Unit 3: Reactivity

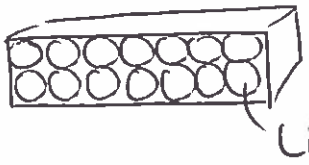
1. Atomic Structure:

atom: the smallest particle of an element that has the properties of that element

ex: atom of lithium

element: a substance that cannot be decomposed into simpler substances

ex: lithium



molecule: a combination of two or more atoms

ex:  or 

two or more of the same atom

= molecule of an element

two or more of different atoms

= molecule of a compound

compound: a substance that is made of simpler substances

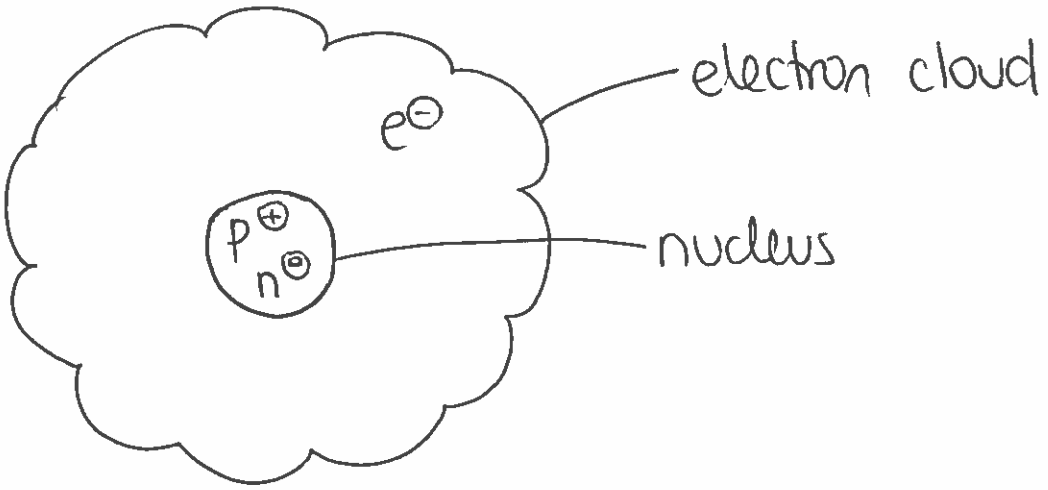
ex: water = H_2O = made from hydrogen and oxygen

Subatomic particles: particles that make up an atom

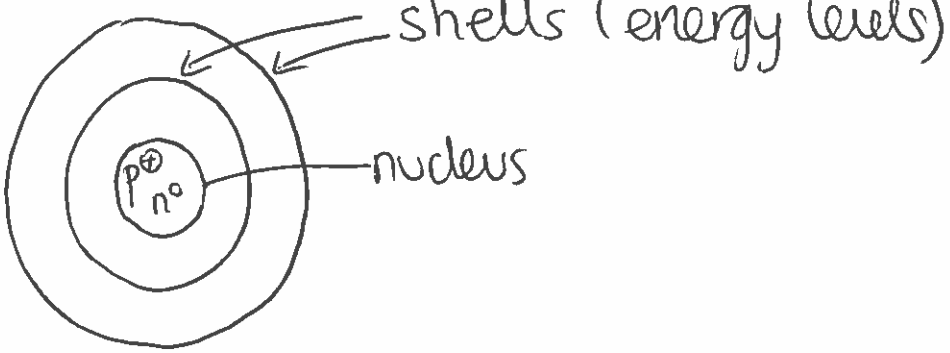
→ protons ($p^{\oplus}$)
→ neutrons (n°)
→ electrons ($e^{\ominus}$)

Subatomic Particle:	Charge	Mass	Location
Proton ($p^{\oplus}$)	Positive (+1)	~1 amu	Nucleus
Neutron (n°)	Neutral (0)	~1 amu (heaviest)	Nucleus
Electron ($e^{\ominus}$)	Negative (-1)	~0.00005 amu (negligible ~0)	Electron cloud - outside the nucleus

↳ amu = atomic mass units

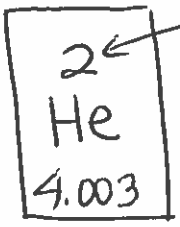


- note: we will also look at how electrons are arranged in shells (energy levels)



