STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI-86
(For candidates admitted during the academic year 2019–20 & thereafter)

B.Sc. DEGREE EXAMINATION, NOVEMBER 2024
BRANCH IV- CHEMISTRY
FIFTH SEMESTER

COURSE : MAJOR CORE
PAPER : PHYSICAL CHEMISTRY-II
SUBJECT CODE : 19CH/MC/PC54
TIME : 3 HOURS **MAX.MARKS :100**

SECTION – A **(30x1=30)**

Answer all the questions.

I. Choose the Correct Answer:

1. Which of the following properties is not a function of state?

   a) concentration b) internal energy c) enthalpy d) entropy

2. The amount of heat required to raise the temperature of one mole of the substance by 1 K is called _____

   a) heat capacity b) molar heat capacity

   c) molar heat d) molar capacity

3. The heat of combustion of solid benzoic acid at constant volume is-312.30 k J at 27°C. The heat of combustion at constant pressure is_____

   a) 100-R b) 200-2R c) -312.3-150R d) 312.3+150R

4. Eutectic temperature of Pb-Ag system is _____

   a) 323°C b) 303°C c)343°C d) 363°C

5. Vapour pressure of pure A is70mm of Hg at 25°C .It forms an ideal solution with B in which mole fraction of A is 0.8 .If the vapour pressure of the solution is 84 mm of Hg at 25°C, the vapour pressure of pure B at 25°C is _____

   a) 56mm b) 70mm c)140mm d) 28mm

6. Work function (A) is defined as_____

   a) A=E-TS b) A=E+TS c) A=TS-E d) A=E/TS

7. The relative molar mass of an ionic compound is 58.5. If the experimentally observed molar mass is 30. The van't Hoff factor is_____

   a) 2.68 b)2.95 c) 1.95 d) 1.85

8. For the study of distribution law the two solvents should be_____

   a) miscible b) non-miscible c) volatile d) reacting with each other

9. The entropy change involved in thermodynamic expansion of 2 moles of a gas from a volume of 5 litres to a volume of 50 litres at 303 K is_____

   a) 38.92 JK^{-1} b)38.29 JK^{-1} c) 39.48 JK^{-1} d) 30.48 JK^{-1}

10. The number of components present in KCl-NaBr-H_2O system is _____

    a) 3 b) 2 c) 4 d) 1

II. Fill in the blanks:

11. Reduced phase rule is _____
12. C_p and C_v are related as _____
13. Standard free energy change and equilibrium constant are related as _____
14. Using partial pressures, the equilibrium constant expression for formation of HI_____
15. Example for path function is _____
16. By convention , the standard heat of formation of all elements is assumed to be _____
17. Mathematical representation of second law of thermodynamics is _____
18. Example for a system with formation of compounds having congruent melting point is _____
19. Phenol + water system has _____critical solution temperature.
20. The expression for molality is _____

III. State whether True or False:

21. The efficiency of a Carnot engine that works between the temperatures 27°C and 127°C is 25%
22. The entropy of a pure crystal is zero at absolute zero.
23. Isotonic solutions have different osmotic pressures.
24. Desilverisation of argentiferous tin is done by Pattinson's process.
25. Lever rule is used to determine mole fraction or weight fraction of each phase of a binary equilibrium phase diagram.

IV. Answer in a line or two:

26. State Le Chatelier's principle.
27. What is inversion temperature?
28. Give any one statement of the third law.
29. Define activity.
30. What is efflorescence? Give an example.

SECTION – B (5X6=30)

Answer any FIVE questions:

31. Derive the expression for w, q and ΔE in an isothermal reversible expansion of a gas that obeys the equation of state PV = nRT

32. a) What is Trouton's rule? Calculate the entropy increase in evaporation of 1 mole of water at 100°C. Heat of vaporisation =540 cal/g

    b) Which of the following solvents – acetone, water , acetonitrile, ethanol, dimethylformamide – are likely to exhibit deviations from the Trouton's rule? Justify the answer. (3+3)

33. Illustrate steam distillation process for the purification of aniline.

34. Derive the thermodynamic phase rule.

35. a) 0.534g of solute is dissolved in 15g of water, then freezing point temperature changes from 0°C to -1.57°C. Molal depression constant of water , K_f =1.85 K kg mol^{-1}. Calculate i) molal concentration ii) molecular weight of the solute.

    b) Explain the significance of Kirchoff's equation. (4+2)

36. a) Draw schematically the Vapour pressure Vs Composition curve for a binary system assuming i) Raoult's law (with deviations) ii) Henry's law

    b) Derive van't Hoff reaction isochore. (3+3)

37. N_2H_4 is a potentially valuable rocket fuel and it is desirable to find a good method for its synthesis. Would there be any justification in finding a suitable catalyst which will make the following reaction proceed at 25°C

$$NH_4NO_{3\,(s)} + 3H_{2(g)} \rightarrow 3H_2O_{(g)} + N_2H_{4(g)}$$

Data given are:

Substance	$NH_4NO_{3\,(s)}$	$H_{2(g)}$	$H_2O_{(g)}$	$N_2H_{4(g)}$
ΔH°_f / kJmol^{-1}	-365	0	-242	50
S^o /JK^{-1}mol^{-1}	150	130	189	120

SECTION - C

Answer any TWO questions: **(2x20=40)**

38. a) What is Joule –Thomson coefficient ? Show that Joule-Thomson coefficient is zero for an ideal gas while it has a positive value in the case of a real gas.

b) Derive the following two Maxwell's relations:

$$\left(\frac{\delta T}{\delta V}\right)_S = -\left(\frac{\delta P}{\delta S}\right)_V$$

$$\left(\frac{\delta P}{\delta T}\right)_V = \left(\frac{\delta S}{\delta V}\right)_T$$

(10+10)

39. a) State Carnot's theorem . Describe in detail Carnot reversible cycle.

b) Explain the phase diagram of sulphur.

c) The enthalpy change(ΔH) for the reaction

$$N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$$

is -92.38 k J at 298 K . What is ΔE at 298 K? (10+6+4)

40. a) Derive the integrated form of Clapeyron- Clausius equation , apply it to liquid-vapour equilibria.

b) Discuss the applications of Nernst Distribution law.

c) Describe the phase diagram of sodium sulphate –water system. (8+6+6)