Okay, helium balloons are light, but they’re not that light! The fanciful picture below serves to make the point that helium is one of the lightest elements. Helium belongs to a group of elements called the noble gases.

Figure 6.11.1: Helium is one of the lightest elements in the periodic table.

What Are Noble Gases?

Noble gases are nonreactive, nonmetallic elements in group 18 of the periodic table. As you can see in the periodic table in the figure below, noble gases include helium (\( \text{He} \)), neon (\( \text{Ne} \)), argon (\( \text{Ar} \)), krypton (\( \text{Kr} \)), xenon (\( \text{Xe} \)), and radon (\( \text{Rn} \)). All noble gases are colorless and odorless. They also have low boiling points, explaining why they are all gases at room temperature. Radon, at the bottom of the group, is radioactive, so it constantly decays to other elements.

Figure 6.11.2: Noble gases are in group 18 of the periodic table, in this case the red column on the far right.
Chemical Properties of Noble Gases

Noble gases are the least reactive of all known elements. That's because with eight valence electrons, their outer energy levels are full. The only exception is helium, which has just two electrons. But helium also has a full outer energy level, because its only energy level (energy level 1) can hold a maximum of two electrons. A full outer energy level is the most stable arrangement of electrons. As a result, noble gases cannot become more stable by reacting with other elements and gaining or losing valence electrons. Therefore, noble gases are rarely involved in chemical reactions and almost never form compounds with other elements.

Noble Gases and the Octet Rule

Because the noble gases are the least reactive of all elements, their eight valence electrons are used as the standard for nonreactivity and to explain how other elements interact. This is stated as the octet ("group of eight") rule. According to this rule, atoms react to form compounds that allow them to have a group of eight valence electrons like the noble gases. For example, sodium (with one valence electron) reacts with chlorine (with seven valence electrons) to form the stable compound sodium chloride (table salt). In this reaction, sodium donates an electron and chlorine accepts it, giving each element an octet of valence electrons.

Some Uses of Noble Gases

Did you ever get helium balloons like those in the opening picture? Unlike a balloon filled with air, a balloon filled with helium needs to be weighted down so it won't float away - although you don't have to use an elephant!

Early incandescent light bulbs, like the one pictured in the figure below, didn't last very long. The filaments quickly burned out. Although air was pumped out of the bulb, it wasn't a complete vacuum. Oxygen in the small amount of air remaining inside the light bulb reacted with the metal filament. This corroded the filament and caused dark deposits on the glass. Filling a light bulb with argon gas prevents these problems. That's why modern light bulbs are filled with argon.
Modern light bulbs are filled with the noble gas argon to prevent corrosion of the filament inside.

Noble gases are also used to fill the glass tubes of lighted signs like the one in the figure below. Although noble gases are chemically nonreactive, their electrons can be energized by sending an electric current through them. When this happens, the electrons jump to a higher energy level. When the electrons return to their original energy level, they give off energy as light. Different noble gases give off light of different colors. Neon gives off a reddish-orange light, like the word "Open" in the sign below. Krypton gives off violet light and xenon gives off blue light.

Signs like this one are filled with noble gases like neon or xenon, which give off light when energized.
Summary

- Noble gases are nonreactive, nonmetallic elements in group 18 of the periodic table.
- Noble gases are the least reactive of all elements. That's because they have eight valence electrons, which fill their outer energy level. This is the most stable arrangement of electrons, so noble gases rarely react with other elements and form compounds.
- The octet rule states that atoms react to form compounds that allow them to have eight valence electrons like the noble gases, which are the least reactive elements.
- Noble gases are used for balloons, light bulbs, and lighted signs.

Explore More

Watch the video about noble gases at the following URL, and then answer the questions below.

- http://www.open.edu/openlearn/scienc...ry/noble-gases

1. Compare and contrast the reactivity of the elements helium, neon, argon, krypton, and xenon.
2. Compare the density of these noble gases to the density of air.
3. Describe how the mass of noble gases changes from the top to the bottom of group 18.

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