Atomic Number: # of protons in an atom

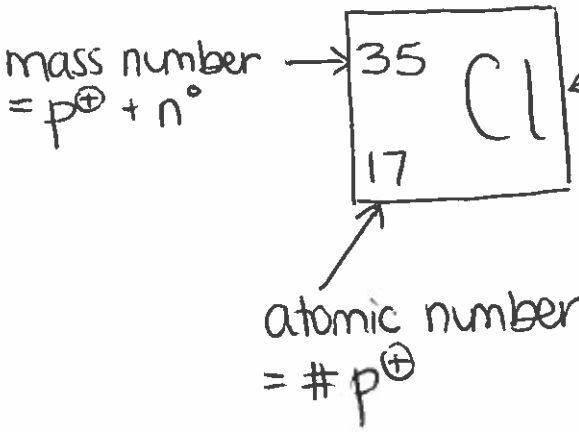
(Z)



the whole # in the periodic table

Mass Number: # of protons and neutrons in an atom

(A)



* there are atoms of different masses for each element (isotopes)

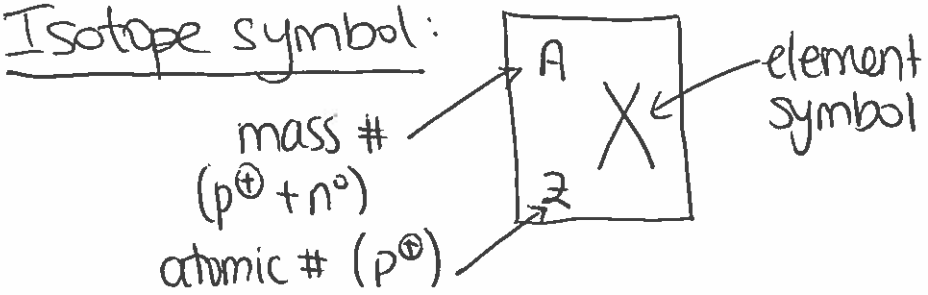
ex: there are chlorine-35, chlorine-37

Isotope name: element - mass number

ex: chlorine-35

mass number
= p⊕ + n°

Isotope symbol:



Finding # of $p^{\oplus}$, n°, $e^{\ominus}$:

protons = atomic number
→ from periodic table

neutrons = mass number − atomic number

$$-{}^{A}_{Z}X$$

electrons = # protons (in a neutral atom)

ex: Oxygen − 17

$p^{\oplus} = 8$

$n^{\circ} = 17 - 8 = 9$

$e^{\ominus} = 8$

${}^{24}_{12}Mg$

$p^{\oplus} = 12$

$n^{\circ} = 24 - 12 = 12$

$e^{\ominus} = 12$

② The Periodic Table:

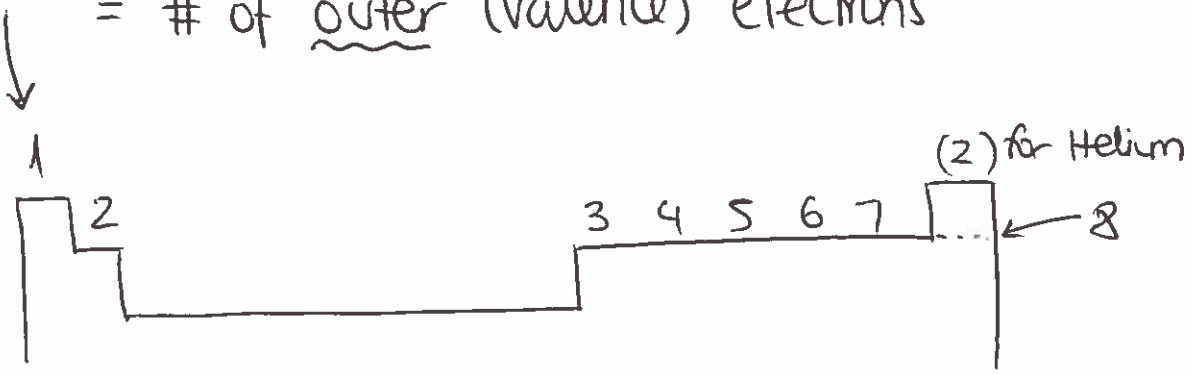
- arranged in order of increasing atomic number

1 → 2

3 4 → ...

