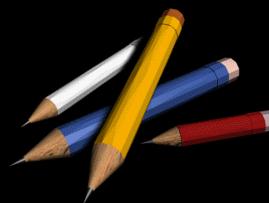


**Facts**



**Lesson**

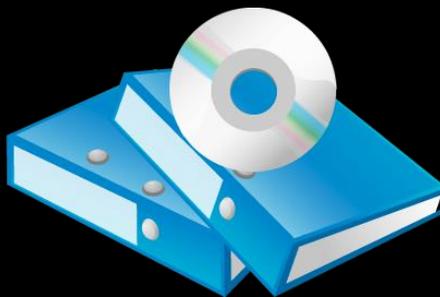


**Assignment**



**References**

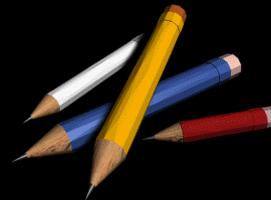
DEPARTMENT OF CHEMISTRY EDUCATION  
FACULTY OF MATHEMATICS AND SCIENCES  
YOGYAKARTA STATE UNIVERSITY



**Facts**



**Lesson**

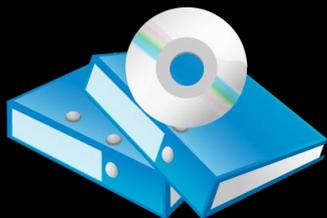


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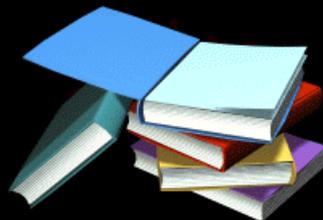


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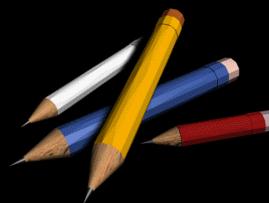
1. Van Helmont (1630) invented the name of “gas”
2. Robert Boyle was probably the first to collect a gas



**Facts**



**Lesson**

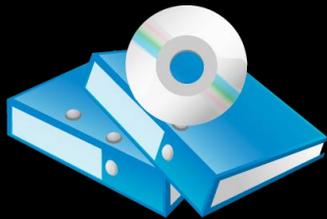


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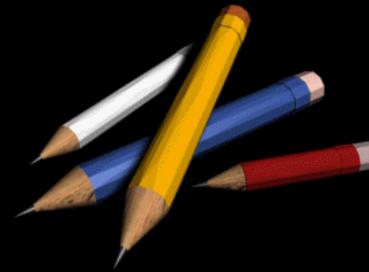
You'll learn about the discovery of gases and the scientists who concern in this field, such as : Hales, Black, Cavendish, Scheele and Priestley



**Facts**



**Lesson**

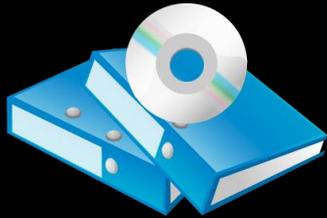


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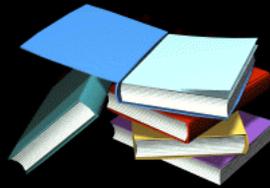


**References**

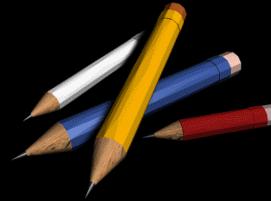
Prepare your presentation. The presentation will start at  
28 April 2011.



**Facts**



**Lesson**



**Assignment**



**References**



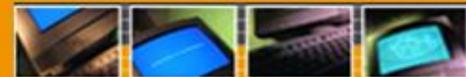
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SCHEELE

PRIESTLEY



Stephen Hales (1677 – 1761) wrote *Vegetable Staticks* (1727) and *Haemastaticks* (1733).

Hales's chemical work is entirely quantitative and inspired both Black and Priestley.

Hales attempted to determine the amount of "air" which could be extracted from various substances by heating in a gun-barrel and collecting over water.

The materials :

1. Coal (which would give coal gas)
2. Red lead and saltpetre (oxygen)
3. Iron filings and dilute sulphuric acid (hydrogen)
4. Iron filings and dilute nitric acid (nitic oxide)





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PRIESTLEY



The various gases were all “air” to Hales; they were measured and then thrown away. Hales regarded air as an element.

Hales come to the vague conclusion that “air abounds in animal, vegetable, and mineral substances”.



a



b

Fig. (a) An illustration of apparatus used by Hales; (b) Stephen Hales





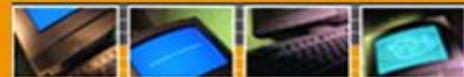
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PRIESTLEY



Joseph Black was born in Bordeaux in 1728. He was educated in medicine at Glasgow University.

