REV-00
MSC/02/05

2017/12

M. Sc. CHEMISTRY
FIRST SEMESTER
PHYSICAL CHEMISTRY - I
MSC – 103(OLD COURSE)

Duration: 3 Hrs. **Marks: 70**

Part : A (Objective) = 20
Part : B (Descriptive) = 50

[PART-B : Descriptive]

Duration: 2 Hrs. 40 Mins. **Marks: 50**

[Answer question no. One (1) & any four (4) from the rest]

1. i. Using the relation $n_1 d\mu_1 = -n_2 d\mu_2$, derive the Gibbs-Duhem-Margules equation $\frac{d\ln\gamma_1}{d\ln x_1} = \frac{d\ln\gamma_2}{d\ln x_2}$ 5

ii. Derive three gas laws from kinetic gas equation.

How can you derive ideal gas equation from these three laws. Determine the value of universal gas constant in SI unit. 3+1+1=4

2. i. State Heisenberg uncertainty principle and establish it with the help of gamma ray microscope. 3

ii. Deduce Schrodinger time independent wave equation. 2

iii. State the condition of orthogonality of wave functions. Prove that if the eigen functions of a Hermitian operator have different eigen values they are orthogonal. 1+2=3

iv. Find the de Broglie wavelength of an electron when it is accelerated through the potential difference of 100 volt. 2

3. i. For a binary mixture of ideal gases, derive the expressions for ΔG_{mix} and ΔS_{mix}. 6

ii. For a real gas show that 4

$$\ln\left(\frac{f}{p}\right) = \int_0^p (z-1)\, d\ln p$$

(*Note: In the above questions, the terms used have their usual meanings*)

4. Derive Most probable velocity and Average velocity from Maxwell distribution law. Calculate the ratio between these two. 9+1=10

5. How can you determine viscosity of a gas from viscosity of liquid. Write the effect of temperature and pressure on viscosity 8+2=10

6. i. Define z-average molar mass. Is it greater or smaller than mass average molecular mass for a polydisperse system? 2

ii. Show that for a equimolar mixture of two substances 3

$$M_1 = \bar{M}_n + (\bar{M}_n\bar{M}_w - \bar{M}_n^2)^{0.5}$$

$$M_2 = \bar{M}_w - (\bar{M}_n\bar{M}_w - \bar{M}_n^2)^{0.5}$$

iii. Equal masses of polymer molecules with M_1=10000 and M_2=100000 are mixed. Calculate $\overline{M}_n$ and $\overline{M}_w$. 3

iv. Briefly discuss the practical significance of molecular weight of polymers. 2

7. i. Derive an overall rate expression for free-radical chain polymerization. 6

ii. What are chain transfer agents? Discuss their role and effect on molecular weight obtained in their presence. 4

8. i. Describe a method commonly employed for the determination of viscosity of a liquid. 5

ii. Write down the Schrodinger wave equation for a particle of mass 'm' confined in a one dimensional wall of length 'a' moving along x direction such that the potential 'V' is zero within the wall and V = ∞ outside the wall. Calculate the wave function and the energy of the particle. Define degeneracy. 1+2+1+1 =5

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[PART-A : Objective]

Choose the correct answer from the following: **1×20=20**

1. Which of the following function is acceptable as wave function?
   a. $\Psi = x$
   b. $\Psi = e^x$
   c. $\Psi = \sin x$
   d. $\Psi = \tan x$

2. Which is not an example of linear operator?
   a. d/dx
   b. d^2/dx^2
   c. $\sqrt{}$
   d. x^2

3. The wave function in quantum mechanics represents
   a. Energy of the system
   b. A state of the system
   c. Probability of a system
   d. Operator

4. The degeneracy of quantum particle in a cubical box having energy three times the ground state energy is
   a. 1
   b. 2
   c. 3
   d. 6

5. The zero point energy of the Harmonic oscillator is
   a. Zero
   b. $\frac{1}{2}\hbar\omega$
   c. $\hbar\omega$
   d. $3/2\hbar\omega$

6. G is the Gibbs energy, then $\oint dG$ is
   a. Equal to 0
   b. Not equal to 0
   c. Equal to 0 only at constant pressure
   d. Equal to 0 only at constant temperature

