

Bond Energy

What makes a reaction endothermic or exothermic?

Why?

Chemical reactions can be a lot like playing with Legos®—you must take apart part of your last creation before you can replace it with something new. For many chemical reactions, we have to first break bonds in the reactants before we can put the atoms back into a new arrangement to form the products. Both of these processes involve changes in energy. The net energy change for a reaction is called the **heat of reaction** or the **change in enthalpy** (ΔH). In this activity we will look at one way energy changes can be approximated for chemical reactions.

Model 1 – Breaking and Forming Bonds

	Reaction	Change in Energy (kJ/mol _{rxn})		Reaction	Change in Energy (kJ/mol _{rxn})
A)	$\text{PCl}_3(\text{g}) \rightarrow \text{P}(\text{g}) + 3\text{Cl}(\text{g})$	+ 966.7 <i>broken</i>	E)	$\text{P}(\text{g}) + 3\text{Cl}(\text{g}) \rightarrow \text{PCl}_3(\text{g})$	- 966.7 <i>formed</i>
B)	$\text{PCl}_5(\text{g}) \rightarrow \text{P}(\text{g}) + 5\text{Cl}(\text{g})$	+ 1,297.9 <i>broken</i>	F)	$\text{P}(\text{g}) + 5\text{Cl}(\text{g}) \rightarrow \text{PCl}_5(\text{g})$	- 1,297.9 <i>formed</i>
C)	$\text{PF}_3(\text{g}) \rightarrow \text{P}(\text{g}) + 3\text{F}(\text{g})$	+ 1,470.4 <i>broken</i>	G)	$\text{P}(\text{g}) + 3\text{F}(\text{g}) \rightarrow \text{PF}_3(\text{g})$	- 1,470.4 <i>formed</i>
D)	$\text{PF}_5(\text{g}) \rightarrow \text{P}(\text{g}) + 5\text{F}(\text{g})$	+ 2,305.4 <i>broken</i>	H)	$\text{P}(\text{g}) + 5\text{F}(\text{g}) \rightarrow \text{PF}_5(\text{g})$	- 2,305.4 <i>formed</i>

- Identify four reactions in Model 1 where bonds are being broken. Write "broken" in the Change in Energy box in the table for each reaction you identify.
- Identify four reactions in Model 1 where bonds are being formed. Write "formed" in the Change in Energy box in the table for each reaction you identify.
- Circle the correct word to complete each sentence below.
 - When bonds are (broken/formed) there is a positive energy change.
 - Breaking bonds is (endothermic/exothermic).
 - When bonds are (broken/formed) there is a negative energy change.
 - Forming bonds is (endothermic/exothermic).
- Find two reactions in Model 1 that are exact opposites of each other, that is, one reaction is the reverse of the other reaction.

- How do the changes in energy for the reverse reactions compare?

The changes in energy for these reactions are the same, but opposite in sign.

- Explain your answer to part a considering what you learned from Questions 1–3 about bond breaking and bond formation.

If a given amount of energy is required to break a bond, then the same amount of energy will be released when the bond is formed.

Bond Energy Pogil

Yu Lin



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Comprehensive Handbook of Chemical Bond Energies Yu-Ran Luo, 2007-03-09 Understanding the energy it takes to build or break chemical bonds is essential for scientists and engineers in a wide range of innovative fields including catalysis nanomaterials bioengineering environmental chemistry and space science Reflecting the frequent additions and updates of bond dissociation energy BDE data throughout the literature the *Comprehensive Handbook of Chemical Bond Energies* compiles the most recent experimental BDE data for more than 19 600 bonds of 102 elements The author organizes the data by bond type functional group bond order bond degree molecular size and structure for ease of use Data can also be located using the Periodic table The book presents data for organic molecules biochemicals and radicals as well as clusters ions hydrogen and surface bonded species van der Waals complexes isotopic species and halogen clusters complexes It also introduces entirely new data for inorganics and organometallics The final chapter summarizes the heats of formation for atoms inorganic organic radicals and monoatomic ions in the gas phase The *Comprehensive Handbook of Chemical Bond Energies* offers quick access to experimental BDE data in the most inclusive well organized and up to date collection available today **Organic Chemistry** Suzanne M. Ruder, The POGIL Project, 2015-12-29 ORGANIC CHEMISTRY

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Bonding and Structures of Light Element Energy Systems Under Extreme Conditions Yu Lin,2013 This dissertation focuses on investigating the effect of pressure on the structure and bonding of three types of light element energy systems using a suite of synchrotron x ray characterization probes including diffraction spectroscopic and imaging techniques Ammonia borane AB which contains a remarkably high hydrogen content shows rich structural and dihydrogen bonding variations upon compression More strikingly AB is found to be capable of storing a significant amount of extra hydrogen molecules in addition to the hydrogen chemically stored in itself which makes this novel AB H₂ compound one of the most hydrogen rich materials currently known LiMn₂O₄ a promising cathode material for Li ion batteries is found to be extremely sensitive to deviatoric stress which triggers a cubic to tetragonal phase transition Such a transition during the battery working environment is detrimental to both the performance and lifetime However the nanostructured material can accommodate more stress and strain compared to its bulk counterpart Glassy carbon which has very low density and 100% sp² bonding at ambient conditions undergoes a transition to amorphous diamond at high pressure This new carbon allotrope

possesses an amorphous structure with 100% sp^3 bonds and exceptional hardness The property of superhardness if turns out to be isotropic can be advantageous relative to crystalline diamond for which the hardness is highly anisotropic The findings could lead to new classes of ultradense and strong materials that can serve as energy efficient components such as wear resistant parts for all kinds of transportation Bond Graphs for Causal Explanations J. L. Top,1992

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