

2019

CHEMISTRY

(Major)

Paper : 6.2

(Physical Chemistry)

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Answer the following in brief :

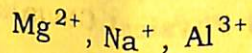
1×7=7

(a) If three elements A, B and C crystallizes in a cubic solid with A atoms at the corners, B atoms at the cube centre and C atoms at the faces of the cube, what will be the formula of the compound?

(b) Calculate the Miller indices of a crystal plane which cuts through the crystal axes at $(6a, 3b, 3c)$.

(c) "When an intense converging beam of light is passed through a colloidal solution kept in dark, the path of the beam gets illuminated with a bluish light." What is the name of this phenomenon?

(d) Arrange the following in increasing order of their effectiveness in coagulating As_2S_3 sol :



(e) What do you mean by polydispersity index of a polymer?

(f) Using the Stirling's approximation, calculate $\ln N_A!$. (N_A is Avogadro's number.)

(g) State whether the following statement is True or False :

"In any ionic solid $[\text{MX}]$ with Schottky defects, the number of positive and negative ions are same."

2. Answer the following questions :

$2 \times 4 = 8$

(a) Silver has a cubic unit cell with a cell edge of 408 pm. Its density is 10.6 g cm^{-3} . How many atoms of silver are there in the unit cell?

(Continued)

(b) Distinguish between error and uncertainty in measurement.

(c) The translational partition function for hydrogen atom at 3000 K confined in a vessel of volume $2.494 \times 10^5 \text{ cm}^3$ is 7.586×10^{30} . Calculate the thermal de Broglie wavelength.

(d) " $\text{CH}_3(\text{CH}_2)_{15}\text{N}(\text{CH}_3)_3\text{Br}$ forms micelles in aqueous solution at a lower molar concentration than $\text{CH}_3(\text{CH}_2)_{11}\text{N}(\text{CH}_3)_3\text{Br}$." Explain this observation.

3. (a) What is a semiconductor? Describe the two main types of semiconductors and contrast their conduction mechanisms. What type of semiconductors are the following? $4+1=5$

(i) Ge doped with In

(ii) B doped with Si

Or

What do you mean by non-stoichiometric defects? Give one example. Explain metal excess and metal deficiency defects with examples. $1+2+2=5$

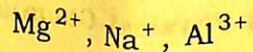
(b) Deduce the relation $S = k \ln W$. 5

A9/717

(Turn Over)

(c) "When an intense converging beam of light is passed through a colloidal solution kept in dark, the path of the beam gets illuminated with a bluish light." What is the name of this phenomenon?

(d) Arrange the following in increasing order of their effectiveness in coagulating AS_2S_3 sol :



(e) What do you mean by polydispersity index of a polymer?

(f) Using the Stirling's approximation, calculate $\ln N_A!$. (N_A is Avogadro's number.)

(g) State whether the following statement is True or False :

"In any ionic solid $[MX]$ with Schottky defects, the number of positive and negative ions are same."

2. Answer the following questions : $2 \times 4 = 8$

(a) Silver has a cubic unit cell with a cell edge of 408 pm. Its density is 10.6 g cm^{-3} . How many atoms of silver are there in the unit cell?

(b) Distinguish between error and uncertainty in measurement.

(c) The translational partition function for hydrogen atom at 3000 K confined in a vessel of volume $2.494 \times 10^5 \text{ cm}^3$ is 7.586×10^{30} . Calculate the thermal de Broglie wavelength.

(d) " $CH_3(CH_2)_{15}N(CH_3)_3Br$ forms micelles in aqueous solution at a lower molar concentration than $CH_3(CH_2)_{11}N(CH_3)_3Br$." Explain this observation.

3. (a) What is a semiconductor? Describe the two main types of semiconductors and contrast their conduction mechanisms. What type of semiconductors are the following? 4+1=5

(i) Ge doped with In

(ii) B doped with Si

Or

What do you mean by non-stoichiometric defects? Give one example. Explain metal excess and metal deficiency defects with examples. 1+2+2=5

(b) Deduce the relation $S = k \ln W$. 5

Or

Deduce an expression for the entropy of monatomic perfect gas in terms of partition function.

