Energy, Structure and Combustion

Class Lesson

The combustion of alkanes.

Exploration:

1. Use the provided molecular model set to build a model representing the simplest alkane molecules: methane, CH_4, ethane (C_2H_6), propane (C_3H_8), and butane (C_4H_{10}). In the latter three compounds the carbon atoms form chains.
2. Describe the geometry of the compound. Are the molecules flexible or rigid? Can you rotate parts of the model?

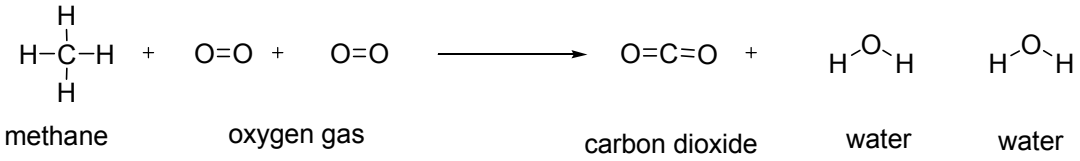
Alkane	Description of shape	Flexibility/Rigidity
methane		
ethane		
propane		
butane		

3. Take one of the models and disconnect/break one of the bonds. Does it cost you energy to disconnect the model, or do you gain energy?

4. In this last exploration you used molecular model to visualize and explore the shape and flexibility of alkanes. Find three reasons why scientists use models.

Concept Development:

5. Is energy consumed or produced when you form a new bond?
6. Complete the table below for the following combustion reaction:



REACTANT SIDE		**PRODUCT SIDE**	
Type of bond	Number of this type of bond	Type of bond	Number of this type of bond
O=O	2	O=O	0
O-O		O-O	
C=O		C=O	
C-O		C-O	
C-C		C-C	
C=C		C=C	
C-H		C-H	
O-H		O-H	
S-S		S-S	
S=O		S=O	
P-O		P-O	

7. We talked about reactions where it costs you energy. Here are some price tags. Do you make a loss or a profit from the combustion of methane? Balance your check book.

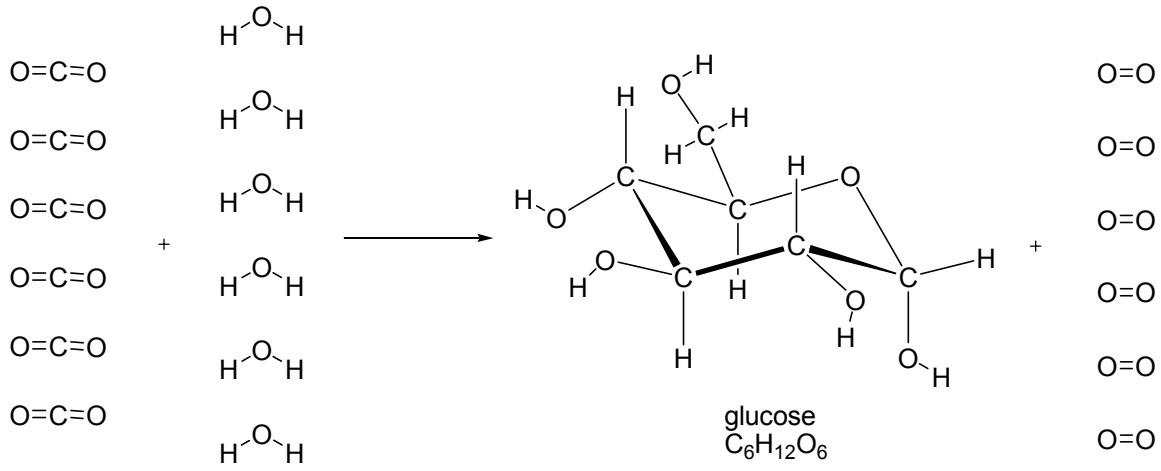
Bond Breaking Costs for Some Bonds in U.S. $

C-C	$ 348.50		O-O	$ 146.25
C=C	$ 612.75		O=O	$ 497.25
C□C	$ 838.25		S-S	$ 264.00
C-O	$ 360		S=O	$ 469
C-H	$ 412.00		H-H	$ 436.36
C=O	$ 801.25		O-H	$ 428.75
C=N	$ 615		P-O	$ 502.00
N□N	$ 945		H-N	$ 390
H-Br	$ 360		Cl-C	$ 330

RECORD ALL TRANSACTIONS THAT APPLY TO YOUR ACCOUNT								
ITEM NO.	DESCRIPTION OF TRANSACTION	**(-)** PAYMENT , WITHDRAWAL OR FEE AMOUNT		√	**(+)** AMOUNT OF DEPOSIT OR INTEREST		BALANCE	
O=O bond	Bond is broken	497	25				-497	25
O-H bond	Bond is formed				428	75	-68	50

8. The price tags correspond to the actual energy changes in the reaction. When you combust a fuel, from where does the energy come from?

Application:
Calculate the loss or profit for the formation of glucose.



This is an important equation that is usually shown in the following format:
$6\ CO_2\ +\ 6\ H_2O\ \rightarrow\ C_6H_{12}O_6\ +\ 6\ O_2$

RECORD ALL TRANSACTIONS THAT APPLY TO YOUR ACCOUNT								
ITEM NO.	DESCRIPTION OF TRANSACTION	(-) PAYMENT , WITHDRAWAL OR FEE AMOUNT		√	(+) AMOUNT OF DEPOSIT OR INTEREST		BALANCE	
O=O bonds	**6 bonds** are formed at $497.25 each				2983	50	2983	50

Hint: glucose contains 5 C-C, 5 O-H, 7 C-O, and 7 C-H bonds
Exploration:

9. Discuss in your group:
    a. How can you tell whether a process or reaction is exothermic? How can you tell whether a process or reaction is endothermic?
    b. Assume you are comparing two exothermic processes. Find a way or develop an experiment that enables you to quantitatively determine which process releases more energy. (Use your findings from a.)

Concept Development

10. How do scientist measure or quantify energy?
    a. In the context of coal.
    b. In the physical sciences.
    c. In the context of food.
11. How much energy do you need daily to support your body?

Application

12. Below are two food labels. Assume you eat 1 g of each food. Which will provide you with more energy?

Nutrition Facts for Tortilla Chips **Serving Size 1 oz (28 g/about 15 chips)** **Servings Per Bag 16**	
Amount Per Serving	
Calories 140	**Calories from Fat 60**
Total Fat *Saturated Fat* *Polyunsaturated Fat* *Monounsaturated Fat*	**7 g** *0.5 g* *1g* *5 g*
Cholesterol	**0 mg**
Sodium	**65 mg**
Total Carbohydrate *Dietary Fiber* *Sugars*	**18 g** 2 g 0 g
Protein	**2 g**

Nutrition Facts for Milk Chocolate Chips **Serving Size 1 tbsp (15 g)** **Servings Per Bag 22**	
Amount Per Serving	
Calories 80	**Calories from Fat 40**
Total Fat *Saturated Fat*	**4.5 g** 2.5 g
Cholesterol	**< 5 mg**
Sodium	**10 mg**
Total Carbohydrate *Dietary Fiber* *Sugars*	**9 g** 0 g 8 g
Protein	**1 g**