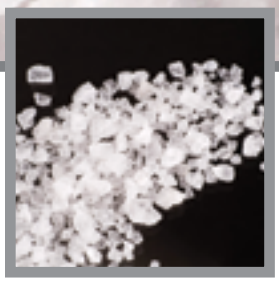
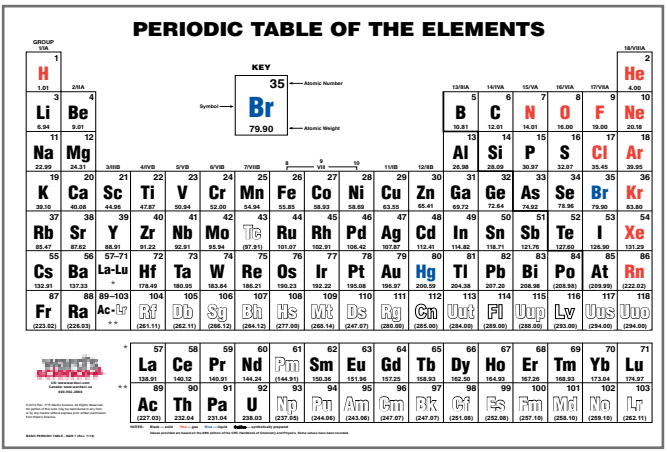


All About Elements:

Sodium

Ward's All About Elements Series

Building Real-World Connections to the Building Blocks of Chemistry



The periodic table of elements is an essential part of any chemistry classroom or science lab, but have you ever stopped to wonder about all of the amazing ways each element is used to create the world around us? Each of the trillions of substances in our universe can be tied back to just these 118 simple, yet powerful elements.

In our ***All About Elements*** series, we've brought together the most fascinating facts and figures about your favorite elements so students can explore their properties and uses in the real world and you can create chemistry connections in your classroom and beyond.

Look for a new featured element each month, plus limited-time savings on select hands-on materials to incorporate these elements in your lessons.

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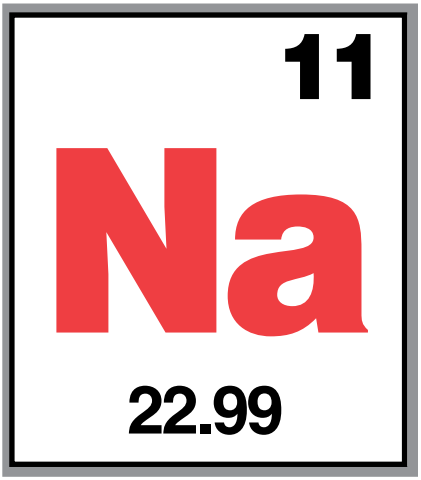
Fun Facts About... Sodium



1. Sodium comprises 2.6% of the earth's crust although it is never found in nature in its elemental form.

2. The first recorded mention of a sodium compound was in the time of the Pharaohs in Ancient Egypt.

3. A sodium-vapor lamp is a gas-discharge lamp that uses sodium in an excited state to produce light.

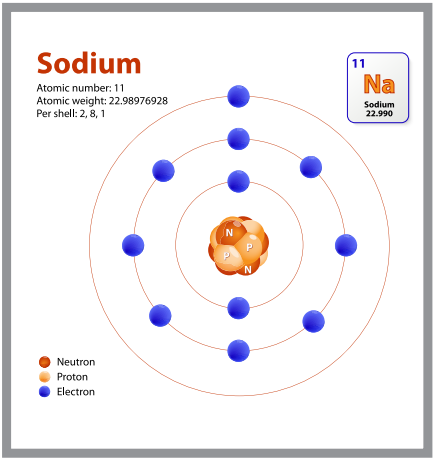
4. According to the Salt Institute, the United States applies roughly 20,000,000 tons of road salt on our roadways every winter. That's 124 pounds of salt for every one of the 322 million people in the United States.

5. The body requires sodium ions to maintain blood pressure and for normal nerve and muscle function. Adult intake of salt should be about 2300 mg per day. In fact, in the US, intake is 3400 mg/day.

