Philogiston theory essay

Phlogiston TheoryAccording to the phlogiston theory, propounded in the 17th century, every combustible substance consisted of a hypothetical principle of fire known as phlogiston, which was liberated through burning, and a residue. The word phlogiston was first used early in the 18th century by the German chemist Georg Ernst Stahl. Stahldeclared that the rusting of iron was also a form of burning in which phlogiston was freed and the metal reduced to an ash or calx. The theory was supersededbetween 1770 and 1790 when the French chemist Antoine Lavoisier showed that burning and rusting both involved oxygen and concluded that both ash and rustwere compounds of oxygen. Lavoisier's oxidization theory has been accepted by scientists from about 1800 to the present day.

The theory of phlogiston was predominantly German in origin, with much early work done in Mainz, though it was widely believed through much of the eighteenthcentury — two of the most prominent followers of the theory, Johann Joachim Becher and Georg Ernst Stahl (who first used the name phlogiston in 1700), wereSwedish. Phlogiston was not only widespread but deep-seated, and gave way to the atomic theory only slowly.

Phlogiston theorists identified three essences which comprise all matter: sulfur or terra pinguis, the essence of inflammability; mercury or terra mercurialis, theessence of fluidity; and salt or terra lapida, the essence of fixity and inertness. In this respect phlogiston theory is similar to the ancient alchemical notions of earth, air, fire, and water. The terra pinguis was renamed phlogiston. In this view, metals were made of a " calx" (or residue) combined with phlogiston, the fiery principle, which was liberated during combustion, leaving only the calx. Air, according to the theory, was merely the receptacle for phlogiston; all combustible or calcinablesubstances, in fact, were not elements but compounds containing phlogiston. Rusting iron, for instance, was believed to be losing its phlogiston and thereby returningto its elemental state.

Phlogiston theory was widely supported throughout the eighteenth century, although it came under increasing attack as empirical research pointed up its difficulties.

When it was determined that some metals actually gained mass when burnt, partisans explained it by giving phlogiston a negative mass. Even Priestley believed in thetheory until his death, convinced that his discovery of oxygen was “ dephlogisticated air.” It was up to Lavoisier to realize the significance of his discovery.

Lavoisier made a symbolic break with phlogiston theory by burning all textbooks that supported the theory, just as Paracelsus had destroyed his copies of the worksof the medieval medical authorities. His theory of oxidation soon replaced phlogiston theory, and remains a part of modern chemistry.

Although he exaggerated its importance, Lavoisier was the first to understand the significance ofPriestley’s work on oxygen, and is considered by some to have discovered the element. Hedisproved phlogiston theory by demonstrating that oxygen is required for combustion, rusting, andrespiration. He combined his chemical abilities with an interest in zoology to produce pioneeringwork on anatomy and physiology.

phlogiston theory , hypothesis regarding combustion. The theory, advanced by J. J. Becher late in the 17th cent. and extended andpopularized by G. E. Stahl, postulates that in all flammable materials there ispresent phlogiston, a substance without color, odor, taste, or weight that isgiven off in burning. emailprotected The ash of theburned material is held to be the true material. The theory received strongand wide support throughout a large part of the 18th cent. until it wasrefuted by the work of A. L. Lavoisier, who revealed the true nature ofcombustion. Joseph Priestley, however, defended the theory throughout hislifetime. Henry Cavendish remained doubtful, but most other chemists of theperiod, including C. L. Berthollet, rejected it.

Phlogiston TheoryThe failure to understand combustion was an insurmountable obstacle to real progress inchemistry. Any theory of chemical change must be able to explain combustion and phlogistonwas the first real attempt to do so.

The fact that wood turns to ashes and metals become soft powders when heated and can bechanged back into metals in the presence of charcoal is hard to reconcile without imagining theaddition or subtraction of some substance.

Phlogiston was that substance.

The theory was simple, and although having serious contradictions, was better than no theory atall. Besides, despite the quantitative work of Galileo and Newton, the importance of quantitativemeasurements had not yet been impressed upon the chemists.

The phlogiston theory was really quite simple.

Metals and combustible substances contained an imponderable substance known as phlogistonwhich was released into the air along with caloric. Air had a limited capacity to absorbphlogiston.

Since phlogiston was an imponderable substance, its properties were incapable of beingdetected by senses and could be contradictory.

Sometimes it had weight, sometimes it had negative weight, and sometimes it had no weight atall.

