Atomic Structure

Topics covered
Atomic structure
Subatomic particles
Atomic number
Mass number
Charge
Cations
Anions
Isotopes
Average atomic mass
Practice questions atomic structure

Sep 27-8:16 PM

Power Standards/ Learning Targets

Sub atomic structure (topic)(#2-1)

(#2-1a)I can model the properties of all subatomic particles.

How does an atom acquires mass?

(#2-1b) I can model how and why different atoms of the same element have different masses.

How does an atom acquires a charge?

(#2-1C) I can model how an atom acquires a charge.

I can understand why an atom acquires a charge.

I can determine an atom's most common charge and why. (octet rule)

What is the electronic structure of an atom? (2-2)

(#2-2a) I can write electron configurations.

(#2-2b) I can write orbital diagrams.

How do the properties of electrons and the electron shells contribute to the periodic trends? (#2-3)

(#2-3a) I can determine how gaining or loosing electrons affects the atomic radius justified by coulombs law and orbital structure.

(#2-3b) I can determine how gaining or loosing protons affects the atomic radius justified by coulombs law and orbital structure.

(#2-3c) I can determine how gaining or loosing electrons affects the ionization energy justified by coulombs law and orbital structure.

(#2-3d) I can determine how gaining or loosing protons affects the ionization energy justified by coulombs law and orbital structure.

(#2-3e) I can determine whether an atom is more or less reactive then another justified by coulombs law and orbital structure.

How is the periodic table structured? (#2-4)

(#2-4a)I can label the various parts of the periodic table. (atomic number, metals, non-metals, metalloids)

Obj: I can model/understand how an atom acquires a charge.

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obj: I can model the properties of all subatomic particles.

Subatomic particles

Name	charge	mass	location
proton	+1	1 amu	nucleus
electron	-1	negligible 0 amu $\frac{1}{1840}$ am	electron cloud
neutron	0	1 amu	nucleus

amu = atomic mass unit

amu = atomic mass unit

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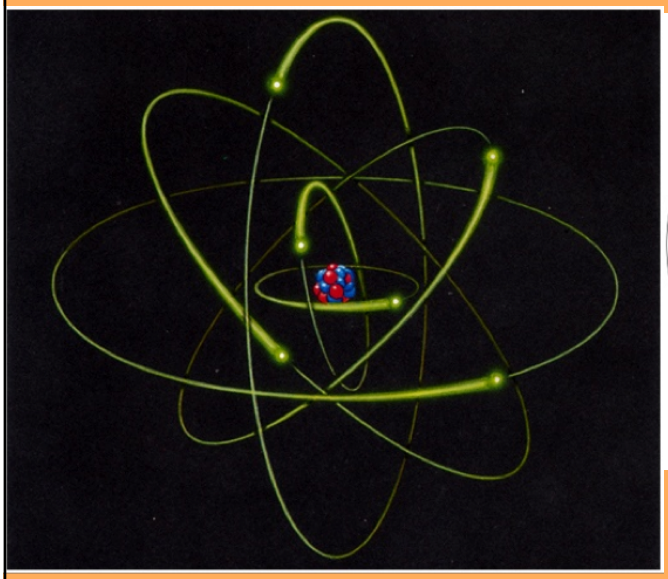
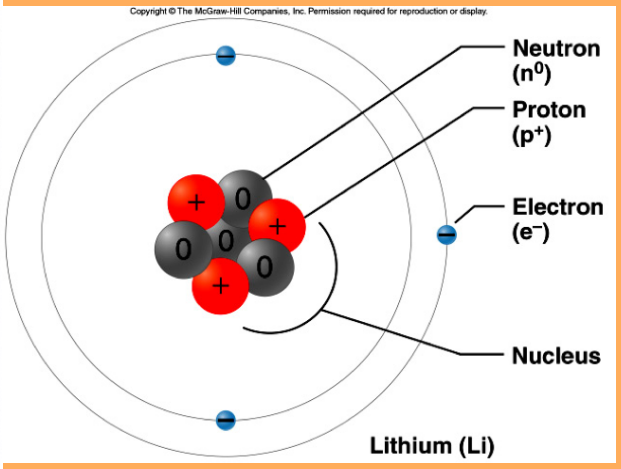
obj: I can model the properties of all subatomic particles.