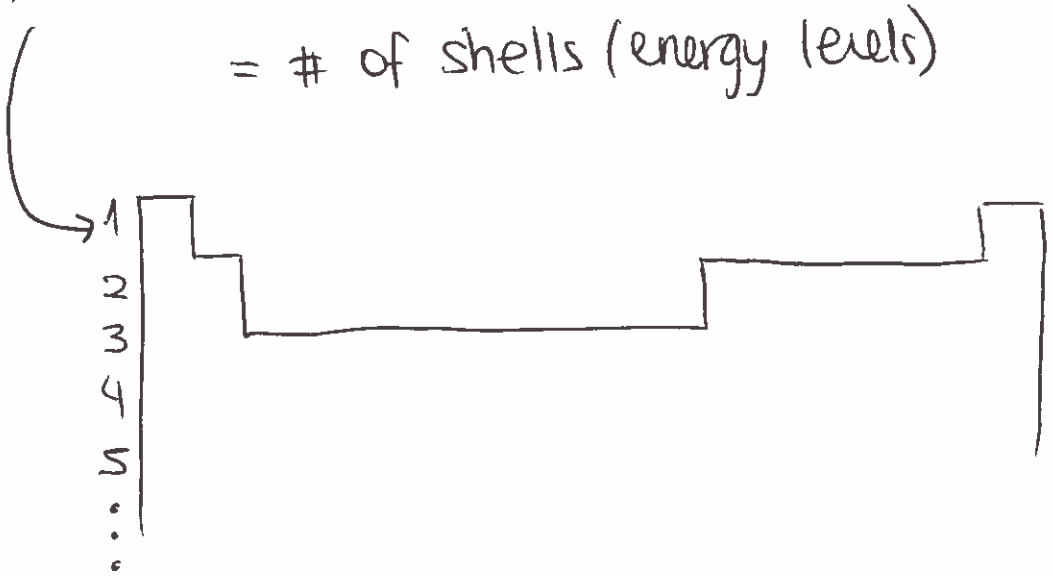
group: a column in the periodic table

= # of outer (valence) electrons



period: a row in the periodic table

= # of shells (energy levels)



(*) Know the placement of : metals
: semi-metals (metalloids)
: nonmetals
: alkali metals
: alkaline earth metals
: halogens
: noble gases
: transition metals

metals: shiny
malleable
conduct electricity or heat

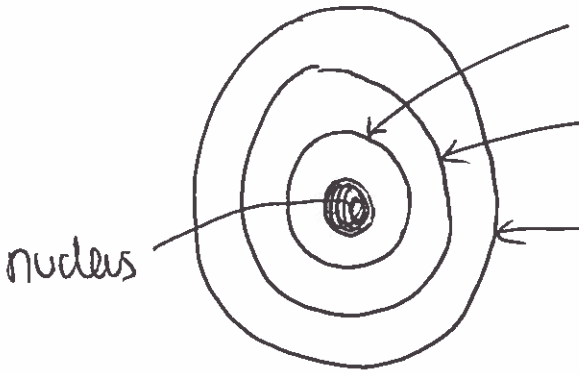
nonmetals: break into pieces if solid
→ not malleable

: dull
→ not shiny

: do not conduct electricity or heat

3. Electron Arrangement:

- electrons are organized in shells (energy levels)



shell 1 = max. $2e^{\ominus}$

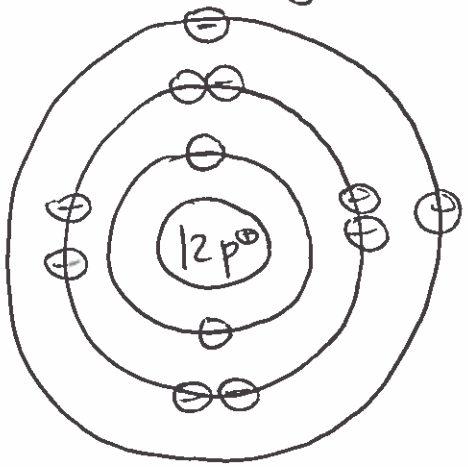
shell 2 = max. $8e^{\ominus}$

shell 3 = max. $8e^{\ominus}$ / $18e^{\ominus}$

ex:

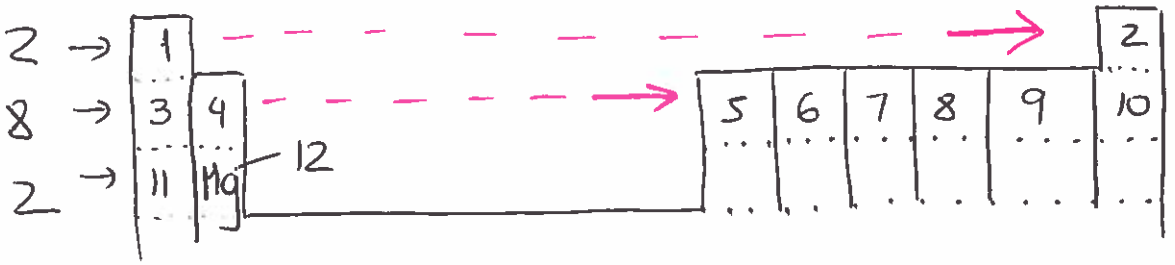
Bohr Model for Mg

- Mg has $12p^{\oplus}$ so $12e^{\ominus}$ (when neutral)



2, 8, 2

- you can read the electron arrangement from the periodic table (use it like a map!)



electron arrangement = 2, 8, 2 for Mg

(4.) Reactivity Series & Displacement Reactions:

- metals can be tested and organized in order of most to least reactive

ex:

most reactive

potassium
sodium
calcium
magnesium
aluminum
zinc
iron
⋮

least reactive

- higher reactivity can be noticed by things like:
  - → a faster reaction
  - → bubbles forming faster, if the reaction forms a gas
  - → more "vigorous" reaction - faster movement!

- metals that are more reactive: lose electrons easier!

: can displace (replace) less reactive metals

potassium
sodium
calcium
⋮

potassium can displace calcium
(replace)

ex: $K_{(s)} + Ca^{+2} \longrightarrow K^{+1} + Ca_{(s)}$

solid

- K can displace (replace) Ca because it is more reactive
- K becomes an ion (loses electrons)
- Ca becomes a solid

$Ca_{(s)} + K^{+1} \longrightarrow$ X no reaction

- Ca cannot displace (replace) K because it is less reactive

- group 1 = alkali metals = most reactive metals
  → need to lose $1e^{\ominus}$

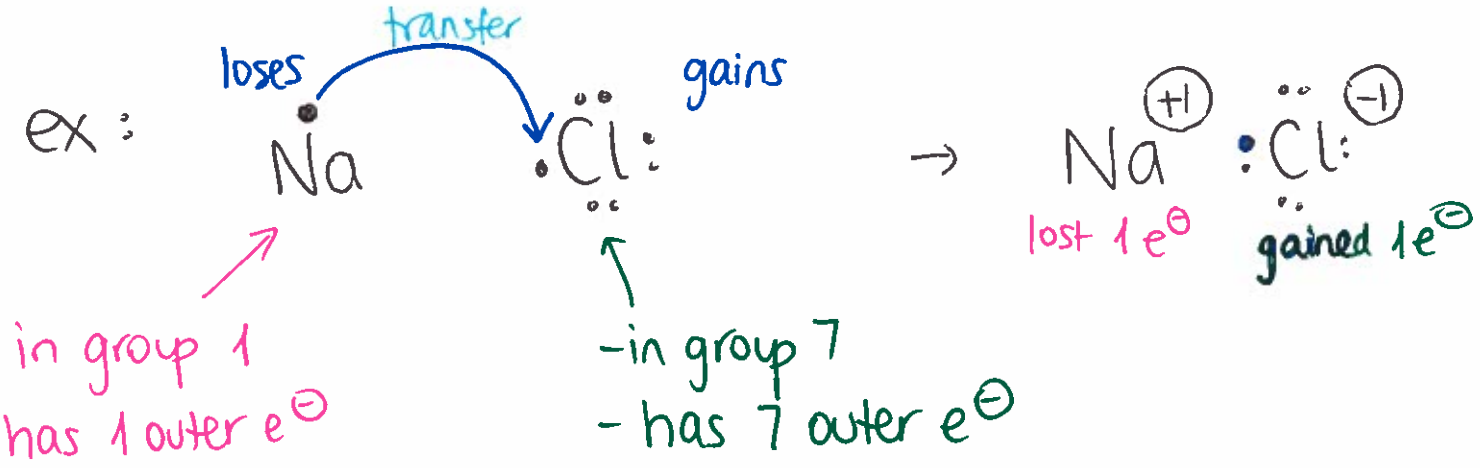
- group 2 = alkaline earth metals = next reactive metals
  → need to lose $2e^{\ominus}$

