Chemistry 11

Atomic Theory I

Name: Key
Date:
Block:

1. Atomic Theorists and Theories
2. Atomic Structure

Atomic Theorists and Theories

Scientists create models to...

1. explain things that they cannot observe directly.
2. make predictions
3. conduct experiments
4. try to understand nature.

Early Greek Theories

- Democritus: 400 BCE
  - Suggested that all matter was made up of tiny indivisible particles called atoms (Greek: atoma)

- Aristotle: 350 BCE
  - Modified an earlier theory and though that matter was made of 4 elements: earth, fire, water, air
  - He was wrong but his theory persisted for 2000 years

John Dalton

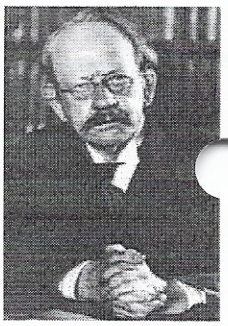
- In 1800, John Dalton proposed a theory based on experimentation
- His ideas accounted for:
  - Law of Conservation of mass
  - Law of Constant composition

⇒ **Dalton's Atomic Theory:**

1. **All matter is made up of** atoms
2. **Atoms of an element are** identical
3. **Each element has** different atoms
4. **Atoms of different elements** combine in constant ratios to form compounds
5. **Atoms are** rearranged **in reactions**

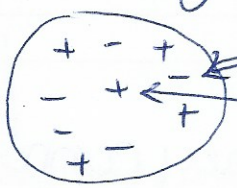
* Billiard ball model. → all atoms are solid and indivisible.

J.J. Thomson

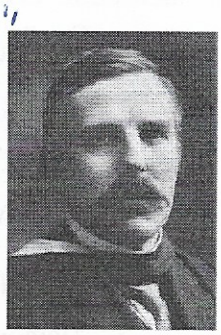


- Using Crooke's Cathode Ray Tube (CRT), Thomson discovered the electron!
- Thomson's discovery of the subatomic particle disproved Dalton's previous theory
- Thomson's model of the atom: Pudding model

electron : -ve
protons : +ve



Ernest Rutherford

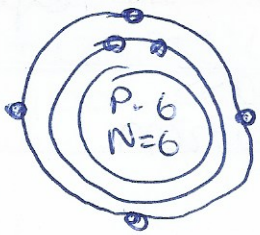


- Discovered the nucleus with his gold foil experiment
- If the plum pudding model was correct, positive particles should go straight through an element
- However, some of the particles were deflected (by the nucleus)
- The flaw in Rutherford's model:
  - He could not explain why the electrons didn't fall into the nucleus and distroy the atom

Niels Bohr

- Bohr pictured the hydrogen atom as having discrete energy "levels" which the electron could "inhabit."
- Each "jump" would give off light of a particular wavelength or color. This gave rise to hydrogen's spectrum
  - When the atom was "excited", the electron could "jump" to a higher energy level
  - When the electron came back down, it released energy in the form of light
- Bohr's model of the atom:

Carbon:



Other Significant Figures:

- Louis De Broglie
  - Suggested that all particles have a "wave nature" and that things like light and electrons could be particles or waves
  - In De Broglie's model of the atom, electrons are like waves that go around the nucleus
- Erwin Schrodinger
  - An orbital is a region in space where the probability of finding an electron is high.
  - The denser the orbital, the higher the probability
- Murray Gell-Mann
  - All subatomic particles are composed of "quarks."
  - quantum chromodynamics

Atomic Structure

- Atomic Number: The number of protons in an element
  - Determines spot on the periodic table
- Mass Number: The number of protons and neutrons in an element
- If an atom has a neutral charge, it must have the same # of protons and electrons
- Isotope: An element that has the same number of protons, but different number of neutrons
  - Same atomic number, different mass number

1. The mass of an atom is contained mainly in its protons and neutrons
2. The identity of an element is determined by its number of protons.
3. Isotopes are atoms with the same number of protons and different number of neutrons.
4. The charge of an atom or ion is determined by its number of electrons.
5. B Particle X contains 9 protons, 10 neutrons, and 9 electrons. Particle Y contains 9 protons, 10 neutrons, and 10 electrons. What is the relationship between particles X and Y?
   A. Particles X and Y are isotopes of the same element.
   B. Particle X is an atom, and particle Y is an ion of the same element.
   C. Particle X and Y are atoms of different elements.
   D. There is no significant difference between particles X and Y.

