COMPTON'S

A Britannica Publication

VOLUME

19

Phill–Pytho
pages 263-544

Compton's Encyclopedia

and Fact-Index

1987 EDITION COMPTON'S ENCYCLOPEDIA

Library of Congress Catalog Card Number: 85-73401
International Standard Book Number: 0-85229-444-1
Printed in U.S.A.

THE UNIVERSITY OF CHICAGO
COMPTON'S ENCYCLOPEDIA IS PUBLISHED WITH THE EDITORIAL ADVICE
OF THE FACULTIES OF THE UNIVERSITY OF CHICAGO

"Let knowledge grow from more to more and thus be human life enriched"

What was the significance of the lead plate that lay buried in a hill in Pierre, S.D., for 170 years? 322.

How does a player piano make music? 317.

What name was given to Pocahontas after she was converted to Christianity? 401.

Why are full-grown fishes dark on the back? 509.

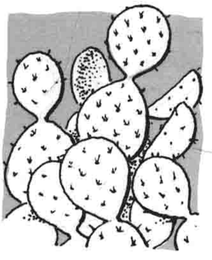
What city's underground railway uses driverless trains? 463.

Why has the passenger pigeon become extinct? 323.

What is blank verse? 405.

How do puppets and marionettes differ? 535.

Can the porcupine "shoot" its quills? 450.



Why does the prickly pear cactus have thorns instead of smooth leaves? 363.

Why are houses of correction often called bridewells? 505c.

Were there ever any female pirates? 342b.

Who was the United States lawyer who gave up his practice because the laws of the land upheld slavery? 263.

How did the terms "left" and "right" in politics originate? 434.

How long did it take the pioneers to build a log cabin? 331.

What reigning king of Portugal lived in Brazil for 15 years? 457–457a.

What artist first drew the elephant and the donkey as symbols of the Republican and Democratic parties? 431 pictures.

What kind of travel guidebooks were available for pilgrims in the Middle Ages? 326–7.

What is the deadliest of all poisons? 411.

Why is the laurel associated with poets? 402.

What ancient keeper of sea creatures changed form to avoid giving information? 514.

What bird is a great traveler, breeding in the Arctic and wintering in South America? 391.

Which scientist earned his way through college by giving instruction in wrestling? 535.

When was the first piano made and how did it get its name? 314.

Who is regarded as the writer of the first modern detective stories? 401.

Why are most Hawaiian pineapples canned? 329.

Which papal election was the swiftest in history? 348.

For how long did a subject have to pose motionless for a daguerreotype portrait? 298 picture.

Why did a French king wear potato flowers in his buttonhole? 467.

Which planet is the largest? 353.

How many pounds of water are needed to produce one pound of alfalfa? 358–9.

Why do polar explorers usually use wooden ships? 418.

What rules must a paroled prisoner follow? 505a.

Where was polo played 2,000 years ago? 441h.

What are corn dodgers? 333.

Which artist had his own studio when he was 16 and was still painting after he was 90? 318, 319.

What is the most important use for phosphorus? 271.

Why are American policemen often called "cops"? 430b.

Can new plants be patented? 367.

How fast can a homing pigeon fly? 324.

Under which president's administration was the southern boundary of the United States fixed? 322.

Can oxygen be frozen? 308.

What city has noise meters on some street corners? 441e picture.

What was the first stringed instrument with a keyboard? 314.

When did the leaning tower of Pisa start to tip? 343.

How are filters used in photography? 288.

How did the color purple become the symbol of kingly rank and great wealth? 267.

A famous political third party was the Know Nothing party. How did it get its name? 433.

Why were some pirates called buccaneers? 342.

What tree produces most of the softwood lumber used in the United States? 328.

What is a phonogram? 268a.

What are the four most common mistakes made by beginning photographers? 283.

Why was the city of Phoenix named after the legendary Egyptian bird? 268.

What plant furnishes the digitalis used in treating heart diseases? 377.

What was the common household musical instrument of the 16th and 17th centuries? 315.

How did the expression "pin money" originate? 327.

What are the two methods used to select the state delegates who attend the national conventions of the political parties? 431.

What causes "wow"? 269–70.

What experiments laid the foundations for modern science? 302 picture.

How do some plants eat insects? 344.

Why is the Red Sea red? 370.

How did a volcano preserve an ancient civilization? 442–3.

What was the shape of the first phonograph records? 268d.

What was the first man-made element? 394.

What is "fox fire"? 270.

What is the Golden Triangle? 345.

Who was the famous journalist who was elected a state representative though he was legally too young for office? 531.

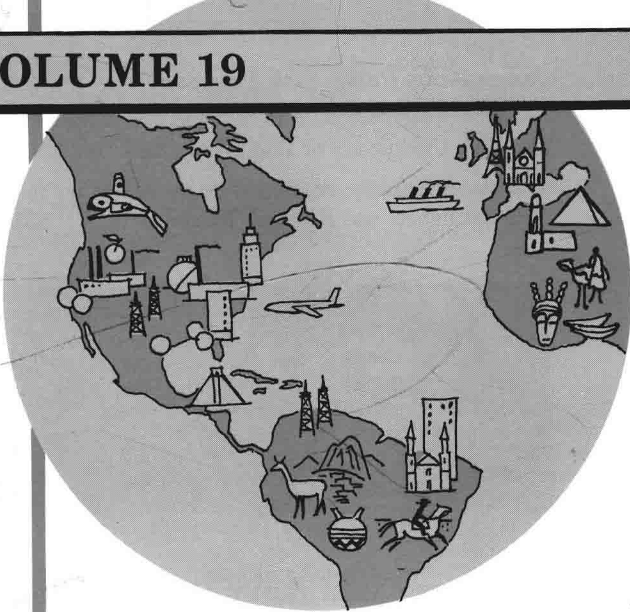
What Spaniard received a roomful of gold and two roomfuls of silver as a ransom for a great Indian chief? 349.

KEY TO PRONUNCIATION

Pronunciations have been indicated in the body of this work only for words which present special difficulties. Marked letters are sounded as in the following words:

cāpe, ăt, fär, fȧst, whạt, fa̤ll; mē, yĕt, fẽrn, thêre;
īce, bĭt; rōw, wȯn, fôr, nŏt, do̤; cūre, bŭt, rṳde, fụll, bûrn; *ou*t;
ü = French *u*, German *ü*; ġem, ḡo; *th*in, *tħ*en;
ṅ = French nasal (Jea*ṅ*); *zh* = French *j* (*z* in azure); *K* = German guttural *ch*.

