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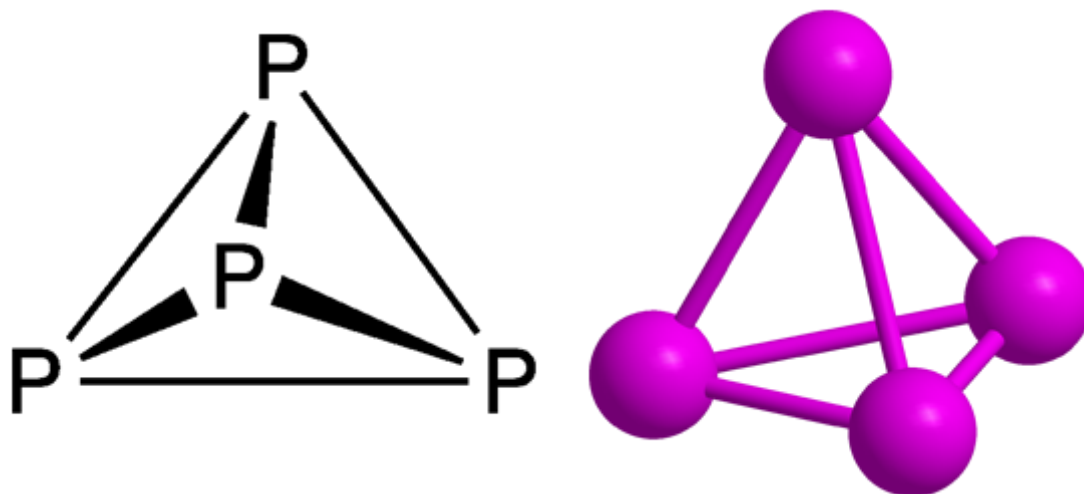
White phosphorus

September 07, 2020

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I'm an inflammatory allotrope of phosphorus.

What molecule am I?



White phosphorus is one of three allotropes of the element phosphorus. The other two are red, an amorphous polymer, and black, a graphitelike polymer. The substance known as yellow phosphorus is actually white phosphorus that contains impurities (e.g., red phosphorus) or that has darkened from exposure to light. Red phosphorus turns violet or purple when it is heated to $>550\text{ }^{\circ}\text{C}$.

White phosphorus (see images) contains four phosphorus atoms in a tetrahedral arrangement. It has an unpleasant, garliclike odor and is extremely toxic (see hazard information table). It is unstable in air—first forming white fumes before bursting into flames. White phosphorus has been called the “[devil's element](#)” because it glows green in the dark and is pyrophoric.

Because of its instability, white phosphorus is typically stored under water, in which it is barely soluble. The allotrope is soluble in hydrocarbons, carbon disulfide, sulfur chloride (S_2Cl_2), and other nonpolar solvents.

Molecular phosphorus does not exist in nature; but it is contained in many minerals, primarily hydroxyapatite, fluorapatite, and chlorapatite. White phosphorus was discovered in 1669 by Hamburg, Germany, pharmacist/chemist Hennig Brandt (in some accounts, Brand), who is the subject of the painting *The Alchemist Discovering Phosphorus* by Joseph Wright. During his search for the mythical philosopher's stone, Brandt serendipitously produced phosphorus by heating phosphate-containing urine solids with carbonaceous substances. Phosphorus was emitted as a gas (P_2), which condensed as a glowing wax.






Brandt did not have an understanding of elements as we know them today. More than 100 years after his discovery, legendary French chemist Antoine Lavoisier recognized phosphorus as an element.

Brandt's crude process is the basis of modern white phosphorus production. Apatites are mixed with silica (sand) and a carbon source such as coke to produce P_2 vapor, which is condensed in water. If fluorapatite is

used, the calcium fluoride byproduct can be used to produce fluorine gas.

Worldwide, ≈900,000 t of phosphorus is produced annually. Most of it, ironically, is oxidized back to phosphates for fertilizers (by far the largest use) and the manufacture of pesticides, plasticizers, and animal food additives. The use of white phosphorus itself is limited to ingredients in metallurgy and rodent poisons. It was used as a component of friction matches, until around the turn of the 20th century, when it was replaced by the safer phosphorus sesquisulfide (P₄S₃).

White phosphorus hazard information

Hazard class*	Hazard statement	
Pyrophoric solids, category 1	H250—Catches fire spontaneously if exposed to air	
Acute toxicity, oral, category 1	H300—Fatal if swallowed	
Skin corrosion/irritation, category 1A	H314—Causes severe skin burns and eye damage	
Acute toxicity, inhalation, category 1	H330—Fatal if inhaled	
Hazardous to the aquatic environment, acute hazard, category 1	H400—Very toxic to aquatic life	

*Globally Harmonized System of Classification and Labeling of Chemicals.

[Explanation of pictograms.](#)

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The Alchemist Discovering Phosphorus
by Joseph Wright

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White phosphorus fast facts

CAS Reg. No.	12185-10-3
SciFinder nomenclature	Phosphorus, mol. (P ₄)
Empirical formula	P ₄
Molar mass	123.90 g/mol
Appearance	White, waxy crystalline solid
Melting point	44.15 °C
Water solubility	≈3 mg/L

[Learn more about this molecule from CAS](#), the most authoritative and comprehensive source for chemical information.

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