

	INDIAN SCHOOL AL WADI AL KABIR		
CLASS: XI	DEPARTMENT: SCIENCE 2024-2025 SUBJECT: CHEMISTRY	DATE: 25-01-2025	
WORKSHEET NO: 08 WITH ANSWERS	TOPIC: THERMODYNAMICS		NOTE: A4 <u>FILE</u> <u>FORMAT</u>
NAME OF THE STUDENT:	CLASS & SEC:	ROLL NO.	

Objective Type Questions

1. Which one of the following is not state function?

- (a) Internal energy
- (b) Work
- (c) Entropy
- (d) Free energy

2. I: H₂O(s) II: H₂O (l) III: H₂O(g)

For the above compounds the order of internal energy content is

- (a) I>II>III
- (b) I=II=III
- (c) I<II>III
- (d) III>II>I

3. In an open system...

- (a) energy is exchanged with surroundings
- (b) matter is exchanged with surroundings
- (c) Both
- (d) neither energy nor matter are exchanged

4. The temperature in K at which $\Delta G = 0$, for a given reaction with $\Delta H = -20.5 \text{ kJ mol}^{-1}$ and $\Delta S = -50.0 \text{ JK mol}^{-1}$ is

- (a) -410 K
- (b) 2.44 K
- (c) -2.44K
- (d) 410 K

5. When heat is absorbed, its sign convention is...

- (a) positive
- (b) negative
- (c) positive / negative

(d) none of these

6. Surface area is an example of

- (a) Extensive
- (b) Intensive
- (c) Both of these
- (d) None of these property

7. The enthalpy of forward reaction is equal to...

- (a) enthalpy of reverse reaction
- (b) negative of enthalpy of reverse reaction
- (c) Both
- (d) None of these

8. When work done by a system was 10 J, the increase in the internal energy of the system was 30 J. The heat 'q' supplied to the system was

- (a) -40 J
- (b) +20 J
- (c) 40 J
- (d) -20 J

Questions 9- 10 are Assertion Reason type questions

- a. If both *Assertion* and *Reason* are correct and *Reason* is the correct explanation of *Assertion*.
- b. If both *Assertion* and *Reason* are correct but *Reason* is not the correct explanation of *Assertion*.
- c. If *Assertion* is correct and *Reason* is wrong.
- d. If *Assertion* is wrong and *Reason* is correct.

9. Assertion (A): Internal energy is a state function and extensive property.

Reason (R): Internal energy is the total sum of all the energies in the system.

10. Assertion (A): Standard enthalpy of graphite is lower than that of diamond.

Reason (R): Standard enthalpy of elements is taken to be zero arbitrarily.

2 Marks questions

11. In a process, 701 J of heat is absorbed by a system and 394 J of work is done by the system. What is the change in internal energy for the process?

12. The enthalpy of atomisation for the reaction $\text{CH}_4(\text{g}) \rightarrow \text{C}(\text{g}) + 4\text{H}(\text{g})$ is 1665 kJ mol^{-1} . What is the bond energy of the C–H bond?

13. Enthalpies of formation of $\text{CO}(\text{g})$, $\text{CO}_2(\text{g})$, $\text{N}_2\text{O}(\text{g})$ and $\text{N}_2\text{O}_4(\text{g})$ are -110 kJ mol^{-1} , -393 kJ mol^{-1} , 81 kJ mol^{-1} and 9.7 kJ mol^{-1} respectively. Find the value of $\Delta_r H$ for the reaction:

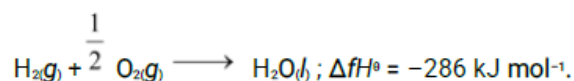
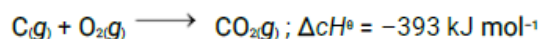
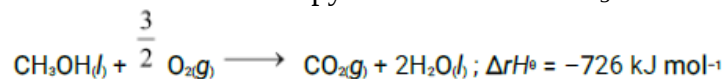
$$\text{N}_2\text{O}_4(\text{g}) + 3\text{CO}(\text{g}) \longrightarrow \text{N}_2\text{O}(\text{g}) + 3\text{CO}_2(\text{g})$$

14. Given that $\Delta H = 0$ for mixing of two gases. Explain whether the diffusion of these gases into each other in a closed container is a spontaneous process or not?