In June 1754, he presented his inaugural dissertation : *De Humore Acido a Cibis orto, at Magnesia Alba*. It was published in 1756 in an extended version as *Experiments upon Magnesia alba, Quicklime, and some other Alkaline Substance*.

In his research, Black showed that when *magnesia alba*, basic carbonate ( $x\text{MgCO}_3 \cdot y\text{Mg}(\text{OH})_2 \cdot z\text{H}_2\text{O}$ ) is heated, a gas is evolved, which he called "fixed air". The residue of *calcined magnesia* ( $\text{MgO}$ ) is lighter than *magnesia alba* and more alkaline.

*Magnesia alba = calcined magnesia + water + fixed air*

*Magnesia alba + acid = magnesia salt + fixed air*

*Calcined magnesia + acid = magnesia salt*





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In another research, Black found that limestone effervesces with acids, giving off fixed air and a salt is formed.

On heating, the limestone forms quicklime and only a trace of water (in contrast to *magnesia alba*). The considerable lost in weight of limestone must be due to the escape of fixed air.



If the quicklime slaked with water and the slaked lime boiled with solution of mild alkali (potassium carbonate), the alkali become caustic and the original weight of limestone is recovered.





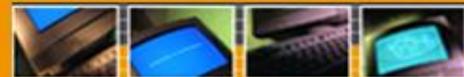
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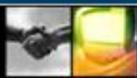
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There were three alkalis recognized in Black's time, i.e. Vegetable (potash), marine (soda) and volatile (ammonia) and a mild and caustic form of each.





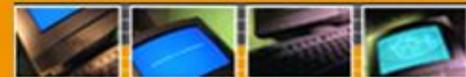
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SCHEELE

PRIESTLEY



Henry Cavendish was born in Nice in 1731. His first publication on chemistry was *On Factitious Airs*. On his book, Cavendish describes the manipulation of gases, including collection in bottles filled with water, the transfer of gas from one bottle to another by pouring upwards through a funnel under water, etc.

In his experiment on inflammable air, Cavendish obtained it by action of dilute sulphuric acid and spirit of salt on zinc, iron and tin. He found that “*the air is the same and of the same amount whichever acid is used to dissolve the same weight of any particular metal*”.

According his experiment, he concluded that the air came from metal and not from the acid. He calls the air as “the inflammable air from metals”.





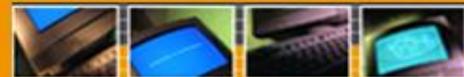
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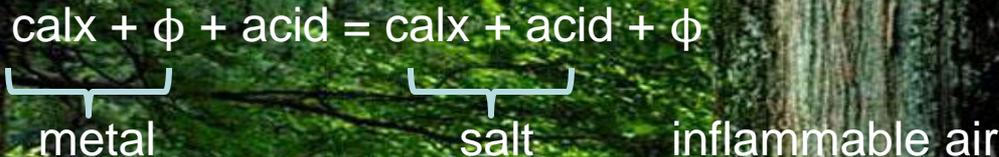
CAVENDISH

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PRIESTLEY



Cavendish was a believer in the theory of phlogiston and would represent the action of an acid on a metal as :



Cavendish gives an explanation :

“their phlogiston (i.e. That in the metals) flies off, without having its nature changed by acid and forms the inflammable air. The gas probably did not come from the acid, since an inflammable air is also evolved in putrefaction and dry distillation of vegetable matter, which (like metals) is rich in phlogiston”





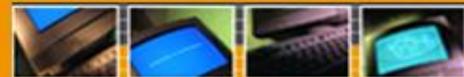
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## WHAT IS PHLOGISTON?????

- a substance without colour, odor, taste or mass that is liberated in burning of metals to form calx, the true form of metals
- Material, sometimes the matter of fire, sometimes a dry earthy substance (soot), sometimes a fatty principle (in sulphur, oils and fats) and sometimes invisible particles emitted by burning a candle.

### History

Johann Joachim Becher, on *Physicae Subterraneae*, states that the constituents of bodies are air, water and three earth, one of which is inflammable (*terra pinguis*). In 1723, Stahl was renamed *terra pinguis* as phlogiston (on *Fundamenta Chymiae*). It means “the matter and principle of fire, not fire itself”.





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PRIESTLEY



Carl Wilhelm Scheele was born in 1742 at Stralsund. He began to study chemistry in Gothenburg in 1757. His works on chemistry was published in *Chemische Abhandlung von der Luft und dem Feuer* (Chemical Treatise on Air and Fire).

