

**Chapter 2**  
**Section 4**

**PERIODIC TABLE**

**movie:**

**hunting for elements**

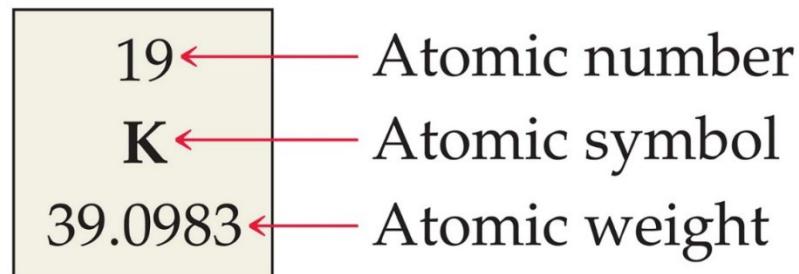
## ACTIVITY #3 on the Periodic Table & movie (15 points)

1. Which of the following statements concerning the element iodine is not correct?
  - a) Iodine gives up electrons readily
  - b) Iodine is in the fifth period of the periodic table
  - c) Iodine has chemical properties similar to those of chlorine
  - d) Iodine is a halogen
  - e) One molecule of iodine contains two atoms
2. With respect to location in the periodic table, metals are on the \_\_\_\_\_, nonmetals on the \_\_\_\_\_ and the two are separated by the \_\_\_\_\_.
3. All the gold mined would fit into a single cube about \_\_\_\_\_ feet on a side.
4. If one (1) atom of an element weighs  $2.0 \times 10^{-23}$  grams, what is its symbol for that element?
5. Protons may determine the identity of an element, but \_\_\_\_\_ rule its reactivity.
6. When copper is mixed with another element, \_\_\_\_\_, it makes bronze. Bronze in bells is \_\_\_\_\_ % Cu & \_\_\_\_\_ % \_\_\_\_\_. Why did the liberty bell crack?
7. Fiesta-ware bowls, made in the 1930's, gets its orange color from \_\_\_\_\_, and it is actually \_\_\_\_\_.
8. What is the atomic number & what does the atomic number indicate? (34:00) \_\_\_\_\_
9. What makes the noble gases stable? (43:00) \_\_\_\_\_
10. The ion chromatograph looks for positively or negatively charged molecules, called \_\_\_\_\_, in the residue, fragments of the original chemical explosive.
11. An atom with \_\_\_\_\_ electrons in its outer shell makes an energetically stable (happy) atom.
12. Why are the alkali metals so reactive?

# Reading the Periodic Table

Boxes on the periodic table list the atomic number **Above** the symbol.

The atomic weight of an element is listed below the symbol on the periodic table.



# Mass Spectrometry

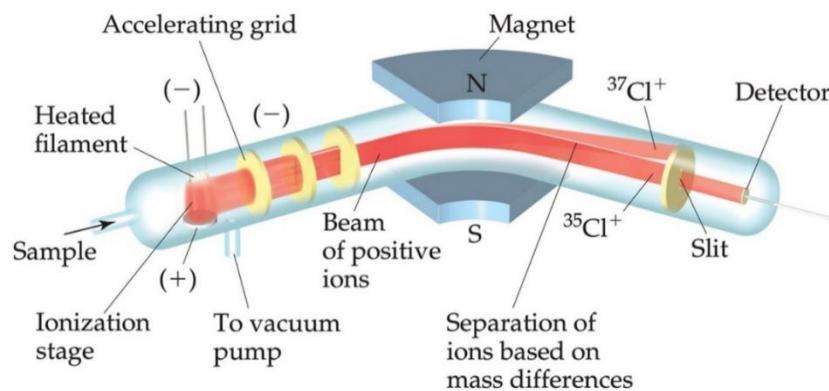
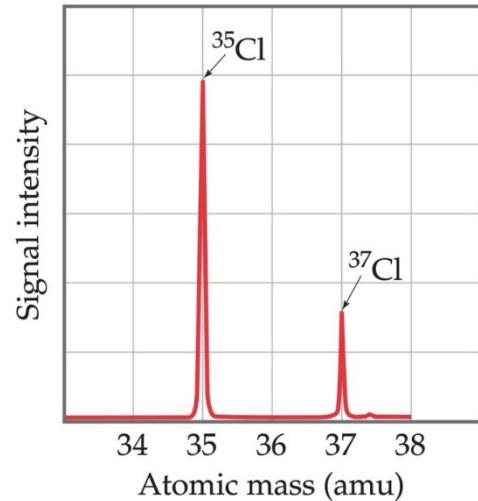
- masses and abundances of isotopes are measured with a **mass spectrometer**
- atoms or molecules are ionized, then accelerated down a tube
  - ✓ some molecules into fragments are broken during the ionization process
  - ✓ these fragments can be used to help determine the structure of the molecule
- their path is bent by a magnetic field, separating them by mass
  - ✓ similar to Thomson's Cathode Ray Experiment