Phlogiston theory explained many facts about combustion1. combustibles lose weight when burning because they lose phlogiston2. a flame goes out in an enclosed space because air becomes saturated with phlogiston3. charcoal leaves little residue upon burning because it is nearly pure phlogiston4. a mouse dies in an airtight space because the air becomes saturated with phlogiston5. some metal calxes turn to metals when heated with charcoal because phlogiston fromcharcoal is restored to the calxA serious problem was that the calx formed when a metal such as magnesium burns weighs morethan the metal from which it formed, just as a rusty nail weighs more than the nail.

The supporters of the phlogiston theory answered this by postulating that metallic phlogiston hasnegative weight while other combustibles contain phlogiston with positive weight.

Adding a special postulate such as this signaled a theory in trouble and led to the ultimatedemise of the theory.

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Hippocrates of Cos (460-ca. 370 BC)Greek physician who founded a medical school on Cos. This school produced more than 50books, as well a system of medical methodology and ethics which is still practiced today. Uponbeing granted their M. D. degrees, new doctors still swear a so-called Hippocratic oath. In OnAncient Medicine, Hippocrates stated that medicine is not philosophy, and therefore must bepracticed on a case-by-case basis rather than from first principles. In The Sacred Disease, hestated that epilepsy (and disease in general) do not have divine causes. He advocated clinicalobservations, diagnosis, and prognosis, and argued that specific diseases come from specificcauses. Hippocrates’s methodology relied on physical examination of the patient and proceeded inwhat was, for the most part, a highly rational deductive framework of understanding throughobservation. (An exception was the belief that disease was caused by “ isonomia”, an imbalance inthe four humors originally suggested by Empedocles and consisting of yellow bile, blood, phlegm, and black bile.) The Hippocratic corpus of knowledge was widely distributed, highly influential, and marked the rise of rationality in both medicine and the physical sciences.

Galen of Pergamum (ca. 130-ca. 200)Greek physician considered second only to Hippocrates of Cos in his importance to thedevelopment of medicine, Galen performed extensive dissections and vivisections on animals.

Although human dissections had fallen into disrepute, he also performed and stressed to hisstudents the importance of human dissections. He recommended that students practice dissectionas often as possible. He studied the muscles, spinal cord, heart, urinary system, and proved thatthe arteries are full of blood. He believed that blood originated in the liver, and sloshed back andforth through the body, passing through the heart, where it was mixed with air, by pores in theseptum. Galen also introduced the spirit system, consisting of natural spirit or “ pneuma” (air hethought was found in the veins), vital spirit (blood mixed with air he believed to found in thearteries), and animal spirit (which he believed to be found in the nervous system). In On theNatural Facilities, Galen minutely described his experimentation on a living dog to investigate thebladder and flow of urine. It was Galen who first introduced the notion of experimentation tomedicine. Galen believed everything in nature has a purpose, and that nature uses a single object for morethan one purpose whenever possible. He maintained that “ the best doctor is also a philosopher,” and so advocated that medical students be well-versed in philosophy, logic, physics, and ethics. Galen and his work On the Natural Faculties remained the authorityon medicine until Vesalius in the sixteenth century, even though many of his views about human anatomy were false since he had performed his dissections on pigs, Barbary apes, and dogs. Galen mistakenly maintained, for instance, that humans have a five-lobed liver (which dogs do) and that the heart had only two chambers (it has four).

Erasistratus of Chios (ca. 304-ca. 250 BC)Greek anatomist who continued the systematic investigation of anatomy begun by Herophilus in Alexandria. He described the cerebrumand cerebellum, studied nerves (which he believed to be hollow) and the valves of the heart. He distinguished between veins and arteries, believing the latter to be full of air. He proposed mechanical explanations for many bodily processes, such as digestion. He believed in a tripartite system of humors consisting of nervous spirit (carried by nerves), animal spirit (carried by the arteries), and blood(carried by the veins). After the work of Erasistratus, the use of dissection and study of anatomy declined.

Vesalius (1514-1564)Flemish anatomist who founded the sixteenth century heritage of careful observation characterizedby “ refinement of observation.” Vesalius changed the organization of the medical schoolclassroom, bringing the students close to the operating table. He demonstrated that, in manyinstances, Galen and Mondino de’ Luzzi were incorrect (the heart, for instance, has fourchambers). He conducted his own dissections, and worked from the outside in so as not todamage the cadaver while cutting into it.

