

Atomic Structure/Octet

objectives:





















How does an atom acquires a charge?

1. (#2-1C) I can model how an atom acquires a charge.
 1. I can understand why an atom acquires a charge.
 2. I can determine an atom's most common charge and why (octet rule, Coulomb's Law)

Lewis Dot Diagrams

PERIODIC TABLE ELEMENTS 1-20							
HYDROGEN 1 H ·							HELIUM 2 He ·
LITHIUM 3 Li ·	BERYLLIUM 4 Be ·	BORON 5 B ·	CARBON 6 C ·	NITROGEN 7 N ·	OXYGEN 8 O ·	FLUORINE 9 F ·	NEON 10 Ne ·
SODIUM 11 Na ·	MAGNESIUM 12 Mg ·	ALUMINUM 13 Al ·	SILICON 14 Si ·	PHOSPHORUS 15 P ·	SULFUR 16 S ·	CHLORINE 17 Cl ·	ARGON 18 Ar ·
POTASSIUM 19 K ·	CALCIUM 20 Ca ·						

Bohr Diagrams

HYDROGEN H 							HELIUM He 
LITHIUM 7 Li 	BERYLLIUM 9 Be 	BORON 11 B 	CARBON 12 C 	NITROGEN 14 N 	OXYGEN 16 O 	FLUORINE 19 F 	NEON 10 Ne 
SODIUM 23 Na 	MAGNESIUM 24 Mg 	ALUMINIUM 27 Al 	SILICON 28 Si 	PHOSPHORUS 31 P 	SULFUR 32 S 	CHLORINE 35 Cl 	ARGON 40 Ar 
POTASSIUM 39 K 	CALCIUM 40 Ca 						

Octet Rule and Stability

valence electrons: electrons in the outermost shell

How many valence electrons?

1 2 multiple and varies 3 4 5 6 7 8

Periodic Table of the Elements

Legend:

- Alkali metals (Group 1)
- Alkaline earth metals (Group 2)
- Transition metals (Groups 3-10)
- Lanthanide series (Groups 11-12)
- Actinide series (Groups 13-18)
- Poor metals (Groups 13-16)
- Nonmetals (Groups 17-18)
- Noble gases (Group 18)
- Solid (Blue)
- Liquid (Green)
- Gas (Red)
- Synthetic (Black)

Atomic masses in parentheses are those of the most stable or common isotope.

Now the subgroup numbers 1, 2 were adopted in 1984 by the International Union of Pure and Applied Chemistry. The names of elements 112-118 are the Latin equivalents of those numbers.

Full valence shell = stability

why? lower energy state
-Coulomb's Law

Octet Rule - atoms gain or lose e^- to achieve 8 e^- in the valence shell for stability

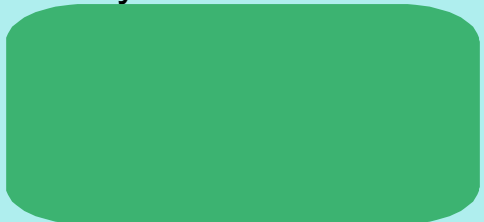
-stability of noble gases (except He stable at $2e^-$)



Periodic Table of the Elements

Which is most stable? Why?

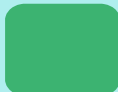
Li C O Ne



Draw a Bohr diagram of a sulfur(S, #16) atom and ion.



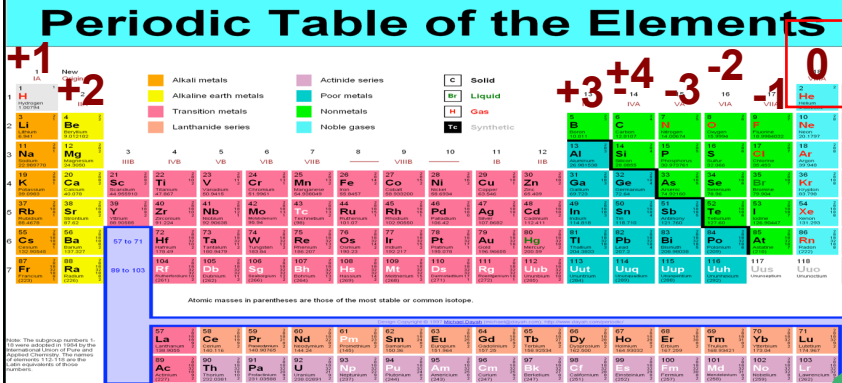
What is the charge on the K ion?