- (c) Define average deviation and standard deviation. Estimation of Fe present in a sample showed the following results in a series of experiments :

Experiment	Amount of Fe
I	7.146%
II	7.098%
III	6.942%
IV	7.256%
V	6.593%

Find average deviation, standard deviation and coefficient of variations for the values. $2+3=5$

4. Answer either (a), (b) and (c) or (d), (e) and (f) :

- (a) What do you mean by packing efficiency? Calculate the packing efficiency of face-centred cubic arrangement. $1+2=3$

(Continued)

- (b) KNO_3 crystallizes in orthorhombic system with the unit cell dimensions $a=542$ pm, $b=917$ pm and $c=645$ pm. Calculate the diffraction angle for first-order X-ray reflections from (1 0 0), (0 1 0) and (1 1 1) planes using radiation with wavelength 154.1 pm. 4

- (c) White coloured zinc oxide turns yellow on heating. Explain. 3

- (d) State Bragg's law and deduce the equation $2d\sin\theta = n\lambda$, symbols have their usual meanings. 4

- (e) Explain the following : $1\frac{1}{2} \times 2 = 3$

(i) Frenkel defect is not found in pure alkali metal halides.

(ii) Antiferromagnetic substances have unpaired electrons but their dipole moment is zero.

- (f) Explain the origin of low temperature superconductivity in terms of Cooper pair. 3

5. Answer either (a), (b) and (c) or (d), (e) and (f) :

- (a) Discuss the viscometric method of determination of molar mass of polymers. What is viscosity number? $3+1=4$

(Turn Over)

Or

Deduce an expression for the entropy of monatomic perfect gas in terms of partition function.

- (c) Define average deviation and standard deviation. Estimation of Fe present in a sample showed the following results in a series of experiments :

Experiment	Amount of Fe
I	7.146%
II	7.098%
III	6.942%
IV	7.256%
V	6.593%

Find average deviation, standard deviation and coefficient of variations for the values. 2+3=5

4. Answer either (a), (b) and (c) or (d), (e) and (f) :

- (a) What do you mean by packing efficiency? Calculate the packing efficiency of face-centred cubic arrangement. 1+2=3

(Continued)

- (b) KNO_3 crystallizes in orthorhombic system with the unit cell dimensions $a=542$ pm, $b=917$ pm and $c=645$ pm. Calculate the diffraction angle for first-order X-ray reflections from (1 0 0), (0 1 0) and (1 1 1) planes using radiation with wavelength 154.1 pm. 4
- (c) White coloured zinc oxide turns yellow on heating. Explain. 3
- (d) State Bragg's law and deduce the equation $2d\sin\theta = n\lambda$, symbols have their usual meanings. 4
- (e) Explain the following : 1½×2=3
- (i) Frenkel defect is not found in pure alkali metal halides.
- (ii) Antiferromagnetic substances have unpaired electrons but their dipole moment is zero.
- (f) Explain the origin of low temperature superconductivity in terms of Cooper pair. 3

5. Answer either (a), (b) and (c) or (d), (e) and (f) :

- (a) Discuss the viscometric method of determination of molar mass of polymers. What is viscosity number? 3+1=4

(Turn Over)

- (b) A solution contains 1:2 ratio of number of particles of two substances with molar masses 5000 g mol^{-1} and 12000 g mol^{-1} respectively. Calculate the number average and weight average molar masses. 3
- (c) What do you mean by critical micelle concentration? Show graphically how molar conductance, surface tension and osmotic pressure of solutions of surfactants change at the critical micelle concentration. 3
- (d) Discuss the kinetics of addition polymerization. Give an example of a polymer produced by this method. 3+1=4
- (e) The osmotic pressure of 1 m^3 of a solution containing 2.5 kg of a polymer is found to be 250 Pa at 298 K. Assuming that the solution does not deviate from ideal behaviour, calculate the molar mass of the polymer. 3
- (f) What are protective colloids? Explain how a lyophilic colloid can stabilize a lyophobic colloid with suitable examples. 3

6. Answer either (a), (b) and (c) or (d), (e) and (f) :

- (a) From the statistical thermodynamical consideration, deduce an expression for the equilibrium constant of an ideal gas reaction equilibrium. 4
- (b) If the thermal wavelength of gaseous argon at 25°C is 16 pm, calculate its standard molar entropy at the same temperature. (Mass of Ar is 39.95 u.) 3
- (c) For a diatomic molecule rotating as a rigid rotor, obtain an expression for rotational partition function. 3
- (d) Consider the molecule of a gas which have two quantum states of energies 0 and ϵ and degeneracies g_1 and g_2 respectively. Calculate the contribution of these quantum states to the molar heat capacity of the gas at constant volume. 4
- (e) The rotational constant of gaseous HCl, determined from microwave spectroscopy is 10.59 cm^{-1} . Calculate the rotational partition function of HCl at 500 K. 3

- (f) Consider a system of six distinguishable particles. One of the macrostate of the system has the following distribution of particles :

Energy level	0	1	2	3	4
Number of particles	1	0	2	1	2

Find the thermodynamic probability.

3