<u>for these groups:</u>
- metals are more reactive down the group

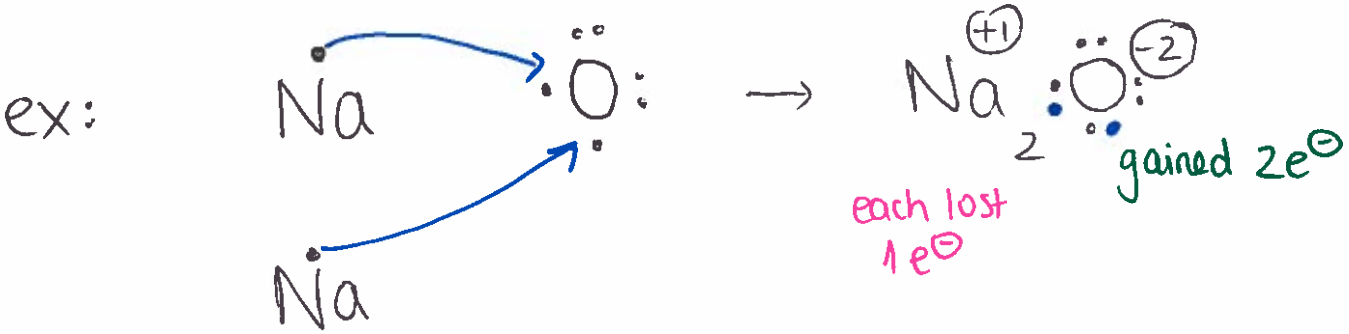
5. Ions and Ionic Bonding:

- ionic bond = bond (connection) between a metal and nonmetal
  - → metal: loses one or more electrons
  - → nonmetal: gains one or more electrons
  - ⊛ both / all atoms need to obtain a **full** outer shell of electrons to be stable
    - → full = 2 $e^{\ominus}$ for H; 8 $e^{\ominus}$ for all other elements
  - → noble gases (group 8) do not lose or gain electrons because they are already full!
    - so, they are stable and unreactive

ex:

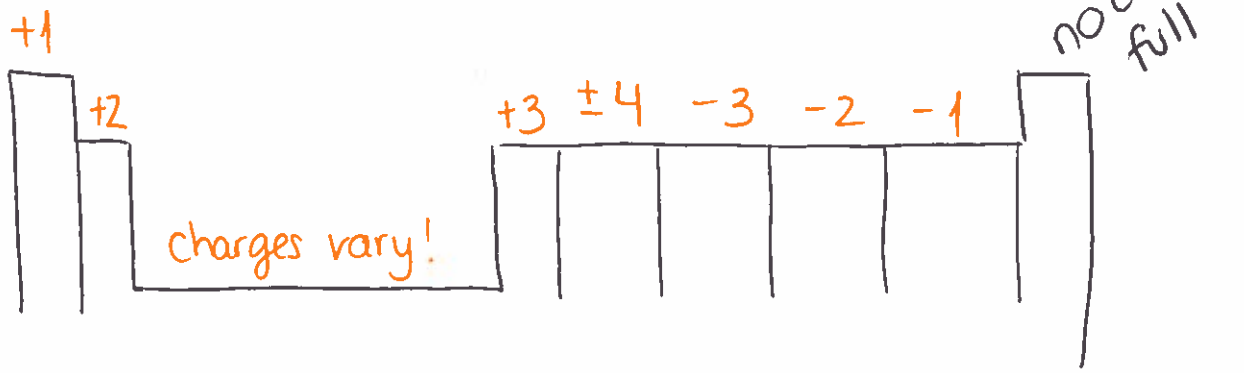


ex:



- ionic compound : can be predicted using the periodic table

⇒ cross balance!



ex: $Al^{+3}\ Cl^{-1} \rightarrow AlCl_3$

- in group 3
- loses $3e^{\ominus}$
- forms (+3) ion

- in group 7
- gains $1e^{\ominus}$
- forms (-1) ion

6. Reactions we have looked at:

⊛ group 1 metals with water:

ex: lithium + water → lithium hydroxide + hydrogen

$$Li + H_2O \longrightarrow LiOH + H_2 \text{ (gas)}$$

(HOH)

⊛ metals with air (oxygen):

ex: magnesium + oxygen → magnesium oxide

$$Mg + O_2 \longrightarrow \overset{+2}{Mg}\overset{-2}{O}$$

⊛ metals with acid:

ex: magnesium + hydrochloric acid → magnesium chloride + hydrogen

$$Mg + HCl \longrightarrow \overset{+2}{Mg}\overset{-1}{Cl_2} + H_2$$