4. The mass of hydrogen atom is  $1.6605 \times 10^{-27}$  kg. What is the reduced mass of hydrogen molecule? 2
- Or,*
- What is zero point energy of anharmonic oscillator?
5. Draw the various vibrational modes of water molecule. 2
  6. Find out the expression for moment of inertia of a rigid diatomic rotor. 3
- Or,*
- Calculate the wave number of stretching vibration of carbon-carbon double bond. Given force constant ( $k = 10 \times 10^5$  dynes cm<sup>-1</sup>).
7. Explain Franck- Condon principle. 3
- Or,*
- What are P, Q and R branches of vibrational rotational spectra?
8. Write short notes on *Overtone*s and *Hot bands*. 4
9. State and explain Einstein's law of photochemical equivalence. What is quantum yield of a photochemical reaction? How to account for low quantum yield of  $\text{H}_2 + \text{Br}_2 \rightarrow 2\text{HBr}$   
2+0.5+0.5= 3
  10. Define the phenomena of fluorescence. What are its characteristics? Explain that delayed fluorescence is phosphorescence. 1+1+1=3
  11. What are a) photosensitized reactions (with eg) b) bioluminescence (with eg) 1.5+1.5 = 3
  12. How would you ascribe physical quantity such as momentum and wavelength to a free particle? Derive. 2
  13. Set up the Schrodinger equation so as to derive vibrational energy of diatomic molecules and zero-point energy 4
  14. Arrive at the separation of variables into angular part and radial part for H<sup>+</sup> ion system using spherical polar coordinates. 3
  15. What is degeneracy? The 6<sup>th</sup> energy level of a particle in a 3D Cube box is 6-fold degenerate. 2
    - a. What is the energy of the 7th energy level?
    - b. What is the degeneracy of the 7th energy level?

1<sup>st</sup> Sessional Examination  
Odd Semester, 2022  
III (GE)  
**CHEMISTRY-GE-301**

**Total marks = 40**

**Time allotted = 90 min**

1. Answer the following (any two). 2× (2+2)=8
- a. Define specific conductance and equivalent conductance.
  - b. Define ionic mobility and transport number.
  - c. Draw the curves of conductometric titrations of strong acid Vs. strong base and weak acid Vs. strong base indicating the neutral points.
2. What are the different applications of conductance? 2
3. The molar conductivities at infinite dilution of KCl, KNO<sub>3</sub> and AgNO<sub>3</sub> at 298 K are 0.01499 ohm<sup>-1</sup>m<sup>2</sup>mol<sup>-1</sup>, 0.01450 ohm<sup>-1</sup>m<sup>2</sup>mol<sup>-1</sup> and 0.01334 ohm<sup>-1</sup>m<sup>2</sup>mol<sup>-1</sup> respectively. What is the molar conductivity of AgCl at infinite dilution at this temperature? 3
4. Define Phase, component and degree of freedom 3
5. Draw a labelled phase diagram of two-component system involving eutectic mixture 4
6. What are azeotropes? Give example 2
7. State Raoult's Law. Plot the vapour pressure-composition curve for ideal solutions. 3
8. Answer any six of the following. 6×2½= 15
- a. Explain the reactivity of phenol with bromine in polar and non-polar solvent.
  - b. How carbene is formed in Reimer Tiemann reaction.
  - c. Phenol is more acidic than ethanol. Explain
  - d. Hinsberg reagent is useful only for 1<sup>o</sup> and 2<sup>o</sup> amine. Explain
  - e. Gabriel phthalimide method is useful only for 1<sup>o</sup> amine. Show one reaction.
  - f. How base catalyzed acyl- oxygen bond cleavage takes place. Explain
  - g. Define hofmann and saytzeff rule.
  - h. Aliphatic nitrous acid reacts differently with 1<sup>o</sup>, 2<sup>o</sup> and 3<sup>o</sup> alcohol. Explain
  - i. Methyl amine is more basic than phenyl amine. Explain