Spontaneous Reactions:

- A chemical reaction that exists without a constant supply of energy.
  > C_3H_8 (g) + $5O_2$ (g) --> CO_2 (g) + H_2O (g)

- Two things to consider if a reaction will be spontaneous:
  > entropy (disorder) ΔS
  > enthalpy (heat) ΔH

  spontaneity does NOT determine rate

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Determining Spontaneity:

- If entropy is increasing, it is likely to be spontaneous.

- If the reaction is exothermic, it is likely to be spontaneous.

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example: Is the reaction below spontaneous?

C_4H_{10}(l) + $9O_2$(g) --> $4CO_2$(g) + $10H_2O$(g) + heat

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$-\Delta H$ = exo

$+\Delta S$ = ↑ disorder

Spont.

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Practice:

	-ΔH (exo)	+ΔH (endo)
+ΔS	always spontaneous	spontaneity depends on temperature
-ΔS	spontaneity depends on temperature	never spontaneous

- $6CO_2(g) + 6H_2O(l) + energy \rightarrow C_6H_{12}O_6(s) + 6O_2(g)$

endo = $+\Delta H$ never spont.
↓disorder = $-\Delta S$

- $H_2O(s) \rightarrow H_2O(l)$

endo = $+\Delta H$ depends on temp.
↑disorder = $+\Delta S$

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Gibb's Free Energy

- Quantitatively determines spontaneity

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

> ΔG = Gibb's Free Energy
> ΔH = enthalpy (kJ) - exo or endo
> T = Temperature in K
> ΔS = entropy (J/K)
> **-ΔG = spontaneous**
> **+ΔG = not spontaneous**

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Example:

- Ice melting
  - > ΔH = 6.03 kJ/mol
  - > ΔS = 22.1 J/K*mol → .0221 kJ/K·mol
    $22.1\ J \times \frac{1\ kJ}{1000\ J}$
- Calculate ΔG at -10°C and 10°C

$\Delta G = 6.03 - 263 \cdot 0.0221$ (263K: −10 +273)

$= 0.218$ not spont.

283K

$\frac{kJ}{mol} - K \cdot \frac{kJ}{mol \cdot K}$

$\Delta G = 6.03 - 283K \cdot 0.0221 = -0.224$ spont.

Remember ΔG & ΔH are given in kJ

ΔS given in J

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Check for Understanding:

Given the following information, determine if the reaction is spontaneous of non-spontaneous.

ΔH = 365 kJ, T = 388 K, ΔS = 55.2 J/K

$55.2\ J \times \frac{1\ kJ}{1000\ J} = .0552\ kJ$

$\Delta G = 365 - 388 \cdot 0.0552$

$= 344$ non-spont.

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