

## 4.7 Hydrogen and Alkali Metals



You probably think of [water](#) as a substance that can put out fires. But some elements are so reactive that they burn in water. In fact, they virtually explode in water. That's what is happening in the photo above. About 3 pounds of sodium were added to water, and the result was this explosive reaction. Why is sodium such a reactive [element](#)? In this lesson you will find out.

### The First Group

Sodium (Na) is an [element](#) in group 1 of the periodic table of the elements. This group (column) of the table is shown in **Figure below**. It includes the nonmetal hydrogen (H) and six [metals](#) that are called **alkali metals**. Elements in the same group of the periodic table have the same number of [valence electrons](#). These are the electrons in their outer [energy level](#) that can be involved in chemical reactions. Valence electrons determine many of the properties of an [element](#), so elements in the same group have similar properties. All the elements in group 1 have just one valence [electron](#). This makes them very reactive.

**Q:** Why does having just one valence [electron](#) make group 1 elements very reactive?

**A:** With just one valence [electron](#), group 1 elements are “eager” to lose that electron. Doing so allows them to achieve a full outer [energy level](#) and maximum stability.

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$\text{H}^1$ Hydrogen
$\text{Li}^3$ Lithium
$\text{Na}^{11}$ Sodium
$\text{K}^{19}$ Potassium
$\text{Rb}^{37}$ Rubidium
$\text{Cs}^{55}$ Cesium
$\text{Fr}^{87}$ Francium

### Reactivity of Group 1 Elements

Hydrogen is a very reactive [gas](#), and the alkali metals are even more reactive. In fact, they are the most reactive metals and, along with the elements in group 17, are the most reactive of all elements. The reactivity of alkali metals increases from the top to the bottom of the group, so lithium (Li) is the least reactive alkali metal and francium (Fr) is the most reactive. Because alkali metals are so reactive, they are found in nature only in combination with other elements. They often combine with group 17 elements, which are very “eager” to gain an electron.

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## Other Properties of Alkali Metals

Besides being very reactive, alkali metals share a number of other properties.

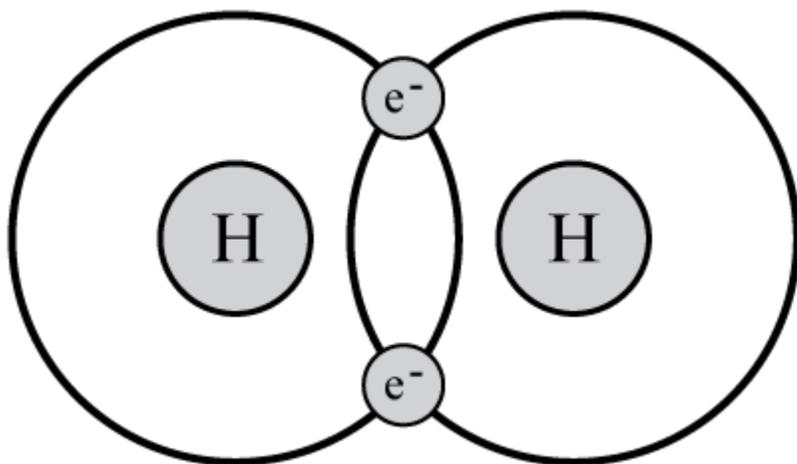
- Alkali metals are all solids at room [temperature](#).
- Alkali metals are low in density, and some of them float on [water](#).
- Alkali metals are relatively soft. Some are even soft enough to cut with a knife, like the sodium pictured in the **Figure** [below](#).



## A Closer Look

Although all group 1 elements share certain properties, such as being very reactive, they are not alike in every way. Three different group 1 elements are described in more detail below. Notice the ways in which they differ from one another.

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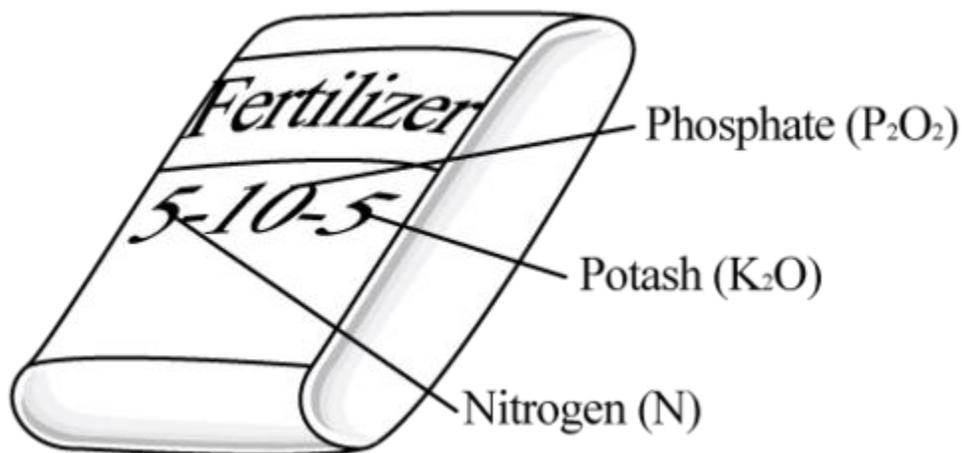
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Hydrogen has the smallest, lightest atoms of all elements. Pure hydrogen is a colorless, odorless, tasteless gas that is nontoxic but highly flammable. Hydrogen gas exists mainly as diatomic (“two-atom”) molecules (H<sub>2</sub>), as shown in the diagram on the right. Hydrogen is the most abundant element in the universe and the third most abundant element on Earth, occurring mainly in compounds such as water.