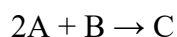
15. Given $\text{N}_{2(\text{g})} + 3\text{H}_{2(\text{g})} \longrightarrow 2\text{NH}_{3(\text{g})}$; $\Delta_r H^\theta = -92.4 \text{ kJ mol}^{-1}$

What is the standard enthalpy of formation of NH_3 gas?

16. Calculate the standard enthalpy of formation of CH_3OH from the following data:



17. For the reaction at 298 K,



$$\Delta H = 400 \text{ kJ mol}^{-1} \text{ and } \Delta S = 0.2 \text{ kJ K}^{-1} \text{ mol}^{-1}$$

At what temperature will the reaction become spontaneous considering ΔH and ΔS to be constant over the temperature range?

3 Marks Questions

18. The values of heat of combustion of graphite and H_2 are - 395 and - 269 KJ respectively. If heat of formation of glucose is -1169 KJ. Calculate the heat of combustion of glucose .

19. a. Which among the following are extensive properties?

Mass, Internal energy, Pressure, Enthalpy, Entropy and Free energy

b. State Hess's law of constant heat summation.

c. State Third law of Thermodynamics

20. What are spontaneous and non-spontaneous process? Under what conditions will the reactions occur if

(i) both ΔH and ΔS are positive

(ii) both ΔH and ΔS are negative

21. How will you distinguish between the two?

(a) Open and closed system

(b) Extensive and intensive property

22. Predict the enthalpy change, free energy change and entropy change when ammonium chloride is dissolved in water and the solution becomes colder.

Case study-based Questions (4 marks)

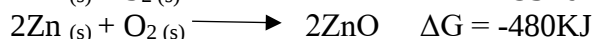
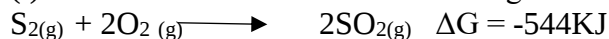
23. The first law of Thermodynamics merely indicates that in any process there is an exact equivalence between the various form of energies involved but does not provide any information about the spontaneity of the process. The spontaneity of the process is predicted on the basis of Gibb's free energy change which is related to enthalpy and entropy change as

$$\Delta G = \Delta H - T\Delta S$$

For a process to be spontaneous, at constant temperature and pressure, there must be decrease in the free energy of the system in the direction of the process $\Delta G < 0$. $\Delta G > 0$ implies the non-spontaneity and $\Delta G = 0$ corresponds to equilibrium condition. The magnitude of ΔH does not change much with change in

temperature but the entropy factor $T\Delta S$ changes appreciably indicating that spontaneity depends very much on temperature.

(i) The ΔG values for the following reaction at 800°C are



The ΔG for the reaction:



(ii) For the reaction $\text{CaCO}_{3(\text{s})} \longrightarrow \text{CO}_{2(\text{g})} + \text{CaO}_{(\text{s})}$ the signs of ΔH and ΔS respectively are

(a) +,-

(b) +,+

(c) -,-

(d) -,+

(iii) Which of the following condition is not favourable for a spontaneous reaction.

(a) $\Delta H = +\text{ve}$, $T\Delta S = +\text{ve}$ and $T\Delta S > \Delta H$

(b) $\Delta H = +\text{ve}$, $T\Delta S = +\text{ve}$ and $T\Delta S < \Delta H$

(c) $\Delta H = -\text{ve}$, $T\Delta S = +\text{ve}$ and $T\Delta S > \Delta H$

(d) $\Delta H = -\text{ve}$, $T\Delta S = -\text{ve}$ and $T\Delta S < \Delta H$

5 Marks Questions

24.(i) Predict in which of the following, entropy increases/decreases:

a) Sublimation of dry ice into CO_2 gas.

b) Temperature of a crystalline solid is raised from 10 K to 115 K.

c) $4\text{Fe}_{(\text{s})} + 3\text{O}_{2(\text{g})} \rightarrow 2\text{Fe}_2\text{O}_{3(\text{s})}$

(ii) The enthalpy changes for a reaction $\text{N}_{2(\text{g})} + 3\text{H}_{2(\text{g})} \rightarrow 2\text{NH}_{3(\text{g})}$ is -4.0 kJ mol^{-1} at 300K. Calculate the value of ΔU . ($R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$)

25.(a) Complete the following table to express the relationship between spontaneity and temperature.

