Atoms and Ions

- <u>Atoms</u> are electrically neutral.
  - Because there is the same number of protons (+) and electrons (-).
- <u>Ions</u> are atoms, or groups of atoms, with a charge (positive or negative)
  - They have *different* numbers of protons and electrons.
- Only *electrons* can move, and **ions** are made by <u>gaining or losing electrons.</u>

An Anion is…

- A negative ion.
- Has gained electrons.
- Nonmetals can gain electrons.
- Charge is written as a superscript on the right.

F^{1-} Has gained one electron (-ide is new ending = fluoride)

O^{2-} Gained two electrons (oxide)

A Cation is…

- A positive ion.
- Formed by losing electrons.
- More protons than electrons.
- Metals can lose electrons

K^{1+} Has lost one electron (no name change for positive ions)

Ca^{2+} Has lost two electrons

Predicting Ionic Charges

<u>Group 1A</u>: Lose 1 electron to form 1+ ions

H^{1+} Li^{1+} Na^{1+} K^{1+} Rb^{1+}

Predicting Ionic Charges

Group 2A: **Loses 2 electrons to form 2+ ions**

$$Be^{2+} \quad Mg^{2+} \quad Ca^{2+} \quad Sr^{2+} \quad Ba^{2+}$$

Predicting Ionic Charges

B^{3+} Al^{3+} Ga^{3+}

Group 3A: Loses 3 electrons to form 3+ ions

Predicting Ionic Charges

Neither! Group 4A elements rarely form ions (they tend to share)

Group 4A: Do they *lose* 4 electrons or *gain* 4 electrons?

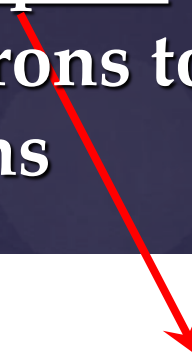| 1 H 1.00794																	2 He 4.002602
3 Li 6.941	4 Be 9.012182											5 B 10.811	6 C 12.0107	7 N 14.00674	8 O 15.9994	9 F 18.9984032	10 Ne 20.1797
11 Na 22.989770	12 Mg 24.3050											13 Al 26.981538	14 Si 28.0855	15 P 30.973761	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
19 K 39.0983	20 Ca 40.078	21 Sc 44.955910	22 Ti 47.867	23 V 50.9415	24 Cr 51.9961	25 Mn 54.938049	26 Fe 55.845	27 Co 58.933200	28 Ni 58.6934	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.92160	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.4678	38 Sr 87.62	39 Y 88.90585	40 Zr 91.224	41 Nb 92.90638	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.90550	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.90447	54 Xe 131.29
55 Cs 132.90545	56 Ba 137.327	57 La 138.9055	72 Hf 178.49	73 Ta 180.9479	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.96655	80 Hg 200.59	81 Tl 204.3833	82 Pb 207.2	83 Bi 208.98038	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 (269)	111 (272)	112 (277)		114 (289) (287)		116 (289)		

Predicting Ionic Charges

N^{3-} **Nitride**

P^{3-} **Phosphide**

As^{3-} **Arsenide**
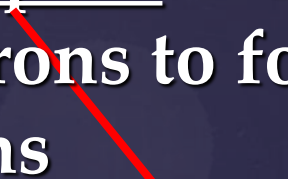
Group 5A: Gains 3 electrons to form 3- ions

Predicting Ionic Charges

O^{2-} **Oxide**

S^{2-} **Sulfide**

Se^{2-} **Selenide**
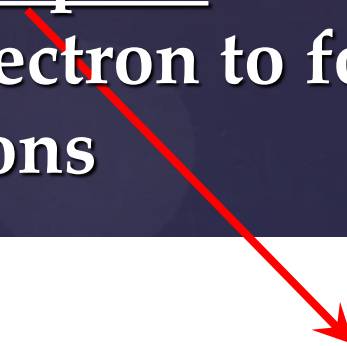
Group 6A: **Gains 2 electrons to form 2- ions**