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**Q:** Why do you think hydrogen [gas](#) usually exists as diatomic molecules?

**A:** Each hydrogen [atom](#) has just one electron. When two hydrogen atoms bond together, they share a pair of electrons. The shared electrons fill their only [energy level](#), giving them the most stable arrangement of electrons.

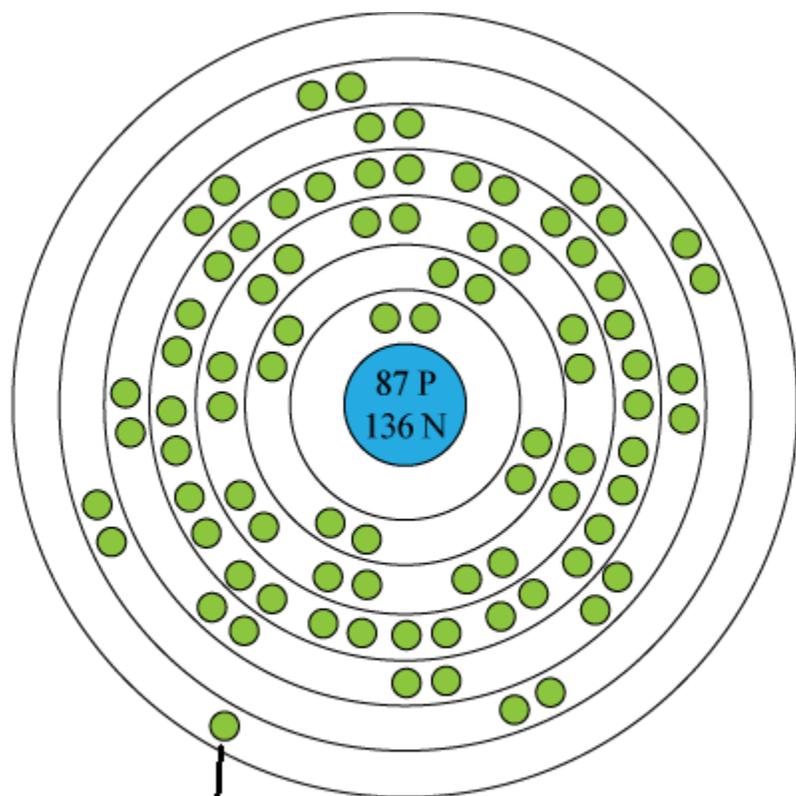


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Potassium is a soft, silvery metal that ignites explosively in water. It easily loses its one valence electron to form positive potassium ions (K<sup>+</sup>), which are needed by all living cells. Potassium is so important for plants that it is found in almost all fertilizers, like the one shown here. Potassium is abundant in Earth’s crust in minerals such as feldspar.

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## 4.7 Hydrogen and Alkali Metals



Francium's one Valence Electron

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Francium has one of the largest, heaviest atoms of all elements. Its one valence electron is far removed from the nucleus, as you can see in the atomic model on the right, so it is easily removed from the atom. Francium is radioactive and quickly decays to form other elements such as radium. This is why francium is extremely rare in nature. Less than an ounce of francium is present on Earth at any given time.

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**Q:** Francium decays too quickly to form compounds with other elements. Which elements do you think it would bond with if it could?

**A:** With one valence electron, francium would bond with a halogen element in group 17, which has seven [valence electrons](#) and needs one more to fill its outer energy level. Elements in group 17 include fluorine and chlorine.

### Summary

- Group 1 of the periodic table includes hydrogen and the alkali metals.
- Because they have just one valence electron, group 1 elements are very reactive. As a result, they are found in nature only in combination with other elements.
- Alkali metals are all solids at room [temperature](#). They are relatively soft and low in density.

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- From the top to the bottom of group 1, the elements have heavier, more reactive atoms.

## Review

1. What are alkali metals?
2. Why is hydrogen, a nonmetal, placed in the same group as the alkali metals?
3. Explain why group 1 elements often form compounds with elements in group 17.
4. Compare and contrast hydrogen and francium.

## Resources

<https://youtu.be/uixxJtJPVXk>