

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.

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P. Blackhurst



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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

CHEMICAL BONDS AND BOND ENERGY. RT. SANDERSON, 1971 *Bond Energies P502-516* Sidney Benson, 1965 *Bond Energies* Vladimir Ivanovich Vedenev, 1966 *Empirical Bond Energies* FRANK JR. WILSON, AIR FORCE FLIGHT TEST CENTER EDWARDS AFB CALIF., Air Force Flight Test Center (U.S.), 1961 A consistent set of bond energy values are calculated on the assumption that bond energy nonconstancies are a minimum when determined from compounds in which all the constituent elements exhibit their normal valency Several empirical rules for estimating the heats of vaporization and fusion are included The report contains sufficient data for the estimation of heats of formation of compounds In many cases estimations can be made within a few kilocalories Author

Calculation of Multiplet Energies and Bond Energies by the HFS-method Tom Ziegler, 1978 *Bond Orders and Energy Components*, 2013 *Bond Energies, Ionization Potentials, and Electron Affinities* Vladimir Ivanovich Vedenev, Lev Veniaminovich Gurvich, V. N. Kondrat'yev, 1966 Calculated Bond Energies and Heats of Formation of Organic and Organometallic Compounds P. Blackhurst, 1984 Bond Energies, Ionization Potentials and Electron Affinities Simon Kuznets, 1966 Energy Refinements to Glass Structure Patrick Joseph Hood, 1985

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Bond Orders and Energy Components István Mayer, 2016-10-14 While modern computational methods can provide us with the wave function of a molecule in numerical form most computer programs lack the sophisticated tools needed to extract chemical concepts from these wave functions Saving researchers vast time and potential confusion this volume collects and organizes those validated tools currently scattered throughout the literature and details their application It provides immediate access for those

needing to calculate such critical factors as bond order and valence indices and atomic and diatomic contributions to molecular energy Supporting material is available for download from the authors continually updated website [Energy and Bonding](#) Michael Hudson (chimiste),1969 **BOND ENERGIES IONIZATION POTENTIALS AND ELECTRON AFFINITIES.** ,1966 [Bond Energies, Ionization Potentials and Electron Affinities, by V.I. Vedeneev \[and Others\]](#) Translated from the Russian by Scripta Technica, Ltd. Foreword to the English Edition by W.C. Price Vladimir Ivanovich Vedeneev,1966 *S.C.F. Calculations of Bond Properties and Potential Energy Surfaces* ,1971 *A Re-examination of Conjugation and Hyperconjugation in Relation to Bond Lengths, Bond Energies and Resonance Energies* H. N. Schmeising,1959 *Bond Orders and Energy Components* Istvan Mayer,Gyorgy Lendvay,Pedro Salvador,2015-12-15 While modern computational methods can provide us with the wave function of a molecule in numerical form most computer programs lack the sophisticated tools needed to extract chemical concepts from these wave functions Saving researchers vast time and potential confusion this volume collects and organizes those validated tools currently scattered throughout the literature and details their application It provides immediate access for those needing to calculate such critical factors as bond order and valence indices and atomic and diatomic contributions to molecular energy Supporting material is available for download from the authors continually updated website

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