

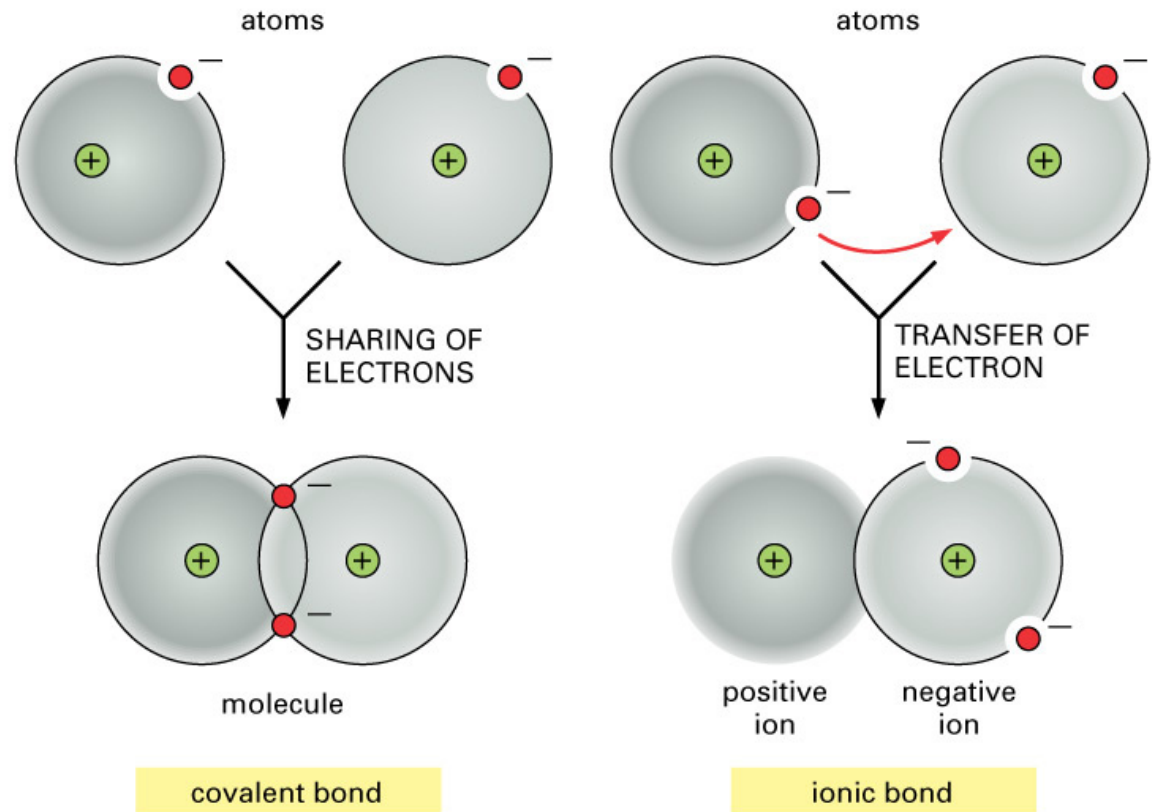
# Ionic Compounds

# How many atoms in a 154 lb person?

- There are  $7.0 \times 10^{27}$  atoms!!!
  - Broken down, there are:
    - $4.7 \times 10^{27}$  atoms of hydrogen
    - $1.8 \times 10^{27}$  atoms of oxygen
    - $7.0 \times 10^{26}$  atoms of carbon
- But when there are so many atoms found together, they do not exist individually. They form compounds.
- They form compounds by chemically bonding to other atoms!

# What's a chemical bond?

- A chemical bond is the **force that holds two atoms together**
- Two types of chemical bonds:
  - Ionic
  - Covalent



# Why do atoms form bonds?

- Formation of chemical bonds is due to number of **valence electrons**
- Why do valence electrons play such an important role?

– Because elements react to get the stable electron structure of a noble gas

## Valence Electrons

IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIIIA
Li·	·Be·	·B·	·C·	·N·	·O·	·F·	·Ne·

In general, the number of valence electrons of a representative element is equal to the group number

How many electrons do atoms want to have in their outermost energy level?

# The Octet Rule

- States that atoms **lose, gain or share electrons** in order to acquire a full set of eight valence electrons
- Why? This is the stable electron configuration of the noble gases

Valence Electrons							
IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIIIA
Li·	·Be·	·B·	·C·	·N·	·O·	·F·	·Ne·

How do we know if they will gain or lose electrons?

