Statistical Molecular Thermodynamics

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Video 1.4

The Hydrogen Chloride Cannon

Common Thermo Question:

What Will Happen If I Mix Stuff?

What if I mix Cl_2 with H_2? Will I "spontaneously" get HCl?

$$Cl_2 + H_2 \longrightarrow 2HCl$$

Cl_2 bond = 242 kJ/mol

H_2 bond = 436 kJ/mol

HCl bond = 431 kJ/mol

breaking 2 bonds *costs*

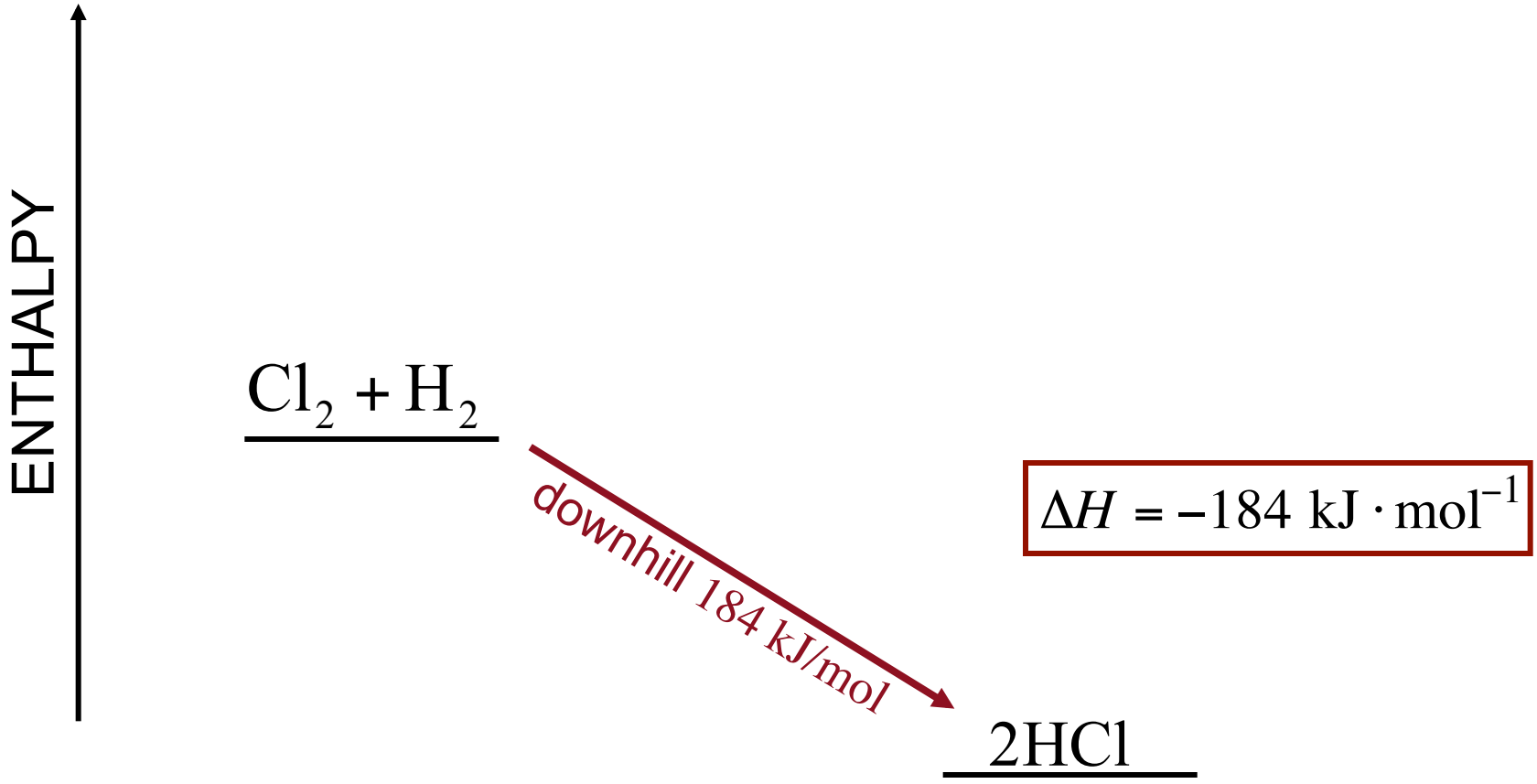
making 2 bonds *releases*

$$\Delta H = (436 + 242)\ \text{kJ} \bullet \text{mol}^{-1} + 2\left(-431\ \text{kJ} \bullet \text{mol}^{-1}\right)$$

