Using Legos® to Model Energy Transfer in Chemical Reactions

Define these terms:

Endothermic:

Exothermic:

Is bond breaking endothermic or exothermic?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ How do you know?

In this activity, you will model what occurs during a chemical reaction at the submicroscopic level using tiny Lego® pieces. You will use specific pieces to represent specific aspects of bond breaking and bond formation. Here’s what each Lego® piece represents:

Brown 1x2 – atom A Light blue 1x1 – bond with energy of 100 Joules (J)

Beige 1x2 – atom B Red, round 1x1 – bond with energy of 33 Joules (J)

Pink 1x2 – atom C

Dark blue 1x2 – Atom D

You will get a bag with a small quantity of each piece that you will use to complete the activity and learn about what it means for a reaction to be truly endothermic and exothermic.

1. Build a molecule of A2 that has an overall bond energy of 200 J.
2. Build a molecule of B2 that has an overall bond energy of 167 J.
3. Break both A2 and B2 completely apart.
4. Did breaking the molecule apart require more energy to do than putting the molecule together?\_\_\_\_\_\_ As you see, breaking bonds requires energy since the attractive force that is a bond is very strong.
5. Now make two molecules of AB. Each molecule has an overall bond energy of 100 J.
6. You should have bond energies “left over.” This adds up to \_\_\_\_\_\_\_ J of energy released to the surroundings. Therefore, this reaction is\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
7. We are going to account for the energy changes in the reaction between A2 and B2 using an energy diagram. It is a line graph that displays energy over time. In order to draw the energy diagram correctly we need to do some figuring:
   1. Total energy of reactants = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. Total energy of products = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   3. Total energy of products – total energy of reactants = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The value you get in part c should be the same size as what you got in #6. What is different about what you got in c? Why is it different?

1. Now let’s sketch an energy diagram. Your axes are labeled appropriately for you.

Energy (J)

Time (s)

This is an energy diagram for an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ reaction. Notice that the “hill” in the middle of the diagram represents the activation energy needed to break the bonds in all the reactant molecules.

1. Make two molecules: a molecule of CD that has an overall bond energy of 233 J and a molecule of AB that has an overall bond energy of 100 J.
2. What is the total energy of the reactants? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Break the bonds between CD and AB.
4. Make two new molecules: a molecule of AC that has an overall bond energy of 400 J and a molecule of BD that has an overall bond energy of 267 J.
5. What did you do differently this time? Why did you do it?

Notice that you took in energy from your surroundings. This is what happens during an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ process. How much energy did you take in? \_\_\_\_\_\_\_\_\_\_\_\_

1. We are going to account for the energy changes in the reaction between AB and CD using an energy diagram. It is a line graph that displays energy over time. In order to draw the energy diagram correctly we need to do some figuring:
   1. Total energy of reactants = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   2. Total energy of products = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
   3. Total energy of products – total energy of reactants = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The value you get in part c should be the same size as what you got in #13. Why is the quantity of energy you got in c the same as what you got in #13?

1. Now let’s sketch an energy diagram. Your axes are labeled appropriately for you.

Energy (J)

Time (s)

This is an energy diagram for an \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ reaction. Notice that the “hill” in the middle of the diagram represents the *activation energy* needed to break the bonds in all the reactant molecules.