



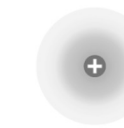


Studying Matter...

All materials on earth and the universe are made of matter. In this unit we will study the basic underpinning of matter...
The ATOM

A HISTORY OF THE ATOM: THEORIES AND MODELS

How have our ideas about atoms changed over the years? This graphic looks at atomic models and how they developed.

SOLID SPHERE MODEL	PLUM PUDDING MODEL	NUCLEAR MODEL	PLANETARY MODEL	QUANTUM MODEL
				
JOHN DALTON	J.J. THOMSON	ERNEST RUTHERFORD	NIELS BOHR	ERWIN SCHRÖDINGER
1803	1904	1911	1913	1926
Dalton drew upon the Ancient Greek idea of atoms (the word 'atom' comes from the Greek 'atomos' meaning indivisible). His theory stated that atoms are indivisible, those of a given element are identical, and compounds are combinations of different types of atoms.	Thomson discovered electrons (which he called 'corpuscles') in atoms in 1897, for which he won a Nobel Prize. He subsequently produced the 'plum pudding' model of the atom. It shows the atom as composed of electrons scattered throughout a spherical cloud of positive charge.	Rutherford fired positively charged alpha particles at a thin sheet of gold foil. Most passed through with little deflection, but some deflected at large angles. This was only possible if the atom was mostly empty space, with the positive charge concentrated in the centre: the nucleus.	Bohr modified Rutherford's model of the atom by stating that electrons moved around the nucleus in orbits of fixed sizes and energies. Electron energy in this model was quantised; electrons could not occupy values of energy between the fixed energy levels.	Schrödinger stated that electrons do not move in set paths around the nucleus, but in waves. It is impossible to know the exact location of the electrons; instead, we have 'clouds of probability' called orbitals, in which we are more likely to find an electron.
RECOGNISED ATOMS OF A PARTICULAR ELEMENT DIFFER FROM OTHER ELEMENTS	RECOGNISED ELECTRONS AS COMPONENTS OF ATOMS	REALISED POSITIVE CHARGE WAS LOCALISED IN THE NUCLEUS OF AN ATOM	PROPOSED STABLE ELECTRON ORBITS; EXPLAINED THE EMISSION SPECTRA OF SOME ELEMENTS	SHOWS ELECTRONS DON'T MOVE AROUND THE NUCLEUS IN ORBITS, BUT IN CLOUDS WHERE THEIR POSITION IS UNCERTAIN
ATOMS AREN'T INDIVISIBLE - THEY'RE COMPOSED FROM SUBATOMIC PARTICLES	NO NUCLEUS; DON'T EXPLAIN LATER EXPERIMENTAL OBSERVATIONS	DID NOT EXPLAIN WHY ELECTRONS REMAIN IN ORBIT AROUND THE NUCLEUS	MOVING ELECTRONS SHOULD LOSE ENERGY AND COLLAPSE INTO THE NUCLEUS; MODEL DID NOT WORK WELL FOR HEAVIER ATOMS	STILL WIDELY ACCEPTED AS THE MOST ACCURATE MODEL OF THE ATOM



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Role of Subatomic Particles

The modern atomic model contains protons, electrons, and neutrons (+, -, and neutral)

Protons

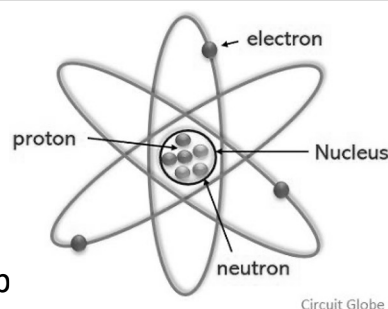
In nucleus (*center of atom*), identifies atom, keep electrons within the outer portion of the atom

Electrons

Atomic communication, connection to other atoms, balancing protons in the atom

Neutrons

Barrier between protons/electrons, shielding



Basic Structure of the Atom

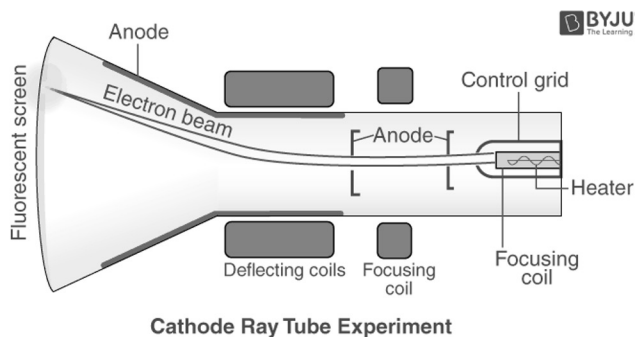
Includes electrons (e^-), protons (p^+), and neutrons (n^0)