Nucleus:

- small area in center of the atom
- contains protons and neutrons
- electrons: located in electron cloud





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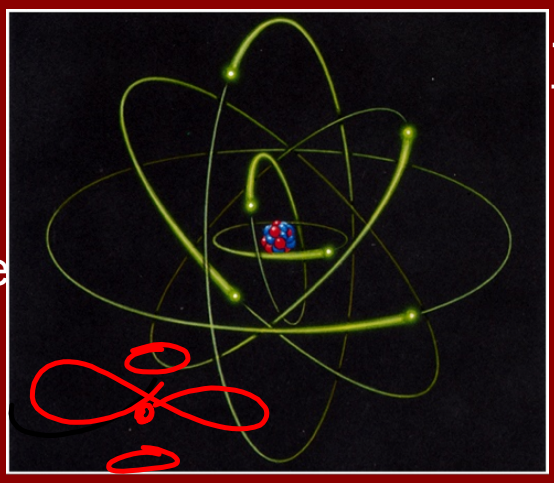
obj: I can model the properties of all subatomic particles.

Truth vs. Myth

<u>Myth</u>

Electrons do not travel around the nucleus like planets.



<u>Truth</u>

Nucleus is located in the center but much smaller

Electrons have energy levels

http://www.ted.com/talks/just_how_small_is_an_atom.html

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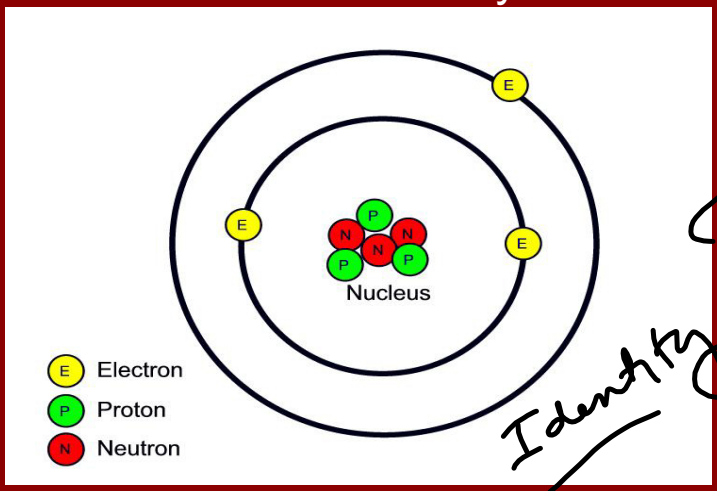
obj: I can model the properties of all subatomic particles.

Atomic number: number of protons in an atom

Why important?

-The number of protons determines the element.

-The periodic table is ordered by increasing protons.



Identity

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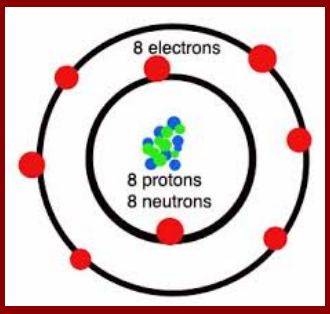
obj: I can model the properties of all subatomic particles.

