

# 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** ( $\Delta H$ ). 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 <sub>rxn</sub> )		Reaction	Change in Energy (kJ/mol <sub>rxn</sub> )
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 Extension Questions

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**Bond Energy Pogil Extension Questions:**

*A Simple Semiempirical Approximation for Bond Energy* Francisco Elias Jorge, Mario Giambiagi, Myriam Segre de Giambiagi, 1985      Energy and Bonding Michael Hudson (chimiste), 1969

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## **Table of Contents Bond Energy Pogil Extension Questions**

1. Understanding the eBook Bond Energy Pogil Extension Questions
  - The Rise of Digital Reading Bond Energy Pogil Extension Questions
  - Advantages of eBooks Over Traditional Books
2. Identifying Bond Energy Pogil Extension Questions
  - 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 Extension Questions
  - User-Friendly Interface
4. Exploring eBook Recommendations from Bond Energy Pogil Extension Questions
  - Personalized Recommendations
  - Bond Energy Pogil Extension Questions User Reviews and Ratings
  - Bond Energy Pogil Extension Questions and Bestseller Lists
5. Accessing Bond Energy Pogil Extension Questions Free and Paid eBooks

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