Predicting Ionic Charges

F^{1-} **Fluoride** Br^{1-} **Bromide**

Cl^{1-} **Chloride** I^{1-} **Iodide**
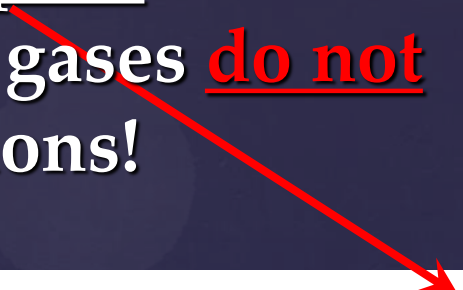
Group 7A: Gains 1 electron to form 1- ions

Predicting Ionic Charges

Group 8A: Stable noble gases do not form ions!

Predicting Ionic Charges

Group B elements: Many *transition* elements have *more than one* possible oxidation state.

Note the use of **Roman numerals** to show charges

Iron (II) = Fe^{2+}
Iron (III) = Fe^{3+}

1 H 1.00794																	2 He 4.002602
3 Li 6.941	4 Be 9.012182											5 B 10.811	6 C 12.0107	7 N 14.00674	8 O 15.9994	9 F 18.9984032	10 Ne 20.1797
11 Na 22.989770	12 Mg 24.3050											13 Al 26.981538	14 Si 28.0855	15 P 30.973761	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
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37 Rb 85.4678	38 Sr 87.62	39 Y 88.90585	40 Zr 91.224	41 Nb 92.90638	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.90550	46 Pd 106.42	47 Ag 107.8682	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.90447	54 Xe 131.29
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Naming cations

- Two methods can clarify when more than one charge is possible:
    1) **Stock system** – uses *roman numerals* in parenthesis to indicate the numerical value
    2) **Classical method** – uses root word with *suffixes* (-ous, -ic)
        - Does not give true value

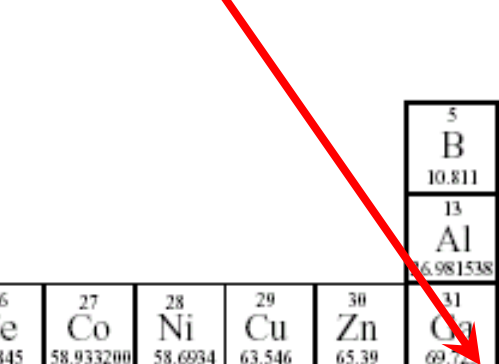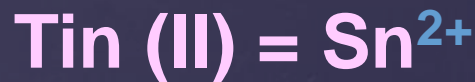# Naming cations

- We will use the **Stock system**.

- Cation - if the charge is always the same (like in the Group A metals) just write the name of the metal.

- Transition metals can have more than one type of charge.

  - Indicate their charge as a *roman numeral* in parenthesis after the name of the metal (Table 9.2, p.255)

Predicting Ionic Charges

Some of the <u>post-transition</u> elements also have *more than one* possible oxidation state.

Tin (II) = Sn^{2+}

Tin (IV) = Sn^{4+}
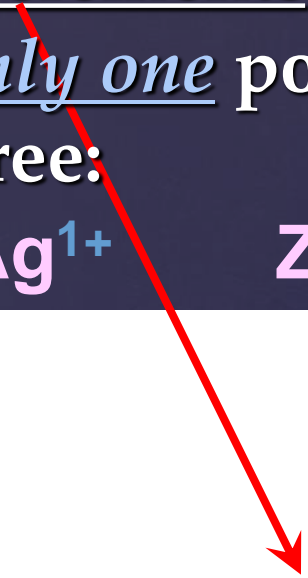
Lead (II) = Pb^{2+}

Lead (IV) = Pb $^{4+}$

Predicting Ionic Charges

Group B elements: Some transition elements have *only one* possible oxidation state, such as these three:

Silver = Ag^{1+} Zinc = Zn^{2+} Cadmium = Cd^{2+}