Modeling Enthalpy Changes Using Stop-Motion-Video

Teacher's Guide

1. Make sure that your classes understand the concept of enthalpy and its relationship to chemical reactions.
2. Assign each group one reaction from the following list (**a-d**) and provide each group with the necessary parts.

a. Hydrogen gas reacting with oxygen gas to form water.

	Atom Centers				Bonds
Qty	Element	Color/Holes		Qty	Type
4	Hydrogen	White/1		4	single
2	Oxygen	Red/4		2	double/triple

b. Carbon (graphite) reacting with oxygen gas to form carbon monoxide.

	Atom Centers				Bonds
Qty	Element	Color/Holes		Qty	Type
2	Carbon	Black/4		6	double/triple
2	Oxygen	Red/4			

c. Nitrogen gas reacting with hydrogen gas to form ammonia.

	Atom Centers				Bonds
Qty	Element	Color/Holes		Qty	Type
6	Hydrogen	White/1		6	single
2	Nitrogen	Blue/4		3	double/triple

d. Hydrogen peroxide decomposing into water and oxygen gas.

	Atom Centers				Bonds
Qty	Element	Color/Holes		Qty	Type
4	Hydrogen	White/1		6	single
4	Oxygen	Red/4		2	double/triple

3. Each group will place an iPhone, android phone, or iPad, with the Stop-Motion-Video app, on a ring stand as shown in the introduction above.

4. The data from the following table are to be used to make enthalpy change determinations.

Average Bond Energies (kJ/mol)

Bond	Energy	Bond	Energy	Bond	Energy	Bond	Energy
Single Bonds							
H—H	432	N—H	391	Si—H	323	S—H	347
H—F	565	N—N	160	Si—Si	226	S—S	266
H—Cl	427	N—P	209	Si—O	368	S—F	327
H—Br	363	N—O	201	Si—S	226	S—Cl	271
H—I	295	N—F	272	Si—F	565	S—Br	218
		N—Cl	200	Si—Cl	381	S—I	~170
C—H	413	N—Br	243	Si—Br	310		
C—C	347	N—I	159	Si—I	234	F—F	159
C—Si	301					F—Cl	193
C—N	305	O—H	467	P—H	320	F—Br	212
C—O	358	O—P	351	P—Si	213	F—I	263
C—P	264	O—O	204	P—P	200	Cl—Cl	243
C—S	259	O—S	265	P—F	490	Cl—Br	215
C—F	453	O—F	190	P—Cl	331	Cl—I	208
C—Cl	339	O—Cl	203	P—Br	272	Br—Br	193
C—Br	276	O—Br	234	P—I	184	Br—I	175
C—I	216	O—I	234			I—I	151
Multiple Bonds							
C=C	614	N=N	418	C≡C	839	N≡N	945
C=N	615	N=O	607	C≡N	891		
C=O	745 (799 in CO_2)	O_2	498	C≡O	1070		

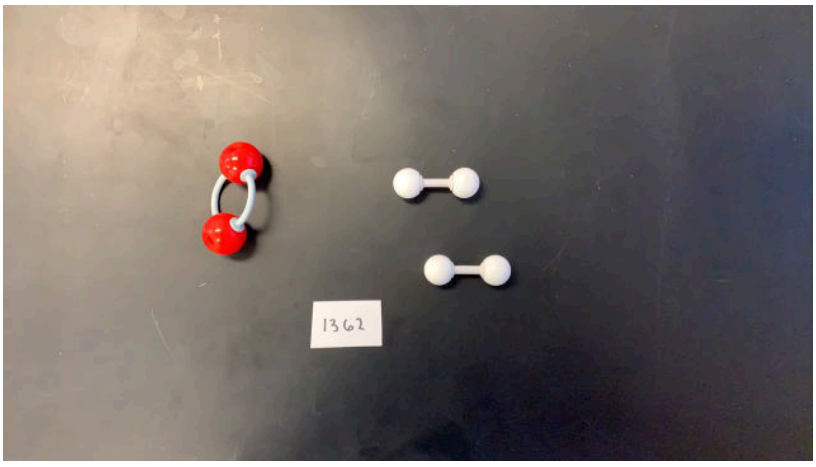
Key:

a. $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$ $\Delta H = (432 \times 2 + 498) - (467 \times 4) = 1362 - 1868 = -506$ kJ

b. $2C_{(s)} + O_{2(g)} \rightarrow 2CO_{(g)}$ $\Delta H = (498) - (1070 \times 2) = 498 - 2140 = -1642$ kJ

c. $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$ $\Delta H = (945 + 432 \times 3) - (391 \times 6) = 2241 - 2346 = -105$ kJ

d. $2H_2O_{2(l)} \rightarrow 2H_2O_{(l)} + O_{2(g)}$ $\Delta H = (467 \times 2 + 204) - (467 \times 4 + 498) = -1228$ kJ



Example Stop-Motion-Video

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Student Procedure

Objective: To model the process of bond breaking and bond formation, and to calculate the change in enthalpy for a chemical reaction.

Materials: Ryler Enterprises model kit parts, Stop-Motion-Video app, ring stand, test tube clamp or ring clamp(s), rubber bands, sticky notes, Sharpie pen.

1. Write the skeleton equation for the reaction assigned to you.

2. Balance the equation. Write the balanced equation.

3. Determine and draw the Lewis structures for the reactants and products in the reaction assigned to you.

4. Clamp (or support on rings) an iPhone, android phone, or iPad onto the ring stand about 10 cm above the lab table.

5. Open a Stop-Motion app to create a stop motion video detailing the collision of molecules, bond breaking (with energy in kJ), bond forming (with energy in kJ) and ΔH (in kJ) for the reaction. Adjust the speed of the movie so that the energy values and the reaction process are legible. The video should show the rearrangements of the atoms to form the products. Write the bond breaking and bond forming enthalpies (in kJ) on sticky notes with a Sharpie pen and include them in your video.

6. Each lab group should share the video with the instructor by the method given to you by your teacher. Put ΔH (in kJ) for the reaction here:_____

Questions:

1. When a chemical bond is broken, is energy absorbed or released?

2. When a chemical bond is formed, is energy absorbed or released?

3. What are the two ways to calculate change in enthalpy for a chemical reaction?