Atomic number

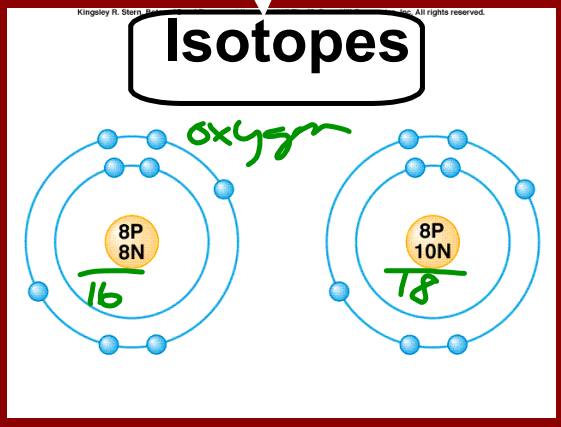


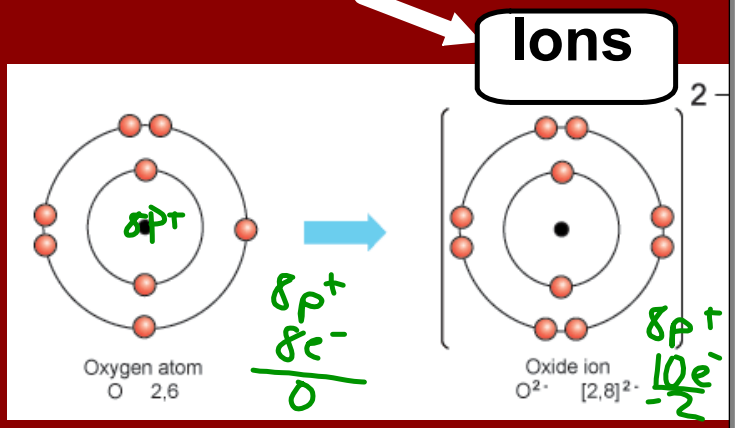
Example:
Oxygen has 8 protons (cannot change)

The number of neutrons and electrons can and will vary.

Altering the neutrons will change the overall mass.

Altering the electrons will change the charge.





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obj: I can model the properties of all subatomic particles.

Mass number

review

mass of proton= 1 amu
mass of neutron= 1 amu
mass of electron= 0 amu

Mass Number-Describes the mass of an individual atom.

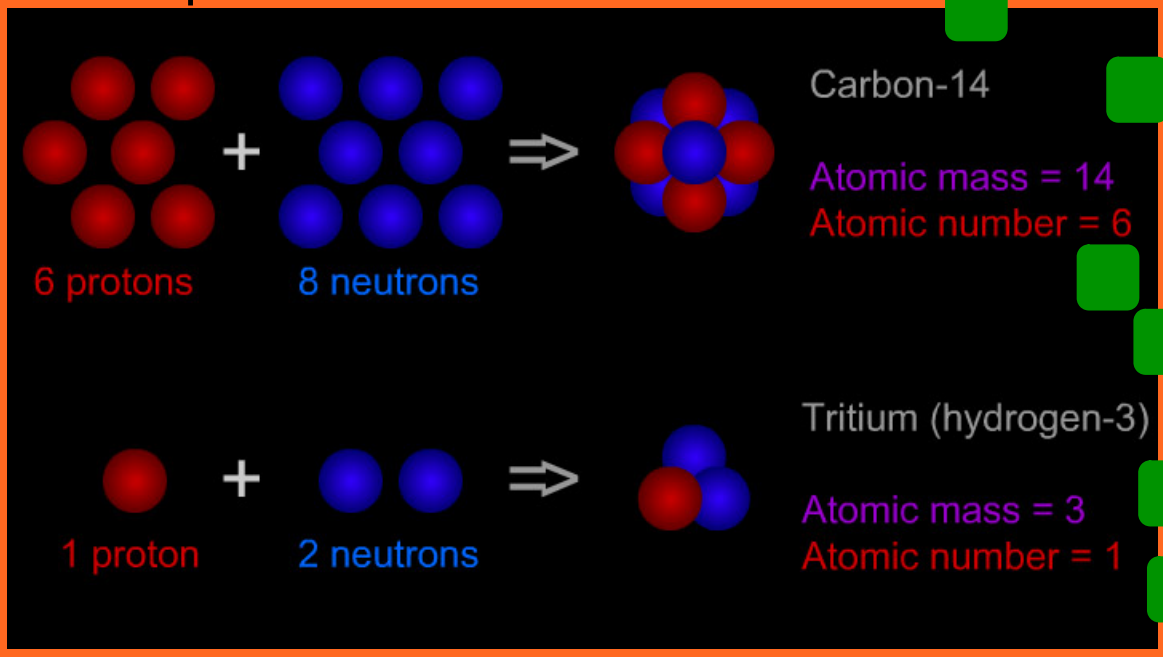
1. Since only Protons and Neutrons have mass all the **mass** is located in the **nucleus.**