HERE AND THERE IN VOLUME 19



AT ODD TIMES when you are just looking for "something interesting to read," without any special plan in mind, this list will help you. With this as a guide, you may visit faraway countries, watch people at their work and play, meet famous persons of ancient and modern times, review history's most brilliant incidents, explore the marvels of nature and science, play games—in short, find whatever suits your fancy of the moment. This list is not intended to serve as a table of contents, an index, or a study guide. For these purposes consult the Fact-Index and the Reference-Outlines.

Picture Highlights

Reading for Pleasure

School and Home; Work and Play

Historical Highlights

Famous People

HERE AND THERE IN VOLUME 19

The Plant and Animal Kingdoms

The Wide World of Facts

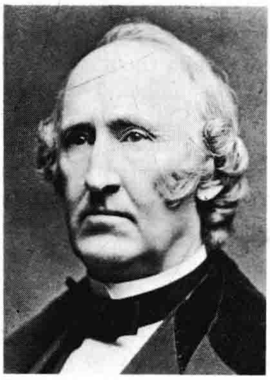
Marvels of Science and Invention

The Arts

At Home and Abroad

THESE ARTICLES ARE IN THE FACT-INDEX

Philipse, Frederick
Philip the Good
Philistines
Phillip, Arthur
Phillips, Horatio Frederick
Phillips, Stephen



Culver Pictures

PHILLIPS, Wendell (1811–1884). For nearly 50 years Wendell Phillips was one of the foremost abolitionists, reformers, and orators in the United States. Born on Nov. 29, 1811, in Boston, Mass., he was one of nine children of John and Salley Phillips. His father was a prominent judge and the city's first mayor.

An excellent student, Wendell attended the Boston Latin School, Harvard College, and Harvard Law School. He opened a law office in 1834. Three years later he married Anne Terry Greene, whose family were friends of the abolitionist William Lloyd Garrison. She encouraged her husband to join the antislavery movement and introduced him to Garrison. Phillips soon gave up his law practice, feeling unable to defend the laws of a land which upheld slavery.

Phillips first gained recognition in 1837 with a stirring speech he delivered in Boston's Faneuil Hall, condemning the murder in Illinois of the antislavery editor Elijah P. Lovejoy. In 1839 Phillips became an agent of the Massachusetts Anti-Slavery Society and lectured throughout the North. To all those who would have retained slavery to preserve the Union, he replied, "... perish the Union if we must abandon the slave." He advocated the disunion of free states from slave states and welcomed the Civil War.

Phillips had agitated for the passage in Massachusetts of the Personal Liberty Act of 1843, which prevented state officials from returning fugitive slaves. He opposed the Mexican War and the annexation of Texas, believing them schemes to extend slavery, and protested the Compromise of 1850 and its fugitive-slave provisions (*see* Compromise of 1850).

During the Civil War, Phillips criticized President Abraham Lincoln for delaying emancipation. He supported the use of black soldiers in the Union army. After the war he urged that blacks have full voting rights and continued to lecture in support of many reforms. He condemned the history of ill-treatment of Indians by white men in the United States. A temperance advocate, he worked to abolish the sale of liquor. To improve conditions for working people, he supported an eight-hour day. He also proposed to destroy the gap between rich and poor by taxing wealth so heavily that "it shall be impossible to be rich. . . ." In 1870 he was the Labor party and Prohibitionist candidate for governor of Massachusetts.

Phillips also spoke out for women's rights. At the World's Anti-Slavery Convention held in London, England, in 1840, he had unsuccessfully demanded that women delegates be admitted. He fought in Massachusetts for educational opportunities for women and argued that women be paid equal wages with men. Often faced with ridicule and the threat of mob violence, Phillips' belief in abolition and basic human rights was greater than any desire for popularity and any fear of danger. He died in Boston on Feb. 2, 1884.

THESE ARTICLES ARE IN THE FACT-INDEX

Phillips Academy
Phillipsburg, N. J.
Phillips Gallery
Phillips Petroleum Company
Phillips University
Phillpotts, Eden
Philo
Philomel

PHILOSOPHY—The Pursuit of Wisdom

PHILOSOPHY. The word philosophy comes from the Greek *philein,* meaning "to love," and *sophia,* meaning "wisdom." Thus philosophy originally meant "love of wisdom," and in a broad sense wisdom is still the goal of philosophy.

Since its beginnings, however, the scope of philosophy has changed. Early philosophers studied aspects of the natural and human world that later became separate sciences—astronomy, physics, psychology, sociology. On the other hand, certain basic problems—the nature of the universe, the standard of justice, the validity of knowledge, the correct application of reason, and the criteria of beauty—have been the domain of philosophy from its beginnings to the present. These problems are the subject matter of the five branches of philosophy—metaphysics, ethics, epistemology, logic, and aesthetics.

THE BRANCHES OF PHILOSOPHY

Metaphysics. The investigation of the nature of being—the cause, the substance, and the ultimate meaning or purpose of things—is the province of *metaphysics.* Metaphysics asks such questions as: What are space and time? What is a thing and how does it differ from an idea? Is man free to decide his fate or do circumstances determine his actions?

Perhaps the simplest distinction in the world is that between persons and things. Persons move of their own will. Things do not move unless they are acted upon. Philosophers who see the world as made up entirely of things, or *matter,* are called *materialists.* Those who believe that the world of reality is primarily *mind* are called *idealists.*

Ethics. When a person is judging right and wrong,

The spirit of philosophic debate is captured in this bas-relief of Plato (right) and Aristotle. The 15th-century sculpture by Luca della Robbia, titled 'Logic and Dialectics', adorns the bell tower of the cathedral in Florence, Italy.

he is using the branch of philosophy called *ethics*. Some philosophers believe that right and wrong can be decided by reason; others believe that they are a matter of feeling. Some hold that the aim of human conduct should be to produce happiness; others feel that man's conduct should make him a better person.

Egoists, or *epicureans*, emphasize the happiness of the person himself. *Altruists* emphasize the happiness of others. One group of altruists are called *utilitarians*, or *Benthamites*, after the English philosopher Jeremy Bentham (1748–1832). Their maxim was "the greatest happiness of the greatest number."

Epistemology. The study of the limits of human knowledge and of the conditions that make knowledge possible is called *epistemology*. Man's knowledge may be regarded as having two parts. On the one hand, he sees, hears, and touches; on the other, he organizes in his mind what he learns through the senses.

Some philosophers think that the particular things seen, heard, and touched are more important. They believe that general ideas are formed from the examination of particular facts. This method is called *induction*, and philosophers who feel that knowledge is acquired in this way are called *empiricists*.

Other philosophers think it more important to find a general law according to which particular facts can be understood or judged. This method is called *deduction;* its advocates are called *rationalists*.

A newer school, *pragmatism*, has a third approach to these problems. Pragmatists believe that *value in use* is the real test of truth and meaning.

Logic. The science of thinking, *logic* develops methods for testing the correctness of reasoning. It develops standards for judging the validity of arguments and of the conclusions drawn from them.

