PROBLEM 1

Using the bond energies in Table 7.3.1, determine the approximate enthalpy change for each of the following reactions:

a. $\text{H}_2(g) + \text{Br}_2(g) \rightarrow 2\text{HBr}(g)$
b. $\text{CH}_4(g) + \text{I}_2(g) \rightarrow \text{CH}_3\text{I}(g) + \text{HI}(g)$
c. $\text{C}_2\text{H}_4(g) + 3\text{O}_2(g) \rightarrow 2\text{CO}_2(g) + 2\text{H}_2\text{O}(g)$

Answer a

$-114 \text{ kJ}$

Answer b

$30 \text{ kJ}$

Answer c

$-1055 \text{ kJ}$

PROBLEM 2

Using the bond energies in Table 7.3.1, determine the approximate enthalpy change for each of the following reactions:

a. $\text{H}_2\text{C=CH}_2(g) + \text{H}_2(g) \rightarrow \text{H}_3\text{CCH}_3(g)$
b. $2\text{C}_2\text{H}_6(g) + 7\text{O}_2(g) \rightarrow 4\text{CO}_2(g) + 6\text{H}_2\text{O}(g)$

Answer a

$-128 \text{ kJ}$

Answer b

$-5175 \text{ kJ}$
PROBLEM \( \PageIndex{3} \)

How does the bond energy of HCl differ from the standard enthalpy of formation of HCl(\(g\))?

**Answer**

The enthalpy of formation is -431.6 kJ, while the bond energy of H-Cl is -432 kJ. They are practically the same.

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PROBLEM \( \PageIndex{4} \)

Using the standard enthalpy of formation data in Appendix \(G\), show how the standard enthalpy of formation of HCl(\(g\)) can be used to determine the bond energy.

**Answer**

\[
\begin{align*}
\ce{HCl}(g) &= \frac{1}{2}\ce{H_2}(g) + \frac{1}{2}\ce{Cl_2}(g) \\
&\hspace{20px} \Delta H^\circ_1 = -\Delta H^\circ_{\text{f}\ce{HCl}(g)} \\
\frac{1}{2}\ce{H_2}(g) &= \ce{H}(g) \\
&\hspace{105px} \Delta H^\circ_2 = \Delta H^\circ_{\text{f}\ce{H}(g)} \\
\frac{1}{2}\ce{Cl_2}(g) &= \ce{Cl}(g) \\
&\hspace{99px} \Delta H^\circ_3 = \Delta H^\circ_{\text{f}\ce{Cl}(g)}
\end{align*}
\]

\[
\ce{HCl}(g) = \ce{H}(g) + \ce{Cl}(g) \\
\Delta H^\circ_{298} = \Delta H^\circ_1 + \Delta H^\circ_2 + \Delta H^\circ_3
\]

\[
D_{\ce{HCl}} = \Delta H^\circ_{298} = \Delta H^\circ_{\text{f}\ce{HCl}(g)} + \Delta H^\circ_{\text{f}\ce{H}(g)} + \Delta H^\circ_{\text{f}\ce{Cl}(g)}
\]

\[
= \text{\texttt{mathrm}}(-(-92.307\text{kJ}) + 217.97\text{kJ} + 121.3\text{kJ})
\]

\[
&= \text{\texttt{mathrm}}(431.6\text{kJ})
\]
PROBLEM \(\PageIndex{5}\)

Using the standard enthalpy of formation data in Appendix G, determine which bond is stronger: the S–F bond in SF\(_4\)(g) or in SF\(_6\)(g)?

**Answer**

The S–F bond in SF\(_4\) is stronger.

PROBLEM \(\PageIndex{6}\)

Complete the following Lewis structure by adding bonds (not atoms), and then indicate the longest bond:

\[
\begin{align*}
\text{H} & \quad \text{H} & \quad \text{H} \\
\text{H} & \quad \text{C} & \quad \text{C} & \quad \text{C} & \quad \text{C} & \quad \text{C} & \quad \text{C} & \quad \text{C} & \quad \text{H} \\
\text{H} & \quad \text{H}
\end{align*}
\]

**Answer**

The C–C single bonds are longest.

PROBLEM \(\PageIndex{7}\)

Use principles of atomic structure to answer each of the following:

a. The radius of the Ca atom is 197 pm; the radius of the Ca\(^{2+}\) ion is 99 pm. Account for the difference.

b. The lattice energy of CaO(s) is –3460 kJ/mol; the lattice energy of K\(_2\)O is –2240 kJ/mol. Account for the difference.

c. Given these ionization values, explain the difference between Ca and K with regard to their first and second ionization energies.

<table>
<thead>
<tr>
<th>Element</th>
<th>First Ionization Energy (kJ/mol)</th>
<th>Second Ionization Energy (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K</td>
<td>419</td>
<td>3050</td>
</tr>
<tr>
<td>Ca</td>
<td>590</td>
<td>1140</td>
</tr>
</tbody>
</table>
d. The first ionization energy of Mg is 738 kJ/mol and that of Al is 578 kJ/mol. Account for this difference.

**Answer a**

When two electrons are removed from the valence shell, the Ca radius loses the outermost energy level and reverts to the lower \( n = 3 \) level, which is much smaller in radius.

**Answer b**

The +2 charge on calcium pulls the oxygen much closer compared with K, thereby increasing the lattice energy relative to a less charged ion.

**Answer c**

Removal of the 4s electron in Ca requires more energy than removal of the 4s electron in K because of the stronger attraction of the nucleus and the extra energy required to break the pairing of the electrons. The second ionization energy for K requires that an electron be removed from a lower energy level, where the attraction is much stronger from the nucleus for the electron. In addition, energy is required to unpair two electrons in a full orbital. For Ca, the second ionization potential requires removing only a lone electron in the exposed outer energy level.

**Answer d**

In Al, the removed electron is relatively unprotected and unpaired in a \( p \) orbital. The higher energy for Mg mainly reflects the unpairing of the 2s electron.

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- Adelaide Clark, Oregon Institute of Technology

**Feedback**

Think one of the answers above is wrong? Let us know [here](http://cnx.org/contents/85abf193-2bd...a7ac8df6@9.110).