

Effects of Temperature on Entropy

<https://gemini.google.com/app/6c213ed9d97d1dab>

Response: To determine which graph correctly shows how entropy varies with temperature as a substance changes state from **solid** → **liquid** → **gas** upon heating:

1. **Heating single phases (Solid, Liquid, Gas):** As temperature increases within a single phase, thermal energy increases molecular motion, which increases randomness/disorder. Therefore, entropy increases continuously with temperature (positive slope) in each phase.
2. **Phase Changes (Melting and Vaporization):** Phase transitions occur at constant temperatures (melting point and boiling point).
 - During **melting** (solid → liquid), there is a jump in entropy at constant temperature.
 - During **vaporization** (liquid → gas), there is a much larger jump in entropy at constant temperature because gas molecules have far higher disorder than liquids.
 - Graphically, phase changes are represented by vertical step increases at fixed temperatures.

Comparing the graphs:

- Graphs (1) and (2) show entropy decreasing with temperature, which is incorrect.
- Graphs (3), (4), and (5) show overall increasing entropy.
- Comparing (3), (4), and (5): The entropy change for vaporization (ΔS_{vap}) is significantly greater than the entropy change for melting (ΔS_{fus}) because a gas is substantially more disordered than a liquid. Thus, the second vertical jump (boiling) must be noticeably larger than the first vertical jump (melting).

In **Graph (3)**, the second vertical jump is larger than the first vertical jump.

The correct graph is **(3)**.