		ΔH_{sys}	
		Positive	Negative
ΔS_{sys}	Positive	Spontaneous only at high temperature	
	Negative		

(b) Define the following terms. i) Enthalpy

ii) For a reaction at 298 K, $\Delta H = 600 \text{ kJ mol}^{-1}$ and $\Delta S = 1200 \text{ J K}^{-1} \text{ mol}^{-1}$. At what temperature will the reaction become spontaneous?

Answers

1.	b
2.	d
3.	c
4.	d

5.	a
6.	a
7.	b
8.	c
9.	b
10	b
11	$\Delta U = Q + W$ $\Delta U = 701\text{J} + (-394\text{J})$ $= 307\text{J}$
12	Bond enthalpy of C – H bond = $1665/4 = 416\text{kJ/mol}$
13	$\Delta H^\circ_f = \sum \Delta H^\circ_f(\text{products}) - \sum \Delta H^\circ_f(\text{reactants}) = [\Delta H^\circ_f(\text{N}_2\text{O}) + 3\Delta H^\circ_f(\text{CO}_2)] - [\Delta H^\circ_f(\text{N}_2\text{O}_4) - 3\Delta H^\circ_f(\text{CO})]$ $= [81 + 3(-393)] - [9.7 + 2(-110)] = -777.7\text{KJ}$
14	The diffusion of two gases into each other in a closed container is a spontaneous process because the increase in entropy (ΔS)
15	$\Delta_f H^\circ = -\frac{92.4}{2} \text{ kJ} \cdot \text{mol}^{-1}$ $= -46.2 \text{ kJ} \cdot \text{mol}^{-1}$
16	Standard enthalpy of formation = $\Delta_f H^\circ = -239 \text{ kJ mol}^{-1}$
17	$\Delta G = \Delta H - T\Delta S = 0$ $T = \Delta H / \Delta S = 4000.2 = 2000\text{K}.$ Above 2000 K the reaction is spontaneous
18	$\text{C}_6\text{H}_{12}\text{O}_6(\text{s}) + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O}$ $\Delta H = H_P - H_R$ $= -2815 \text{ kJ/mole}$
19	a. Mass, Internal energy, Enthalpy, Entropy, Free energy b. The law states that the change in enthalpy for a reaction is the same whether the reaction takes place in one or a series of steps. c. The third law of thermodynamics states that the entropy of a system approaches a constant value as the temperature approaches absolute zero.
20	A spontaneous process takes place on its own without the external influence. For spontaneous processes, the change in Gibbs free energy is negative. It is irreversible. A non-spontaneous process does not take place on its own. It needs continuous external influence. (i) If both ΔH and ΔS are positive ΔG can be – ve only if $T\Delta S > \Delta H$ in magnitude. (ii) When temperature becomes less
21	(a) An open system is one that can exchange both matter and energy with its surroundings. A closed system is one that can exchange energy but not matter with its surroundings. (b) An extensive property of a system depends on the system size or the amount of matter in the system. An intensive property is one that does not depend on the mass of the substance or system.
22	$\Delta H = +ve, \Delta S = +ve, \Delta G = -ve$
23	(i) $\Delta G_r = -544 + 293 - 480 = -731 \text{ KJ}$ (ii) (b) +, + (iii) (b) $\Delta H = +ve, T\Delta S = +ve$ and $T\Delta S < \Delta H$
24	(i) (a) Entropy increases (b) increases (c) decreases (ii) 988.4J/mol

		ΔH_{sys}	
		Positive	Negative
ΔS_{sys}	Positive	Spontaneous only at high temperature	Always spontaneous
	Negative	Never spontaneous	Spontaneous only at low temperature

(a)

(b) (i) It is defined as the total heat energy of a system.

(ii) $\Delta G = \Delta H - T\Delta S$ $\Delta G = 0$, $\Delta H = T\Delta S$ $T = 500 \text{ K}$ Above 500 K, reaction is spontaneous.

Prepared by
Ms Jenesha Joseph

Checked by
HoD Science