Aesthetics. The establishment of criteria of beauty is the function of *aesthetics*. Aesthetics is the science of the beautiful in its various manifestations—including the sublime, comic, tragic, pathetic, and ugly. (*See also* Arts, The.)

THE HISTORY OF PHILOSOPHY

When men began trying to explain the nature and origin of the universe through reasoning and observation, instead of through poetry and mythology, they were taking the first step in the development of philosophy. The first people in the Western world to take this step were Greeks who lived between 600 and 430 B.C.

Philosophy of Ancient Times

The earliest Greek philosophers raised several basic questions: what substance or substances is the universe made of? How does the varied universe develop from a single underlying substance? Is reality permanent or changing?

Thales (640?–546? B.C.) thought that water was the basic substance from which all things developed. Other early Greek philosophers regarded fire, air, or earth as the basic substance. Pythagoras (582?–500? B.C.) thought that number was the basis of reality because the forms and relations of things could be expressed numerically. Democritus (5th century B.C.) taught that all substances were made up of indivisible particles, or atoms.

Heraclitus (540?–475? B.C.) argued that the basic characteristic of the universe was change and permanence was only an appearance. Parmenides (5th century B.C.) held that permanence was fundamental and change only an appearance. Succeeding philosophers tried to reconcile the views of Heraclitus and Parmenides by saying that relative change was possible, absolute change impossible.

During the 5th century B.C. considerable influence was achieved by the Sophists, traveling teachers who opposed philosophic speculation. Protagoras (480?–411 B.C.), the first Sophist, did not believe the human mind could find truth. He lectured on the civic virtues and taught that all sides of a question could be argued equally well.

The greatest period of Greek philosophy—the classical period—extended from about 430 B.C. to 320 B.C. The first great classical philosopher was Socrates (470?–399 B.C.). Socrates challenged the Sophists' views. He believed in the possibility and value of absolute virtue and in man's ability to attain truth. He sought universal principles by pursuing the clear, common meaning of terms and raised some of the basic questions of knowledge and ethics (*see* Ethics). He did this by a dialogue technique that was later called the Socratic method.

Plato (427–347 B.C.), Socrates' foremost pupil, developed a many-sided philosophy, including a theory of knowledge, a theory of human conduct, a theory of the state, and a theory of the universe. He reconciled the views of Heraclitus and Parmenides by accepting two levels of existence. One was the sensory world of appearances, which was always changing. The other was the intelligible world of unchanging forms or ideas, which Plato regarded as the only true reality. Plato's world of ideas resembled a blueprint after which the varied forms of the sensory world were fashioned.

Aristotle (384–322 B.C.), Plato's most famous pupil, also made wide-ranging contributions to philosophy. Unlike Plato, he maintained that the sensory world was real, not a reflection of a world of forms. He taught that individual things combined form and matter and that the forms they incorporated determined how they moved, grew, and evolved. Aristotle was the founder of formal logic (*see* Logic).

Philosophy from Aristotle's time to about A.D. 100 was marked by a concern with ways of living. Epicurus (342?–270 B.C.) regarded reality as a random arrangement of atoms and maintained that the main good was pleasure. The Stoics, led by Zeno of Citium (335?–265? B.C.), believed that the universe was ordered and rational and that man must discipline himself to accept his place in it.

Roman philosophy consisted, for the most part, of ideas borrowed from the Greeks. Cicero (106–43 B.C.) introduced Greek thought into Rome. Prominent Roman philosophers included Lucretius (96?–55 B.C.), an Epicurean, and the Stoics Epictetus (A.D. 60?–130?) and Marcus Aurelius (121–180).

Philosophers showed an increasing concern with religion during the first centuries of the Christian era. Some combined Greek philosophy with Oriental religious mysticism. The Neoplatonists created religious philosophies based on Plato's teachings. A prominent Neoplatonist was Plotinus (205?–270), whose views were used to combat the doctrines of Christianity. The greatest early Christian thinker was St. Augustine (354–430), whose philosophy drew heavily upon Platonic concepts.

Philosophy in the Middle Ages

Medieval Christian philosophers sought to harmonize rational explanations of life and the world with the doctrines of the Roman Catholic church. These thinkers were known as Schoolmen, or Scholastics, and their philosophy was called *scholasticism*. Among the problems they considered was whether universals (general ideas) were merely words or actually referred to real things. For the *nominalists* only individual things existed; the early *realists*, on the contrary, not only accepted the existence of universals but even went so far as to deny that there was any other reality. Peter Abelard (1079–1142) and his pupil Peter Lombard (1100?–60) held a middle ground between nominalism and realism.

Scholasticism culminated in the philosophy of St. Thomas Aquinas (1225?–74). Thomas attempted to settle the conflict between faith and reason by showing that reason should deal with the facts of nature and that the supernatural truths of revelation must be accepted on faith. Some truths, according to Thomas, were both revealed and provable. Among these was the existence of God. Opposition to Thomas' realism and rationalism by Duns Scotus (1265?–1308) and William of Ockham (1280?–1349?) resulted in a revival of nominalism.

Philosophy in Modern Times

With the coming of the Renaissance, European philosophers turned from supernatural to natural or rational explanations of the external world. Experimentation, observation, and the application of mathematics in the natural sciences set standards for philosophic inquiry. The scientific achievements of Copernicus, Galileo, Kepler, and Newton influenced the thinking of philosophers.

SOME PHILOSOPHIC DOCTRINES

Atomism. The universe consists of indivisible units, or atoms.

Determinism. All events in nature or society, including human choices and actions, are the inevitable result of existing conditions.

Dualism. The universe is basically composed of two substances, matter and mind.

Empiricism. All knowledge is derived from experience by way of the senses.

Hedonism. Pleasure or happiness is the highest good and the proper goal of man.

Idealism. Reality is essentially mental or spiritual, and outside of the mind things do not exist.

Intuitionism. Knowledge of reality is gained through the immediate apprehension of self-evident truths.

Materialism. Reality consists essentially of physical substances.

Mechanism. The processes of nature—animate and inanimate—are machinelike; the functioning and behavior of biological organisms are mechanical.

Monism. The universe is composed of only one substance, whether matter or mind.

Naturalism. Because the phenomena of nature are regular and not haphazard, they are all subject to scientific explanation.

Pluralism. The universe consists of more than one substance, such as matter *and* spirit.

Positivism. The principles and methods of science should be used to guide individual behavior and to solve social problems.

Pragmatism. The meaning and truth of an idea are tested by its practical consequences.

Rationalism. Truth and knowledge are gained by reason rather than by experience or perception.

Realism (the name for two separate doctrines). 1. General ideas are not merely words but refer to real things. 2. Material objects exist independently of any knowledge or perception of them.

