

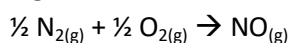
# Bond Energy and the Types of Reactions

## Homework – Teacher’s Edition

Use the bond enthalpies in the following table to answer the questions which follow:

H—H	436	N≡N	945	O=O	498	N—H	391
C—H	414	O—H	463	C=O	804	C—O	358
Cl—Cl	242	C—Cl	327	H—Cl	431		
F—F	159	H—F	567	C—F	489		
C—Br	285	H—Br	366	N=O	632		

1. Nitrogen oxide (NO), is formed during electrical storms, The equation for this reaction is:



Complete each of the tasks to calculate the bond enthalpy for the above reaction.

- a) Complete the table to show the energy absorbed by each of the bonds in reaction when they are broken

Reactant	Number of bonds	Enthalpy of bonds broken	Total enthalpy
N <sub>2</sub>			
O <sub>2</sub>			

- b) Calculate the total energy required

- c) Complete the table to show the energy released by each of the bonds in reaction when they are formed

Product	Number of bonds	Enthalpy of bonds formed	Total enthalpy
NO			

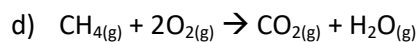
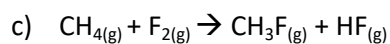
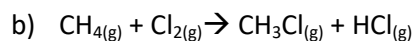
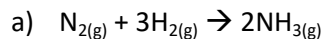
- d) How much energy is released?

- e) Calculate the enthalpy change in the reaction.

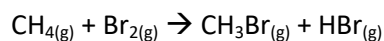
# Bond Energy and the Types of Reactions

## Homework – Teacher’s Edition

2. Calculate the enthalpy change for each of the following reactions:



3. The reaction between bromine and methane is as follows:



If the enthalpy change for the reaction is  $-45 \text{ kJ mol}^{-1}$ , calculate the bond energy for Br—Br.

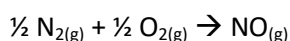
# Bond Energy and the Types of Reactions

## Homework – Teacher’s Edition

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H—H	436	N≡N	945	O=O	498	N—H	391
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Cl—Cl	242	C—Cl	327	H—Cl	431		
F—F	159	H—F	567	C—F	489		
C—Br	285	H—Br	366	N=O	632		

1. Nitrogen oxide (NO), is formed during electrical storms, The equation for this reaction is:



Complete each of the tasks to calculate the bond enthalpy for the above reaction.

- a) Complete the table to show the energy absorbed by each of the bonds in reaction when they are broken

Reactant	Number of bonds	Enthalpy of bonds broken	Total enthalpy
N <sub>2</sub>	0.5 x N≡N	0.5 x 945 = kJ mol <sup>-1</sup>	472.5 kJ
O <sub>2</sub>	0.5 x O=O	0.5 x 498 = kJ mol <sup>-1</sup>	249 kJ

- b) Calculate the total energy required

$$472.5 \text{ kJ} + 249 \text{ kJ} = 721.5 \text{ kJ}$$

- c) Complete the table to show the energy released by each of the bonds in reaction when they are formed

Product	Number of bonds	Enthalpy of bonds formed	Total enthalpy
NO	1 x N=O	632	632

- d) How much energy is released?

$$632$$

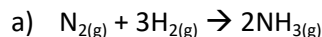
- e) Calculate the enthalpy change in the reaction.

$$721.5 - 632 = 89.5 \text{ kJ}$$

# Bond Energy and the Types of Reactions

## Homework – Teacher’s Edition

2. Calculate the enthalpy change for each of the following reactions:



Bonds broken:

$$3 \times \text{H—H} = 3 \times 436 = 1308$$

$$\text{N}\equiv\text{N} = 945$$

Total energy required to break bonds =

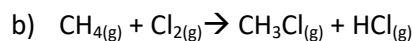
$$1308 + 945 = 2253 \text{ kJ}$$

Bonds formed:

$$6 \times \text{N—H} = 6 \times 391 = 2346$$

Total enthalpy change:

$$2253 - 2346 = -93 \text{ kJ mol}^{-1}$$



Bonds broken:

$$4 \times \text{C—H} = 4 \times 414 = 1656$$

$$\text{Cl—Cl} = 242$$

Total energy required to break bonds =

$$1656 + 242 = 1898 \text{ kJ}$$

Bonds formed:

$$3 \times \text{C—H} = 3 \times 414 = 1242$$

$$1 \times \text{C—Cl} = 327$$

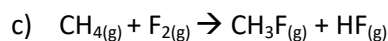
$$1 \times \text{H—Cl} = 431$$

Total energy released =

$$1242 + 327 + 431 = 2000 \text{ kJ}$$

Total enthalpy change =

$$1898 - 2000 = -102 \text{ kJ mol}^{-1}$$



Bonds broken:

$$4 \times \text{C—H} = 4 \times 414 = 1656$$

$$\text{F—F} = 159$$

Total energy required to break bonds =

$$1656 + 159 = 1815$$

Bonds formed:

$$3 \times \text{C—H} = 3 \times 414 = 1242$$

$$1 \times \text{C—F} = 489$$

$$1 \times \text{H—F} = 567$$

Total energy required to form bonds =

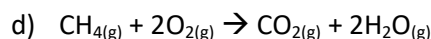
# Bond Energy and the Types of Reactions

## Homework – Teacher’s Edition

$$1242 + 489 + 567 = 2298 \text{ kJ mol}^{-1}$$

Total enthalpy change =

$$1815 - 2298 = -483 \text{ kJ mol}^{-1}$$



Bonds broken:

$$4 \times \text{C—H} = 4 \times 414 = 1656$$

$$2 \times \text{O=O} = 2 \times 498 = 996$$

Total energy needed to break bonds =

$$1656 + 996 = 2652 \text{ kJ mol}^{-1}$$

Bonds formed:

$$2 \times \text{C=O} = 2 \times 804 = 1608$$

$$4 \times \text{O—H} = 4 \times 463 = 1852$$

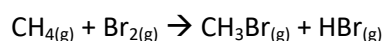
Total energy released when bonds form =

$$1608 + 1852 = 3460 \text{ kJ mol}^{-1}$$

Total enthalpy change =

$$2652 - 3460 = -808 \text{ kJ mol}^{-1}$$

3. The reaction between bromine and methane is as follows:



If the enthalpy change for the reaction is  $-45 \text{ kJ mol}^{-1}$ , calculate the bond energy for Br—Br.

Bonds broken:

$$4 \times \text{C—H} = 4 \times 414 = 1656$$

$$E_{\text{Br—Br}} = ?$$

Bonds formed:

$$3 \times \text{C—H} = 3 \times 414 = 1242$$

$$\text{C—Br} = 285$$

$$\text{H—Br} = 366$$

Total bonds formed =

$$1242 + 285 + 366 = 1893 \text{ kJ mol}^{-1}$$

$$E_{\text{Br—Br}} = -45 - 1893 - 1656$$

$$E_{\text{Br—Br}} = 192 \text{ kJ mol}^{-1}$$