

What is Entropy?

Worksheet

Entropy quantifies the number of microstates (molecular arrangements) available to a system. Higher entropy means more disorder. In spontaneous reactions, the total entropy change (system + surroundings) is positive: $\Delta S_{\text{universe}} > 0$.

$$\Delta S_{\text{universe}} = \Delta S_{\text{system}} + \Delta S_{\text{surroundings}}$$

$\Delta S_{\text{universe}}$ = Total entropy change (J/(mol·K))

ΔS_{system} = Entropy change of system (J/(mol·K))

$\Delta S_{\text{surroundings}}$ = Entropy change of surroundings (J/(mol·K))

Questions

- Which has higher entropy: ice or water?
A) Ice
B) Water
C) Equal entropy
D) Depends on temperature
- In a spontaneous reaction, $\Delta S_{\text{universe}}$ is:
A) Negative
B) Positive (>0)
C) Zero
D) Undefined
- Dissolving salt in water. System entropy ΔS_{system} is:
A) Negative
B) Zero
C) Positive
D) Variable
- Which process is entropy-driven?
A) Crystallization of salt
B) Gas spreading throughout room
C) Ice forming
D) Organized sand on beach
- Ice melts to water at 0°C . Does entropy increase?
- Gas dissolving in water at room temperature. Is it spontaneous?
- Why does spilled perfume spread through a room spontaneously?
- Define: What is entropy?
- Define: Does ice have high or low entropy?
- Define: Does gas have high or low entropy?

Answer Key

1. B) Water — Water is liquid → more molecular motion and disorder → higher entropy than solid ice.
2. B) Positive (>0) — Second Law: spontaneous reactions always have $\Delta S_{\text{universe}} > 0$.
3. C) Positive — Solid salt dissociates → ions spread in solution → disorder increases → $\Delta S_{\text{system}} > 0$.
4. B) Gas spreading throughout room — Gas expanding to fill space has $\Delta S \gg 0$ — highly spontaneous and entropy-driven.
5. Solid ice has ordered crystal structure (low S) Liquid water has more random molecular motion (high S) $\Delta S_{\text{system}} > 0$ (entropy of system increases) Reaction is spontaneous → $\Delta S_{\text{universe}} > 0$
6. Gas molecules expand into solution (many more microstates) $\Delta S_{\text{system}} \gg 0$ (large positive entropy increase) Spontaneous process ($\Delta S_{\text{universe}} > 0$)
7. Perfume molecules escape (high ΔS_{system}) Molecules occupy larger volume → many more microstates Process has $\Delta S_{\text{universe}} > 0$ → spontaneous Reverse (perfume gathering) has $\Delta S < 0$ → never observed
8. A measure of disorder/randomness; related to the number of molecular microstates.
9. Low entropy — crystal lattice is highly ordered.
10. High entropy — molecules move freely, many possible arrangements.

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