Vesalius also wrote the first anatomically accuratemedical textbook, De Humani Corporis Fabrica (1543), which was complete with preciseillustrations. Vesalius’s careful observation, emphasis on the active participation of medicalstudents in dissection lectures, and anatomically accurate textbooks revolutionized the practice ofmedicine. Through Vesalius’s efforts, medicine was now on the road to its modernimplementation, although major modifications and leaps of understanding were, of course, necessary to make its practice actually safe for the patient.

Harvey, William (1578-1657)English physician who, by observing the action of the heart in small animals and fishes, proved thatheart receives and expels blood during each cycle. Experimentally, he also found valves in theveins, and correctly identified them as restricting the flow of blood in one direction. He developedthe first complete theory of the circulation of blood, believing that it was pushed throughout thebody by the heart’s contractions. He published his observations and interpretations in ExercitatioAnatomica de Motu Cordis et Sanguinis in Animalibus (1628), often abbreviated De MotuCordis. Harvey also noted, as earlier anatomists, that fetal circulation short circuits the lungs. Hedemonstrated that this is because the lungs were collapsed and inactive. Harvey could not explain, however, how blood passed from the arterial to the venous system. The discovery of theconnective capillaries would have to await the development of the microscope and the work of Malpighi. He was heavily influenced bythe mechanical philosophy in his investigations of the flow of blood through the body. In fact, he used a mechanical analogy withhydraulics. He could not, however, explain why the heart beats. Furthermore, Harvey used quantitative methods to measure thecapacity of the ventricles. Harvey was the first doctor to use quantitative and observation methods simultaneously in his medical investigations. In Exercitationesde Generatione Animalium (On the Generation of Animals, 1651), he was extremely skeptical of spontaneous generation and proposed that all animals originally came from an egg. His experiments with chick embryos were the first to suggest the theory ofepigenesis, which views organic development as the production in a cumulative manner of increasingly complex structures from aninitially homogeneous material.

Lavoisier, Antoine (1743-1794)French chemist who, through a conscious revolution, became the father of modern chemistry. Asa student, he stated " I am young and avid for glory." He was educated in a radical tradition, afriend of Condillac and read Maquois's dictionary. He won a prize on lighting the streets of Paris, and designed a new method for preparing saltpeter. He also married a young, beautiful13-year-old girl named Marie-Anne, who translated from English for him and illustrated hisbooks. Lavoisier demonstrated with careful measurements that transmutation of water to earthwas not possible, but that the sediment observed from boiling water came from the container. Heburnt phosphorus and sulfur in air, and proved that the products weighed more than he original.

Nevertheless, the weight gained was lost from the air. Thus he established the Law ofConservation of Mass. Repeating the experiments of Priestley, he demonstrated that air is composed of two parts, one ofwhich combines with metals to form calxes. However, he tried to take credit for Priestley'sdiscovery. This tendency to use the results of others without acknowledgment then drawconclusions was characteristic of Lavoisier. In Considrations Gnrales sur la Nature desAcides (1778), he demonstrated that the " air" responsible for combustion was also the source ofacidity. The next year, he named this portion oxygen (Greek for acid-former), and the other azote (Greek for no life). He alsodiscovered that the inflammable air of Cavendish which he termed hydrogen (Greek for water-former), combined with oxygen toproduce a dew, as Priestley had reported, which appeared to be water. In Reflexions sur le Phlogistique (1783), Lavoisier showed the phlogiston theory to be inconsistent. In Methods of ChemicalNomenclature (1787), he invented the system of chemical nomenclature still largely in use today, including names such as sulfuric acid, sulfates, and sulfites. His Trait lmentaire de Chimie (Elementary Treatise of Chemistry, 1789) was the first modern chemicaltextbook, and presented a unified view of new theories of chemistry, contained a clear statement of the Law of Conservation of Mass, and denied the existence of phlogiston. In addition, it contained a list of elements, or substances that could not be broken down further, which included oxygen, nitrogen, hydrogen, phosphorus, mercury, zinc, and sulfur. His list, however, also included light, and caloric, which he believed to be material substances. In the work, Lavoisier underscored the observational basis of his chemistry, stating " Ihave tried…to arrive at the truth by linking up facts; to suppress as much as possible the use of reasoning, which is often an unreliableinstrument which deceives us, in order to follow as much as possible the torch of observation and of experiment." Nevertheless, hebelieved that the real existence of atoms was philosophically impossible. Lavoisier demonstrated that organisms disassemble andreconstitute atmospheric air in the same manner as a burning body. With Laplace, he used a calorimeter to estimate the heat evolved per unit of carbon dioxide produced. They found the same ratio for aflame and animals, indicating that animals produced energy by a type of combustion. Lavoisier believed in the radical theory, believingthat radicals, which function as a single group in a chemical reaction, would combine with oxygen in reactions. He believed all acidscontained oxygen. He also discovered that diamond is a crystalline form of carbon. Lavoisier made many fundamental contributions tothe science of chemistry. The revolution in chemistry which he brought about was a result of a conscious effort to fit all experiments intothe framework of a single theory. He established the consistent use of chemical balance, used oxygen to overthrow the phlogistontheory, and developed a new system of chemical nomenclature. He was beheaded during the French revolution.