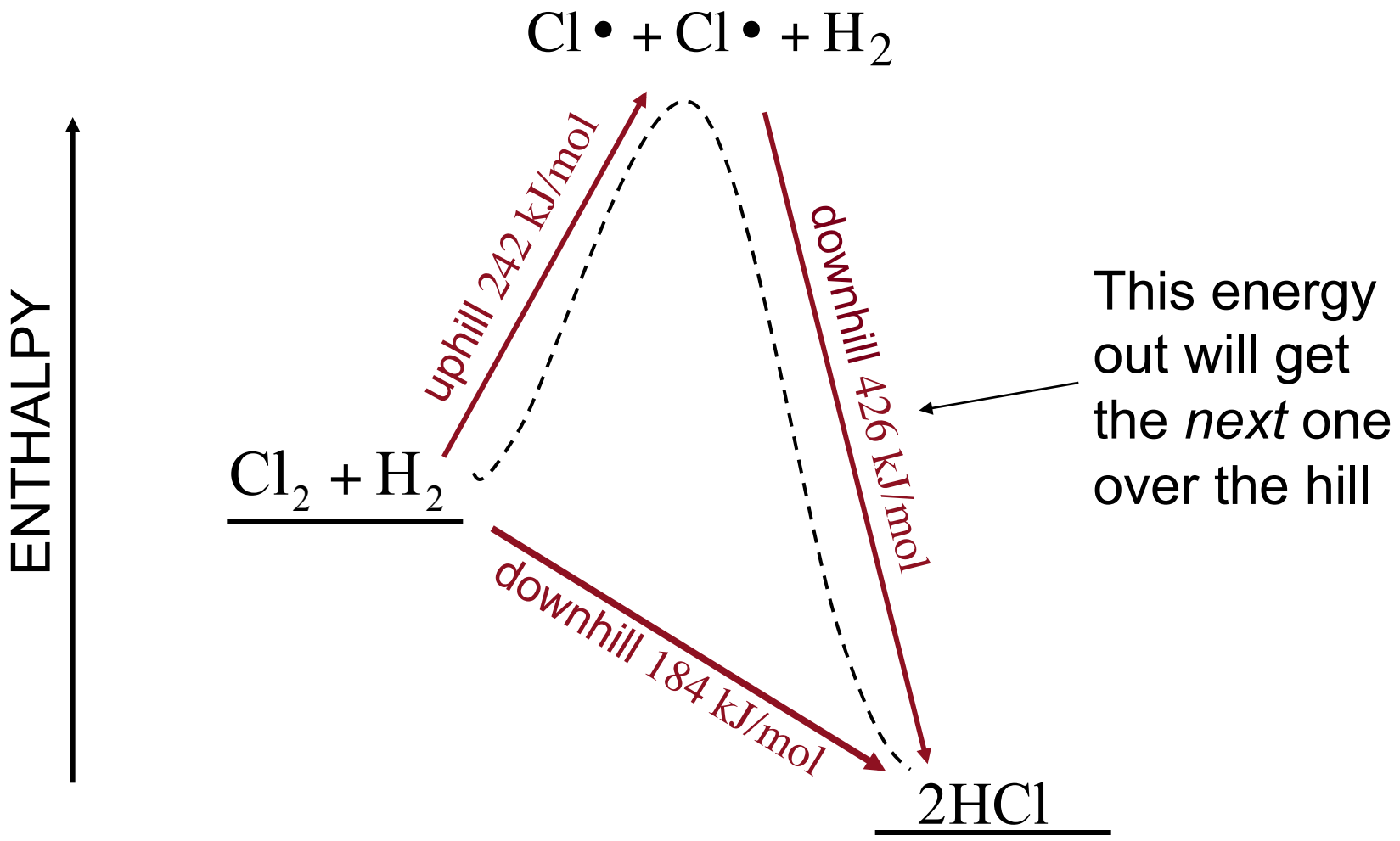
$$\boxed{\Delta H = -184\ \text{kJ} \cdot \text{mol}^{-1}}$$

Energy Release — Going Downhill

$$Cl_2 + H_2 \longrightarrow 2HCl$$



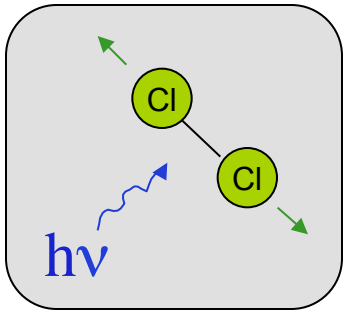
Energy Release May Face A Barrier

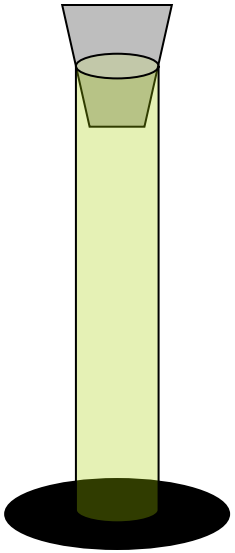


Self assessment insert here

- Verification that 485 nm breaks Cl_2 bond
- multiple answers with color next to wavelength upon answering?

And Once The Reaction Is Started?





- The reaction releases $184\ \mathrm{kJ/mol}$ in heat.
- The temp will go up (*assume an ideal diatomic gas at high temp*)

$$\Delta U = C_V \Delta T \longrightarrow \Delta T = \frac{\Delta U}{C_V} = \frac{\Delta U}{\frac{7}{2}R} \approx 6323\ \mathrm{K}$$

- At constant volume, the pressure will go up (Amonton's Law),

$$\frac{P_2}{P_1} = \frac{T_2}{T_1} \longrightarrow P_2 = (1\ \mathrm{atm})\left(\frac{300\ \mathrm{K} + 6323\ \mathrm{K}}{300\ \mathrm{K}}\right) \approx \underline{22\ \mathrm{atm}}$$

Next: Atomic Energy Levels