## Atoms, Elements, and the Periodic Table

# Everything in the universe is made up of matter.

All matter is made up of tiny particles called ATOMS.

- Atoms make up elements
- Elements make up all matter.

#### Elements

- An element is a substance that cannot be broken down into any other substance by chemical or physical means.
- All the different kinds of matter in the universe are made from about 100 different substances, called elements.
- Elements are called the building blocks of matter because all matter is composed of elements.
- All elements are arranged on the Periodic Table of Elements

#### Understanding the Elements on the Periodic Table



H 1.008				= A = O = Al = N = Tr = Ha = Ra	Ikali M Ther A Ikali Ed oble G ransitio alogens are Ear	letals Metals arth Ma ases on Met s "th Me	etals als tals										He
Li	₽e	Be Black = Solid Green = Gas										B	c	N	0	F	Ne
Na	Mg	12 White = Synthetic										13 <b>A</b>	si Si	15 P	s S	<b>C</b>	Ar
19 K	20 Ca	21 Sc	Ti	23 V	Cr <sup>24</sup>	25 Mn	Fe	27 <b>Co</b>	28 Ni	<sup>29</sup> Cu	30 Zn	Ga	<sup>32</sup> Ge	33 As	<sup>34</sup> Se	<sup>35</sup> Br	<sup>36</sup> Kr
37 Rb	38 Sr	39 <b>Y</b>	₄₀ Zr	Nb	42 Mo	<b>T</b> c	Ru	₄₅ Rh	₽ď	47 Ag	Cd	49 In	50 Sn	51 Sb	52 Te	53 <b>I</b>	Xe
Cs	56 Ba	57 La	Hf	73 Ta	74 W	<sup>75</sup> Re	<sup>76</sup> Os	" Ir	78 P†	79 Au	нg	81 T	82 Pb	<sup>83</sup> Bi	84 Po	85 At	Rn
Fr	88 Ra	89 AC	<sup>104</sup> Rf	105 Db	<sup>106</sup> Sg	<sup>107</sup> Bh	<sup>108</sup> Hs	109 M†	110 Uun	<sup>111</sup> Uuu	112 Uub		114 Uuq		116 Uuh		118 <b>Uuo</b>

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Fu	Gd	Th	DV	Ho	Fr	Tm	Vb	1.0
CE	••	1.40		$\sim$	Lu	σu		υ,	• ••	с.		10	Lu
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Τĥ				D	A	<b>C</b>	DÍ	C.C.	<b>E</b> <sup>~</sup>	<b>E</b>			
IN	ra	U	NP	PU	AM	Cm	BK	CT	ES	гт	Ma	NO	Lr



#### The Periodic Table

- Each element has its own symbol
- Elements are arranged in order of increasing atomic number.
- Elements are also arranged according to whether they are metals, metalloids, or nonmetals.

#### Metalloids

- Border at the zigzag on the periodic table
- Also called semiconductors some conduct electric current and thermal energy, and others do not
- Some are shiny, some dull
- They have the properties of both metals and nonmetals

#### Metals

- Found to the left of the zigzag on the period table.
- Have few electrons in their outer energy level
- Shiny
- Good conductors of thermal energy
- Good conductors of electric current
- Malleable
- Ductile

#### Nonmetals

- Found to the right of the zigzag on the periodic table
- Have an almost complete set of electrons on its outer energy level
- Dull
- Poor conductors of electric current or thermal energy
- Tend to be brittle

#### Rows of the Periodic Table

- The horizontal rows of the periodic table are called periods
- A row is called a period because the properties of elements in a row follow a repeating, or *periodic*, pattern
- The elements in a row become less metallic from left to right

22

Ti

19

20

Ca

21

Sc

23

V

24

Cr

25

Mn

26

Fe

• The row number indicates the number of "rings" (energy levels) around the nucleus

28

Ni

29

Cu

30

Zn

31

Ga

27

Co

36

Kr

35

Br

34

Se

33

As

32

Ge

#### Columns of the Periodic Table

- Columns are called groups.
- Groups go from top to bottom
- Elements in a group often have common chemical and physical properties.
- Sometimes called a family

#### Group 1: Alkali Metals

- Very reactive can easily give away their one electron on outer shell
- Soft
- Silver-colored
- Low density
- shiny

#### Group 2: Alkaline Earth Metals

- Very reactive less reactive than the alkali metals
- Shiny
- Low density
- 2 outer electrons

#### Groups 3-12: Transition Metals

- Becoming less reactive
- Shiny
- Good conductors of thermal energy and electric current
- Higher densities
- Higher melting points (except mercury)
- Include the Lanthanides and Actinides

#### Lanthanides

- Shiny, reactive metals
- Some are used to make different types of steel

#### Actinides

- All are radioactive this means they are unstable, or can change into atoms of a different element
- Some of these are produced in labs

## Group 13: Boron Group

- These have 3 electrons in the outer level
- Solid at room temperature
- Fairly reactive
- Aluminum is the most common element in this group and actually is the most common element in the earth's crust

#### Group 14: Carbon Group

- Al solid at room temperature
- 4 electrons in the outer level.

## Group 15: Nitrogen Group

- Al solid at room temperature
- 5 electrons in the outer level.

