

Question Bank – Unit II
Thermodynamics and Phase Rule (2011-2012)

Part – A

1. Differentiate between –
a) Reversible and irreversible process b) Adiabatic and isothermal process.
2. How would you predict the spontaneity of a chemical reaction, given changes in enthalpy and entropy?
3. State the first law of thermodynamics for a closed system undergoing cyclic process.
4. Calculate the change in entropy, in joules, when 5 moles of an ideal gas expands from a value of 4 lits. to 40 lits. at 27°C. ($R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$)
5. In thermodynamics language what is the meaning of the following terms?
a) Open and closed systems b) Intensive and extensive properties.
6. What is spontaneous process? Give examples.
7. What is state and path functions? Give examples.
8. Obtain an expression for work done during reversible isothermal expansion.
9. Explain the terms open, closed and isolated system. Give examples.
10. Calculate the efficiency of a Carnot engine operating reversibly between 40°C to 20°C.
11. What is a thermodynamic process? Give a brief account of any two such processes.
12. 'q' is a path function. Under what conditions it will be a state function?
13. Define & explain homogenous and heterogeneous systems with examples.
14. When is a system said to have attained equilibrium. Explain.
15. The change in entropy of a system, in a process is positive. Could the process be a spontaneous one? Explain.
16. Explain briefly the significance of entropy
17. Calculate the work done when 2 mole of an ideal gas expands isothermally and reversibly from 10 atm. To 2 atm. Pressure at 27 °C
18. What happens to Internal Energy of a system ,if work is done (i) by the system,(ii) on the system.
19. Calculate the change in Entropy accompanying the isothermal expansion of 5 moles of an ideal gas to 6 times to its initial volume at 330 k.
20. Differentiate between Gibb's and Helmholtz's free energy.

Part – B

21. State the first law of thermodynamics. Deduce its mathematical form, give the first law equation for different processes. What are its limitations?
22. 10 moles of an ideal gas expands isothermally and reversibly from a volume of 5 lit. to 50 lit. at 25°C. What is the maximum work done? Express the result in Joules.
23. Obtain an expression relating T and V in an adiabatic reversible expansion of a gas obeying the equation of state $PV = nRT$.
24. One mole of an ideal gas at 0°C is compressed adiabatically reversibly to a pressure of 20 times its initial pressure. Calculate the final temperature. ($\gamma = 1.4$)
25. Derive Gibbs – Helmholtz equation. What are its applications?
26. A Heat engine operating between temperatures 500 K and 300 K rejects 6 Kcal of heat to the sink. How much heat it could have absorbed from the high temperature reservoir?
27. Derive the expression $PV^\gamma = \text{constant}$ for an ideal gas undergoing adiabatic reversible expansion.
28. Two moles of an ideal gas expands isothermally and reversibly to ten times its volume at 25°C. Calculate the change in entropy during the process. ($R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$)
29. One mole of H_2 at 300 K occupies a volume of 10 lits in a cylinder fitted with a piston. It is expanded isothermally to 20 lits. Assuming ideal behavior for the gas, calculate W, Q, ΔE , ΔH , if the expansion is carried out (i) reversibly, (ii) against a constant external pressure of 0.1 atm., (iii) against zero external pressure (vacuum).
30. Discuss briefly the conditions for equilibrium and spontaneity of a reaction in terms of change of Free energy, Enthalpy and Entropy.
31. In a cyclic process of a system, the heat transfers involved are +14.7 KJ, -25.2 KJ, -3.56 KJ, +31.5 KJ. What is the network involved in the process.
32. Discuss Entropy change in reversible and irreversible process. Show that the ΔS_{total} for an irreversible process $>$ ΔS_{total} for reversible process.
33. Write a note on enthalpy, internal energy and entropy.
34. Give various statements of the second law of thermodynamics.

35. The enthalpy change in a reaction is -22.6 kcal. The entropy change for the same reaction is -45.2 cal K^{-1} . Calculate the free energy change at $27^{\circ}C$ and $327^{\circ}C$. At what temperature the reaction is spontaneous? What is the temperature of equilibrium?
36. One mole of ideal gas is subjected to thermodynamic process in which 512 J of heat flows into the system and 387 J of work is done by the system. Calculate the change in temperature. ($C_v = 12.47$)
37. Calculate the entropy change in melting of 5 gm of ice at $0^{\circ}C$. Given that molar heat of fusion of ice is 1440 Cal.
38. Compare the reversible work done in isothermal and adiabatic process, which process gives maximum work, why?
39. Explain why the efficiency of Carnot Engine working between two temperatures is never unity.
40. Calculate the amount of work obtain in isothermal reversible expansion of 20 gm of Ar. At $27^{\circ}C$ from a pressure of 4 atm to 1 atm.
- 41. Describe Carnot's cycle for establishing the maximum convertibility of heat into work?**
- 42. 1 mole of an ideal mono atomic gas at 298 K and pressure of 5 atm is expanded to a final pressure of 1 atm. Calculate given $\gamma=1.66$ and $C_v= 3/2R$**
- (i) Final temperature of the gas. (ii) Heat absorbed by the gas.**
(iii) Work done by the gas. (iv) Change in internal energy.
(v) Change in enthalpy.
- For each process taking place under**
- a) Isothermal reversible process. b) Isothermal irreversible process**
c) Adiabatic reversible process. d) Adiabatic irreversible process.
43. A gas expands against a const external pressure of 1 atm from a volume of 20 lit to 30 lit. Calculate the work done in joules.
44. Calculate q , w , ΔE , ΔH for a reversible isothermal expansion of 2 moles of an ideal gas at $30^{\circ}C$ from 1 dm³ to 2 dm³.
45. Gibbs free energy of a reaction at $27^{\circ}C$ and $37^{\circ}C$ are -20 k.cals and -30 k.cals. Calculate ΔH , ΔS in this temperature range.
46. The temperature of 1 mole of an ideal gas increases from $8^{\circ}C$ to $55^{\circ}C$ as the gas is compressed adiabatically. Calculate the work done and ΔH for this process assuming that $C_v=5/2R$.
- 47. 2 moles of an ideal gas expands isothermally from a volume of 10 to 20 liters at $27^{\circ}C$. Calculate change in entropy, change in free energy, and change in enthalpy, work and q reversible for the process.**
- Phase rule**
48. What is phase of system? How many phases are present in each of the following systems?
 a) Mixture of N_2 , H_2 and O_2 .
 b) A piece of molten ice.
 c) mixture of monoclinic and rhombic sulphur.
49. Explain the term component. How many components are present in the following systems?
 a) water in equilibrium with water vapour
 b) aqueous NaCl solution
50. State phase rule calculate the degree of freedom for the following systems?
 a) solid ice in equilibrium liquid water
 b) mixture of N_2 and O_2
51. Explain with a neat labeled phase diagram for one component - water system, what is triple point?
- 52. a) Draw a neat sketch of phase diagram of Pb-Ag system and label various regions of the diagram?**
b) Apply phase rule equation to each region and calculate the number of degrees of freedom?
53. What is eutectic mixture? Give its commercial importance.
- 54. State phase rule and explain the terms involved with suitable examples?**
55. Discuss Pattinson's process for desilverization of Argentiferrous Lead.