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(February)

CHEMISTRY

(Honours)

(Part-A : Physical)

[Chem-H-503]

Marks : 37

Time : 2 hours

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

1. (a) Using Maxwell's distribution law of molecular velocities, show that the root-mean-square velocity of a molecule is $\sqrt{\frac{3RT}{M}}$, the terms having their usual meanings. 4
- (b) What is most probable velocity? Calculate the most probable velocity of CO₂ molecule at 27 °C.
[Given, $R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$] 1+2=3
- (c) Explain the term 'collision frequency'. 2

OR

2. (a) Discuss the principle of equipartition of energy. 4
- (b) Define mean-free path of a molecule. What are the effects of increase of temperature and pressure on the mean-free path? 1+2=3
- (c) Calculate the Boyle temperature for oxygen assuming that it is a van der Waals' gas. Given that $a = 1.36 \text{ dm}^6 \text{ atm mol}^{-2}$ and $b = 0.0318 \text{ dm}^3 \text{ mol}^{-1}$. 2
3. (a) Define surface tension of a liquid. Describe the capillary rise method for determining surface tension of a liquid. 1+3=4
- (b) What are additive and constitutive properties? Give one example for each. $1\frac{1}{2} + 1\frac{1}{2} = 3$

OR

4. (a) Write notes on the following : $1\frac{1}{2} \times 3 = 4\frac{1}{2}$
- (i) Parachor
- (ii) Molar volume
- (iii) Molar refraction
- (b) In water molecule (H₂O), there are two identical O—H bonds, each with a bond moment of 1.5 D. The net dipole moment of water molecule is 1.84 D. Calculate the bond angle in water molecule. $2\frac{1}{2}$

(3)

5. (a) Define the following elements of symmetry : $1 \times 3 = 3$
- (i) Plane of symmetry
 - (ii) Axis of symmetry
 - (iii) Centre of symmetry
- (b) Calculate the number of atoms contained within (i) a primitive cubic unit cell, (ii) a body-centred cubic unit cell and (iii) a face-centred cubic unit cell. $1 + 1 + 1 = 3$

OR

6. (a) Describe the powder method for the determination of the crystal structure of sodium chloride. 3
- (b) Calculate the angle at which first-order reflection will occur in an X-ray spectrometer when X-rays of wavelength $1.50 \text{ \AA}$ are diffracted by the atoms of a crystal. Given that the interplanar distance is $4.04 \text{ \AA}$. 3
7. (a) Discuss the collision theory of reaction rates. Mention one of its limitations. $3 + 1 = 4$
- (b) Write notes on the following : $1\frac{1}{2} + 1\frac{1}{2} = 3$
- (i) Homogeneous catalysis
 - (ii) Opposing or reversible reactions

(4)

OR

8. (a) Write a note on parallel reactions and obtain the rate expression for such reactions. 4
- (b) Explain transition state theory of reaction rates with relevant expressions. 3
9. (a) Write down the expression for the rotational energy of a diatomic molecule taking it as rigid rotor. Draw the rotational energy-level diagram for such molecule. $2 + 2 = 4$
- (b) The fundamental vibrational frequency of HCl is 2890 cm^{-1} . Calculate the force constant of this molecule. 4

OR

10. (a) State Beer-Lambert law. Give its mathematical expression and hence define molar extinction coefficient. $1 + 2 + 1 = 4$
- (b) Explain the following : $2 + 2 = 4$
- (i) Born-Oppenheimer approximation
 - (ii) Isotope effect in vibrational spectrum

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