## Group 16: Oxygen Group

- 6 electrons in the outer level
- All solid at room temperature but oxygen

## Group 17: Halogens

- 7 electrons in the outer level
- Very reactive they only need to gain one electron in their outer level
- Nonmetals
- Poor conductors of electric current
- React violently with alkali metals to form salts
- Never found uncombined in nature

#### Group 18: Noble Gases

- 8 electrons in the outer level
- Unreactive
- Colorless, odorless gases at room temp

## Dalton's Atomic Theory

- Matter is composed of small indivisible pieces called atoms.
- Atoms are indestructible.
- All atoms of the same element are identical.
- All atoms of different elements are different.
- Atoms combine in whole number ratios to form compounds.
- The result of this Theory was the creation of Dalton 's Model of the atom. Solid indestructible sphere.

#### Current Model of the Atom

- The current model of the atom shows electrons moving about rapidly around the nucleus from one energy level to another.
- Exact location of electrons is impossible to detect



#### So what is an **ATOM**?

- An atom is the smallest part of an element that has all the properties of an element
- An atom consists of a dense <u>nucleus</u> surrounded by a much larger <u>electron</u> <u>cloud</u>.
- Atoms DO have mass!

## Inside the **NUCLEUS** of an atom

- The nucleus of an atom is made of particles called protons and neutrons
- NEUTRONS have no charge
- PROTONS have a positive charge
- Most of the mass of an atom is found in the nucleus.

#### **Protons and Neutrons**

• The number of **PROTONS** will tell us the **atomic number** of an element

• **PROTONS** plus **NEUTRONS** give us the **atomic mass** of an element

#### So what is an **electron**?

- Electrons are negatively charged particles in an atom.
- There are the same number of protons as there are electrons.
- Electrons surround the nucleus of an atom in the **electron cloud**.
- Electrons are constantly moving around on their *energy level*.

#### Valence Electrons

• The electrons in the outermost energy level are called VALENCE ELECTRONS

 The number of valence electrons is the SAME as the number group the element is in!!



#### Electron-Dot Diagrams or Lewis Structures

 Dot diagrams show only the valence electrons in an atom



#### What does an atom look like?



## The simplest atom has one proton and one electron



This is HYDROGEN!!!

#### Bohr's Model of the Atom

 German scientist Neils Bohr developed a model of the atom that shows the electrons on energy levels or shells as they surround the nucleus



Because protons have a charge, they will repel from one another.



For every additional proton in an atom, there has to be neutron to keep the protons together in the nucleus.

## An atom can have as many neutrons as it wants

- This is what is called an *isotope*.
- Isotopes are atoms that have the same number of protons but have different numbers of neutrons.
- Isotopes are always the same element because the number of protons in each atom is the same
- Isotopes can occur naturally

#### What is an ion?

- An <u>ion</u> is an atom or a group of atoms that has become <u>electrically charged</u>
- When an atom loses an electron, it loses a negative charge and becomes a positive ion. CATION
- When an atom gains an electron, it gains a negative charge and becomes a negative ion. ANION

Two atoms talking together ... I just lost an electron' Im positive! Are you sure? .

#### Electron Number and Organization

 Remember, in an atom, the number of electrons is equal to the number of protons and the atomic number tells us the number of protons/ electrons

 An ion has either lost or gained an electron

#### Becoming an Ion

- Elements with 1, 2, or 3 valence electrons
  GIVE away their outer electrons and become positive ions.
- Elements with 5, 6, or 7 valence electrons STEAL electrons and become negative ions.
- Metals give electrons
- Non-metals take electrons

#### **Ionization Charge**

- To show the ionization charge, use the element symbol, indicate whether it is positive or negative, and show the number electrons lost or gained
- Examples:
  - Sodium ion Na<sup>+</sup>
  - Chlorine ion Cl<sup>-</sup>
  - Oxygen ion O<sup>2-</sup>
  - Aluminum Al<sup>3+</sup>

#### Atoms that SHARE Electrons

- Sometimes atoms share valence electrons to have a complete outer energy level
- Only NONMETALS will share their valence electrons
- This does include Hydrogen!

#### **Sharing Electrons**



Oxygen (O2) Molecule



#### What is chemical bonding?

• Chemical bonding is the joining of atoms to form new substances.

• The force of attraction that holds two atoms together is called a chemical bond.

Atoms bond according to their
 ELECTRONS

#### What will make an atom bond?

- Atoms bond to have a filled outermost level
- An atom that has fewer than 8 electrons is more reactive, or more likely to form bonds
- Atoms bond by gaining, losing, or sharing electrons to have a filled outermost level

#### Types of Chemical Bonds

# • **Ioníc**

# Covalent



when the Na<sup>+</sup> and



## HOW IONIC!

#### What is an ionic bond?

- An ionic bond is the attraction between two oppositely charged ions.
- Ionic bonds occur between a metal and a nonmetal
- "Opposites Attract"



#### Properties of ionic bonds

Crystal shape

High melting points

Electrical conductivity







#### Remember...

# The overall charge of an ionic compounds must equal ZERO



#### What is a covalent bond?

- A chemical bond formed when two atoms share electrons.
- In a covalent bond, both atoms attract the two shared electrons at the same time.
- By sharing, both atoms have a full set of valence electrons.
- Covalent bonds occur between nonmetals.

#### **Shared Electron Pairs**



#### Oxygen (O2) Molecule

#### MOLECULES

 Molecules are formed when two or more atoms are covalently bonded

![](_page_54_Picture_2.jpeg)

#### Ionic and Molecular Compounds

#### **Ionic Compounds**

- Form between metals and nonmetals
- Conductors of electricity
- High melting points
- Brittle
- Crystal in shape

#### **Covalent Compounds**

- Formed between nonmetals
- Can have positive or negative charges (polyatomic ions)
- Do not conduct electricity
- Low melting points
- No specific crystalline structure