Chapter 18

THE GROUP 18 ELEMENTS: THE NOBLE GASES

Exercises

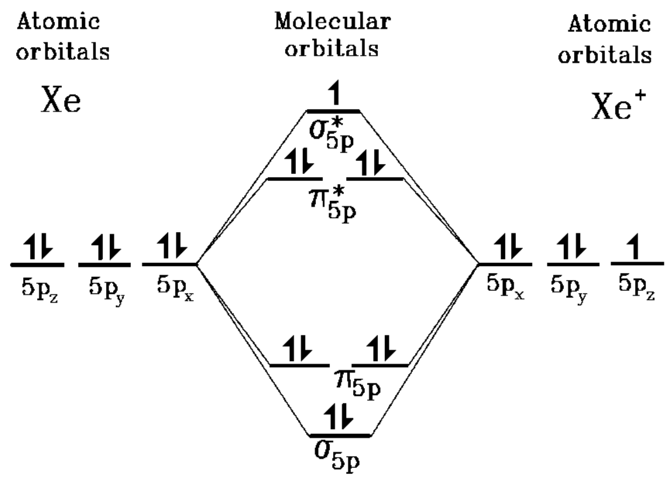
18.1 (a) $Xe(g) + 2\ F_2(g) \rightarrow XeF_4(s)$

(b) $XeF_4(s) + 2\ PF_3(g) \rightarrow 2\ PF_5(g) + Xe(g)$

18.3 Descending the group, the melting and boiling points increase, as do the densities.

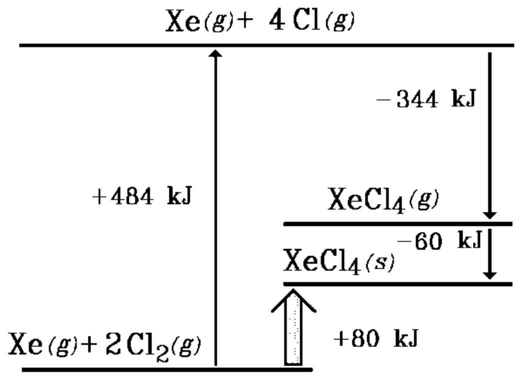
18.5 Helium cannot be solidified at any temperature under normal pressure; when cooled close to absolute zero, liquid helium (helium II) becomes an incredible thermal conductor and its viscosity drops to close to zero.

18.7 Assuming the molecular orbitals formed from 5*p* atomic orbitals are similar to those formed from 2*p* atomic orbitals, we can construct the following diagram and deduce that the bond order must be ½.



18.9 The thermodynamic factors are the weakness of the fluorine-fluorine bond that has to be broken in the energy cycle and the comparative strength of the xenon-fluorine bond that is formed.

18.11



18.13 The double-bond structure has zero formal charge while the single-bond representation has a negative charge on the oxygen and a positive charge on the xenon. Thus the double-bonded structure probably makes a major contribution to the bonding.

18.15 Using the calculation method:

(a) $[N_{ox}(Xe)] + 3(-1) = +1$

$[N_{ox}(Xe)] = +4$

(b) $[N_{ox}(Xe)] + 5(-1) = +1$

$[N_{ox}(Xe)] = +6$

(c) $[N_{ox}(Xe)] + 6(-2) = -4$

$[N_{ox}(Xe)] = +8$

18.17 Rubidium or cesium, because a large low-charge cation is needed to stabilize a large low-charge anion.

18.19 Half reactions:

$Au \rightarrow Au^{5+} + 5\ e^-$

$KrF_2 + 2\ e^- \rightarrow Kr + 2\ F^-$

Redox reaction:

$2\ Au + 5\ KrF_2 \rightarrow 2\ AuF_5 + 5\ Kr$

Plus two extra KrF_2 to result in salt formation:

$2\ Au + 7\ KrF_2 \rightarrow 2\ (KrF)^+(AuF_6^-) + 5\ Kr$

18.21 $Xe(g) + F_2(g) \rightarrow XeF_2(s)$

$2\ XeF_2(s) + 2\ H_2O(l) \rightarrow 2\ Xe(g) + O_2(g) + 4\ HF(l)$

$Xe(g) + 2\ F_2(g) \rightarrow XeF_4(s)$

$Xe(g) + 3\ F_2(g) \rightarrow XeF_6(s)$

$XeF_6(s) + H_2O(l) \rightarrow XeOF_4(l) + 2\ HF(l)$

$XeOF_4(l) + 2\ H_2O(l) \rightarrow XeO_3(s) + 4\ HF(l)$

$XeO_3(s) + OH^-(aq) \rightarrow HXeO_4^-(aq)$

$2\ HXeO_4^-(aq) + 2\ OH^-(aq) \rightarrow XeO_6^{4-}(aq) + Xe(g) + O_2(g) + H_2O(l)$

$XeO_6^{4-}(aq) + 2\ Ba^{2+}(aq) \rightarrow Ba_2XeO_6(s)$

$Ba_2XeO_6(s) + 2\ H_2SO_4(aq) \rightarrow 2\ BaSO_4(s) + XeO_4(g) + 2\ H_2O(l)$

Beyond the Basics

18.23 $XeF_2(SbF_5) + SbF_5(l) \rightarrow XeF^+(SbF_5) + SbF_6^-(SbF_5)$

18.25 $Ar(g) + F_2(g) \rightarrow ArF_2(g)$

Even assuming argon difluoride would be a gas, there is a decrease in entropy in the synthesis. Thus the enthalpy change has to be less than zero (exothermic). Assuming zero is the limiting value, we can construct an energy cycle. Thus the Ar–F bond energy can be no more than 77.5 $kJ \cdot mol^{-1}$.