All About Sodium:

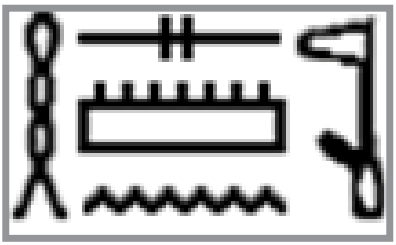
Sodium is the eleventh element on the Periodic Table. It's electron configuration is

$1s^2$, $2s^2$, $2p^6$, $3s^1$. Just like the other alkali metals in Group 1A, it is a very reactive element, losing one electron to form the Na+1 ion. In its elemental form, it is a shiny, silver material, but turns dull gray quickly due to reaction with oxygen and water vapor in the air. In the laboratory, it is kept under mineral oil in order to prevent these reactions. Sodium comprises 2.6% of the earth's crust although it is never found in nature in its elemental form. Sodium's atomic mass is 22.99. It has only one stable isotope with 11protons and 12 neutrons in its nucleus. It is a relatively low melting metal with a melting point of 97.8˚C.



Properties of Sodium

Discovery and History



Salt (sodium chloride, NaCl) obtained from sea water has been known since prehistoric times and used as a flavoring agent. The first recorded mention of a sodium compound was in the time of the Pharaohs in Ancient Egypt in the form of hieroglyphics. The pictogram means divine or pure and also refers to washing soda, which is sodium carbonate (Na_2CO_3).

Soda or sodium carbonate was used in soap and in the process of mummification. Also, glass was made by mixing soda with lime (CaO). This kind of glass was made on a large scale as early as 1370BCE.

In medieval Europe, sodium carbonate was used as a cure for headaches, and so took the Latin name sodanum, from the Arabic suda, meaning headache. These names caused Sir Humphrey Davy, a British chemist to name the element sodium. Davy isolated sodium in 1807, by passing an electric current through caustic soda, or sodium hydroxide (NaOH). A variation of this process, called electrolysis, is still used today in the synthesis of sodium metal.

Reactions of Sodium

Similar to other alkali metals, when a piece of fresh cut sodium is dropped into water a violent reaction occurs. This exothermic process produces sodium hydroxide (NaOH) and hydrogen gas (H_2). The heat produced in this **exothermic** reaction may ignite the hydrogen gas producing an explosion. On a small scale, this is a favorite demo in a chemistry laboratory.

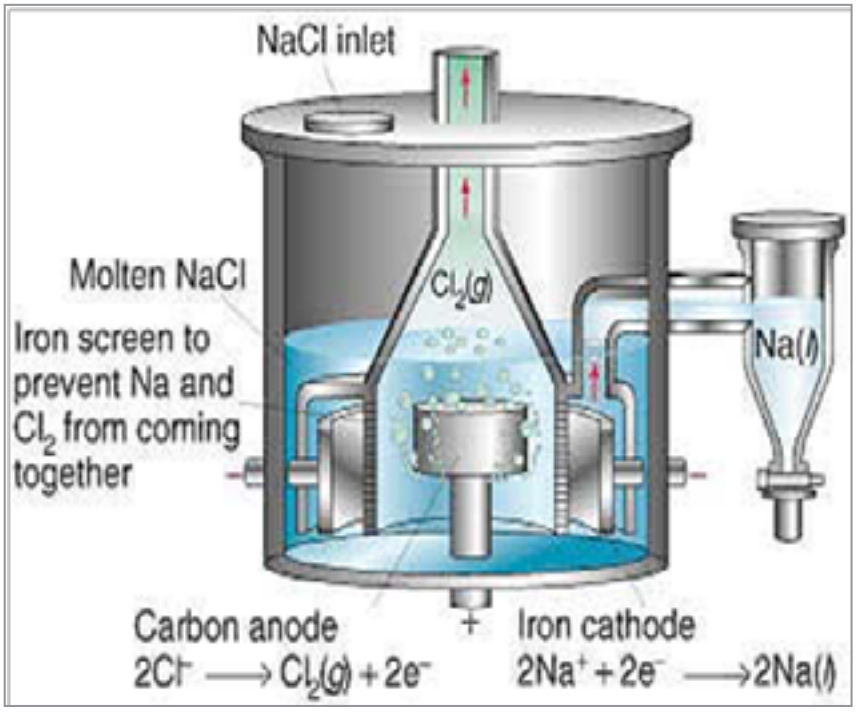
Sodium metal will also react with alcohols to form alkoxides and hydrogen gas. This reaction is slower than the reaction with water. Sodium readily reacts with non-metals such as the halogens, sulfur and oxygen to form ionic compounds