Full valence shell = stability why? lower energy state
-Coulomb's Law

Octet Rule - atoms gain or lose e^- to achieve 8 e^- in the valence shell for stability

-stability of noble gases (except He stable at $2e^-$)



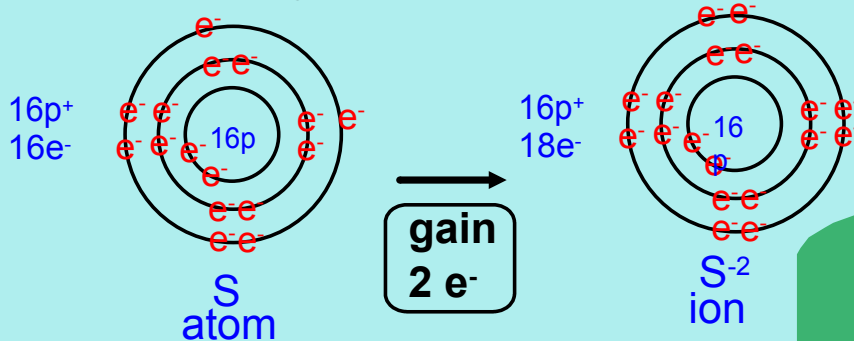
Which is most stable? Why?

Li C O Ne

Ne

- full valence shell
- e^- are held "tight"
- Coulomb's Law

Draw a Bohr diagram of a sulfur(S, #16) atom and ion.



What is the charge on the K ion?

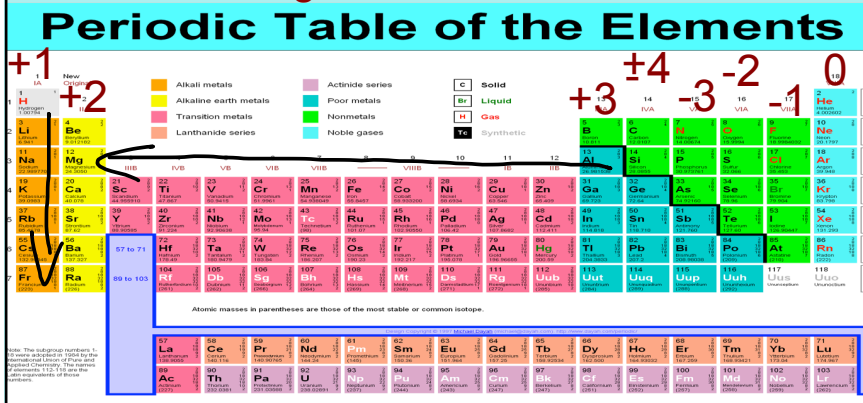
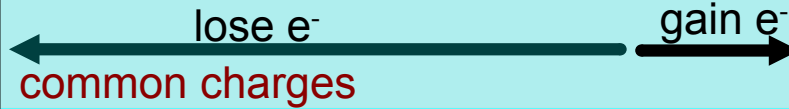
+1

Full valence shell= stability

why? lower energy state
-Coulomb's Law

Octet Rule - atoms gain or lose e⁻ to achieve 8 e⁻ in the valence shell for stability

-stability of noble gases (except He stable at 2e⁻)



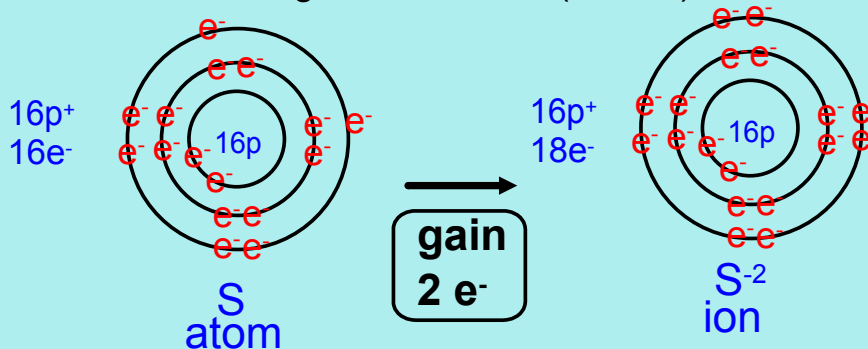
Which is most stable? Why?

