

4. ATOMIC STRUCTURE




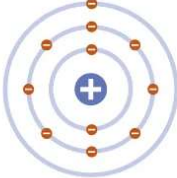






CH30S

UNIT 1 – ELEMENTS & COMPOUNDS

1

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.

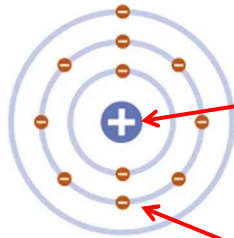
SOLID SPHERE MODEL	PLUM PUDDING MODEL	NUCLEAR MODEL	PLANETARY MODEL	QUANTUM MODEL
				
JOHN DALTON	J. J. THOMSON	ERNEST RUTHERFORD	NIELS BOHR	ERWIN SCHRÖDINGER
 1803	 1904	 1911	 1913	 1926
Dalton drew upon the Ancient Greek idea of atoms (the word 'atom' comes from the Greek 'atomos' meaning indivisible). 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.

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THE ATOMIC MODEL

The most common model of the atom is like a mini solar system. While this is not truly accurate, it works for now!

PLANETARY MODEL



THE MASS OF THE ATOM IS DUE TO THE SIZE OF THE NUCLEUS.

NIELS BOHR



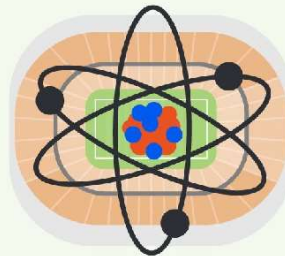
1913

THE SIZE OF THE ATOM IS DUE TO THE NUMBER OF ELECTRONS.

3

PUTTING IN TO PERSPECTIVE

If an atom were the size of an NFL football stadium...



...the nucleus would be the size of a pea at the 50-yard line.



TECH INSIDER

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WHAT MAKES UP AN ATOM?

Most people already know that the atom is made up of three main parts, the protons and neutrons in the **nucleus** and the electrons somewhere outside of the **nucleus**.

	PROTONS	NEUTRONS	ELECTRONS
SYMBOL			
CHARGE			
LOCATION			

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ATOMIC NOTATION

Mass number
Number of protons
and neutrons in atom

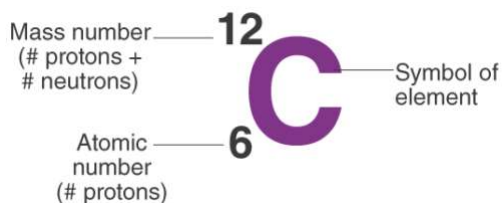


Atomic symbol
Abbreviation used
to represent atom
in chemical
formulas

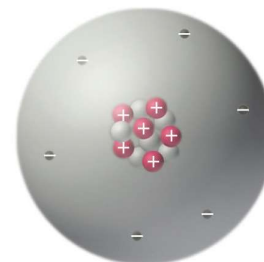
Atomic number
Number of protons
in atom

6

ATOMIC NOTATION



6 protons $+$
6 neutrons \bullet
6 electrons $-$



CARBON - 12

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ATOMIC NUMBER (Z)

The proton is the particle that determines the identity of the element.

The atomic number of an element is the number of protons found in the nucleus of the atom.

ATOMIC NUMBER (Z)	NUMBER OF PROTONS	IDENTITY OF ELEMENT
23		
92		
		Chlorine
		Magnesium

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ATOMIC NUMBER (Z)

Atoms (as opposed to ions) are electrically neutral, meaning they have one electron for every proton.

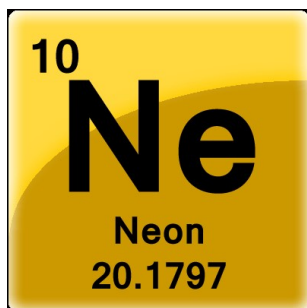
ELEMENT	NUMBER OF PROTONS	NUMBER OF ELECTRONS
sodium		
potassium		
sulphur		
bromine		

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MASS NUMBER (A)

The mass of an atom is found in its nucleus.

The mass number of an atom is the sum of its protons and neutrons.

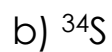
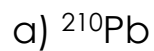


Determining Neutrons:

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EXAMPLE #1

Determine the number of protons, electrons, and neutrons in:

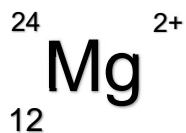


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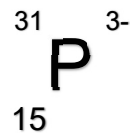
IONS

Chemical changes involve the gaining or losing of electrons only.