Transcendentalism. Man is intuitively aware of a reality beyond sensory phenomena.

Francis Bacon (1561–1626) held that knowledge could not be based on an appeal to accepted authorities but must begin with experience and proceed inductively to general principles. Bacon helped lay the foundation for empiricism, which became one of the two main schools of modern philosophy.

Rationalism, the other dominant school of modern philosophy, was founded by the Frenchman René Descartes (1596–1650). From the statement, "I think, therefore I am," Descartes proceeded deductively to build a system in which God and mind belonged to one order of reality and the natural world to another. He saw nature as a mechanism that could be explained mathematically and God as pure spirit.

The reconciliation of Descartes's two orders of reality occupied many later philosophers, including his countryman Nicolas de Malebranche (1638–1715). Other important 17th-century rationalists were the Dutch philosopher Baruch Spinoza (1632–77) and Gottfried Wilhelm Leibniz (1646–1716), a German.

While rationalism was taking hold in continental Europe, empiricism underwent development in Great Britain. Important British empiricists included Thomas Hobbes (1588–1679), John Locke (1632–1704), George Berkeley (1685–1753), and David Hume (1711–76). Berkeley, an idealist, argued that things not perceived did not exist. Hume carried empiricism to skeptical conclusions, contending that there was no justification for assuming the reality of either material or spiritual substances.

In the 18th century it was widely believed that the application of intelligence and the growth of knowledge would ensure human happiness. This view was challenged by the Frenchman Jean Jacques Rousseau (1712–78), who held that man's moral nature was more important than his intellect. He believed that men were born good but were corrupted by society. Nevertheless, he saw the solution not in a return to the primitive state but in a new type of education and a reorganization of society.

Immanuel Kant (1724–1804), a German, agreed with Rousseau that man's moral nature was most important. A critical examination of human reason led Kant to argue that it worked only in the area of experience. Questions about God, freedom, and immortality were therefore beyond the reach of "pure reason." Yet such questions could be justified on practical grounds because moral decisions made no sense without them. Kant's followers included the Germans Johann Gottlieb Fichte (1762–1814), F. W. J. von Schelling (1775–1854), and G. W. F. Hegel (1770–1831). Hegel formulated a dialectical logic which he believed accounted for evolution in nature, history, and human thought.

Prominent German philosophers after Hegel included Johann Friedrich Herbart (1776–1841), Arthur Schopenhauer (1788–1860), and Friedrich Nietzsche (1844–1900). Nietzsche believed that the "will to power" was the biological instinct behind evolution and would lead to the development of a "higher type" of men.

The Danish philosopher Sören Kierkegaard (1813–55) held that reality could not be fully comprehended by reason because human existence involved choices that were absurd from a rational standpoint. He conceived of each individual as a unique being who was responsible for his own development and free to direct his own inner life.

Auguste Comte (1798–1857) of France founded the philosophy of positivism, which attempted to apply the methods of the natural sciences to the discovery of social laws. The English philosophers John Stuart Mill (1806–73) and Herbert Spencer (1820–1903) were influenced by positivism.

In the late 19th century the leading British philosophers were idealistic critics of empiricism. Among them were T. H. Green (1836–82) and F. H. Bradley (1846–1924). In the United States Josiah Royce (1855–1916) advanced similar views. Earlier American thinkers had also tended to follow the lead of their British contemporaries. Thus, Jonathan Edwards (1703–58) was strongly influenced by the doctrines of Locke, and Ralph Waldo Emerson (1803–82) was an ardent admirer of Thomas Carlyle (1795–1881).

The principal contribution of 19th-century United States philosophy was pragmatism, first formulated by C. S. Peirce (1839–1914). For Peirce the meaning of an idea was seen in its practical consequences. William James (1842–1910) extended pragmatism to include a theory of truth: a proposition was true if it fulfilled its purpose. John Dewey (1859–1952) was the leading 20th-century exponent of pragmatism.

A tendency toward idealism and a reaction against intellectualism were manifested in the philosophies of the Frenchman Henri Bergson (1859–1941) and the Italian Benedetto Croce (1866–1952). The Spanish-born George Santayana (1863–1952) combined elements from a number of philosophic schools.

During the 20th century, philosophy developed along two major lines—existentialism in continental Europe and the logical analysis of science, mathematics, knowledge, and language in Great Britain and the United States. The analytic philosophers were concerned with examining and clarifying how men thought, how they spoke, and how they claimed to know. Their work descended from the efforts of the British philosophers Alfred North Whitehead (1861–1947) and Bertrand Russell (1872–1970), whose 'Principia Mathematica' reduced the concepts of mathematics to those of logic and demonstrated the importance of language in philosophy by distinguishing between the logical and the grammatical form of a statement.

Two schools of analytic and linguistic philosophy developed subsequently. The logical positivists, influenced by the Austrian-born Ludwig Wittgenstein (1889–1951), wanted to restrict philosophy to the clarification of scientific and mathematical concepts. A group led by the Englishman G. E. Moore (1873–1958) believed that statements used in ordinary language often had more certainty than those employing the terminology of philosophy.

The existentialists were concerned with man, with freedom, and with society. Kierkegaard's concept of the individual as a unique being free to make choices became the core of existentialist philosophies developed by Martin Heidegger (1889–1976) and Karl Jaspers (1883–1969) of Germany and Jean Paul Sartre (1905–80) of France. Gabriel Marcel (1889–1973), a Frenchman, sought to reconcile existentialism with Christianity.

Books About Philosophy

Adler, Irving. Logic for Beginners (John Day, 1964).
Beardsley, M. C. and E. L. Philosophical Thinking (Harcourt, 1965).
Black, A. D. The First Book of Ethics (Watts, 1965).
Chase, Stuart. Guides to Straight Thinking (Harper, 1956).
Clarke, M. L. The Roman Mind (Norton, 1968).
Durant, W. J. The Pleasures of Philosophy (Simon & Schuster, 1953).
Finley, M. I. The Ancient Greeks (Penguin, 1977).
Magill, F. N., ed. Masterpieces of World Philosophy in Summary Form (Harper, 1961).
Ozmon, Howard. Twelve Great Philosophers (Oddo, 1968).
Parrington, V. L. Main Currents in American Thought, 3 vols. (Harcourt, 1955–63).
Pittenger, W. N. Plato, His Life and Teachings (Watts, 1971).
Rosenberg, Jay. The Practice of Philosophy: a Handbook for Beginners (Prentice, 1978).
Ruchlis, Hyman. Clear Thinking (Harper, 1962).

THESE ARTICLES ARE IN THE FACT-INDEX
Phineus
Phips, Sir William

PHLOX. A favorite garden and wild flower is the phlox. The bright colors of the blossoms—blue, purple, pink, crimson, salmon, and white—gave the flower its name, the Greek word for "flame."

