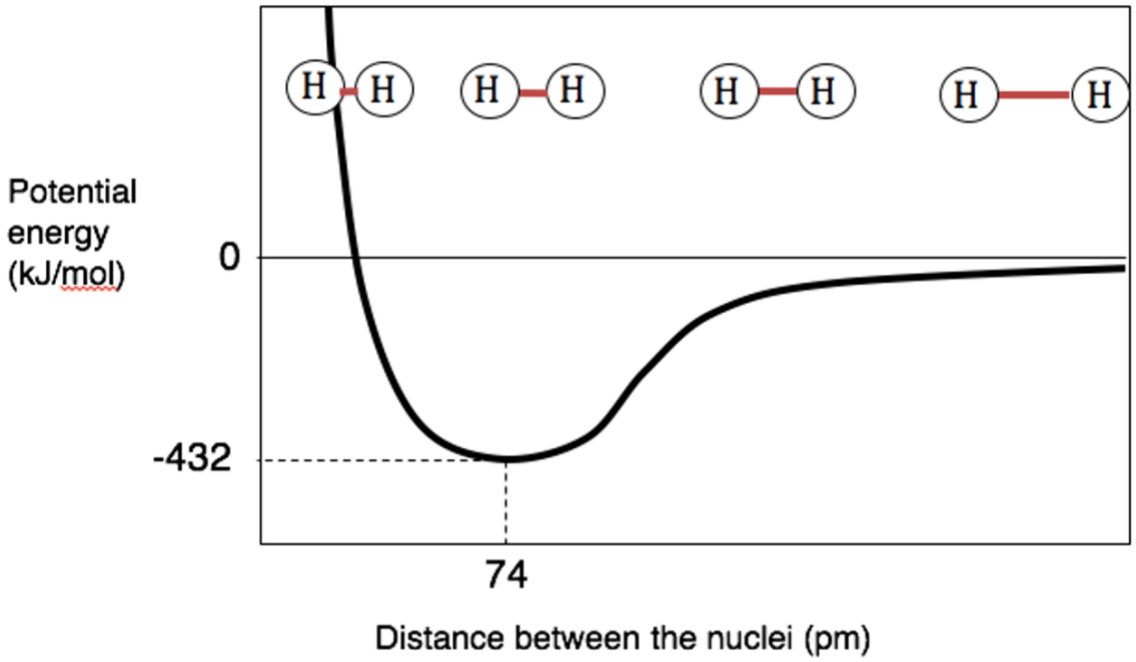
HW 3

Energy is typically described as the ability to perform work. There are different forms of energy: kinetic and potential. Every piece of matter possesses some energy, which we refer to as internal energy. We can define internal energy as the total amount of energy (both potential and kinetic) in a sample of a substance. Different forms of energy can be converted into one another, but energy cannot be lost; this principle is known as the law of conservation of energy, which is the **first law of thermodynamics**.

Bond energy is the amount of energy required to break one mole of a specific type of chemical bond in the gaseous state. Units can be kilojoules per mole (kJ/mol). A stronger bond means that more energy is needed to break it.



Some examples: In H_2, two hydrogen atoms are bonded by a single covalent bond. Bond energy of H–H bond ≈ 432 kJ/mol. This means breaking 1 mole of H–H bonds requires 432 kJ of energy.

O_2 has a double bond between two oxygen atoms. Bond energy of O=O ≈ 498 kJ/mol. Since the bond is stronger than H–H, more energy is needed to break it.

Average bond energies, kJ/mol (you should use this information to answer questions below): Cl-Cl 243, F-F 158, H-F 565, H-Cl 431, Fe-O 400

Questions:

1. Is the following statement true: Breaking chemical bonds releases energy.
2. Which has higher potential energy: separated atoms or the same atoms once a bond has formed?
3. Using the bond energies above consider the following reactions:

$H_2 + F_2 \rightarrow 2HF$

Can you calculate the energy (kJ) of bonds broken (left part of the chemical reaction) and bonds formed (right).

Can you do the same for this reaction: $H_2 + Cl_2 \rightarrow 2HCl$

4. Consider simplified rust formation reaction:

$4Fe + 3O_2 \rightarrow 2Fe_2O_3$

Can you calculate the energy of broken bonds. We ignore the energy of metal (zero). We only consider the energy of oxygen gas bond.

Can you calculate the energy of newly formed bonds. We consider that Fe_2O_3 has 6 Fe-O bonds.