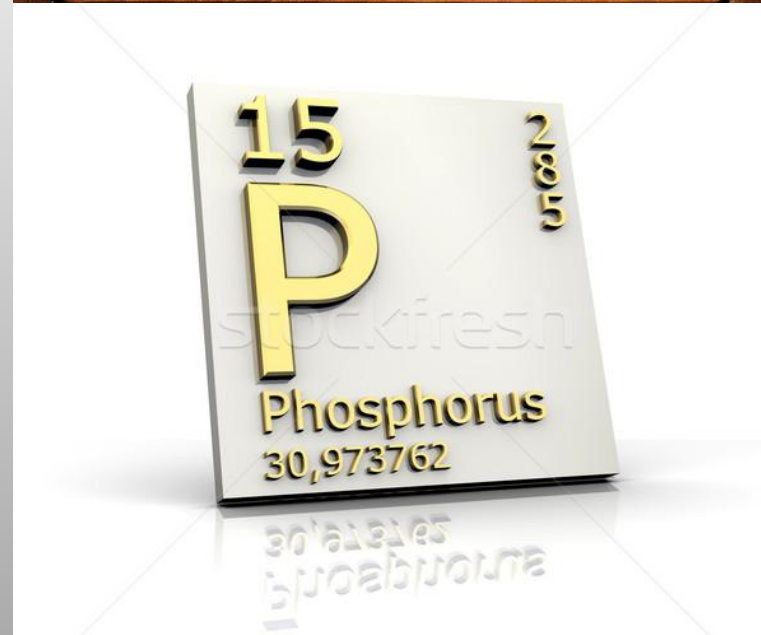
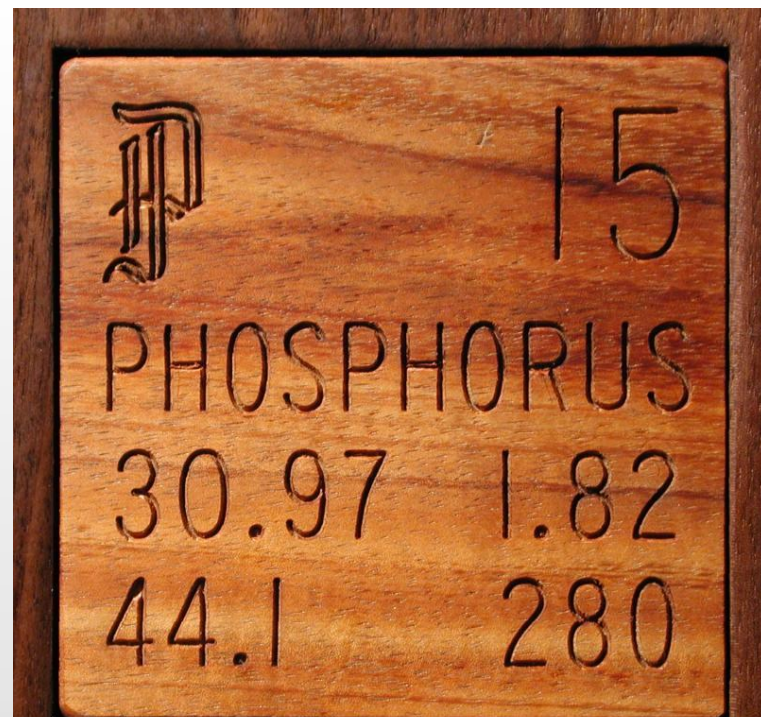


# PHOSPHORUS

- **SYMBOL**  
*P*
- **ATOMIC NUMBER**  
*15*
- **ATOMIC MASS**  
*30.97376*
- **FAMILY**  
*Group 15 (VA)*  
*Nitrogen*
- **PRONUNCIATION**  
*FOS-fer-us*



Phosphorus is element 15 on the periodic table, with the element symbol

P. Because it is so chemically reactive, phosphorus is never found free in nature,

yet you



15



P

ΦΟСΦΟΡ

30,97376

# DISCOVER

## Y

Phosphorus was discovered in 1669 by Hennig Brand in Germany. Brand isolated phosphorus from urine. The discovery made Brand the first person to discover a new element. Other elements, such as gold and iron were known, but no specific person found them. Brand called the new element "cold fire" because it glowed in the dark. The name of the element comes from the Greek word *phosphoros*, which means "bringer of light". The form of phosphorus Brand discovered was white phosphorus, which reacts with oxygen in air to produce a green-white light.

# PHYSICAL PROPERTIES OF PHOSPHORUS

# WHITE PHOSPHORUS

White phosphorus is a waxy, transparent solid. Its melting point is 44.1°C (111°F) and its boiling point is 280°C (536°F). It has a density of 1.88 grams per cubic centimeter. If kept in a vacuum, it sublimates if exposed to light. It does not dissolve well in water, although it does dissolve in other liquids, such as benzene, chloroform, and **carbon disulfide**. White phosphorus sometimes appears slightly yellowish because of traces of red phosphorus

# RED PHOSPHORUS

*Red phosphorus* is a red powder. It can be made by heating white phosphorus with a catalyst to 240°C (464°F). A catalyst is a substance used to speed up or slow down a chemical reaction without undergoing any change itself. Without a catalyst, red phosphorus sublimates at 416°C (781°F). Its density is 2.34 grams per cubic centimeter. It does not dissolve in most liquids.

# BLACK PHOSPHORUS

**Black phosphorus** looks like graphite powder. Graphite is a form of carbon used in "lead" pencils. Black phosphorus can be made by applying extreme pressure to white phosphorus. It has a density of 3.56 to 3.83 grams per cubic centimeter. One of its interesting properties is that it conducts an electric current in spite of being a non-metal.