The wild blue phlox, or sweet William, grows in the spring in moist woods from Canada to the Gulf coast. The western sweet William has pink blossoms. Prairie phlox, a large plant with pink or purple flowers, grows on the prairies in the summer. Ground, or moss, pink has short, spreading stems that form a compact ground cover like moss. The small blossoms stand two to six inches above the ground. The leaves are thick and needlelike. Alpine phlox, also a creeping plant, grows on rocky mountain slopes.

The garden phloxes are annuals or perennials. Both are easily cultivated but require fertile soil and plenty of moisture and sunshine. Usually new plants are grown from the vigorous young shoots on the outside of the clump. Old clumps should be divided and transplanted every year or two. This is done in the fall when growth has stopped.

The phloxes belong to the genus *Phlox* of the family *Polemoniaceae*. Nearly 50 species are native to North America. The blossoms grow in clusters, called *cymes*, at the top of the stem. The flower has a calyx of five slender, pointed sepals. The corolla is a narrow tube, opening out to five salver-form (flat-spreading) petals.

The scientific name of the sweet William is *Phlox divaricata;* of western sweet William, *P. longifolia;* of prairie phlox, *P. pilosa;* of moss pink, *P. subulata;* of Alpine phlox, *P. Douglasii.* Most garden annuals are varieties of *Phlox Drummondii,* which is native to Texas; most perennials, varieties of *P. paniculata* and *P. maculata.* (For picture, *see* Flowers, Wild.)

THESE ARTICLES ARE IN THE FACT-INDEX
Phlox family **Phocis**
Phnom Penh, Cambodia **Phoebe**
Phocion **Phoebus**

PHOENICIANS (*fē-nĭsh'ànz*). More than 2,500 years ago Phoenician mariners sailed to Mediterranean and southwestern European ports. The Phoenicians were the great merchants of ancient times. They sold rich treasures from many lands—perfumes and spices from the Far East; fine linen from Egypt; wool from Arabia; vessels of brass, silver, and gold made by their own skilled artisans; ornaments of carved ivory; and emeralds, coral, agate, and amber.

These Phoenicians (the Canaanites or Sidonians of the Bible) were Semitic people. Their country was a narrow strip of the Syrian coast, about 200 miles long and 20 miles wide. It was a land of pastures, orchards, and vineyards, but it was so small the Phoenicians were forced to the sea for a living. Surpassing their teachers, the Egyptians, they became the most skillful shipbuilders and navigators of their time. They worked the silver mines of Spain, passed through the Strait of Gibraltar, and founded the city of Cadiz on the western coast. They sailed to the British Isles for tin, and may have even passed around southern Africa. They founded many colonies, the greatest being Carthage. This city grew into a great empire and rival of Rome (*see* Carthage).

The Phoenicians began to develop as a great seafaring, manufacturing, and trading nation when the Cretans—the first masters of the Mediterranean—were overthrown by the Greeks (*see* Aegean Civilization). Not only did they take the fine wares of the Eastern nations to the Western barbarians, but they became skilled in making such wares themselves—especially metalwork, glass, and cloth. From a shellfish, the *murex*, they obtained a crimson dye, called Tyrian purple. This was so costly that only kings and rich nobles could afford garments dyed with it. Purple became the symbol of kingly rank and great wealth.

The most useful Phoenician service was spreading the alphabet. The alphabet had been invented by another Semitic people (*see* Alphabet); but Phoenician traders, who used it to keep their accounts, carried it to the other peoples of the Mediterranean.

The Wealth of Tyre and Sidon

There were two great cities of Phoenicia—Sidon, the center of the glass industry, and Tyre, the center of the purple industry. In the middle of the 10th century B.C. Tyre assumed the leadership of all

Phoenicia. Friendly relations were established with the Hebrews, and King Solomon sent to King Hiram of Tyre not only for materials but for skilled workmen to build the temple. There were none with "skill to hew timber like unto the Sidonians."

In the 6th century the Phoenicians supplied the great fleets with which Darius and Xerxes attacked Greece. Usually they submitted readily to foreign conquerors and paid tribute. In return, they were allowed to pursue their commercial enterprises as they liked. Alexander the Great in 333 B.C. took Tyre, after one of the greatest sieges of history. In 64 B.C. Phoenicia came under the control of the Romans, and under their rule the native language and institutions soon became extinct.

The chief divinities of the Phoenician religion were the god Baal and the goddess Astarte, or Astoreth. In times of great distress human sacrifices were offered to the god Moloch.

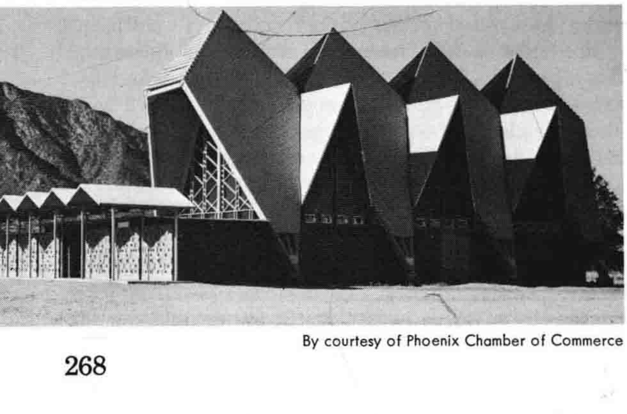
Today the small island on which Tyre once stood is connected with the mainland by a broad tongue of land. It grew out of the mole built during Alexander's siege. The town is called Sur in Arabic. Fruit gardens flourish at Sidon (Saida). It is the port for a giant pipeline that carries Saudi Arabia oil to the Mediterranean. Both cities are in Lebanon.

THIS ARTICLE IS IN THE FACT-INDEX
Phoenix

PHOENIX, Ariz. One of the fastest-growing cities in America is Phoenix, the capital of Arizona. A favorable geographic location has helped the state's largest city in its rapid growth.

About midway between El Paso, Tex., and Los Angeles, Calif., Phoenix is a major trade and transportation center for the entire Southwest. It is also the shipping point for products of the Salt River valley. One reason for the city's prosperity is its healthful climate. It is noted for its clear, dry air and many sunny days. In winter the average temperatures are in the 50's and 60's; rainfall averages 7.3 inches annually. This pleasant climate has made Phoenix a leading winter and health resort.

IMAGINATIVE ARCHITECTURE
Phoenix is known for a wide variety of church architecture. Styles range from old Spanish motifs to the most modern architectural forms.



By courtesy of Phoenix Chamber of Commerce

By courtesy of Phoenix Chamber of Commerce

GROWING PHOENIX SKYLINE
Looking northeastward toward Squaw Peak, this airview of Phoenix shows some of the burgeoning high-rise buildings that are changing the city's skyline.