The table below contains information about several ions. Use the information given to fill in the blanks.

Element Name	Ion Symbol	Atomic Number	Mass Number	# of Protons	# of Neutrons	# of Electrons
6. Chlorine	Cl^-	17	35.45	17	18	18
7. Silver	Ag^+	47	107	47	60	46
8. Oxygen	O^{2-}	8	15.99	8	8	10
9. Aluminum	Al^{3+}	13	27	13	14	10

mass # ↓ A, Z X, ↑ atomic #

The table below contains information about several isotopes. Use the information given to fill in the blanks. Assume all atoms are neutral.

Isotope Name (mass #)	Nuclear Symbol	Atomic Number	Mass Number	# of Protons	# of Neutrons	# of Electrons
10. Calcium-40	$^{40}_{20}Ca$	20	40	20	20	20
11. Calcium-42	$^{42}_{20}Ca$	20	42	20	22	20
12. Iron-56	$^{56}_{26}Fe$	26	56	26	30	26
13. Oxygen-18	$^{18}_{8}O$	8	18	8	10	8
14. Gold-197	$^{197}_{79}Au$	79	197	79	118	79

15. Calculate the average atomic mass for neon if its abundance in nature is 90.5% neon-20, 0.3% neon-21, and 9.2% neon-22.

$$\frac{(90.5 \times 20) + (0.3 \times 21) + (9.2 \times 22)}{100}$$

$$= \boxed{20.19 \text{ amu}}$$

16. Calculate the average atomic mass of silver if 13 out of 25 atoms are silver-107 and 12 out of 25 atoms are silver-109.

$\frac{13}{25} = 52\%$

$\frac{12}{25} = 48\%$

$$\frac{(107 \times 52) + (109 \times 48)}{100}$$

$$= \boxed{107.96 \text{ amu}}$$

17. Please use the following table to calculate the average atomic mass of chlorine.

Isotope	% Abundance	Mass (amu)
^{35}Cl	75.78%	34.969
^{37}Cl	24.22%	36.966

$$\frac{(75.78)(34.969) + (24.22)(36.966)}{100}$$

$$= \boxed{35.453 \text{ amu}}$$

18. Raiderium (Cv) has three naturally occurring isotopes. Raiderium is 74.655% ^{44}Cv, which has an atomic mass of 43.064 amu, 24.958% ^{46}Cv, which has a mass of 46.125 amu, and 0.387% ^{48}Cv, which has an atomic mass of 47.982 amu. Please calculate the average atomic mass of Raiderium.

$$\frac{(74.655)(43.064) + (24.958)(46.125) + (0.387)(47.982)}{100}$$

$$= \boxed{43.847 \text{ amu}}$$

19. Naturally occurring silicon consists of three stable isotopes (see table). The average atomic weight is 28.09 AMU.

What is the atomic mass of ^{30}Si?

Isotope	% Abundance	Mass (amu)
^{28}Si	92.21% = 0.9221	27.977
^{29}Si	4.70% = 0.0470	28.976
^{30}Si	3.09% = 0.0309	?

$$28.09 \text{ amu} = (0.9221)(27.977 \text{ amu}) + (0.0470)(28.976 \text{ amu}) + (0.0309)x$$

$$\boxed{x = 30.11 \text{ amu}}$$

15) 20.19 amu 16) 107.96 amu 17) 35.453 amu 18)43.847 amu 19) 30.11 amu