

Thermodynamics Questions:

1.	Heat capacity at constant pressure is the change in (a) internal energy with temperature at constant volume (b) internal energy with temperature at constant pressure (c) enthalpy with temperature at constant volume (d) enthalpy with temperature at constant pressure
2.	The chemical potential (μ_i) of the i^{th} component is defined as— (A) $\mu_i = \left(\frac{\partial U}{\partial n_i}\right)_{T,P}$ (B) $\mu_i = \left(\frac{\partial H}{\partial n_i}\right)_{T,P}$ (C) $\mu_i = \left(\frac{\partial A}{\partial n_i}\right)_{T,P}$ (D) $\mu_i = \left(\frac{\partial G}{\partial n_i}\right)_{T,P}$
3.	The heat capacity of 10 mol of an ideal gas at a certain temperature is 300 JK^{-1} at constant pressure. The heat capacity of the same gas at the same temperature and at constant volume would be— (A) 383 JK^{-1} (B) 217 JK^{-1} (C) 134 JK^{-1} (D) 466 JK^{-1}
4.	A thermodynamic equation that relates the chemical potential to the composition of a mixture is known as— (A) Gibbs-Helmholtz equation (B) Gibbs-Duhem equation (C) Joule-Thomson equation (D) Debye-Hückel equation
5.	Heat capacity at constant volume is the change in (a) internal energy with temperature at constant volume (b) internal energy with temperature at constant pressure (c) enthalpy with temperature at constant volume (d) enthalpy with temperature at constant pressure

6.	<p>Without performing a calculation, estimate whether the standard entropies of the following reactions are positive or negative:</p> <p>(a) $\text{Ala-Ser-Thr-Lys-Gly-Arg-Ser} \xrightarrow{\text{trypsin}} \text{Ala-Ser-Thr-Lys} + \text{Gly-Arg}$</p> <p>(b) $\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightarrow 2 \text{NH}_3(\text{g})$</p> <p>(c) $\text{ATP}^{4-}(\text{aq}) + 2 \text{H}_2\text{O}(\text{l}) \rightarrow \text{ADP}^{3-}(\text{aq}) + \text{HPO}_4^{2-}(\text{aq}) + \text{H}_3\text{O}^+(\text{aq})$</p>
7.	<p>The Gibb's Helmholtz equation is applicable to</p> <p>(a) all processes, chemical or physical</p> <p>(b) all process, chemical or physical but in a closed system</p> <p>(c) all chemical processes in a closed system</p> <p>(d) all physical processes in a closed system</p>
8.	<p>When 3.00 mol of a certain gas is heated reversibly from 275 K and 1 bar to 375 K and 1 bar, ΔS is 20.0 J/K. If 3.00 mol of this gas is heated irreversibly from 275 K and 1 bar to 375 K and 1 bar, will ΔS be less than, the same as, or greater than 20.0 J/K?</p>
9.	<p>Which of the following sets of properties constitute intensive properties?</p> <p>(a) temperature, pressure and volume (b) mass, density and volume</p> <p>(c) density, pressure and temperature (d) internal energy, density and pressure</p>
10.	<p>Calculate the value of ΔE and ΔH on heating 64.0 g of oxygen from 0°C to 100°C. C_v and C_p on an average are 5.0 and 7.0 cal mol⁻¹ degree⁻¹.</p>
11.	<p>For the reaction $\text{H}_2\text{F}_2(\text{g}) \longrightarrow \text{H}_2(\text{g}) + \text{F}_2(\text{g})$</p> <p>$\Delta E = -14.2$ kcal/mole at 25°C</p> <p>Calculate ΔH for the reaction.</p>
12.	<p>Give the conditions of applicability of each of these equations: (a) $dU = dq + dw$; (b) $dU = T dS - P dV$</p>

13.	Which is not true about thermodynamics? (a) it ignores the internal structure of atoms and molecules (b) it involves the matter in bulk (c) it is concerned only with the initial and final states of the system (d) it is not applicable to macroscopic systems
14.	At 25°C for the combustion of 1 mole of liquid benzene the heat of reaction at constant pressure is given by $\text{C}_6\text{H}_6(l) + 7\frac{1}{2}\text{O}_2(g) \longrightarrow 6\text{CO}_2(g) + 3\text{H}_2\text{O}(l)$ $\Delta H = -780980 \text{ cal}$ What would be the heat of reaction at constant volume ?
15.	Under what conditions $\Delta E = \Delta H$ for a chemical reaction?
16.	Which has greater entropy magnetised iron rod and non magnetised iron rod.