# Atomic Weight Measurement

- Atomic and molecular weight can be measured using a mass spectrometer (below).

The spectrum of chlorine showing two isotopes is seen on the right.

Abundances can also be determined this way.



# The Periodic Table of Elements

# Mendeleev

- order elements by atomic mass
- saw a repeating pattern of properties
- **Periodic Law** – When the elements are arranged in order of increasing atomic mass, certain sets of properties recur periodically
- put elements with similar properties in the same column
- used pattern to predict properties of undiscovered elements
- where atomic mass order did not fit other properties, he re-ordered by other properties
  - ✓ Te & I

# Periodic Pattern

## A Simple Periodic Table

H hydrogen																			He helium
---------------	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--------------

### The Periodic Law

1 H	2 He	3 Li	4 Be	5 B	6 C	7 N	8 O	9 F	10 Ne	11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	19 K	20 Ca
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Elements with similar properties recur in a regular pattern.

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francium	radium	actinium
K	Ca	

Elements with similar properties fall into columns.

Mn manganese	Yb ytterbium	Lu lutetium
Dy dysprosium	No nobelium	Lr lawrencium

# Periodic Pattern

nm	$\text{H}_2\text{O}$
H	a/b
1	$\text{H}_2$

m	$\text{Li}_2\text{O}$	m/nm	$\text{BeO}$	nm	$\text{B}_2\text{O}_3$	nm	$\text{CO}_2$	nm	$\text{N}_2\text{O}_5$	nm	$\text{O}_2$	nm	
Li	b	Be	a/b	B	a	C	a	N	a	O		F	
7	$\text{LiH}$	9	$\text{BeH}_2$	11	$(\text{BH}_3)_n$	12	$\text{CH}_4$	14	$\text{NH}_3$	16	$\text{H}_2\text{O}$	19	HF
m	$\text{Na}_2\text{O}$	m	$\text{MgO}$	m	$\text{Al}_2\text{O}_3$	nm/m	$\text{SiO}_2$	nm	$\text{P}_4\text{O}_{10}$	nm	$\text{SO}_3$	nm	$\text{Cl}_2\text{O}_7$
Na	b	Mg	b	Al	a/b	Si	a	P	a	S	a	Cl	a
23	$\text{NaH}$	24	$\text{MgH}_2$	27	$(\text{AlH}_3)$	28	$\text{SiH}_4$	31	$\text{PH}_3$	32	$\text{H}_2\text{S}$	35.5	$\text{HCl}$

m = metal, nm = nonmetal, m/nm = metalloid

a = acidic oxide, b = basic oxide, a/b = amphoteric oxide

# Periodic Table (1 of 3)

Metals are on the left side of the periodic table.

