

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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Organic Chemistry Suzanne M. Ruder, The POGIL Project, 2015-12-29 *ORGANIC CHEMISTRY* *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

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Energy Components ,2013 **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 *Chemistry* Richard S. Moog,John J. Farrell,2017-06-26 In the newly updated 7th Edition Chemistry A Guided Inquiry continues to follow the underlying principles developed by years of extensive research on how students learn and draws on testing by those using the POGIL methodology This text follows the principles of inquiry based learning and correspondingly emphasizes underlying chemistry concepts and the reasoning behind them This text provides an approach that follows modern cognitive learning principles by having students learn how to create knowledge based on experimental data and how to test that knowledge *Renewable Energy Finance - Green Bonds* International Renewable Energy Agency IRENA,2020 Bond-based Corrections to Improve Atomization Energy Calculations Neelabh Maheshwari,2012

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Table of Contents Bond Energy Pogil

1. Understanding the eBook Bond Energy Pogil
 - The Rise of Digital Reading Bond Energy Pogil
 - Advantages of eBooks Over Traditional Books
2. Identifying Bond Energy Pogil
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Bond Energy Pogil
 - User-Friendly Interface
4. Exploring eBook Recommendations from Bond Energy Pogil
 - Personalized Recommendations
 - Bond Energy Pogil User Reviews and Ratings

- Bond Energy Pogil and Bestseller Lists
- 5. Accessing Bond Energy Pogil Free and Paid eBooks
 - Bond Energy Pogil Public Domain eBooks
 - Bond Energy Pogil eBook Subscription Services
 - Bond Energy Pogil Budget-Friendly Options
- 6. Navigating Bond Energy Pogil eBook Formats
 - ePub, PDF, MOBI, and More
 - Bond Energy Pogil Compatibility with Devices
 - Bond Energy Pogil Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Bond Energy Pogil
 - Highlighting and Note-Taking Bond Energy Pogil
 - Interactive Elements Bond Energy Pogil
- 8. Staying Engaged with Bond Energy Pogil
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Bond Energy Pogil
- 9. Balancing eBooks and Physical Books Bond Energy Pogil
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Bond Energy Pogil
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Bond Energy Pogil
 - Setting Reading Goals Bond Energy Pogil
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Bond Energy Pogil
 - Fact-Checking eBook Content of Bond Energy Pogil
 - Distinguishing Credible Sources

13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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