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Subatomic Particles

Thomson's Cathode Ray Experiments

Thomson worked with Cathode "Canal" Rays in a vacuum to determine the energy and charge of e^-



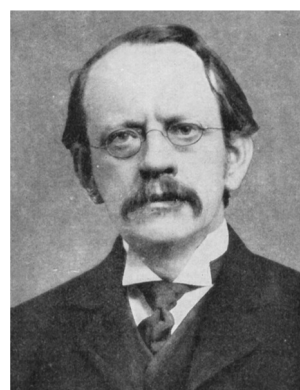
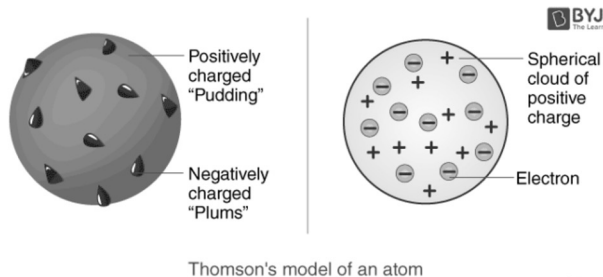
Joseph John Thomson
English Chemist
1856 - 1940AD

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Subatomic Particles

Thomson's Plum Pudding Model

Thomson's discovery of the electron (e^-) led to the *plum pudding model*, e^- in an atom surrounded by a positive *matrix*



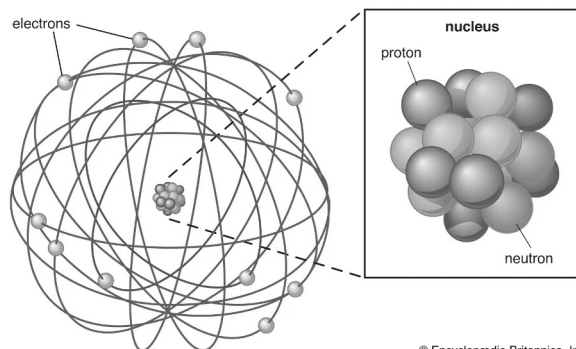
Joseph John Thomson
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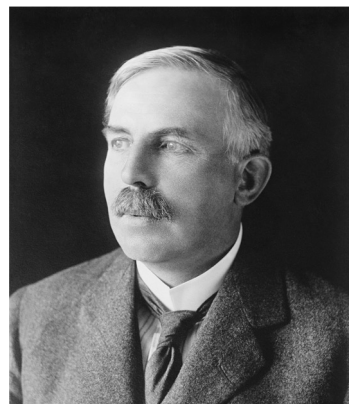
Subatomic Particles

Rutherford's Atomic Model

Strong positive center to the atom (*nucleus*) surrounded by negatively charged electrons (e^-)



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Ernest Rutherford

*New Zealand Chemist
1871 - 1931AD*

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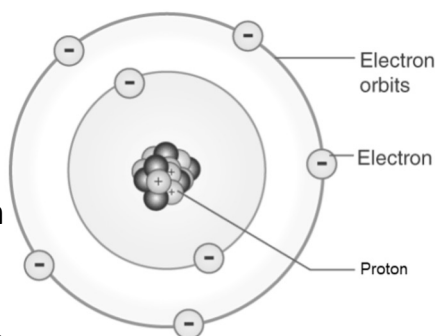
Subatomic Particles

Bohr's Atomic Model

e^- travel in orbits around the center of the atom

Atomic Orbits

Pathways around nucleus e^- travel in to maintain distance between other e^- and keep e^- and p^+ from colliding (*nucleus*)



Bohr atomic model of a Nitrogen atom

© Byjus



Neil Bohr

*Polish Chemist
1885 - 1962AD*

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Subatomic Particles

Inner and Valence Electrons (e^-)