Some properties of metals include

- Shiny luster
- Conducting heat and electricity
- Solids (except mercury)



The diagram illustrates the Periodic Table with the following features:

- Periods** — horizontal rows: Rows 1 through 7 are labeled on the left.
- Groups** — vertical columns: Groups 1A through 8A are labeled at the top; groups 13A through 18A are labeled on the right.
- Elements arranged in order of increasing atomic number**: An arrow points from the text to the sequence of elements from hydrogen (H) to helium (He).
- Steplike line divides metals from nonmetals**: A stepped line separates the metalloids from the metals and nonmetals.
- Legend**:
  - Metals (light blue)
  - Metalloids (medium blue)
  - Nonmetals (dark blue)

57	58	59	60	61	62	63	64	65	66	67	68	69	70
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb
89	90	91	92	93	94	95	96	97	98	99	100	101	102
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No

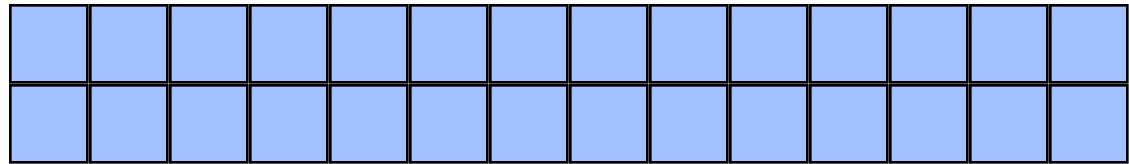
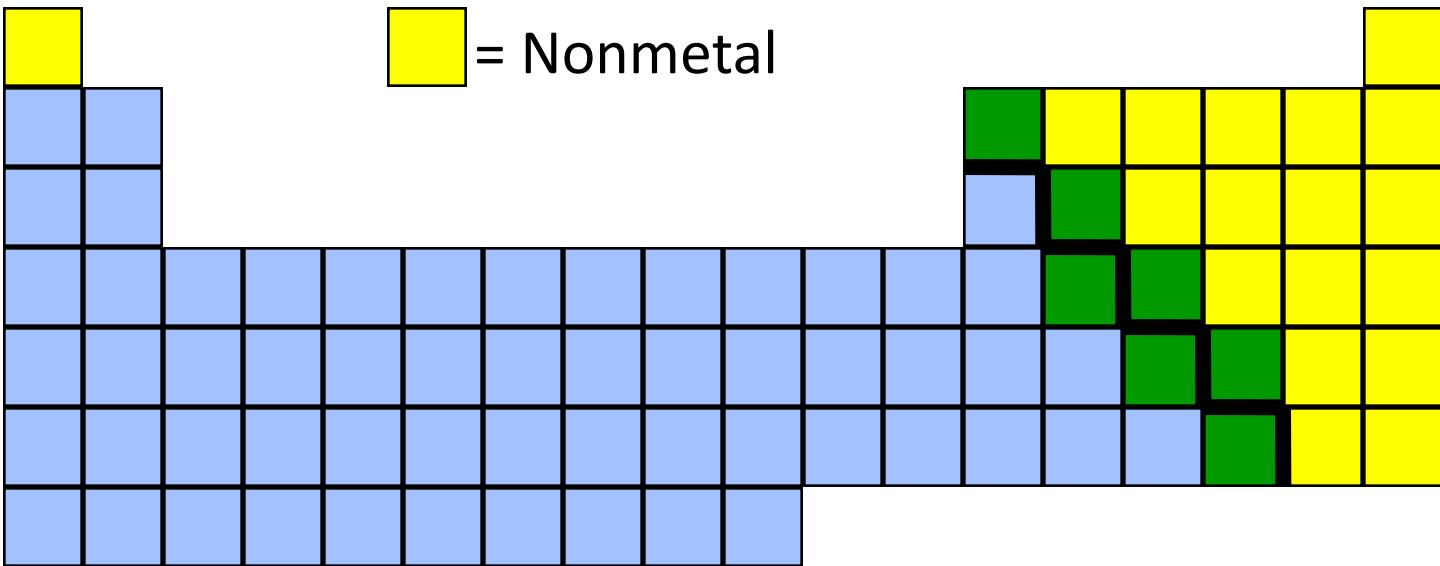


# Patterns in Metallic Character

 = Metal

 = Metalloid

 = Nonmetal



# Metals

- solids at room temperature, except Hg
- reflective surface
  - ✓ shiny
- conduct heat
- conduct electricity
- malleable
  - ✓ can be shaped
- ductile
  - ✓ drawn or pulled into wires
- lose electrons and form cations in reactions
- about 75% of the elements are metals
- lower left on the table

Strontium



Copper



# Periodic Table (2 of 3)

Nonmetals are on the right side of the periodic table (they include H).

