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24.0.C.1 Hands-on Chemical Energy

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This reaction helped launch the space shuttle into orbit.

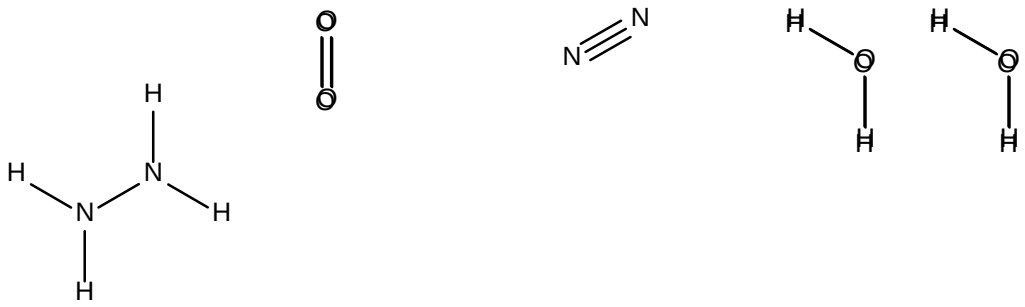
$2H_2\ (g) + O_2\ (g) \rightarrow 2\ H_2O\ (g)$

This reaction is natural gas combustion for home heating.

$CH_4\ (g) + 2\ O_2\ (g) \rightarrow CO_2\ (g) + 2\ H_2O\ (g)$

This reaction has been used for attitude control jets on space ships.

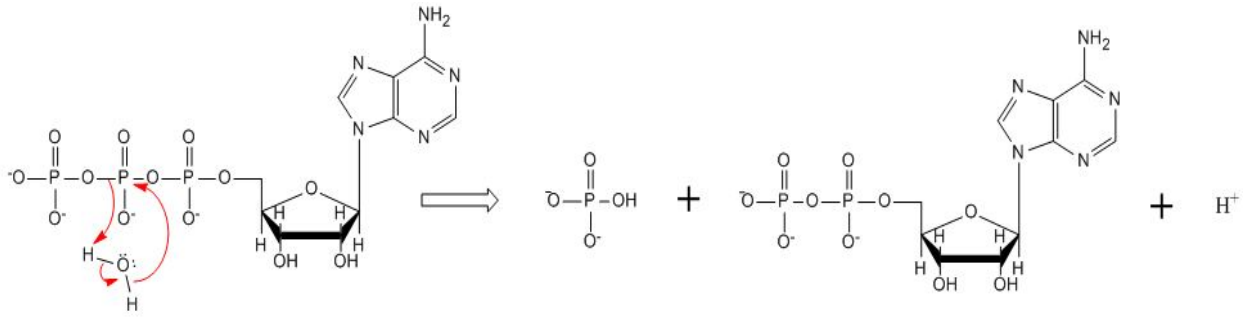
$N_2H_4\ (g) + O_2\ (g) \rightarrow N_2\ (g) + 2\ H_2O\ (g)$



This is the Haber Process, which takes nitrogen from air
and "fixes" it in a form to use for fertilizer.

$N_2\ (g) + 3\ H_2\ (g) \rightarrow 2\ NH_3\ (g)$

This is the ATP to ADP reaction in the body,
which is a source of energy for many biochemical and cellular processes.



Bond	Energy (10^{-19} Joules)
H – H	7.2
H – C	6.9
H – N	6.5
H – O	7.8
O = O	8.3
C = O	13.3
N – N	2.7
N ≡ N	15.7
P – O	5.8
C – C	5.8
C = C	10.2

Christopher F. Bauer, Principal Investigator.
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Consider your reaction, showing molecular and structural formulas.
One line indicates a "single bond". Two lines indicate a "double bond". Three is triple.

4.1 I will give you a set of models for the reactants. What must happen in order to get the reactants to become the products?	
4.2 Do it (change the reactants into the products). Keep track of every change that needs to be made. (You will need this later.)	
4.3 Now we need to relate this to energy. Two group members should shake hands, but hold on as if your life depended on it. A third group member should – carefully – attempt to separate them. What must happen (in terms of energy) in order to separate the hand-shakers?	
4.4 What must happen (in terms of energy) in order to separate ANY bonded atoms from each other?	
4.5 Get a large steel ball, a slab of metal, and a thermochromic sheet. Lay the metal on the table. Put the sheet on that (it should show some non-black color). Put your finger on the sheet to see what color will be produced by a heat input. You observe:	
4.6 Gently place the steel ball on the sheet for a few seconds. Inspect the resting point for any color change. What do you observe? Does resting a heavy mass on the sheet release any energy?	
4.7 Hold the steel ball about 4 inches above the sheet. Drop it on the sheet. Immediately pick up the ball and inspect the sheet. What do you observe? Does dropping a heavy mass on the sheet release any energy?	
4.8 Where did the energy come from?	

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4.9 The ball and the Earth were attracted to each other by gravity. When they fall together because of attraction, energy is … what?	
4.10 What happens (in terms of energy) when ANY pair of atoms fall together (forming a bond) because of a chemical attraction?	
4.11 Summarize your answer to 4.4 and 4.10 here by completing these sentences: When a chemical bond breaks, energy is … When a chemical bond forms, energy is …	
Send your ambassador to a group not yet visited to see whether you agree on 4.11	
4.12 Calculate the net energy change for going from the reactants to products for your reaction. You need info collected at 4.2, your statements from 4.11, and data from the handout.	
4.13 Is your reaction endothermic or exothermic and how do you know?	
4.14 Prepare your spokesperson to describe to the class how you did your calculation, and your answers to 4.12 and 4.13.	
Spokesperson presentations (very brief).	
4.15 Describe an exothermic reaction in terms of the relative magnitude of bond energies of reactants and products. (This summarizes the previous questions.) Then do the same for an endothermic reaction. Write your best concise descriptions here.	

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