Atoms will do **what is easiest to get the most stable electron configuration.**

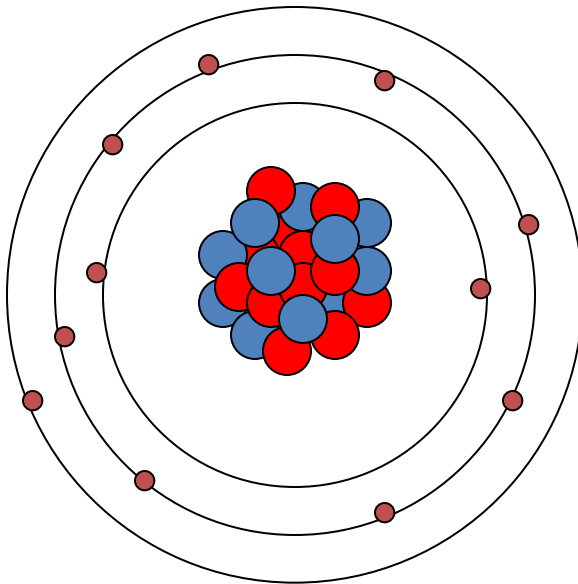
Atoms with 1, 2 or 3 valence electrons will lose electrons.

Atoms with 5, 6 or 7 valence electrons will gain electrons.

# How do atoms form bonds?

- One way is by the formation of ions.
- An ion is **an atom** (or a group of bonded atoms) with a **positive or negative charge**.

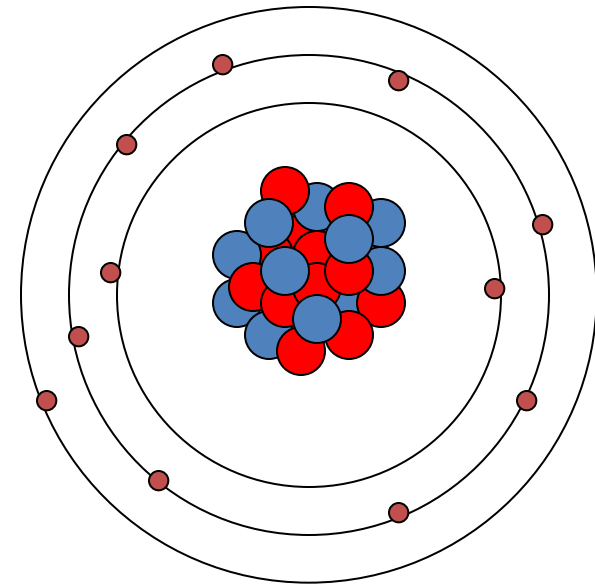
● - Proton  
● - Neutron  
● - Electron



Sodium Atom



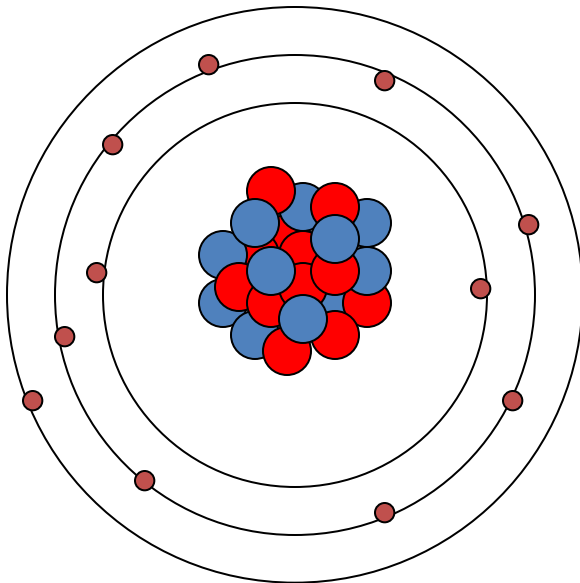
What would be the easiest way this sodium atom could get the perfect 8?



Sodium Ion

# Positive or Negative Ion?

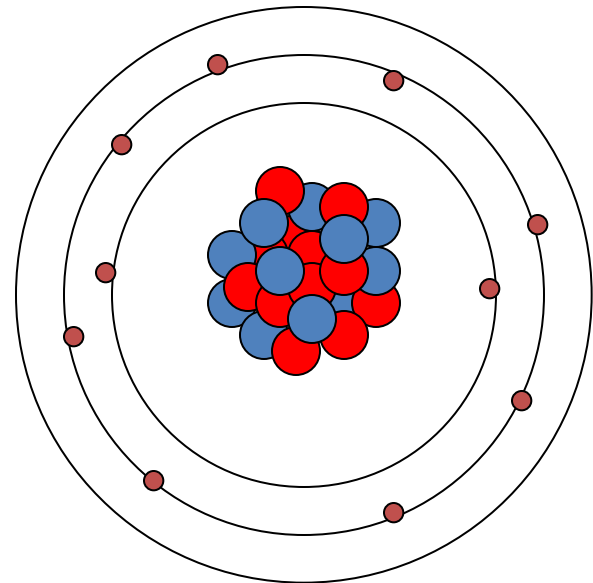
- How can you tell if the ion formed will be positive or negative?
  - Count the protons and electrons



How many protons? 11

How many electrons? 11

What's the charge? 0



How many protons? 11

How many electrons? 10

What's the charge? +1

# Activity Time

- Obtain an ion card from teacher
- If you have a metal ion, go to the back of the room
- If you have a nonmetal ion, go to the front of the room
- Once there, look at the other members of your group and start generating conclusions



