

The ATOM

Why study the atom?

- To increase our understanding of how nature works
- To give us the ability to predict properties of matter to develop useful products

Early Atomic Theory

Ancient Greeks

Democritus

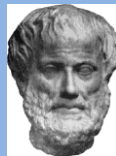
(460-370 BC)

- Atoms cause the phenomena of nature
- All atoms are made of the same basic material but different in size and shape
- Atoms cannot be further subdivided
 - “Discontinuous theory”



Aristotle

(384-322 BC)



- “Continuous theory”
 - No such things as atoms
 - Lead arguments against it
- Four elements: earth, air, fire, water

For the next 2200 years:

- Aristotle’s influence and continuist belief ruled
- Idea of atoms drifted in and out of philosophical discussions

The Dark and Middle Ages:

- The Catholic church ruled - politics, economics, science
- Aristotles' teaching were elevated to dogma
- The existence of atoms is a challenge to God

The Alchemists' Symbols for Some Common Elements and Compounds

Substance	Alchemists' Symbol
Silver	
Lead	
Tin	
Platinum	
Sulfuric acid	
Alcohol	
Sea salt	

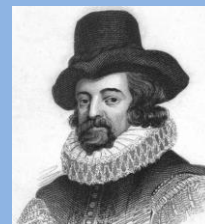
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1500s-1600s

- Chemical methods described
 - Distillation, metallurgy, mineralogy
- Emphasis on the practical (1500s)
- Theoretical speculation more frequent (1600s)
- Pharmacists mainly responsible for development of chemistry as an independent science

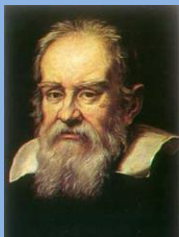
Francis Bacon (1561-1626)

- Speculated that heat is motion by very small particles
- Stressed the importance of experiment and inductive reasoning
- Believed it necessary to pay attention to evidence that might contradict a held belief
- Insistence on facts (truth is not derived from authority)



Galileo (1564-1642)

- Reasoned that the appearance of new substances in chemical changes involved the rearrangement of parts too small to see



Robert Boyle (1627-1691)

- Discovered the pressure/volume relationship of gases
- Physical phenomena can be explained in terms of matter in motion
- Properties of a substance are determined by the shape, number and motion of particles which make it up



Late 1700s/Early 1800s

Lavoisier (1743-1794)

- 1st to use systematic names for elements/compounds
- Found combustion was reaction with oxygen
- Realized the importance of very accurate weight measurements of chemical changes
- *Law of Conservation of Mass*



Proust (1754-1826)

- Investigated quantitative aspects of compound formation
 - Ex: Copper carbonate – regardless of how it's prepared in lab or found in nature, it's always 5 parts copper, 4 parts oxygen, 1 part carbon by mass
- *Law of Definite Proportions* (Law of Constant Composition): Elements in a compound are always present in a definite proportion by mass



John Dalton (1766-1844)

- Well-read in many science topics, scientists
- Quantitative studies of different compounds
- Forcefully revived the idea of the atom (1808)
- Father of modern chemistry



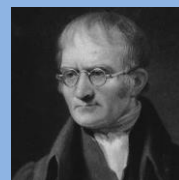
Dalton's Atomic Theory

1. All matter is made of very small particles called atoms
2. All atoms of one element are identical and have a unique set of chemical properties, different than atoms of another element
3. Atoms are indivisible and do not disappear/appear and do not change into atoms of another element
4. Compounds are formed when atoms of two or more elements combine in a fixed ratio
5. Chemical reactions take place by rearranging atoms

Dalton's Atomic Theory explains:

Law of Conservation of Mass

Law of Definite Proportions



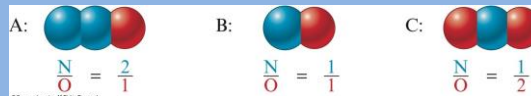
John Dalton
(1766-1844)

- Dalton's Atomic Theory predicts:

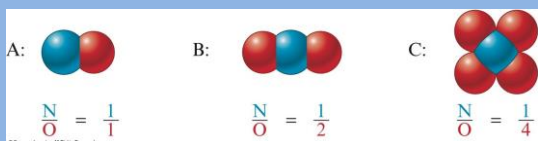
- Law of Multiple Proportions

- When two or more compounds are formed from the same elements, the mass of one element that combines with the other, is in whole number ratios

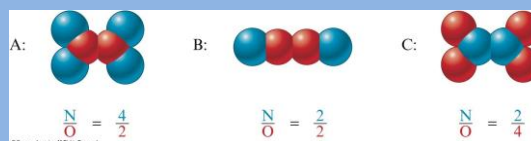
carbon dioxide	CO ₂	C-3	O-8
carbon monoxide	CO	C-3	O-4
	N ₂ O	N-7	O-4
	NO ₂	N-7	O-16
	NO	N-7	O-8
		N-7	O-32



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- Until mid 1800s:

The atom is an indivisible,
stable particle

THE ATOM

"The atom is one of science's greatest achievements. The idea, born in the mind of a Greek man many years before the birth of Christ, now dominates the science and technology that surrounds us. With this idea, scientists can explain nearly all the phenomenon of nature. With this idea, technicians have developed TV, radio, computers. They have probed the human body and mind, and the farthest reaches of outer space. On this idea we trust our lives.

From a simple beginning, the idea has grown, contorted, rebelled, exploded, lay dormant, baffled and confused, surprised and enlightened. The idea has been down many roads, some rough, some smooth, some of them dead ends. The trek along the road lays open to all of us and now to you. Not so that you may join the masses that know what the idea is, but so you may join the faithful who know why it is, how it came to be. The power comes from understanding the idea, knowing its strengths and weaknesses, and how it can be used. Satisfaction comes from mastering the most sophisticated idea in all of nature. The joy and misery comes from the mysteries that lie within, the idea, the atom."