This page describes the reactions of the Period 3 elements from sodium to argon with water, oxygen and chlorine.

Reactions with water

**Sodium:** Sodium reacts with cold water, producing hydrogen and a colorless solution of sodium hydroxide:

\[2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2\]

This reaction is very exothermic.

**Magnesium:** Magnesium has a very mild reaction with cold water. A very clean coil of magnesium dropped into cold water develops a layer of small bubbles of hydrogen, which floats it to the surface. A very thin layer of magnesium hydroxide is forms on the metal and stops the reaction (this process is called passivation).

\[\text{Mg} + 2\text{H}_2\text{O} \rightarrow \text{Mg(OH)}_2 + \text{H}_2\]

Magnesium also burns in water vapor with its characteristic white flame to produce white magnesium oxide and hydrogen.

\[\text{Mg} + \text{H}_2\text{O} \rightarrow \text{MgO} + \text{H}_2\]

**Note:** When heating the magnesium in a glass tube, the magnesium also reacts with the glass, leaving dark grey products (including silicon and perhaps boron from the glass) as well as the white magnesium oxide.

**Aluminum:** Aluminum powder heated in water vapor produces hydrogen and aluminum oxide. The reaction is relatively slow because of the existing strong aluminum oxide layer on the metal, and the build-up of more oxide during the reaction.

\[2\text{Al} + 3\text{H}_2\text{O} \rightarrow \text{Al}_2\text{O}_3 + 3\text{H}_2\]

**Silicon:** Sources disagree about what silicon does with water or steam. The reaction seems to depend on the form of silicon. Monocrystalline silicon is fairly unreactive. Most sources suggest that this form of silicon will react with steam at red heat to produce silicon dioxide and hydrogen.

\[\text{Si} + 2\text{H}_2\text{O} \rightarrow \text{SiO}_2 + 2\text{H}_2\]

It is possible to make more reactive forms of silicon which will react with cold water to give the same products.

**Phosphorus and sulfur:** These have no reaction with water.

**Chlorine:** Chlorine dissolves in water to give a green solution. A reversible reaction produces a mixture of hydrochloric acid and chloric(I) acid (hypochlorous acid).

\[2\text{Cl}_2 + 2\text{H}_2\text{O} \leftrightarrow \text{HCl} + \text{HOCl}\]

In the presence of sunlight, the chloric(I) acid slowly decomposes to produce more hydrochloric acid, releasing oxygen gas:
\[ 2\text{Cl}_2 + 2\text{H}_2\text{O} \rightarrow 4\text{HCl} + \text{O}_2 \]

**Argon:** There is no reaction between argon and water.

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**Reactions with oxygen**

**Sodium:** Sodium burns in oxygen with an orange flame to produce a white solid mixture of sodium oxide and sodium peroxide.

For the simple oxide:

\[ 4\text{Na} + \text{O}_2 \rightarrow 2\text{Na}_2\text{O} \]

For the peroxide:

\[ 2\text{Na} + \text{O}_2 \rightarrow 2\text{Na}_2\text{O}_2 \]

**Magnesium:** Magnesium burns in oxygen with an intense white flame to give white solid magnesium oxide.

\[ 2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO} \]

**Note:** If magnesium is burns in air rather than in pure oxygen, it also reacts with the nitrogen in the air, forming a mixture of magnesium oxide and magnesium nitride.

**Aluminum:** Powdered aluminum burns in oxygen if it is powdered; in other forms the strong oxide layer on the aluminum inhibits the reaction. Aluminum powder sprinkled into a Bunsen flame produces white sparkles. White aluminum oxide is formed.

\[ 4\text{Al} + 3\text{O}_2 \rightarrow 2\text{Al}_2\text{O}_3 \]

**Silicon:** Silicon burns in oxygen if heated strongly enough, producing silicon dioxide:

\[ \text{Si} + \text{O}_2 \rightarrow \text{SiO}_2 \]

**Phosphorus:** White phosphorus ignites spontaneously in air, burning with a white flame and producing clouds of white smoke, a mixture of phosphorus(III) oxide and phosphorus(V) oxide. The proportions of these products depend on the amount of oxygen available. In an excess of oxygen, the product is almost entirely phosphorus(V) oxide.

For the phosphorus(III) oxide:

\[ \text{P}_4 + 3\text{O}_2 \rightarrow \text{P}_4\text{O}_6 \]

For the phosphorus(V) oxide:

\[ \text{P}_4 + 5\text{O}_2 \rightarrow \text{P}_4\text{O}_{10} \]

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**Contributors**