7. For aqueous $CaCl_2$ solution
   a. $\gamma_\pm = \gamma_+^{1/3}\gamma_-^{2/3}$
   b. $\gamma_\pm = \gamma_+^{1/3}\gamma_-^{1/3}$
   c. $\gamma_\pm = \gamma_+\gamma_-^{1/2}$
   d. $\gamma_\pm = \gamma_+\gamma_-$

8. On the basis of $dA = -PdV - SdT$, the correct thermodynamic relation is
   a. $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$
   b. $\left(\frac{\partial A}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$
   c. $\left(\frac{\partial S}{\partial V}\right)_T = -\left(\frac{\partial P}{\partial T}\right)_V$
   d. $\left(\frac{\partial S}{\partial T}\right)_V = \left(\frac{\partial P}{\partial V}\right)_T$

9. Which of the following is a partial molar property?
   a. $\left(\frac{\partial A}{\partial n_i}\right)_{V,T,n_j}$
   b. $\left(\frac{\partial H}{\partial n_i}\right)_{S,P,n_j}$
   c. $\left(\frac{\partial V}{\partial n_i}\right)_{P,T,n_j}$
   d. $\left(\frac{\partial U}{\partial n_i}\right)_{S,V,n_j}$

10. The enthalpy of a process is equal to the slope of the plot of
    a. G versus T
    b. G/T versus 1/T
    c. G/T versus T
    d. G versus 1/T

11. Boyl's law is applicable in
    a. Isochoric process
    b. Isothermal process
    c. Isobaric process
    d. Isotonic process

12. The mean kinetic energy of one gram-mole of a perfect gas at absolute temperature T is
    a. 1/2 KT
    b. 1/2 RT
    c. 3/2 KT
    d. 3/2 RT

13. We have a jar 'A' filled with a gas characterized by parameter P, V and T. another jar 'B' filled with a gas with parameters 2P, V/2 and 2T, where symbols have their usual meanings. The ratio of the number of molecules of jar 'A' to those of jar 'B' is
    a. 1: 1
    b. 1: 2
    c. 2: 1
    d. 4: 1

14. Mean free path of a gas molecule with collision diameter σ at given density is proportional to
    a. σ^0
    b. σ
    c. σ^2
    d. $1/\sigma^2$

15. Following gases are kept at the same temperature. Which gas possesses maximum r.m.s. speed?
    a. Oxygen
    b. Nitrogen
    c. Hydrogen
    d. Carbon dioxide

16. The relationship between degree of polymerization (DP) and number average molecular weight is
    a. $\overline{M_n} = DP$
    b. $\overline{M_n} = DP \times M$
    c. $\overline{M_n} = \frac{DP}{M}$
    d. $\overline{M_n} = DP \times M^2$

17. The expression $(\eta_{sp}/c)_{c \to 0}$ is called as
    a. Relative viscosity
    b. Reduced viscosity
    c. Inherent viscosity
    d. Intrinsic viscosity

18. The molecular weights obtained by measuring colligative properties
    a. $\bar{M}_n$
    b. $\bar{M}_w$
    c. $\bar{M}_v$
    d. $\bar{M}_z$

19. Diisopropyl xanthate disulphide is associated in polymerization as
    a. Chain inhibitor
    b. Chain modifier
    c. Telogen
    d. Initiator

20. In chain polymerization, which of the following is true?
    a. Identity of monomer retains
    b. No byproduct is formed
    c. Hybridization of C-atom changes
    d. All the three

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UNIVERSITY OF SCIENCE & TECHNOLOGY, MEGHALAYA

[PART (A) : OBJECTIVE]

Duration : 20 Minutes

Serial no. of the main Answer sheet

Course : .....

Semester : ..... **Roll No :** .....

Enrollment No : ..... **Course code :** .....

Course Title : .....

Session : 2017-18 **Date :** .....

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Instructions / Guidelines

- The paper contains twenty (20) / ten (10) questions.
- Students shall tick (✓) the correct answer.
- No marks shall be given for overwrite / erasing.
- Students have to submit the Objective Part (Part-A) to the invigilator just after completion of the allotted time from the starting of examination.

Full Marks	Marks Obtained
20	

Scrutinizer's Signature *Examiner's Signature* *Invigilator's Signature*