

What is Gibbs Free Energy?

Worksheet

$G = H - TS$. If $G < 0$, the reaction is spontaneous (favourable); if $G > 0$, it is non-spontaneous (requires energy).

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

Questions

1. $G = H - TS$. When is reaction spontaneous?

- A) $G > 0$
- B) $G = 0$
- C) $G < 0$
- D) never

2. What happens at $G = 0$?

- A) spontaneous
- B) non-spontaneous
- C) at equilibrium
- D) no reaction

3. Entropy-driven reaction: H and S signs?

- A) $H < 0, S < 0$
- B) $H > 0, S > 0$
- C) $H > 0, S < 0$
- D) $H < 0, S > 0$

4. How does T affect $G = H - TS$ if $S > 0$?

- A) no effect
- B) G increases
- C) G decreases
- D) undefined

5. $H = 50 \text{ kJ/mol}$, $S = 120 \text{ J/(molK)}$, $T = 298 \text{ K}$. Is the reaction spontaneous?

6. $H = 80 \text{ kJ/mol}$, $S = 100 \text{ J/(molK)}$, $T = 400 \text{ K}$. Is it spontaneous?

7. At what temperature does $G = 0$ for $H = 60 \text{ kJ}$, $S = 150 \text{ J/K}$?

8. Define: What is Gibbs free energy (G)?

9. Define: Gibbs free energy formula?

10. Define: If $G < 0$, is the reaction spontaneous?

Answer Key

1. C) $G < 0$ - $G < 0$ means the reaction is spontaneous (favourable).
2. C) at equilibrium - $G = 0$ is the transition point (equilibrium).
3. B) $H > 0$, $S > 0$ - Endothermic but entropy favours it: TS overcomes $+H$.
4. C) G decreases - Higher T larger TS term G decreases (more favourable).
5. $G = H - TS = 50\,298 - (120/1000) \times 50\,357.6 = 85.76$ kJ/mol $G < 0$ spontaneous (very favourable)
6. $G = 80\,400 - (100/1000) \times 80\,400 = 40$ kJ/mol $G > 0$ non-spontaneous (requires energy)
7. $0 = H - TS$ $T = H/S$ $T = 60\,000 / 150 = 400$ K (phase transition point)
8. Energy available to do non-expansion work; predicts reaction spontaneity.
9. $G = H - TS$. Combines enthalpy, temperature, and entropy.
10. Yes, $G < 0 =$ spontaneous (favourable, proceeds forward).

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