Li C O Ne

Ne

- full valence shell
- e⁻ are held "tight"
- Coulomb's Law

Draw a Bohr diagram of a sulfur(S, #16) atom and ion.



What is the charge on the K ion?

+1

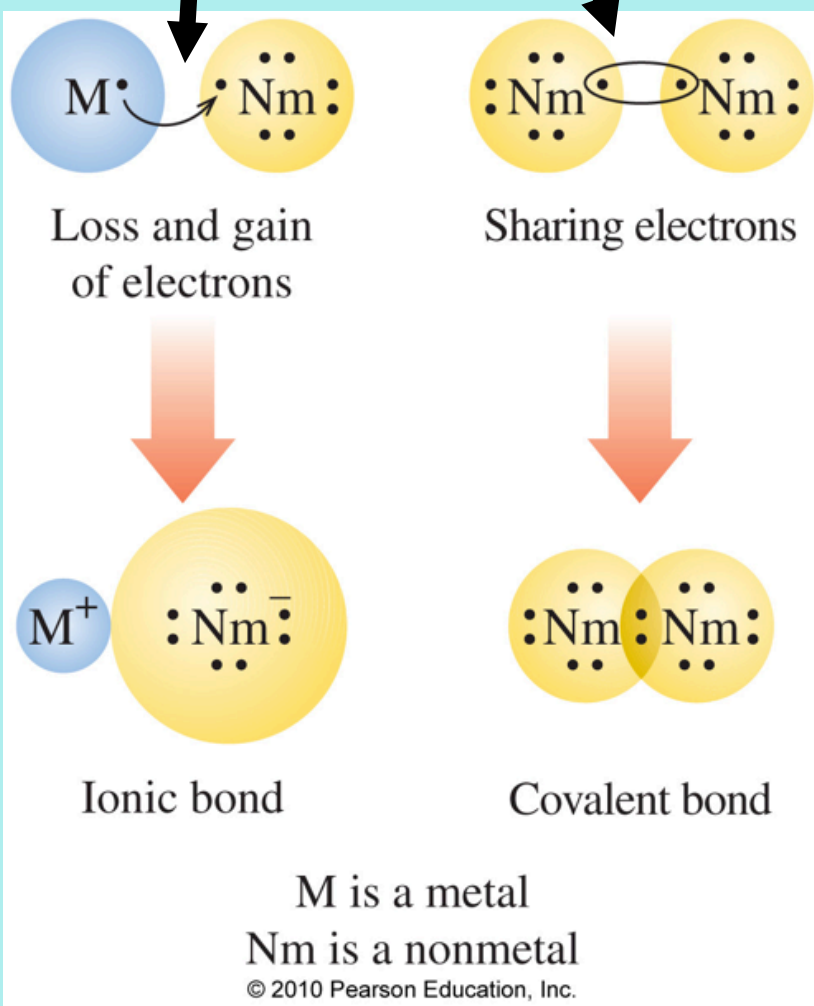


Ionic and Covalent Bonds

Atoms form octets to become more stable
by losing, gaining, or sharing valence electrons

forming
ionic bonds

forming
covalent bonds

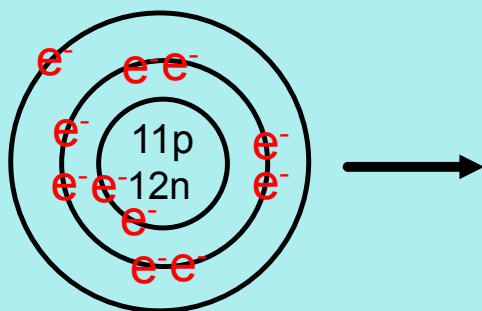


Atom form ions to
achieve the electron configuration of their nearest noble gas

Noble Gases		Metals Lose Valence Electrons			Nonmetals Gain Valence Electrons				Noble Gases
		1A (1)	2A (2)	3A (13)	5A (15)	6A (16)	7A (17)		
He	←	Li ⁺							
Ne	←	Na ⁺	Mg ²⁺	Al ³⁺	N ³⁻	O ²⁻	F ⁻	→	Ne
Ar	←	K ⁺	Ca ²⁺		P ³⁻	S ²⁻	Cl ⁻	→	Ar
Kr	←	Rb ⁺	Sr ²⁺				Br ⁻	→	Kr
Xe	←	Cs ⁺	Ba ²⁺				I ⁻	→	Xe

Metals Form Cations, (Positive Ions)

Nearest noble gas to Na is _____



Na $11p^+$ $11e^-$
0 charge

Na^{+1}

Octet achieved by _____

Draw a Lewis dot diagram of a calcium(Ca, #20)
atom and **ion**.