Tourism and Other Industry

Entertaining tourists in the informal manner of the "Old West" is one of the city's biggest businesses. Its scenery and recreational facilities attract thousands of visitors each year. Palms and semitropical plants line residential streets. On the outskirts of the city are picturesque dude (guest) ranches and luxurious hotels and motels.

Phoenix has more than 50 municipal park areas. South Mountain Park, the largest city-owned park in the United States, covers more than 14,800 acres on the slopes of the Salt River Mountains. Also of interest are the State House (capitol), the Phoenix Indian School, and the Heard and Arizona museums. Phoenix and Grand Canyon colleges are in the city.

Phoenix lies in the center of the huge saucer-shaped valley of the Salt River. An irrigation system based on dams on the Salt and Verde rivers has made it a rich farming area. Cotton, vegetables, fruits, and alfalfa are grown. Manufacturing is the city's major source of income. Factories produce electronic equipment, machinery, aircraft and parts, and processed foods.

Ruins of prehistoric mounds and irrigation ditches in the valley suggested the city's name. The phoenix was the fabled Egyptian bird that destroyed itself in fire and rose again from its own ashes.

The seat of Maricopa County, Phoenix was incorporated as a city in 1881. When Arizona became a state in 1912, the city, then the territorial capital, became the state capital. It has a manager-council form of government. (*See also* Arizona.) Population (1970 census), 581,562.

THESE ARTICLES ARE IN THE FACT-INDEX
Phoenix Islands
Phoenixville, Pa.

cutting stylus (*see* Microphone). The electrical phonograph—using essentially the principles employed in the modern phonograph—was introduced at about the same time.

The Evolution of Discs

Although the earliest discs were made of hard rubber, shellac soon became the most common material for discs. On acoustic phonographs disc speed generally varied from about 74 to 82 revolutions per minute (rpm). The electrical phonograph standardized the speed at 78 rpm. Most 78's were 10 inches in diameter, with a playing time of about four minutes.

In 1948 commercial long-playing (LP) records, designed to be played at $33\frac{1}{3}$ rpm, were introduced. The first LP's were 10 inches in diameter, but 12 inches became the standard size, with 16-inch discs used for transcriptions. In 1949 7-inch 45-rpm discs were introduced. Shellac was replaced by plastic vinyl, which is less fragile, as the standard material.

Both LP's and 45's used microgrooves, very narrow grooves spaced about 300 to an inch, which further increased their playing time. Because the larger size and slower speed of the LP permitted the recording of longer musical works—often without breaks within movements—the LP became the standard format for classical music, musical comedy scores, and collected performances. With a shorter playing time, the 45 became the format for single popular songs.

A separate format, the $16\frac{2}{3}$-rpm disc, was developed for "talking books." Videodiscs, which use laser techniques to reproduce both a picture and sound, were introduced in the late 1970's.

Until the late 1940's all recordings were made directly onto discs. Since the development of the magnetic tape recorder, nearly all recordings have been made on tape and later transferred to disc (*see* Tape Recorder). Tape permits the mixing of sound from several microphones, the dubbing of one recording session over another, and the replacement of notes through splicing. In the 1970's digital, or computer, techniques introduced even more flexibility.

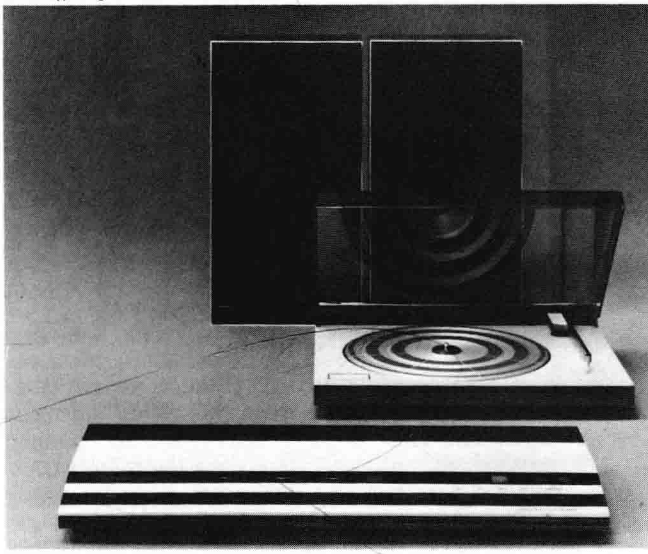
The earliest discs, and cylinders, were recorded individually. By 1890, however, Berliner had developed the process of making a negative mold from the master, or original, disc. The mold, or stamper, could then be used to press a large number of discs. The technique has been refined and has continued to be used to mass-produce discs.

Hi-Fi Recording

After World War II the term *high fidelity*, or hi-fi, came to be widely used to refer to the realistic recording and reproduction of sound on discs. Improvements in recording techniques and in phonographs allowed more of the original sound to be captured on discs and reproduced in playback.

Until the 1950's all discs were monophonic. They used one channel, which reduced the sound—even the sound of a large musical group—to a single point in space. In 1958 the first commercial two-channel, or stereo, discs were introduced. Using so-called right and left channels of sound, stereo recording more closely reproduces the normal process of hearing. Stereo discs produce better-defined sounds, with a greater sense of space and dimension.

Courtesy, Bang & Olufsen of America Inc.



A hi-fi component system often includes a receiver, a turntable, and loudspeakers. These components have been exhibited in museums as examples of modern design.

The first commercial four-channel, or quadraphonic, discs were introduced in 1971. Some quadraphonic discs are designed to surround the listener with sound. Other quadraphonic discs use the two additional channels to reproduce the ambience, or reflected sound, that is heard in a live performance.

Hi-Fi Systems

The search for high fidelity has also led to improvements in the phonograph itself. Modern hi-fi systems can reproduce sounds throughout the full range of hearing, without the accompanying noise and distortion created by earlier phonographs.

The phonograph was originally a self-contained mechanism. Today, the several stages involved in reproducing the sound recorded on discs are commonly divided among components.

Modern turntables rotate discs at precise speeds without the slight variations that produce changes in pitch called "wow" and "flutter." Stylus, cartridge, and arm assemblies are light in weight and capable of tracking the groove of a record with only a small force but with great sensitivity.

An amplifier—sometimes separated into two components called a power amplifier and a control amplifier—strengthens the electrical signals produced by the stylus and cartridge. The signal generated by the amplifier is free of audible distortion, yet strong enough to drive two or more loudspeakers.