According to his several experiments, Scheele was concluded that “the air is composed of two fluids, which are *Foul Air* (“*verdorbene Luft*”) and *Fire Air* (“*Feuerluft*”)”; they were afterwards named nitrogen and oxygen, respectively.

Scheele assumed that the inflammable substance (hydrogen) had combined with the fire air to produce heat. He tried to decompose heat and set free the fire air in several methods.

heat = fire air +  $\phi$





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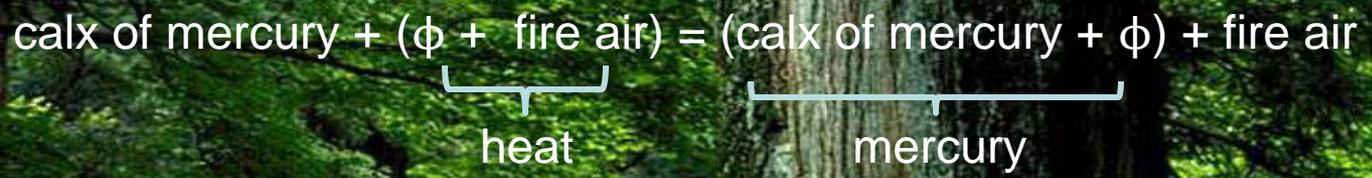
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PRIESTLEY



Scheele prepared fire air (oxygen) in several ways. He heated calx of mercury (mercuric oxide), which he supposed absorbed phlogiston from the heat, setting free the fire air :



He also obtained fire air by heating “black manganese” (manganese dioxide) with sulphuric acid; by strongly heating nitre alone; and by heating silver carbonate (the *aerial acid* (carbon dioxide) simultaneously produced being absorbed by bringing the gas in contact with an alkali.





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Scheele's Isolation of Fire Air





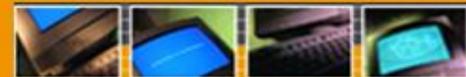
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Other discoveries by Scheele :

1. Chlorine and manganese in an investigation on “black manganese” (native manganese dioxide)
2. Silicon fluoride and hydrofluoric acid from fluorspar
3. Phosphorus from bone ash and phosphoric acid by an action of nitric acid on phosphorus
4. Arsenic acid; molybdic acid, tungstic acid
5. Several organic acids : tartaric, lactic, oxalic, citric, malic, glycerol, several esters, aldehyde and casein
6. Action of light on silver salt
7. Hydrogen sulphide (“stinking sulphurous air”)
8. Distinction between nitric oxide, nitrous acid ( $\text{N}_2\text{O}_3$ ) and nitrogen dioxide





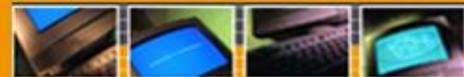
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PRIESTLEY



Joseph Priestley was born in 1733 at Fieldhead (UK). He wrote several writing on theological and political which made him many enemies. In science he was somewhat an amateur and his defective knowledge of chemical analysis exposed him to many mistakes.

In 1772, Priestley published a long and important paper, *Observations on Different Kinds of Airs*. He describes the methods of collecting and manipulating gases and the preparation of several new gases. Nitrous air was obtained from copper and dilute nitric acid, phlogisticated air(nitrogen), nitrous vapour (nitrogen dioxide) from copper or bismuth and concentrated nitric acid, etc.





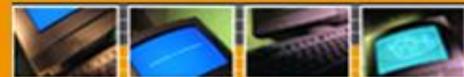
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PRIESTLEY



In 1771, Priestley recognized that air which has been vitiated by putrefaction, by the breathing of animals or by the burning of candles, is restored by growing green plants.

Priestley did not at first realize the important part played by light in the change, now called photosynthesis.

Senebier in 1782 showed that green plants, under the influence of light, convert fixed air (carbon dioxide) into dephlogisticated air (oxygen)

Priestley obtained oxygen in 1771 by heating nitre, but he had confused it with air. He says, "in one quantity (of air) which I got from saltpetre, a candle not only burned, but the flame was increased and something was heard like a hissing".





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Priestley concluded that the new gas must contain little or no phlogiston and hence he called it "*dephlogisticated air*". The gas left when bodies burnt out in ordinary air was named "*phlogisticated air*"

Phlogisticated air (nitrogen) = Air +  $\phi$  (Scheele's Foul Air)

Dephlogisticated air (oxygen) = Air -  $\phi$  (Scheele's Fire Air)

Early in 1775, Priestley found that a mouse lived twice as long in the dephlogisticated air as in the same confined volume of common air. He breathed it himself and fancied his "breast felt peculiarly light and easy for sometime afterwards". Hence he recommended its use in medicine (for treatment of gas poisoning)





**Thank You !**