Ca

Ca

Nearest noble gas to Ca? _____

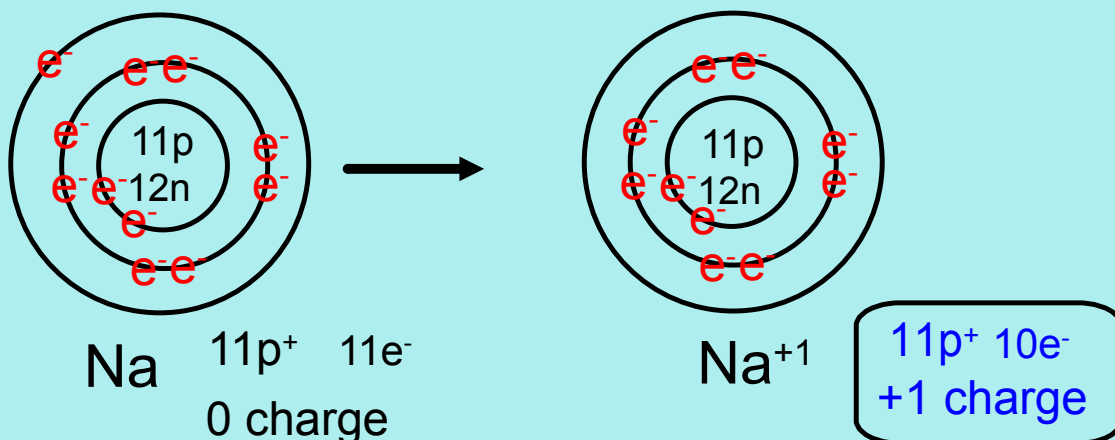
What is the charge on the Ca ion?

What is the symbol for the Ca ion?

Octet achieved by _____

Metals Form Cations, (Positive Ions)

Nearest noble gas to Na is Neon, #10



Octet achieved by losing 1 e^-

Draw a Lewis dot diagram of a calcium(Ca, #20)
atom and **ion**.



Nearest noble gas to Ca? Argon, #18

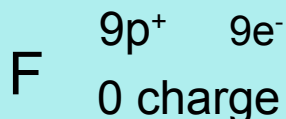
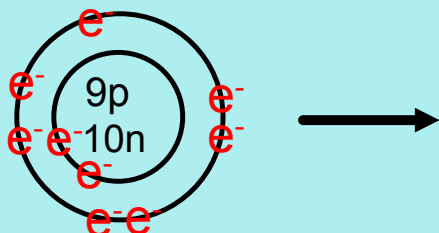
What is the charge on the Ca ion? **+2**

What is the symbol for the Ca ion? **Ca^{+2}**

Octet achieved by losing 2 e^-

Non-Metals Form Anions (Negative Ions)

Nearest noble gas? _____



Octet achieved by _____

Draw a Lewis dot diagram of a phosphorus(P, #15) **atom** and **ion**.

P

P

Nearest noble gas?

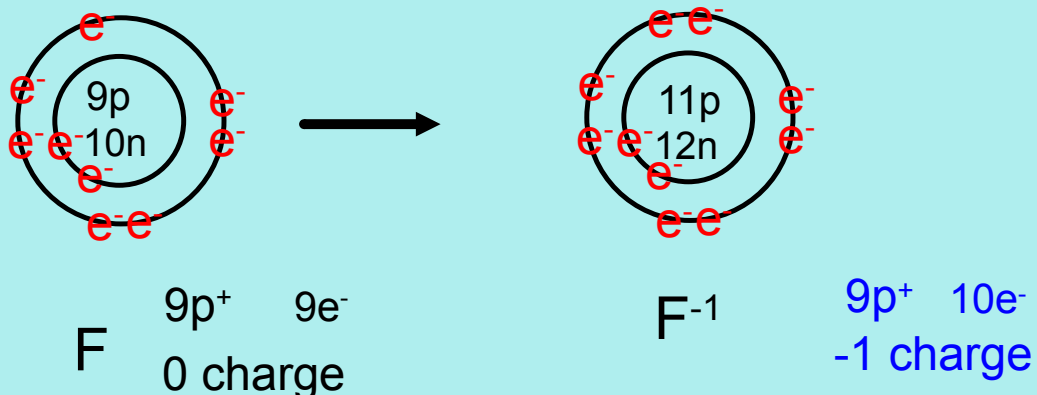
What is the charge on the P ion?