Each loudspeaker usually consists of two or more connected individual speakers mounted in an enclosure. Each of the individual speakers reproduces a

1877	Edison invents cylinder phonograph
1887	Berliner invents disc Gramophone
1904	Double-sided records introduced
1925	Electrical recording era begins
1948	33⅓-rpm long-playing (LP) records introduced
1949	45-rpm records introduced
1958	Stereo recording era begins
1971	4-channel records introduced
1978	Digital records and videodiscs introduced

part of the sound spectrum. The woofer, for example, reproduces the lower sounds, while the tweeter reproduces the higher frequencies. A midrange speaker is often used to reproduce the wide range of middle frequencies.

Tape recorders, tuners, and other components are common parts of a modern hi-fi system. The tuner, which captures radio signals for playback through the amplifier and loudspeakers, is often combined with the amplifier into a receiver (*see* Radio).

The Impact of the Phonograph

During its first century the phonograph has had important effects on society. Were it not for the phonograph, the performances of great musicians and the voices of important and interesting people would have been lost to history. Collections of musical discs in the home have broadened the appreciation of music and have changed people's musical tastes. Some performers have become world-famous through their recordings and have continued to remain popular long after they stopped performing. (*See also* Sound.)

As this pianist performs in a recording session, microphones transmit the sound to the control booth. Most recordings are made on tape and later transferred to disc.

Courtesy, RCA

Books and Films About Phonograph

Feldman, Len. The Rolling Stone Guide to High Fidelity Sound (Straight Arrow, 1974).

Gelatt, Roland. The Fabulous Phonograph, 1877–1977, 2d rev. ed. (Macmillan, 1977).

Hemming, Roy. Discovering Music: Where to Start on Records and Tapes, the Great Composers and Their Works, Today's Major Recording Artists (Four Winds, 1974).

Institute of High Fidelity. Official Guide to High Fidelity, 2d ed. (Sams, 1978).

The Portable Phonograph, film (Encyclopaedia Britannica Films).

Read, Oliver and Welch, W. L. From Tin Foil to Stereo: Evolution of the Phonograph, 2d ed. (Sams, 1976).

Schwann Record Catalogs. Schwann-1 Record & Tape Guide (ABC Schwann, monthly).

THESE ARTICLES ARE IN THE FACT-INDEX

Phorcys
Phormio
Phosphor

PHOSPHORESCENCE AND LUMINESCENCE. When a substance is heated to a certain temperature, it glows and emits light of certain wavelengths (*see* Nuclear Energy). If a substance emits light due to any cause other than this, it has the property of *luminescence.* In most cases a luminescent material emits light when it is stimulated by radiation or by emissions such as cathode rays or X rays.

The property of luminescence (often called "cold light") is very complex and is displayed in different forms. If the substance emits light only as long as the exciting radiation falls on it, the characteristic is called *fluorescence* (*see* Fluorescence). The fluorescence of a doctor's fluoroscope is a response to X rays. If the substance continues to emit light after the exciting radiation is removed, the characteristic is then called *phosphorescence.* Zinc sulfide is a phosphorescent substance. It glows brightly for a definite period after exposure to sunlight or lamplight.

The emission of light that accompanies certain chemical reactions is called *chemiluminescence.* A familiar example is the light emitted by a firefly (*see* Fireflies and Glowworms). This light is released when luciferin, a complex chemical compound, is oxidized in the fly's body. The oxidation of decaying wood containing certain bacteria can also produce light (sometimes called "fox fire"), as can the oxidation of yellow phosphorus.

It is generally agreed that luminescence is produced when electrons are knocked out of molecules by the energy of the exciting radiation. If the loose electrons return to the molecule, they release part or all of the energy originally absorbed. A material which has the property of luminescence is called a phosphor. A phosphor-dot plate is used for reproducing television images in color (*see* Television).

PHOSPHORUS—Its Value to Plants and Animals

PHOSPHORUS. In 1669 the alchemist Hennig Brand of Hamburg was trying to find the "philosopher's stone." The stone was supposed to change other metals into gold. Of course he did not find it; but he did discover something unusual. It was the chemical element which we call phosphorus.

The strange fact was that, in the dark and in moist air, phosphorus could be seen glowing with a dull white light. The element was named phosphorus for this reason, from Greek terms meaning "light bearer." For a time men thought that phosphorus might be the source of the light given off by fireflies and rotting wood at night. It is not. This light, however, as well as that given off by many minerals, looks like the light emitted by phosphorus. Hence all such light may be called "phosphorescence" (*see* Phosphorescence and Luminescence).

Phosphorus is used in making tips for matches; but much more important uses are made of it by plants and animals. Man and many other creatures need phosphorus to build teeth and bones. All living organisms use it to build their cells and to help them get and use the energy they need to keep alive.

Most soil has enough phosphorus for some wild plants. Farm crops use more phosphorus, year after year, than the soil can provide. Hence the supply in the soil must be renewed by adding phosphate fertilizer. This is man's most important use of phosphorus.

Where Phosphorus Is Found

Phosphorus is the eleventh most abundant element in the earth's crust. It is never free, or pure, in nature, however, because it is intensely active chemically. It is always combined with other elements.

Common mineral forms are called *phosphate rock.* A leading type is calcium phosphate, or *phosphorite.* This may be combined with calcium fluoride as *apatite* or with calcium chloride. In the United States, phosphate rock is found in Tennessee, Florida, Idaho, and Montana. It is also found in many other countries.

In the human body, calcium phosphate is the main ingredient of bones. Normal bones are 48 per cent phosphorus. Phosphorus is also important in the protein of body cells. About one per cent of the human body is phosphorus. Good food sources are milk, cottage cheese, fish, and egg yolks. (*See also* Food.)

Kinds of Phosphorus and Their Uses

Phosphorus is not metallic in appearance, so it is called a nonmetal. It can be obtained pure in two crystalline forms. One, called white or yellow phosphorus, is very active chemically. The other, violet phosphorus, is not active.

White (yellow) phosphorus is prepared by heating phosphate rock or bones with sand and coke in an electric furnace. It is a waxy solid. To avoid chemical activity, it is usually kept under water. It combines directly with most elements, and it will combine with oxygen even at a low temperature. This slow oxidation produces the white light of true phosphorescence.

White phosphorus melts at 44.1° C. (111.38° F.). It was used in the tips of matches because it would take fire from the heat generated by scratching it. Workers who made matches, however, frequently developed diseases of the bones in the face, especially in the jaw ("phossy jaw"). For this reason, all civilized nations forbid the use of matches containing white phosphorus.

At room temperature white phosphorus changes gradually to red phosphorus. This is a partial change to crystalline violet phosphorus. The change can be made quickly by heating white phosphorus in a closed vessel at between 240° and 300° C. (572° F.).

Red phosphorus has very different properties from those of the white form. It is not poisonous, and it does not combine readily with oxygen at low temperatures. It can be used in combinations with other substances to make match tips (*see* Matches).