Commercial Synthesis of Sodium Metal

In the commercial preparation of sodium, molten NaCl is electrolyzed in a specially constructed cell called a Downs cell. Calcium chloride, $CaCl_2$, is added to lower the melting point of the cell material from the normal melting point of NaCl, 804°C, to around 600°C. The liquid sodium (Na) and gaseous chlorine (Cl_2) produced in the electrolysis are kept from coming in contact with each other. The sodium must also be prevented from contact with oxygen because the metal quickly oxidizes under the high-temperature conditions of the cell reaction. The electrolysis reaction can be written as:

$$2NaCl_{(l)} \text{ --> } 2Na_{(l)} + Cl_{2(g)}.$$

The cell is designed to collect sodium at the cathode and chlorine at the anode. No calcium metalis produced because the reduction of sodium ions occurs at a less negative cathode potential than does the reduction of calcium ions. Modern Downs cells operate at 25 to 40 kA and at potentials of 7 to 8 volts. The Downs cell is the major production process for sodium metal and is a minor source of industrial chlorine.



Uses of Sodium

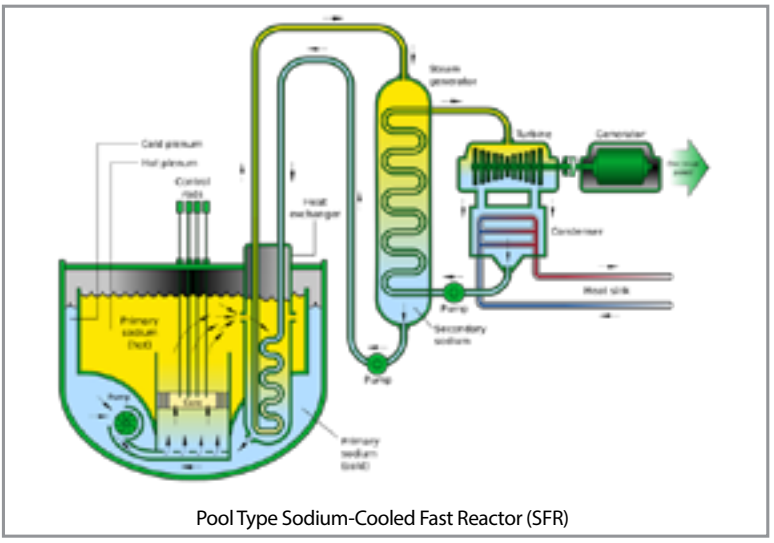
We can divide the uses of sodium into uses of the metal and uses and importance of sodium compounds or ions.

Sodium Metal

When alkali metals or metal compounds are excited, (placed in a flame or a voltage is applied), they emit light of characteristic colors. When compounds of sodium are used, the sodium cations are reduced to sodium metal atoms. The atoms gain energy to form an excited state. When these electrons return to the ground state, they emit yellow light of wavelength 589nm. A sodium-vapor lamp is a gas-discharge lamp that uses sodium in an excited state to produce light. These sodium lamps are highly efficient electrical light sources, but their yellow light limits applications to outdoor lighting such as street lamps.

(Nighttime Sodium Lights)

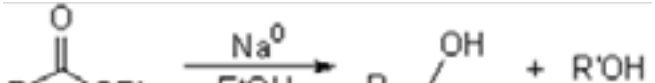
Interestingly, liquid sodium metal can be used to cool nuclear reactors, because it will not boil like water at the high temperatures produced. Sodium has a relatively high heat capacity which allows heat to be dissipated.



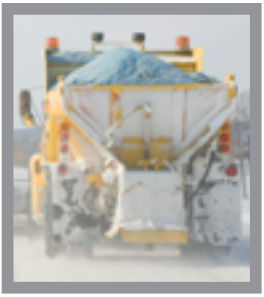
Pool Type Sodium-Cooled Fast Reactor (SFR)

Sodium metal is also used as a reducing agent in organic reactions. Some examples are:

$$CH_3C{\equiv}CCH_3 + Na(NH_3) \rightarrow \text{trans } CH_3CH{=}CHCH_3 + NaNH_2$$



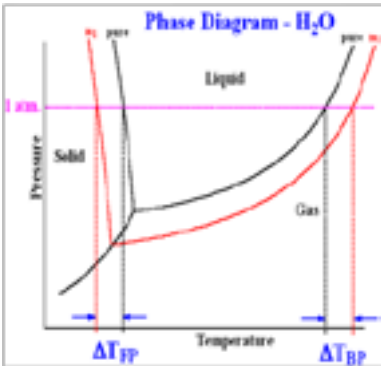
Metal Ions On the Road with Sodium Chloride