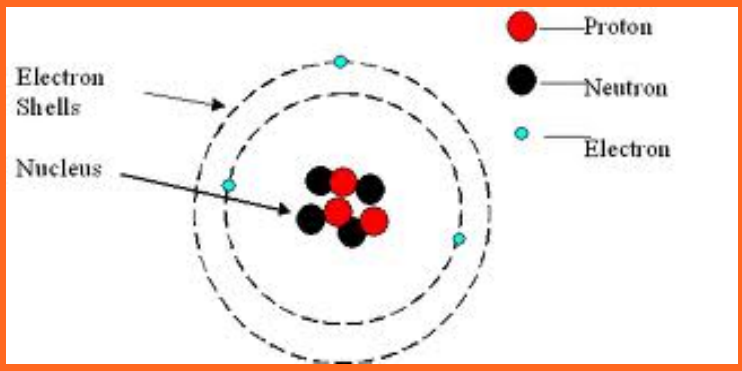
2. Each neutron and proton has a mass of 1 amu so...

Mass number = protons + neutrons

Mass # = p^+ + n°

examples:





atomic number: 3
element: Li
mass number: 7

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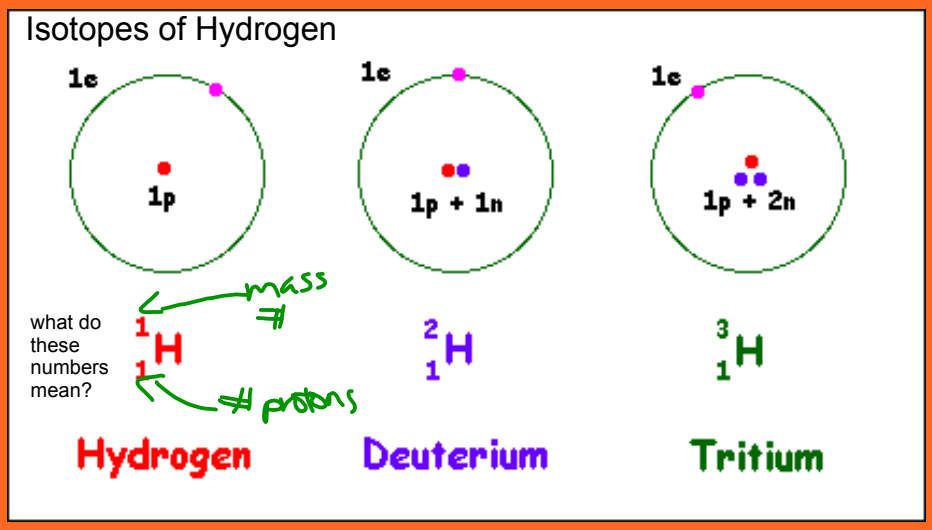
obj: I can model how and why different atoms of the same element have different masses.

Isotopes

2 atoms with the same number of protons but different number of neutrons

Atoms of a single element can vary in mass.
Protons must stay constant. (locked)
Neutrons can vary.



Hydrogen
Atomic Mass = 1
Atomic Number = 1

Hydrogen (Deuterium)
Atomic Mass = 2
Atomic Number = 1

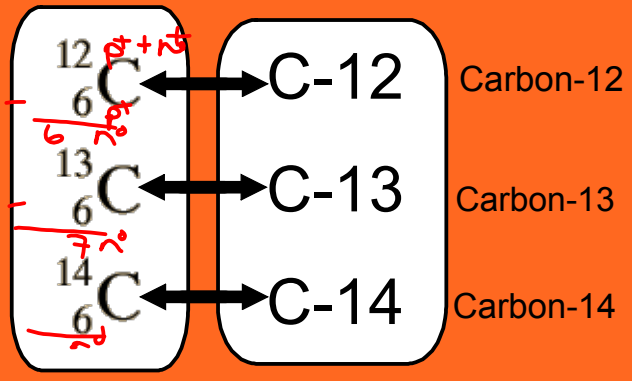
Hydrogen (Tritium)
Atomic Mass = 3
Atomic Number = 1

Isotope --Notation

mass number
X
atomic number

mass number = protons + neutrons
atomic number = protons
$^{3}_{1}H$
symbol of element

three ways to write:



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1.What is the mass of a proton? Neutron? Electron?

2.A neutral atom has 14 protons and 18 neutrons. Write the correct nuclear (isotope) symbol.

3.Which of the following pairs show two atoms with the same number of neutrons?