The greatest use of free phosphorus is as a flux in making certain kinds of bronze. In wartime phosphorus is also used to make smoke clouds, antipersonnel bombs, and tracer bullets. Incendiary bombs are made of phosphorus (*see* Chemical Warfare). Large amounts of phosphorus go into the manufacture of phosphoric acid and other compounds. Phosphate rock is made into superphosphates for use as fertilizer.

Chemical Nature of Phosphorus

Phosphorus belongs to the nitrogen family of elements. This means that it depends for its chemical activity upon five electrons in its outermost shell (*see* Nuclear Energy; Chemistry). Two chlorine com-

HOW WHITE PHOSPHORUS BURNS
White phosphorus is very active chemically. For safety, it is usually kept under water. When it is lighted with a match, it burns, spits, and fumes violently. The chemist who burned this piece used tweezers and an asbestos glove for protection.

pounds are formed by these *valence* electrons. In one, three electrons form bonds with three chlorine atoms, making PCl_3. Five electrons will form PCl_5. (How atoms form bonds with electrons is explained in the article Matter.) A compound similar to PCl_3 is the poisonous, flammable gas, phosphine (PH_3).

The molecule of phosphorus is another simple combination. The molecular weight indicates that the molecule has four atoms (P_4). They are held closely together, as shown in the top picture (molecule at the left). If the molecule is "opened out" to show its structure (diagram at right), the atoms are at corners of a four-sided figure, or tetrahedron. (Lines show the shape of the tetrahedron.)

In making this molecule, each atom shares one electron with a neighbor. Thus it exerts a "valence of 3" and leaves two electrons for making other bonds. Using these exerts a "valence of 5." These valences are also called *oxidation states* 3 and 5, as explained in the article on Chemistry.

Oxides and Phosphoric Acids

Phosphorus forms two oxides (P_4O_6 and P_4O_{10}). As shown in the diagram at the right, the simpler one (P_4O_6) has one oxygen atom between two phosphorus atoms along each "edge" of the molecular tetrahedron. Since a tetrahedron has six edges, there are six oxygen atoms.

The phosphorus atoms are still in valence state 3. Each one, however, can exert a valence of 5 by forming a double bond (two electrons from each atom) with four oxygen atoms. This forms P_4O_{10}.

When an element can exert two valences (such as 3 and 5), the name ending *-ous* indicates compounds formed with the lower valence; the ending *-ic* indicates the higher valence. Therefore P_4O_6 is called phosphor*ous* oxide, and P_4O_{10} is called phosphor*ic* acid.

The structures of phosphoric oxides provide clues to the structures of *phosphoric acids*. If each corner is viewed as "broken off" with all its oxygen atoms, each of these atoms has a "loose valence" where it had been bound to a phosphorus atom. Substituting a hydrogen atom at each valence on four corners yields four molecules of sirupy phosphoric acid (H_3PO_4). This can be done with a reaction between water and phosphoric acid:

$$P_4O_{10} + 6H_2O \longrightarrow 4H_3PO_4$$

Phosphoric chloride (PCl_5) acts similarly. The acid is commonly manufactured with a reaction between rock (calcium) phosphate and sulfuric acid.

Similarly, an edge of the tetrahedron with two phosphorus atoms yields pyrophosphoric acid ($H_4P_2O_7$). Weaker phosphor*ous* acid (H_3PO_3) can be formed from water and phosphorous chloride (PCl_3).

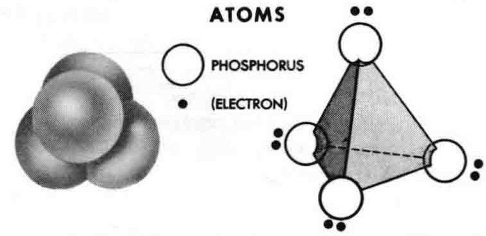
Vitally Important Phosphates

The phosphoric acids form salts called phosphates with suitable basic (alkaline) elements. Sodium (Na) and calcium (Ca), for instance, replace one or more hydrogen atoms in the acid. Sodium can form three salts with phosphoric acid —NaH_2PO_4, Na_2HPO_4, and Na_3PO_4. The last is called normal sodium phosphate, or trisodium phosphate (TSP). It gives a strong alkaline reaction with water.

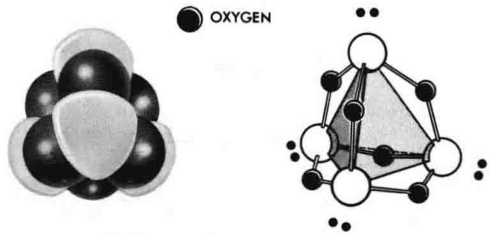
Normal calcium phosphate ($Ca_3(PO_4)_2$) is insoluble in water. It is useless to plants, because they cannot absorb it. It can be made soluble by treating it with sulfuric acid or phosphoric acid. Either treatment replaces some calcium with hydrogen, making a

PHOSPHORUS AND ITS COMPOUNDS

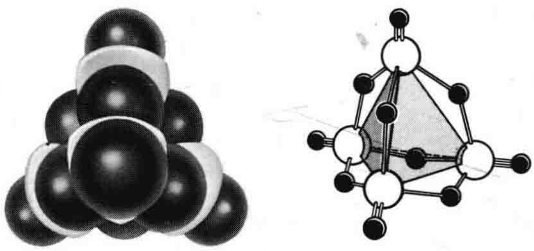
Many complicated phosphorus compounds can be traced from the molecule of four atoms (P_4). Below are molecules in space (left) and arrangements of atoms within molecules (right).



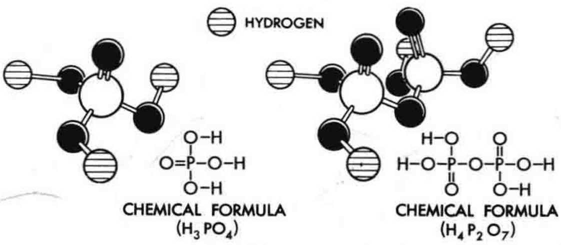
The atoms (left) are clumped as they are in space. The molecule is "opened out" (right) to show how the atoms make a four-sided figure. Eight electrons are still free to form bonds.



An oxygen atom is inserted between each two phosphorus atoms of the four-atom (P_4) molecule to make an oxide of phosphorus (P_4O_6). Two electrons on each atom are still free to make bonds.



Here each phosphorus atom has used its last free electrons to make a double bond with an oxygen atom, thus adding four oxygen atoms to make P_4O_{10}. All electrons are now satisfied.



Phosphoric acid (left, H_3PO_4) can be made from one corner of P_4O_{10} by substituting hydrogen atoms for the oxygen atoms in the bonds which hold the oxide together. Pyrophosphoric acid (right, $H_4P_2O_7$) is made with two corners of P_4O_{10}.