Those of us living in the northern US are familiar with salt (NaCl) used on our roads in winter. It makes a mess of our cars but it makes travel safer because it melts ice. The sodium chloride lowers the melting point temperature of ice. The foreign molecules dissolve in the water, but do not pack easily into the array of molecules in the solid.

$$H_2O(liquid) = H_2O(solid) + heat$$

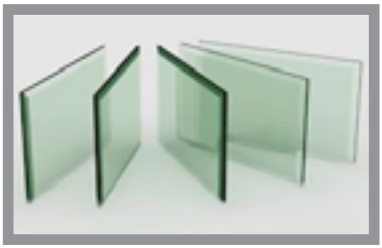
There are fewer molecules of water on the liquid side because some of the water has been replaced by salt. The equilibrium is shifted toward the liquid. It therefore requires a lower temperature for the water to freeze. A phase diagram can be used to explain the effect.



Note: Freezing point of water is reduced (ΔTFP) while boiling point is raised (ΔTBP)

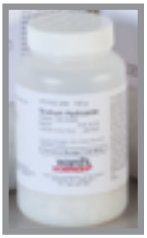
Soda-Lime Glass

Soda-lime glass (sounds like a drink) is the most common form of glass produced. It is composed of about 70 percent silica (silicon dioxide, SiO_2), 15 percent soda (sodium oxide, Na_2O), and 9 percent lime (calcium oxide, CaO). It is used for windowpanes and glass containers (bottles and jars) for drinks, and food.



Sodium Hydroxide

Sodium hydroxide (NaOH) is an important chemical in organic synthesis. It is also the key ingredient in drain cleaners. The sodium hydroxide can dissolve hair (containing proteins) and fats inside pipes by hydrolyzing them.



$$RCONH_2(amide\ or\ proteins) + Na_+ + OH- \rightarrow NH_3 + RCOO-Na_+$$

$$RCO_2R'(ester\ or\ fats) + Na_+ + OH- \rightarrow R'OH + RCOO-Na_+$$

The resulting sodium salts are more water soluble than the proteins or the fats, and hence the clog is gone!

Sodium Bicarbonate

Sodium bicarbonate ($NaHCO_3$) is baking soda. It decomposes above 70˚C to carbon dioxide, which makes dough rise.

Sodium Ions in the Body

IThe body requires sodium to maintain blood pressure and for normal nerve and muscle function. Getting too much sodium might cause high blood pressure problems that can lead to health problems and increased probability of heart attacks. It's easy to get enough sodium from the foods you eat. Intake of sodium for adults up to 50 years of ageshould be no more than 2,300 milligrams per day and 1,500 milligrams for adults over the age of 50. The average daily salt intake for Americans is about 3,400 mg per day. Processed foods and fast foods are high in sodium if they contain salt for flavoring or sodium benzoate or sodium phosphate as preservatives. For example, a foot long Italian sub might have as much as 3200 mg of sodium.

Fluid Balance

Sodium is an electrolyte, which means it is a mobile particle with a charge. Electrolytes are needed to control blood pressure and blood volume. The kidneys remove excess fluid from the body blood by osmosis.(The process of osmosis involves fluid being drawn across semi-permeable membranes like cell walls). A delicate balance of sodium ions and potassium ions in the blood stream is required for the right amount of fluid to be drawn from the blood into the kidneys and removed as urine. Too much sodium results in reduced passage of fluid, which results in high blood pressure.

Muscle and Nerve Function

Sodium is necessary for electrical impulses to travel along nerves and for muscle function. Sodium is pumped out of the cells, and potassium is pumped into the cells, creating an electrical charge,which leads to the transmission of impulses along nerves. This sodium-potassium pump is also necessary for muscles to contract.

Too Much Sodium

According to medical sources, getting too much sodium will cause high blood pressure in some people, and it will cause fluids to build up in the tissues of people with congestive heart failure, cirrhosis of the liver or kidney disease. High blood pressure can put a strain on the kidneys, arteries, heart and brain.

Sodium Ions in Pharmaceuticals

Sodium salts of pharmaceuticals containing carboxylic acid groups are often easier to manufacture because they are crystalline materials. More important they are more soluble and therefore much more effectively absorbed than the parent acid. For example, the NSAID, (Non-Steroidal Anti-inflammatory Drug),Naproxen, is usually used as its sodium salt, Naproxen Sodium.