avoisier, Antoine LaurentPronounced As: Ntwn lorN lvwzya , 1743-94, French chemist and physicist, a founder of modernchemistry. He studied under eminent men of his day, won early recognition, and was admitted to theAcademy of Sciences in 1768. Much of his work wasthe result of extending and coordinating the research ofothers; his concepts were largely evolved through hissuperior ability to organize and interpret and weresubstantiated by his own experiments. He was one ofthe first to introduce effective quantitative methods inthe study of chemical reactions. He explainedcombustion and thereby discredited the phlogistontheory. He also described clearly the role of oxygen inthe respiration of both animals and plants. Hisclassification of substances is the basis of the moderndistinction between chemical elements andcompounds and of the system of chemicalnomenclature. He also conducted experiments toestablish the composition of water and of manyorganic compounds. Lavoisier worked as well toimprove economic and social conditions in France, holding various government posts. He was appointeddirector of the gunpowder commission (1775), member of the committee on agriculture (1785), director of the Academy of Sciences (1785), member ofthe commission on weights and measures (1790), and commissioner of the treasury (1791). As one of thefarmers general, however, charged with the collectionof taxes, he was guillotined during the Reign of Terror.

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Introduction to the Scientific MethodThe scientific method is the process by which scientists, collectively and over time, endeavor to construct an accurate (that is, reliable, consistent and non-arbitrary) representation of the world.

Recognizing that personal and cultural beliefs influence both our perceptions and our interpretations of natural phenomena, we aimthrough the use of standard procedures and criteria to minimize those influences when developing a theory. As a famous scientistonce said, “ Smart people (like smart lawyers) can come up with very good explanations for mistaken points of view.” In summary, the scientific method attempts to minimize the influence of bias or prejudice in the experimenter when testing an hypothesis or atheory. I. The scientific method has four steps1. Observation and description of a phenomenon or group of phenomena. 2. Formulation of an hypothesis to explain the phenomena. In physics, the hypothesis often takes the form of a causal mechanism ora mathematical relation. 3. Use of the hypothesis to predict the existence of other phenomena, or to predict quantitatively the results of new observations. 4. Performance of experimental tests of the predictions by several independent experimenters and properly performed experiments.

If the experiments bear out the hypothesis it may come to be regarded as a theory or law of nature (more on the concepts ofhypothesis, model, theory and law below). If the experiments do not bear out the hypothesis, it must be rejected or modified. Whatis key in the description of the scientific method just given is the predictive power (the ability to get more out of the theory than youput in; see Barrow, 1991) of the hypothesis or theory, as tested by experiment. It is often said in science that theories can never beproved, only disproved. There is always the possibility that a new observation or a new experiment will conflict with a long-standingtheory. II. Testing hypothesesAs just stated, experimental tests may lead either to the confirmation of the hypothesis, or to the ruling out of the hypothesis. Thescientific method requires that an hypothesis be ruled out or modified if its predictions are clearly and repeatedly incompatible withexperimental tests. Further, no matter how elegant a theory is, its predictions must agree with experimental results if we are tobelieve that it is a valid description of nature. In physics, as in every experimental science, “ experiment is supreme” and experimentalverification of hypothetical predictions is absolutely necessary. Experiments may test the theory directly (for example, theobservation of a new particle) or may test for consequences derived from the theory using mathematics and logic (the rate of aradioactive decay process requiring the existence of the new particle). Note that the necessity of experiment also implies that atheory must be testable. Theories which cannot be tested, because, for instance, they have no observable ramifications (such as, aparticle whose characteristics make it unobservable), do not qualify as scientific theories.

If the predictions of a long-standing theory are found to be in disagreement with new experimental results, the theory may bediscarded as a description of reality, but it may continue to be applicable within a limited range of measurable parameters. Forexample, the laws of classical mechanics (Newton’s Laws) are valid only when the velocities of interest are much smaller than thespeed of light (that is, in algebraic form, when v/c