They can be solid (like carbon), liquid (like bromine), or gas (like neon) at room temperature.



Periods — horizontal rows  
Groups — vertical columns containing elements with similar properties

Elements arranged in order of increasing atomic number

Steplike line divides metals from nonmetals

1A	1	2A	2	3B	4B	5B	6B	7B	8B	1B	2B	3A	4A	5A	6A	7A	8A
1	H	2	3	Li	4	Be	5	6	7	8	9	10	11	12	13	14	18
11	Na	12	Mg	3	4	5	6	7	8	9	10	1B	2B	13	14	15	He
19	K	20	Ca	21	22	23	24	25	26	27	28	29	30	31	32	9	10
37	Rb	38	Sr	39	40	41	42	43	44	45	46	47	48	49	50	51	Ar
55	Cs	56	Ba	71	72	73	74	75	76	77	78	79	80	81	82	83	36
87	Fr	88	Ra	103	104	105	106	107	108	109	110	111	112	113	114	115	118
				Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Nh	Fl	Mc	Ts
																	Og

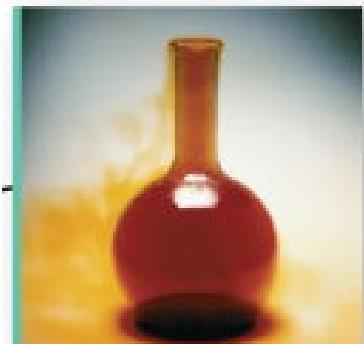
Legend:  
Metals (light blue)  
Metalloids (medium blue)  
Nonmetals (dark blue)

Sulfur, S(s)

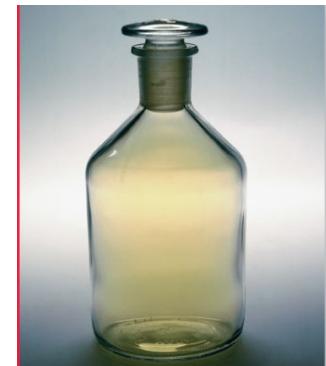


- found in all 3 states
- poor conductors of heat
- poor conductors of electricity
- solids are brittle
- gain electrons in reactions to become anions
- upper right on the table  
✓ except H

Bromine, Br<sub>2</sub>(l)



Chlorine, Cl<sub>2</sub>(l)



# Metalloids

## Silicon

- show some properties of metals and some of nonmetals
- also known as semiconductors



**Properties of Silicon**

- shiny
- conducts electricity
- does not conduct heat well
- brittle

# The Modern Periodic Table

- Elements with similar chemical and physical properties are in the same column
- columns are called **Groups** or **Families**
  - ✓ designated by a number and letter at top
- rows are called **Periods**
- each period shows the pattern of properties repeated in the next period

Main-group elements		Transition elements										Main-group elements								
Group number																				
1A												8A								
1	H											2	He							
2	Li	4	Be									5	6	7	8	9	10	Ne		
3	Na	11	Mg	3B	4B	5B	6B	7B	8B		1B	2B	13	14	15	16	17	18	Ar	
4	K	19	Ca	Sc	Tl	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
5	Rb	37	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
6	Cs	55	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
7	Fr	87	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	114		116					

# The Modern Periodic Table

- Main Group = Representative Elements = “A” groups
- Transition Elements = “B” groups
  - ✓ all metals
- Bottom Rows = Inner Transition Elements = Rare Earth Elements
  - ✓ metals
  - ✓ really belong in Period 6 & 7