1. Prove that, $\Delta G = \Delta H + T \left[\frac{\delta(\Delta G)}{\delta T} \right]_P$, where G, H, T and P are usual thermodynamic parameter.
2. Prove that $\left[\frac{\delta(\Delta G/T)}{\delta T} \right]_P = -\frac{\Delta H}{T^2}$
3. Explain why the entropy of a gas increases (a) with volume, (b) with temperature.
4. For a reaction, the value of ΔH is 2 times that of ΔS . Predict the spontaneity of the reaction at 298 K. $\Delta S = 0.05 \text{ HJ/mol}$.
5. Prove that for a chemical reaction the heat change occurring at constant volume is equal to the change in internal energy of the reaction.
6. 10 moles of an ideal gas are expanded from 10 lit to 50 lit at 298 K. Find the Gibb's free energy for the process.
7. Two moles of an ideal gas are allowed to expand reversibly and isothermally at 300 K from a pressure of 1 atm to a pressure of 0.1 atm. What is the change in Gibbs free energy ?
8. Free energy change for a given reaction is -90 KJ at 25 °C and -85 KJ at 35 °C. Calculate the change in enthalpy for the reaction at 30 °C.
9. Calculate entropy change if 2 moles of water at 373 K are evaporated to vapours at 373 K. Give its units also. (Given molar heat of vaporisation of water is 9650 cal)
10. Equilibrium constant for a reaction is 1.6×10^{-4} for 400 °C. What will be the equilibrium constant at 500 °C? Heat of reaction in this temperature range is -25.0 Kcal.
11. Derive the Clausius-Clapeyron equation for the transformation of phases.
12. The decrease in free energy is nothing but the maximum work obtainable from system other than that due to change in volume. Explain
13. The equilibrium constant K_p for a reaction $A + B \rightleftharpoons C + D$ is 10^{-12} at 327°C and 10^{-7} at 427 °C. Calculate the enthalpy of the reaction.

14. 5 moles of an ideal gas (diatomic) are expanded from 12 lit to 48 lit at 298 K. Find the change of Gibb's free energy and change of entropy for the process.
15. Prove that for reversible isothermal process $dG = nRT \ln \frac{P_2}{P_1} = nRT \ln \frac{V_1}{V_2}$, where G, n, T and P are usual thermodynamic parameter.
16. Ethanol boils at 78.4 °C and standard enthalpy of vaporisation of ethanol is 42 kJ mol⁻¹. Calculate the entropy of vaporisation of ethanol.
17. Prove that the decrease in work function at constant temperature is equal to maximum work done by the system in reversible process.
18. For the following reaction $N_2(g) + 3H_2(g) = 2NH_3(g)$ The free energy changes at 25 °C and 35 °C are – 33.089 and – 28.018 kJ respectively. Calculate the heat of reaction.
19. Calculate the increase in entropy when 2 moles of ice at 0 °C is melted to water completely. Molar heat of fusion of ice = 1436 cal.
20. Prove that the entropy change of system and surrounding for reversible process is lesser than that the entropy change of system and surrounding for irreversible process.
21. Prove that for a chemical reaction the heat change occurring at constant pressure is equal to the change in enthalpy of the reaction.
22. At 373.6 K and 372.6 K the vapour pressure of H₂O (l) are 1.018 and 0.982 atm respectively. What is the heat of vaporization of water? (R = 1.987 cal)
23. Four moles of an ideal gas expand isothermally from 1 litre to 10 litres at 300 K. Calculate the change in free energy of the gas. (R = 8.314 JK⁻¹ mol⁻¹)
24. At what temperature will water boil under a pressure of 787 mm? The latent heat of vaporisation is 536 cal per gram.
25. Derive the integral Clausius-Clapeyron equation.

6. Partial molal properties are studied for
- (a) Extensive properties, closed system
 - (b) Intensive properties, open system
 - (c) Extensive properties, open system

Which one of the following is an expression of the van't Hoff equation?