$^{37}_{17}Cl$ and $^{38}_{18}Ar$ $^{59}_{27}Co$ and $^{61}_{27}Co$

$^{32}_{15}P$ and $^{32}_{16}S$ $^{65}_{30}Zn$ and $^{67}_{30}Zn$

4.There are 3 stable isotopes of Argon: Argon-36, Argon-38 and Argon-40.
What would the atoms of these isotopes have in common?
What would be different about their atoms?

Oct 13-8:35 AM

1.What is the mass of a proton? Neutron? Electron?
1 amu 1 amu 0 amu

2.A neutral atom has 14 protons and 18 neutrons. Write the correct nuclear (isotope) symbol. $^{32}_{14}Si$

3.Which of the following pairs show two atoms with the same number of neutrons?

$^{37}_{17}Cl$ and $^{38}_{18}Ar$

both have 20 neutrons

$^{59}_{27}Co$ and $^{61}_{27}Co$

$^{32}_{15}P$ and $^{32}_{16}S$

$^{65}_{30}Zn$ and $^{67}_{30}Zn$

4.There are 3 stable isotopes of Argon:
Argon-36, Argon-38 and Argon-40.
What would the atoms of these isotopes have in common?
same # p^+ and e^-
What would be different about their atoms? different # n^0

Protons and Neutrons

Instructions
Below you will practice figuring out the different protons, electrons, and neutrons for the table. I have left some open to help you out, but once you have an answer click on the cell shade to reveal the answers. If you need the periodic table click on the animal below to go to the periodic table.

no charge
$e^- = p^+$

Isotope	Number of p^+	Number of e	Number of n	Nuclear Symbol
Hydrogen-2	1	1	1	$^{2}_{1}H$
Helium-3	2	2	1	$^{3}_{2}He$
Lithium-7	3	3	4	$^{7}_{3}Li$
Beryllium-9	4	4	5	$^{9}_{4}Be$
Boron-11	5	5	6	$^{11}_{5}B$

Previous

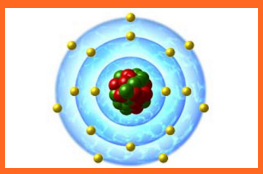
Next

obj: I can model how and why different atoms of the same element have different masses.

Average atomic mass

The Atomic mass of Chlorine is 35.453.

Q: Is there actually an atom of Chlorine with a mass of 35.453?



Chlorine: How many Protons? 17

How many Neutrons?

If the mass number = 35

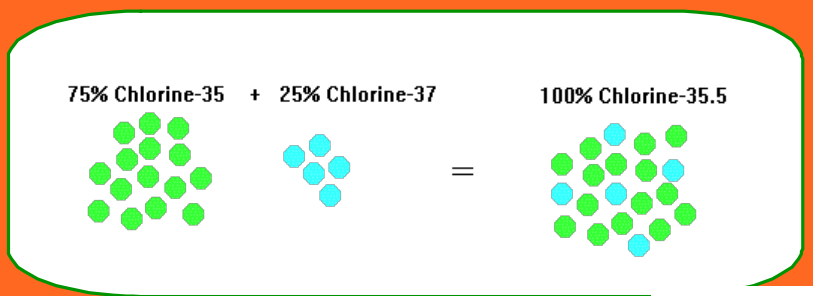
Neutrons = **18**

If the mass number = 37

Neutrons = **20**

No-- only **35** and **37.** So why the decimal?

Average atomic mass is the average mass in relation to its relative abundance of its isotopes.



The periodic table shows the **average atomic mass** of all atoms

$$\frac{(15 \times 35) + (5 \times 37)}{20} = 35.5 \text{ amu}$$

$$(0.75 \times 35) + (0.25 \times 37) = 35.5 \text{ amu}$$

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obj: I can model how and why different atoms of the same element have different masses.

Example with averages:

A student receives a 84.6%
This is a B but the student never actually scored a B on any assignments.

How is this possible?