 = Alkali Metals

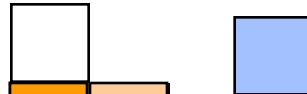
 = Alkali Earth Metals

 = Noble Gases

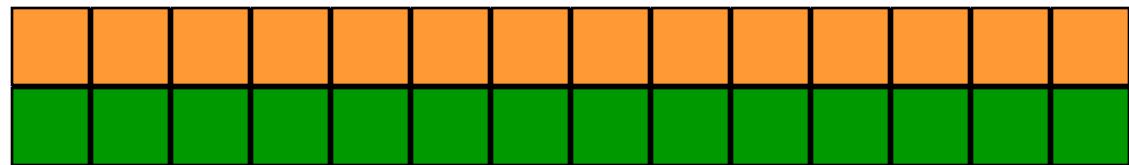
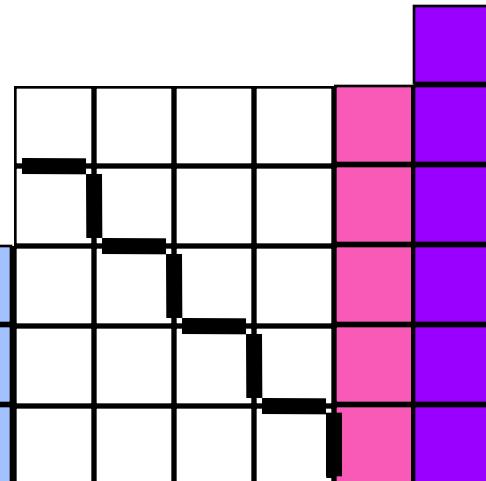
 = Halogens

 = Lanthanides

 = Actinides



 Transition Metals



# Diatomeric Molecules

These seven elements occur naturally as molecules containing two atoms:

- Hydrogen
- Nitrogen
- Oxygen
- Fluorine
- Chlorine
- Bromine
- Iodine

# Important Groups - Hydrogen

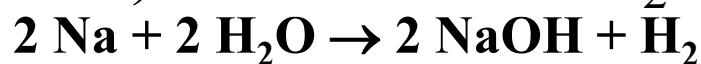
- nonmetal
- colorless, diatomic gas
  - ✓ very low melting point and density
- reacts with nonmetals to form molecular compounds
  - ✓ HCl is acidic gas
  - ✓  $\text{H}_2\text{O}$  is a liquid
- reacts with metals to form hydrides
  - ✓ metal hydrides react with water to form  $\text{H}_2$
- $\text{HX}$  dissolves in water to form acids

# Important Groups - Alkali Metals

- Group IA = Alkali Metals
- hydrogen usually placed here, though it doesn't belong
- soft, low melting points, low density
- flame tests → Li = red, Na = yellow, K = violet
- very reactive, never find uncombined in nature
- tend to form water-soluble compounds, therefore crystallized from seawater then molten salt electrolyzed

➤ colorless solutions

- react with water to form basic (alkaline) solutions and H<sub>2</sub>



➤ releases a lot of heat

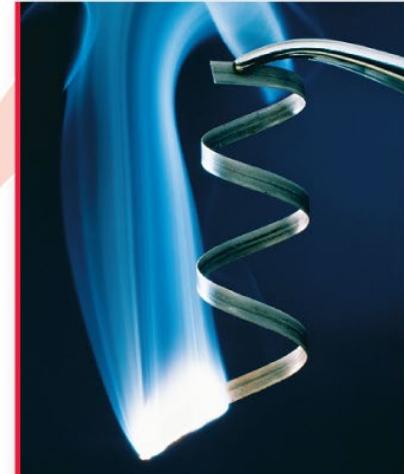
Li	lithium
Na	sodium
K	potassium
Rb	rubidium
Cs	cesium