# Conclusions from Activity

- What type of atoms form positive ions?
  - Metals
- What type of atoms form negative ions?
  - Nonmetals

hydrogen 1 H 1.0079																			helium 2 He 4.0026						
lithium 3 Li 6.941	beryllium 4 Be 9.0122																		boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180	
sodium 11 Na 22.990	magnesium 12 Mg 24.305																		aluminum 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948	
potassium 19 K 39.098	calcium 20 Ca 40.078		scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80							
rubidium 37 Rb 85.468	strontium 38 Sr 87.62		yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29							
cesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 *	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]							
francium 87 Fr [223]	radium 88 Ra [226]	89-102 **	lawrencium 103 Lr [260]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [263]	bohrium 107 Bh [264]	hassium 108 Hs [265]	meitnerium 109 Mt [266]	unnilium 110 Uun [267]	ununium 111 Uuu [268]	unbinium 112 Uub [269]		ununquadium 114 Uuq [270]											

\* Lanthanide series

lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendeleevium 101 Md [258]	nobelium 102 No [259]

\*\* Actinide series

# Let's Go Further

- If you have an alkali metal, stand near the fire extinguisher
- If you have an alkaline earth metal, stand by the fume hood
- If you have a transition metal, go to the front middle lab table
- If you have a halogen, stand near the computer
- Any others? Stand by my desk

# What did we learn?

- All alkali metals have a charge of +1.
- All alkaline earth metals have a charge of +2.
- All halogens have a charge of -1.
- Group 6A elements have a charge of -2.

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\*\* Actinide series

# Transition Elements

- How many valence electrons do transition elements have?
  - Two ( $ns^2$ )
- They will commonly lose those two valence electrons to form ions with a **+2** charge
- But....they can also lose some of their d electrons to form ions of **+3**, **+4** or greater

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\* Lanthanide series

\*\* Actinide series

# Roman Numerals

- System used to indicate numbers
  - I = 1
  - II = 2
  - III = 3
  - IV = 4
- We use Roman Numerals to indicate charge of transition metals
  - Copper (II) = Copper +2
  - Iron (III) = Iron +3

# Names of Ions

- A positively charged ion is called a **cation**.
  - A cation's name is the same as the element
- A negatively charge ion is called an **anion**.
  - An anion's name has the ending “**-ide**” added to the root name
    - Example: Anion of chlorine is the chloride ion.

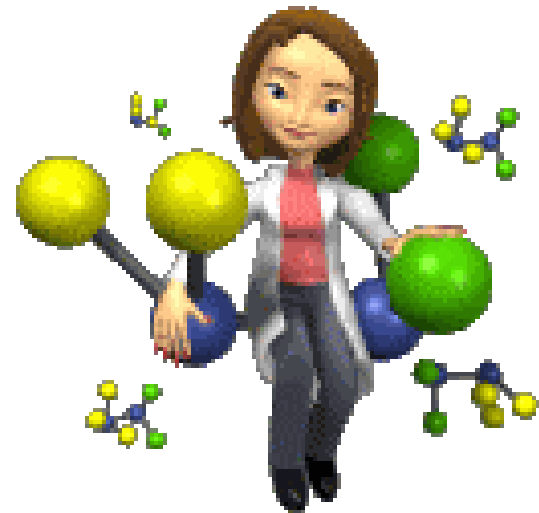
1. What is the oxygen ion called? **oxide**
2. What is the fluorine ion called? **fluoride**
3. What is the bromine ion called? **bromide**

# Practice Questions

1. Which type of atoms form cations? metals
2. Which type of atoms form anions? nonmetals
3. Is  $\text{Na}^+$  a cation or anion? cation
4. Is  $\text{F}^-$  a cation or anion? anion
5. Is  $\text{Ca}^{2+}$  a cation or anion? cation
6. Is  $\text{Mg}^{2+}$  a cation or anion? cation
7. What is the charge of the iodine ion? -1
8. What is the name of the iodine anion? iodide
9. Would oxygen form a cation or anion? anion
10. What is the net charge of zinc (II)? 2+

# Monatomic vs. Polyatomic

- Mono means one
- Poly means many
- So, a monatomic ion refers to **ions with single atoms**
- A polyatomic ion refers to **ions with more than one atom**







# Polyatomic Ions

- Formed when more than one atom are grouped together
- Charge on polyatomic ions applies to entire group of atoms.
- The polyatomic ion acts as an individual ion



Sulfate



**CHLORATES**

Carbonate



Common Polyatomic Ions

$\text{NH}_4^+$	Ammonium
$\text{NO}_3^-$	Nitrate
$\text{OH}^-$	Hydroxide
$\text{CO}_3^{2-}$	Carbonate
$\text{SO}_4^{2-}$	Sulfate
$\text{PO}_4^{3-}$	Phosphate
$\text{NO}_2^-$	Nitrite