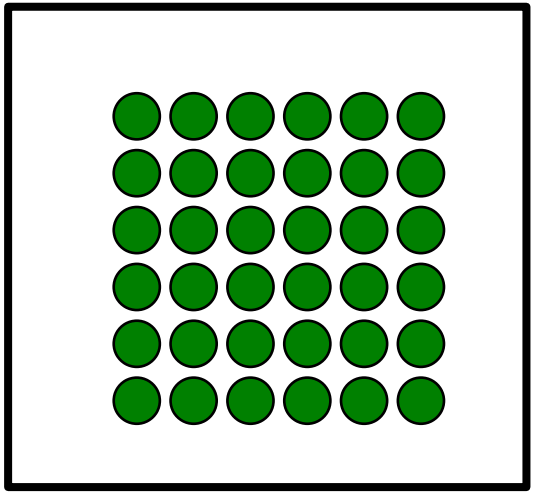
Essential Question

How do we calculate an entropy change?

Absolute Entropy (S°)

- *S*° = entropy of 1 mol of a substance at standard conditions
- A perfect crystal at 0 K has *S* = 0

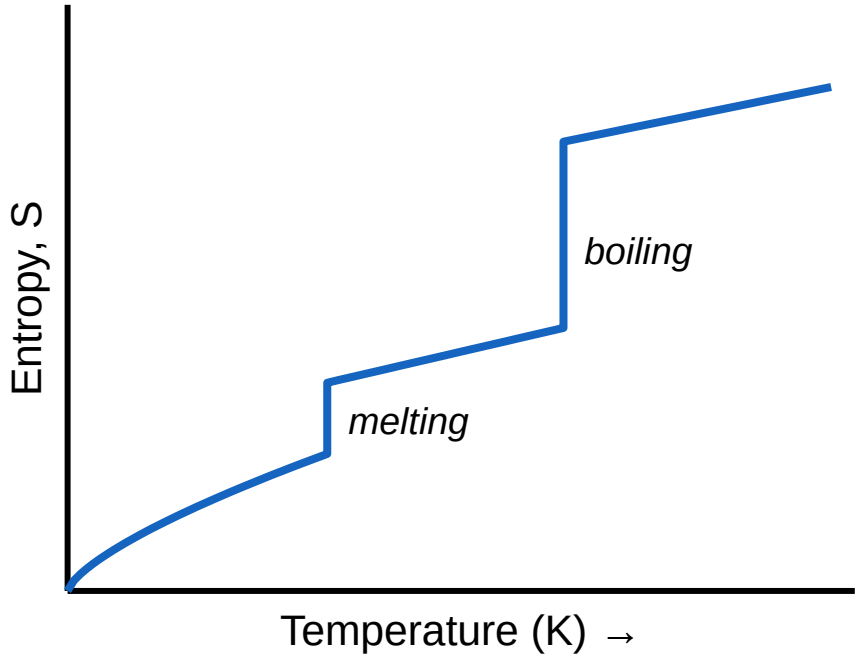


Perfect crystal at 0 K

$S = 0$

Entropy Rises with Temperature

- *S* rises as *T* goes up
- Big jumps at phase changes
- Biggest jump: boiling



Reading S° Values

- Gases have large *S*°
- Similar molecules: more atoms → larger *S*°

Substance	*S*° (J/(mol·K))
C(s, diamond)	2.4
$H_2O(l)$	69.9
$H_2O(g)$	188.8
$CH_4(g)$	186.3
$C_2H_6(g)$	229.6

Elements Are Not Zero

- $\Delta H_f°$ of an element = 0
- $S°$ of an element is not 0

$\Delta H_f°$ of $O_2(g)$
0 kJ/mol

$S°$ of $O_2(g)$
205.0 J/(mol·K)

Calculating ΔS° for a Reaction

$$\Delta S^\circ_{rxn} = \Sigma S^\circ_{products} - \Sigma S^\circ_{reactants}$$

Σ
means "add up"

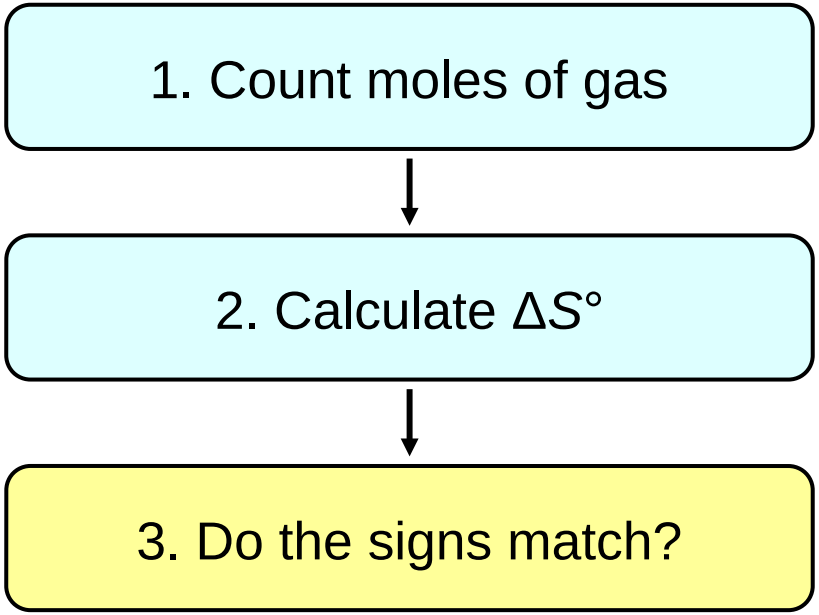
Multiply each *S*° by its coefficient

Products minus reactants

Units: $J/(mol_{rxn} \cdot K)$

Check Your Answer

- Predict the sign first
- Your answer should agree



Example: Burning Methane

Calculate $\Delta S°$ for this reaction.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$$

Substance	$S°$ (J/(mol·K))
$CH_4(g)$	186.3
$O_2(g)$	205.0
$CO_2(g)$	213.7
$H_2O(l)$	69.9

Example: A Solid Makes Two Gases

Calculate $\Delta S°$ for this reaction.

$$NH_4Cl(s) \rightarrow NH_3(g) + HCl(g)$$

Substance	$S°$ (J/(mol·K))
$NH_4Cl(s)$	94.6
$NH_3(g)$	192.5
$HCl(g)$	186.9

Example: Finding a Missing S°

For this reaction, $\Delta S^\circ = -146.4$ J/(mol·K). Use the data to find S° for $NO_2(g)$.

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$$

Substance	S° (J/(mol·K))
NO(g)	210.8
$O_2(g)$	205.0
$NO_2(g)$	?

Absolute Entropy and Entropy Change

Big Ideas

- $S°$ of a pure substance is not 0, even for elements
- $\Delta S° = \Sigma S°_{\text{products}} - \Sigma S°_{\text{reactants}}$
- Multiply each $S°$ by its coefficient
- Predict the sign first, then check

Units:
J/(mol·K)