Teach All About Sodium with these Hands-on Materials:

Save 13% on these items through January 2017 with promo code EOM16

SAVE 13%

Click item or search by item number to see complete product details and current pricing available at **wardsci.com.**

Sodium Hydroxide

Caustic Soda

NaOH

F.W.: 40.00 CAS#: 1310-73-2

Hazard: Corrosive, Toxic
Shelf Life (months): 36
Storage: White
Soluble: Water and Alcohol
bp (°C): 1388
mp (°C): 323
Density (g/mL): 2.13

Solution, 1.0 M

Item Number: 470302-572

Sodium Bicarbonate

Sodium Hydrogen Carbonate, Baking Soda

$NaHCO_3$

F.W.: 84.01 CAS#: 144-55-8

Shelf Life (months): 36
Storage: Green
Soluble: Water
mp (°C): 50
Density (g/mL): 2.2

General Storage

Grade: Laboratory, Powder

Item Number: 470302-440

Sodium

Packed in oil.

Na

F.W.: 22.99 CAS#: 7440-23-5

Hazard: Flammable (dangerous when wet)

Shelf Life (months): 12

Storage: Red

bp (°C): 883

mp (°C): 98

Density (g/mL): 0.97

Grade: Laboratory, Pieces

Item Number: 470302-622

Sodium Chloride

Salt

NaCl

F.W.: 58.44 CAS#: 7647-14-5

Shelf Life (months): 36

Storage: Green

bp (°C): 1465

mp (°C): 800.7

Density (g/mL): 2.17

Grade: Laboratory, Large Crystal (Rock Salt)

Item Number: 470302-500

Safer Sodium Demonstration

Provide a Great Display About Density, Chemical Reactions and pH Indicators

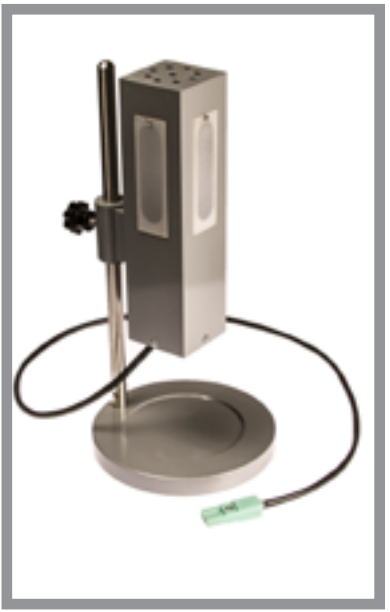
Show your classroom exactly what happens when you mix alkali metals with water. In this safe demonstration, students will mix two immiscible liquids — mineral oil and water — in a graduated cylinder. Place a small amount of sodium in the mixture and watch it permeate through the mineral oil and react with the two liquids on the bottom. Watch the reaction as gas bubbles form and rise to the mineral oil layer and then drop back down to the water and react yet again. Apply a pH indicator to the water layer to display the production of a base when sodium and water react.

Item Number: 470118-182

Spectroscopy Light Sources

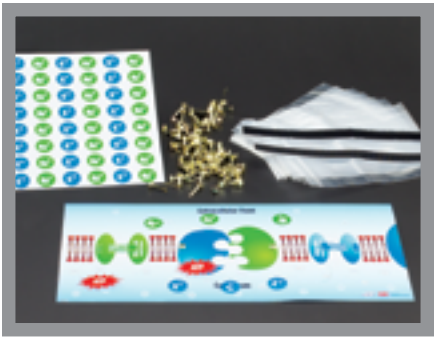
Perfect for spectroscopy and other optics experiments. Sodium and Mercury light sources have predictable and unique spectral lines which make them perfect for calibrating your spectrometers or other equipment. Each lamp house includes a closable shield to block out light when it is not needed. The power supply, available separately, can power one lamp at a time.

Item Number: 470218-716



Power Supply for Light Source
Item Number: 470218-720

Ward's® Manipulate Your Own Action Potential Neuron



Students use the manipulatives in this activity kit, developed by Teacher Carole MacMullan, to depolarize and repolarize a neuron as they model sodium and potassium ion movement through gated channel proteins embedded in the plasma membrane of a neuron.

- Hands-on learning helps solidify an abstract concept
- Suitable for grades 10-12

Students manipulate, then restore the neuron to its resting potential state with the help of ATP and a sodium/potassium pump.

Item Number: 6730308

Content Contributed by Joe Simson