# CHEMICAL PROPERTIES

- Red and black phosphorus is obtained from white. White phosphorus is obtained by reducing the calcium phosphate:



- Reaction with oxygen:  $4\text{P}_0 + 5\text{O}_2 \rightarrow 2\text{P}_2 + 5\text{O}_5$
- With a lack of oxygen:  $4\text{P}_0 + 3\text{O}_2 \rightarrow 2\text{P}_2 + 3\text{O}_3$
- Phosphorus halides decompose easily with water:



- Nitric acid:

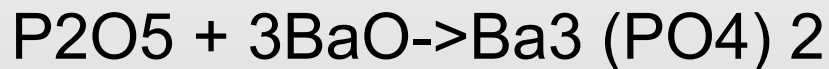


All chemical properties of acidic oxides: is reacted with water, basic oxides and alkalis:

1)



2)



3)

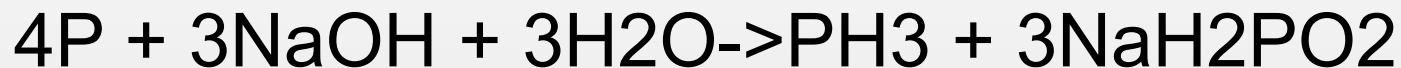


$\text{P}_2\text{O}_5$  – (strong dehydrating agent)

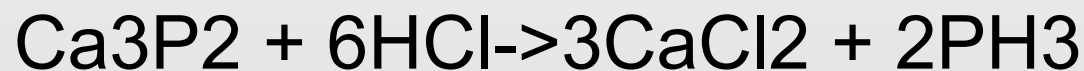
4)



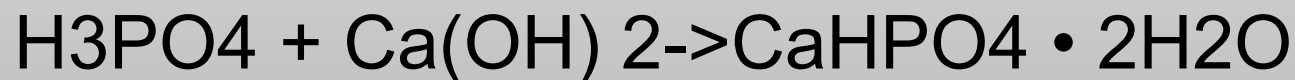
- With alkali:



- Phosphides alkali and alkaline earth metals and acids decompose water to produce phosphine:



- Neutralization with lime with phosphoric acid, the precipitate:



# COMPOUNDS

- $\text{H}_3\text{PO}_4$  – orthophosphoric acid
- $\text{H}_3\text{PO}_3$  – phosphorous acid
- $\text{H}_4\text{P}_2\text{O}_6$  – hypophosphoric acid
- $\text{H}_3\text{PO}_2$  – hypophosphorous acid
- $\text{H}_4\text{P}_2\text{O}_8$  – perphosphoric acid
- $\text{PH}_3$  – hydrogen phosphide, or phosphine
- $\text{P}_2\text{H}_4$  – diphosphine
- $\text{P}_2\text{O}_5$  – pentoxide
- $\text{P}_2\text{O}_3$  – trioxide

# ISOTOPES

- Phosphorus has 22 known isotopes. P-31 is the only stable isotope.
- Six radioactive isotopes of phosphorus are known also. One radioactive isotope, phosphorus-32, has applications in medicine, industry, and tracer studies. Phosphorus-32 is especially useful in medical studies, because phosphorus occurs in many parts of the body.

# OCCURRENCE

Because of its chemical activity phosphorus does not occur uncombined in nature but is widely distributed in many minerals. A major source is apatite, an impure calcium phosphate mineral found in phosphate rocks. In the United States major deposits are found in Florida, Tennessee, Montana, and Idaho. White phosphorus is prepared commercially from phosphate rock in an electric furnace or blast furnace.



# PRODUCTION

About 1,000,000 short tons (910,000 t) of elemental phosphorus is produced annually. Calcium phosphate (phosphate rock), mostly mined in Florida and North Africa, can be heated to 1,200-1,500 °C with sand, which is mostly  $\text{SiO}_2$ , and coke (impure carbon) to produce vaporized  $\text{P}_4$ . The product is subsequently condensed into a white powder underwater to prevent oxidation by air



# USES OF PHOSPHORUS

Red phosphorus, which is relatively stable, is used to make safety matches, tracer bullets, incendiary devices, pesticides, pyrotechnic devices, fireworks and many other products. There is a high demand for phosphates for use as fertilizers. Phosphates are also used to make certain glasses (e.g., for sodium lamps). Trisodium phosphate is used as a cleaner, water softener, and scale/corrosion inhibitor.

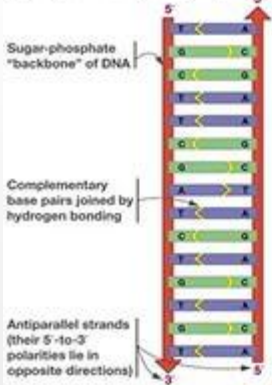




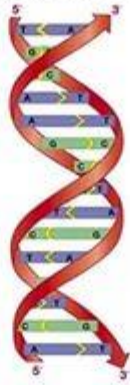


Bone ash (calcium phosphate) is used to make chinaware and to make monocalcium phosphate for baking powder. Phosphorus is used to make steels and phosphor bronze and is added to other alloys. There are many uses for organic phosphorus compounds. Phosphorus is an essential element in plant and animal cytoplasm. In humans, it is essential for proper skeletal and nervous system formation and function.

(a) Complementary base pairing



(b) The double helix



(c) A space-filling model



**THANKS FOR  
YOUR  
ATTENTION!!!**