**A Broken Rule: Chemical Reactions of the Noble Gases**

**Discovery of “Inert” Gases**
The noble gas elements (helium, neon, argon, krypton, xenon, and radon) were identified in the eighteenth and nineteenth centuries. However, the ability of noble gases to combine with other elements was discovered less than 50 years ago when the first noble gas compounds were produced. These discoveries illustrate that chemistry is a constantly changing science.

The noble gases were long known as inert gases because of their particularly stable and unreactive structures. The first clues to their existence actually arose from their lack of reactivity. English scientist Henry Cavendish identified a small component of air that did not undergo certain chemical reactions common for the elements thought to be present in air (oxygen, nitrogen, and hydrogen). However, the unreacted portion was not identified as a new element until more than a century later when Lord Rayleigh and Sir William Ramsay repeated Cavendish’s experiment using new analysis techniques.

Because of the noble gases’ history of inactivity, most chemists prior to the 1960s believed that these gases were not capable of forming compounds. This belief continues to influence our understanding of chemistry. The reactivity of atoms is still partly attributed to the stability an atom has when the outer electron shell is completely filled, as it is in the noble gases.

**Noble Gases React**
The belief that noble gases were inert was shattered in 1962 when the first compound containing a noble gas element was prepared by Neil Bartlett, then a professor at the University of British Columbia. He was studying the chemical reaction between molecular oxygen (O₂) and platinum hexafluoride (PtF₆), which is an extremely strong oxidant. (An oxidant is a compound that has the ability to take electrons away from other compounds.) Realizing that xenon and oxygen gas have similar abilities for giving up electrons (ionization potentials), Bartlett hoped that PtF₆ might also react with xenon. He placed colorless xenon gas in one tube that was separated by a seal from a second tube containing the red PtF₆. When the seal was broken, the gases mixed, and a yellow solid formed. This solid was xenon hexafluoroplatinate, the first noble gas compound!

**Noble Gas Compounds**
Bartlett’s amazing discovery that the “inert” gases were not completely inert caused great excitement. In less than two years, other researchers discovered that other noble gas compounds, such as xenon tetrafluoride (XeF₄) and krypton difluoride (KrF₂), could be prepared by reacting xenon or krypton with fluorine gas.

The simple compounds made of xenon and fluorine are stable solids at normal temperatures, as long as they are kept away from water or other compounds with which they react. However, other noble gas compounds that were discovered during the 1960s are not stable. Xenon trioxide, which forms when xenon tetrafluoride reacts with water, is highly unstable and explosive.

Chemists are still actively studying the reactivity of the noble gases. Recently, an argon compound was identified at very low temperatures. However, there are still no known stable compounds of helium or neon.

Today the noble gas elements have many important applications, such as neon lights and gas lasers. In contrast, the noble gas compounds have yet to be developed to solve any specific technological problems. However, the fluorine atoms in xenon hexafluoride and similar compounds will bond to organic molecules, which may be useful for drug preparation.

**Questions**

1. Because radon is a noble gas, it is considered chemically inert. However, this element is often in the news. Why is radon a safety concern?

2. Given that XeF₄ reacts with water to form explosive XeO₃, chemists would not handle it near water. However, why would you still not want to work with it on the lab bench, even if there was apparently no water around?