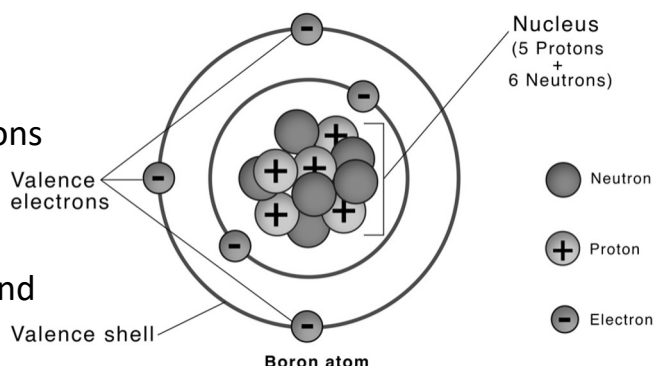
Electrons contain different roles within the atom

Inner (*Shell*) Electrons

Provide repulsive force (- to -)
helping protect valence electrons

Valence (*Outer*) Electrons

Electrons that communicate
(*transferred or shared*) and bond
(*connect*) with other atoms



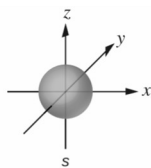
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Subatomic Particles

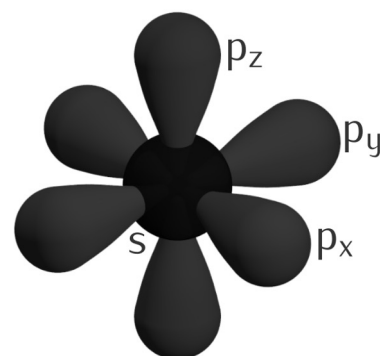
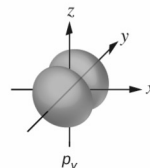
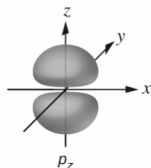
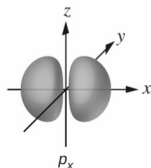
Atomic Orbitals and Electron Filling

Orbitals are predicted electron locations around the atom to minimize electron repulsion in the orbitals.

0, 1 or 2 e^-
allowed per
orbital



Electrons always
fill one per
suborbital before
pairing together



Overall Orbital Set

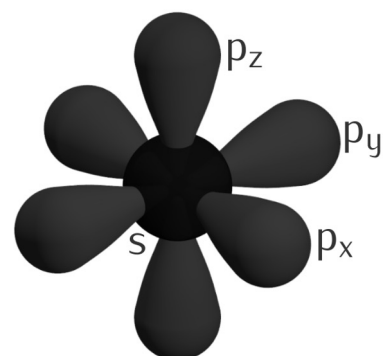
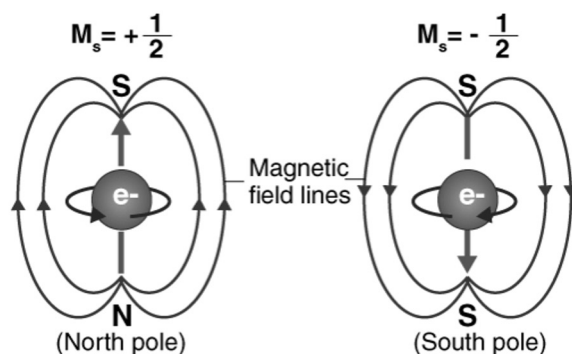
8 electrons fit within 4
orbitals in the s, p_x , p_y , p_z
orbital set

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Subatomic Particles

Atomic Orbital Electron Spin

Within an orbital electrons spin in opposite directions (+1/2 and -1/2) to min. repulsion



Overall Orbital Set

8 electrons fit within 4 orbitals in the s, p_x, p_y, p_z orbital set

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Subatomic Particles

Counting Valence Electrons (e⁻) [*Representative Groups*]

Valence Electrons are based on group on the table

Group	Name	Val e ⁻	Group		Val e ⁻
1A (1)	Alkali Metals	1	5A (15)	Pnictogens	5
2A (2)	Alkali Earth Metals	2	6A (16)	Chalcogens	6
3A (13)	Earth Metals	3	7A (17)	Halogens	7
4A (14)	Carbon Group	4	8A (18)	Noble Gases	8

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Subatomic Particles

Counting Valence Electrons (e⁻) [*Transition Metals*]

Valence Electrons are based on group on the table

Transition Metals can have 1 – 7 valence electrons (*base 2*)

Group	3B (3)	4B (4)	5B (5)	6B (6)	7B (7)	8B (8)	8B (9)	8B (10)	1B (11)	2B (12)
Element	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
Possible Valence electron	3	3 4	2 3 4 5	2 3 4 6	2 3 4 5 7	2 3 6	2 3	2 3	1 2 3	2