PROBLEM \PageIndex{1}

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

a. \(\ce{H2(g)+Br2(g)?2HBr(g)}\)
b. \(\ce{CH4(g)+I2(g)?CH3I(g)+HI(g)}\)
c. \(\ce{C2H4(g)+3O2(g)?2CO2(g)+2H2O(g)}\)

Answer a
-114 kJ

Answer b
30 kJ

Answer c
-1055 kJ

PROBLEM \PageIndex{2}

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

a. \(\ce{H2C=CH2(g)+H2(g)?CH3CH3(g)}\)
b. \(\ce{2C2H6(g)+7O2(g)?4CO2(g)+6H2O(g)}\)

Answer a
-128 kJ

Answer b
-5175 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.

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

\[
\begin{align*}
D_{\text{HCl}} &= ΔH^\circ_{298} = ΔH^\circ_{\text{f[HCl}(g)])} + ΔH^\circ_{\text{f[H}(g)])} + ΔH^\circ_{\text{f[Cl}(g)])} \\
&= \text{mathrm}{−(−92.307\text{kJ}) + 217.97\text{kJ} + 121.3\text{kJ}} \\
&= \text{mathrm}{431.6\text{kJ}}
\end{align*}
\]
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:

\[
\begin{array}{ccccccc}
  & & \text{H} & & \text{H} & & \text{H} \\
\text{H} & & \text{C} & & \text{C} & & \text{C} \\
\text{H} & & & & \text{C} & & \text{C} \\
\text{H} & & & & & & \text{H} \\
\end{array}
\]

**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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Have a video solution request?

Let your professors know here.

***Please know that you are helping future students - videos will be made in time for next term's class.

Contributors

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- Adelaide Clark, Oregon Institute of Technology

Feedback

Think one of the answers above is wrong? Let us know here.