A. $\ln K = -\frac{\Delta H^\theta}{RT} + \frac{\Delta G^\theta}{R}$ B. $\Delta H(T_2) = \Delta H(T_1) + \Delta C_p (T_2 - T_1)$ C. $\Delta G^\theta = \Delta H^\theta - T \Delta S^\theta$ D. $\Delta U =$

q + w

The equilibrium constant for a gaseous reaction gets doubled when the temperature is raised from 27 °C to 37 °C. Calculate the heat of reaction.
(Ans 53598.59 J)

For a reaction, $2A_3 \rightleftharpoons 3A_2$, the equilibrium constant and ΔG° values at a certain temperature are 1×10^{30} and $-172.4 \text{ kJ mol}^{-1}$ respectively. The equilibrium temperature in $^\circ\text{C}$ is about
 A. 300 K, B. 273 K C. 27 D. 298

cc

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2	For a reaction, $2A_3 \rightleftharpoons 3A_2$, the equilibrium constant and ΔG° values at a certain temperature are 1×10^{30} and $-172.4 \text{ kJ mol}^{-1}$ respectively. The equilibrium temperature in $^\circ\text{C}$ is about -
	A. 300 K B. 273 K C. 27 K D. 298 K
3	A thermodynamic equation that relates the chemical potential to the composition of a mixture is known as-
	A. Gibbs-Helmholtz equation B. Gibbs-Duhem equation C. Joule-Thomson equation D. Debye-Huckel equation
4	The boiling point of a liquid ($\Delta H_{\text{vap}} = 21 \text{ cal K}^{-1} \text{ mole}^{-1}$) is 27°C . Its molar enthalpy of vaporization is roughly-
	A. $567 \text{ cal mole}^{-1}$ B. $6300 \text{ cal mole}^{-1}$ C. $3150 \text{ cal mole}^{-1}$ D. $1575 \text{ cal mole}^{-1}$

5	The equilibrium constant for a gaseous reaction gets doubled when the temperature is raised from 27 °C to 37 °C. The heat of reaction is-
	A. 53598.59 J B. 44356.61 J C. 23476.34 J D. 34289.43 J
6	For a reaction, $2A_3 \rightleftharpoons 3A_2$, the equilibrium constant and ΔG° values at a certain temperature are 1×10^{30} and $-172.4 \text{ kJ mol}^{-1}$ respectively. The equilibrium temperature in °C is about -
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7	The entropy of vaporisation of a liquid is $58 \text{ JK}^{-1} \text{ mol}^{-1}$. If 100 g of its vapour condenses at its boiling point of 123 °C, the value of entropy change for the process is (molar mass of the liquid = 58 mol^{-1})-
	A. -0.2525 JK^{-1} B. 100 JK^{-1} C. 123 JK^{-1} D. 0.2525 JK^{-1}
8	The equation $\frac{dP}{dT} = \frac{\Delta H}{T(V_2 - V_1)}$ is called
	A. Gibb's Helmholtz equation B. Kirchoff's equation C. Clapeyron equation D. Clausius-Clapeyron equation
9	The Clausius- Clapeyron equation helps to calculate-
	A. latent heat of vaporization B. boiling point or freezing point C. Vapour pressure at one temperature, if at another temperature is given D. all of the above
10	The equation $\frac{\Delta H}{RT^2} = \frac{d(\ln K_p)}{dT}$ is known as
	A. van't Hoff equation B. van't Hoff isochore C. Gibbs equation D. Gibbs Duhem equation
11	Which of the following may be used to define chemical potential- G
	i. $\left(\frac{\partial G}{\partial n_i}\right)_{T,P,n_j;i \neq J}$ ii. $\left(\frac{\partial A}{\partial n_i}\right)_{T,V,n_j;i \neq J}$ iii. $\left(\frac{\partial H}{\partial n_i}\right)_{S,P,n_j;i \neq J}$ iv. $\left(\frac{\partial E}{\partial n_i}\right)_{S,V,n_j;i \neq J}$
	A. Option (i) only B. (ii) only C. (iii) only D. (i), (ii), (iii) and (iv) only
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SECOND LAW OF THERMODYNAMICS 353

34. The equation $\frac{dP}{dT} = \frac{\Delta H}{T(V_2 - V_1)}$ is called

(a) Gibb's Helmholtz equation (b) Kirchoff's equation
 (c) Clapeyron equation (d) Clausius Clapeyron equation

Answer: (c)

35. The Clausius Clapeyron equation helps to calculate

(a) latent heat of vaporization
 (b) boiling point or freezing point
 (c) vapour pressure at one temperature, if at another temperature is given
 (d) all of the above

Answer: (d)

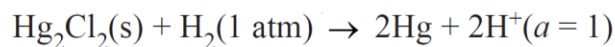
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A. van't Hoff equation B. van't Hoff isochore
 C. Gibbs equation D. Gibbs Duhem equation

From the cell reaction in a cell



the E° of the cell at 25°C is 0.2676 volt and $\left(\frac{\partial E^\circ}{\partial T}\right)_P = -31.9 \times 10^{-4} \text{ volt deg}^{-1}$. Calculate ΔH° and ΔS° .

Answer: 33.299 kJ; -6.1567 J K^{-1}