Ions are atoms (or groups of atoms) that have gained or lost electrons during a reaction to become electrically charged.



Magnesium Cation
Lost 2 electrons

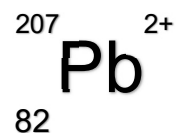
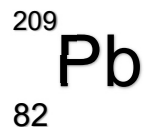
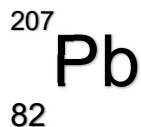


Phosphide Anion
Gained 3 electrons

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EXAMPLE #2

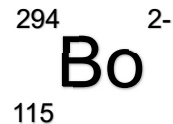
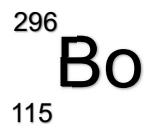
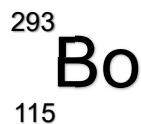
Determine the number of protons, neutrons, and electrons present in the following substances:



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YOUR TURN!

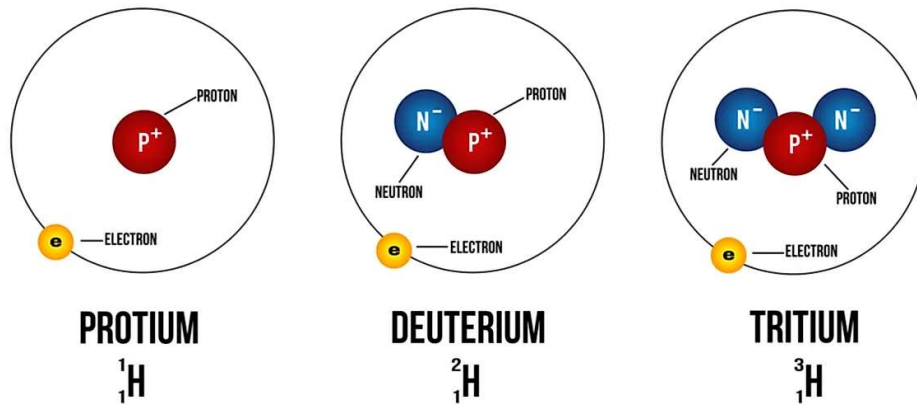
NASA has just discovered a delicious new element on Mars that smells and tastes like lunch meat. They have called it Bolognium (Bo). Determine the number of protons (p^+), neutrons (n^0) and electrons (e^-) in the following atomic notation of Bolognium.



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ISOTOPES

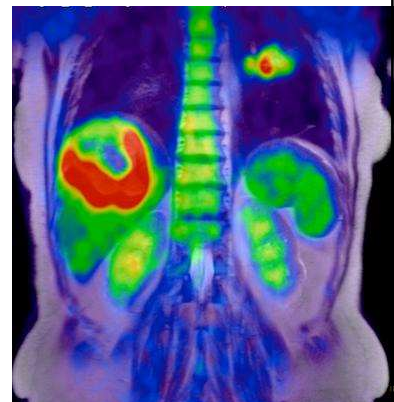
Isotopes are atoms of the same element having different masses due to **varying numbers of neutrons.**



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COMMON MEDICAL ISOTOPES

Radioactive Isotope	Applications in Medicine
Cobalt-60	Radiation therapy to prevent cancer
Iodine-131	Locate brain tumors, monitor cardiac, liver and thyroid activity
Carbon-14	Study metabolism changes for patients with diabetes, gout and anemia
Carbon-11	Tagged onto glucose to monitor organs during a PET scan
Sodium-24	Study blood circulation
Thallium-201	Determine damage in heart tissue, detection of tumors



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AVERAGE ATOMIC MASS

- The average mass of all the naturally occurring isotopes of that element.
- This explains why atomic masses on your periodic table are decimals and not whole numbers, as you might expect.

Isotope	Symbol	Composition of the nucleus	% in nature
Carbon-12	^{12}C	6 protons 6 neutrons	98.89%
Carbon-13	^{13}C	6 protons 7 neutrons	1.11%
Carbon-14	^{14}C	6 protons 8 neutrons	<0.01%

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EXAMPLE # 3

Use the mass spectrometry data below to calculate the average atomic mass of iron.

Table 2. Stable Isotopes of Iron

Isotope	Mass (amu)	% Abundance
^{54}Fe	53.94	5.845
^{56}Fe	55.93	91.75
^{57}Fe	56.94	2.119

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YOUR TURN

Use the mass spectrometry data below to calculate the average atomic mass of neon.

Strontium		
Isotope	Mass (amu)	Abundance
Sr-84	83.913428	0.56%
Sr-86	85.909273	9.86%
Sr-87	86.908902	7.00%
Sr-88	87.905625	82.58%