# Important Groups - Alkali Earth Metals

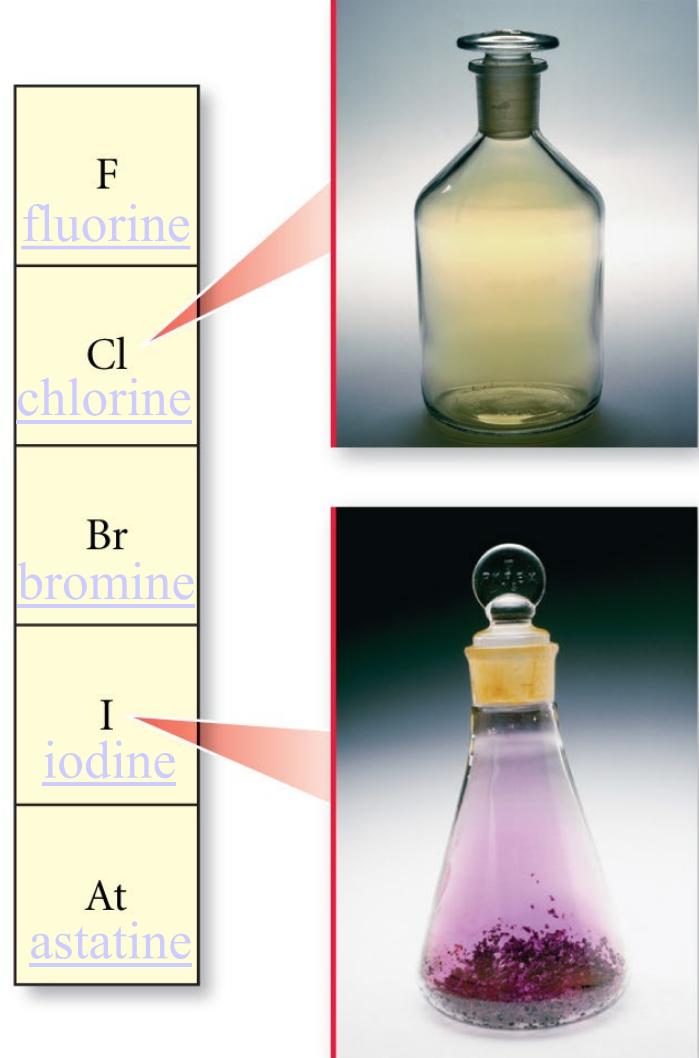
- Group IIA = Alkali Earth Metals
- harder, higher melting, and denser than alkali metals
  - ✓ Mg alloys used as structural materials
- flame tests → Ca = red, Sr = red, Ba = yellow-green
- reactive, but less than corresponding alkali metal
- form stable, insoluble oxides from which they are normally extracted
- oxides are basic = alkaline earth
- reactivity with water to form  $H_2 \rightarrow$  Be = none; Mg = steam; Ca, Sr, Ba = cold water

Be	<u>beryllium</u>
Mg	<u>magnesium</u>
Ca	<u>calcium</u>
Sr	<u>strontium</u>
Ba	<u>barium</u>



# Important Groups - Halogens

- Group VIIA = Halogens
- nonmetals
- $F_2$  and  $Cl_2$  gases;  $Br_2$  liquid;  $I_2$  solid
- all diatomic
- very reactive
- $Cl_2$ ,  $Br_2$  react slowly with water  
 $Br_2 + H_2O \rightarrow HBr + HOBr$
- react with metals to form ionic compounds
- $HX$  all acids
  - ✓ HF weak <  $HCl$  <  $HBr$  <  $HI$



# Important Groups - Noble Gases

- Group VIIIA = Noble Gases
- all gases at room temperature
  - ✓ very low melting and boiling points
- very unreactive, practically inert
- very hard to remove electron from or give an electron to

He	helium
Ne	neon
Ar	argon
Kr	krypton
Xe	xenon



# **Ion Charge and the Periodic Table**

- the charge on an ion can often be determined from an element's position on the Periodic Table
- metals are always positively charged ions, nonmetals are negatively charged ions
- for many main group metals, the charge = the group number
- for nonmetals, the charge = the group number - 8

These must be memorized.

1A

		2A						3A		5A	6A	7A	
	Li <sup>+1</sup>								N <sup>-3</sup>	O <sup>-2</sup>	F <sup>-1</sup>		
	Na <sup>+1</sup>	Mg <sup>+2</sup>						Al <sup>+3</sup>		S <sup>-2</sup>	Cl <sup>-1</sup>		
	K <sup>+1</sup>	Ca <sup>+2</sup>								Se <sup>-2</sup>	Br <sup>-1</sup>		
	Rb <sup>+1</sup>	Sr <sup>+2</sup>								Te <sup>-2</sup>	I <sup>-1</sup>		
	Cs <sup>+1</sup>	Ba <sup>+2</sup>											