What is the symbol for the P ion?

Octet achieved by _____

Non-Metals Form Anions (Negative Ions)

Nearest noble gas? _____



Octet achieved by gaining 1 e⁻

Draw a Lewis dot diagram of a phosphorus (P, #15) **atom** and **ion**.



Nearest noble gas? **Argon**

What is the charge on the P ion? **-3**

What is the symbol for the P ion? **P⁻³**

Octet achieved by gaining 3 e⁻

Review:

1.
 - A. The number of valence electrons in aluminum is
 - 1) $1e^-$
 - 2) $2e^-$
 - 3) $3e^-$
 - B. To acquire an octet of electrons in aluminum requires
 - 1) a loss of $3e^-$
 - 2) a gain of $3e^-$
 - 3) a gain of $5e^-$
 - C. The ionic charge of aluminum is
 - 1) 3^-
 - 2) 5^-
 - 3) 3^+
 - D. The symbol for the aluminum ion is
 - 1) Al^{3+}
 - 2) Al^{3-}
 - 3) Al^+

2. List a 3 cations and 3 anions that are isoelectric with Argon.

- A. The Group number for sulfur is
 - 1) 4A(14)
 - 2) 8A(18)
 - 3) 6A(16)
- B. The number of valence electrons in sulfur is
 - 1) $4e$
 - 2) $6e$
 - 3) $8e$
- C. The change in electrons for an octet requires a
 - 1) gain of $2e$
 - 2) loss of $2e$
 - 3) a gain of $4e$
- D. The ionic charge of sulfur is
 - 1) 2^+
 - 2) 2
 - 3) 4

Review:

1. A. The number of valence electrons in aluminum is
 1) $1e^-$ 2) $2e^-$ **3) $3e^-$**
- B. To acquire an octet of electrons in aluminum requires
1) a loss of $3e^-$ 2) a gain of $3e^-$ 3) a gain of $5e^-$
- C. The ionic charge of aluminum is
 1) 3^- 2) 5^- **3) 3^+**
- D. The symbol for the aluminum ion is
1) Al^{3+} 2) Al^{3-} 3) Al^+

2. List a 3 cations and 3 anions that are isoelectric with Neon.
 (same # of e^-)

cations: Na^{+1} , Mg^{+2} , and Al^{+3}

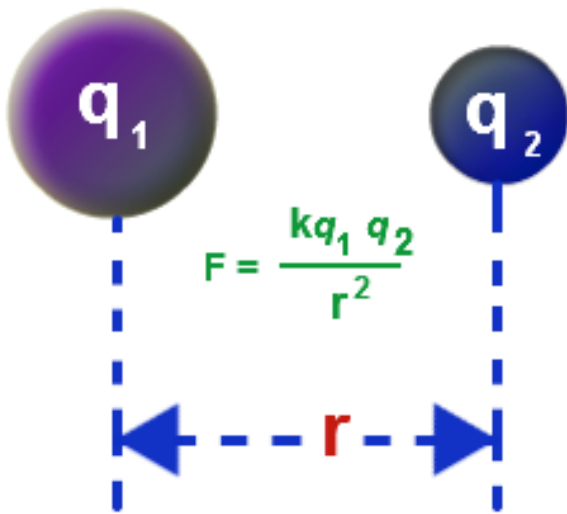
anions: N^{-3} , O^{-2} , and F^{-1}

- A. The Group number for sulfur is
 1) 4A(14) 2) 8A(18) **3) 6A(16)**
- B. The number of valence electrons in sulfur is
 1) $4e$ **2) $6e$** 3) $8e$
- C. The change in electrons for an octet requires a
1) gain of $2e$ 2) loss of $2e$ 3) a gain of $4e$
- D. The ionic charge of sulfur is
 1) $+2$ **2) -2** 3) -4

Coulomb's Law

basis stability of atoms and ions
and periodic trends

2 variables: distance and charges



Coulomb's law

Distance:

The closer two charges are, the stronger the force between them



Charge:

The greater the charges are, the stronger the force of attraction

F = Force

q = charge of a particle, need + and - to attract

r = radius (distance)

k = constant