The student is scored on many assignments.
Some where higher then a B and others where lower then a B.

assignment	grade
1	100%/A+
2	50%/F
3	75%/C
4	98%/A
5	100%/A+
average	84.6/B

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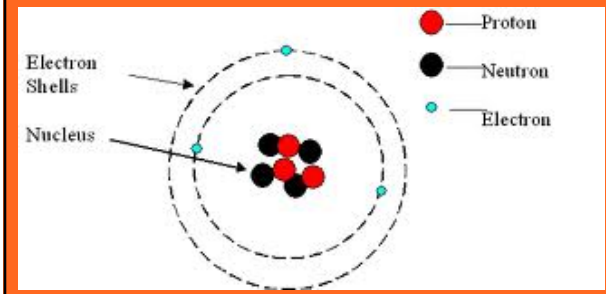
obj: I can model the properties of all subatomic particles.

The mass number is not located on the periodic table. Why?



Lithium mass number: 7

Mass number describes a SINGLE atom and ave. atomic mass (periodic table) describes MANY atoms

average atomic mass:
some Li-6 and
mostly Li-7

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obj: I can model how and why different atoms of the same element have different masses.

Find the element Rf on the periodic table.
Atomic #104
What is different about this element as opposed to other elements?

(261)

see the key:
this element has no stable isotope,
the mass number of the isotope with the longest half-life is in parenthesis.

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obj: I can model how and why different atoms of the same element have different masses.

Average atomic masses

1st – When we mass out a sample, we are getting a mixture of different isotopes. Some heavier… some lighter

2nd – Scientists have actually measured the abundance of different isotopes and determined the **average mass** for Cl is 35.47.

Isotope	Half Life
Cl-35	Stable
Cl-36	301000 years
Cl-37	Stable
Cl-38	37.2 minutes

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Obj: I can model/understand how an atom acquires a charge.

Charge on an atom

What two subatomic particles contain a charge?

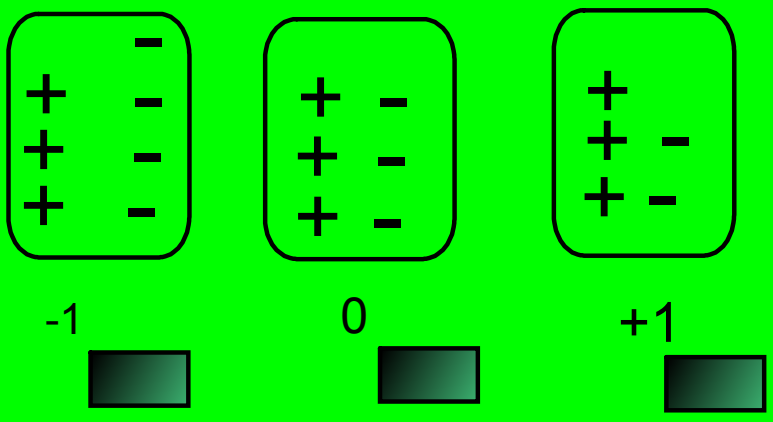
Protons = +1
Electrons = -1

How do you figure out the charge on an atom?

Charge = $p^+ - e^-$

If the protons = electrons the charge is zero.
Each + cancels out a –

(What do you have more of, + or -)



An atom of oxygen has 9 electrons.
what is the charge?

Oxygen
Protons 8 +'s
Electrons 9 –'s

One more e^- than p^+, so the charge is -1

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Obj: I can model/understand how an atom acquires a charge.

Ion: Charged particle

Anion: Negativly charged particle

aNion = Negative ion

Cation: Positivly charged particle.

Ca+ion
Pronounced: “cat + ion”

Sep 27-9:02 PM

Obj: I can model/understand how an atom acquires a charge.

Behavior of protons and electrons

Very important:

Atoms can ***easily*** lose or gain electrons

↓

alter the charge

Atoms can ***NOT easily*** gain or lose protons.

↓

this would be a nuclear reaction.

If an atom ...

acquires a negative charge it _gains_ electrons

acquires a positive charge it _loses_ electrons

Protons NEVER move!

Any change is relative to the number of electrons moving.

$Zn^o \rightarrow Zn^{2+}$

What happened? Zn "lost" 2 electrons

$Zn^o \rightarrow Zn^{2+} + 2e^-$

$F_2 \rightarrow 2F^-$

What happened here? F_2 "gained" 2 electrons

$F_2 + 2e^- \rightarrow 2F^-$

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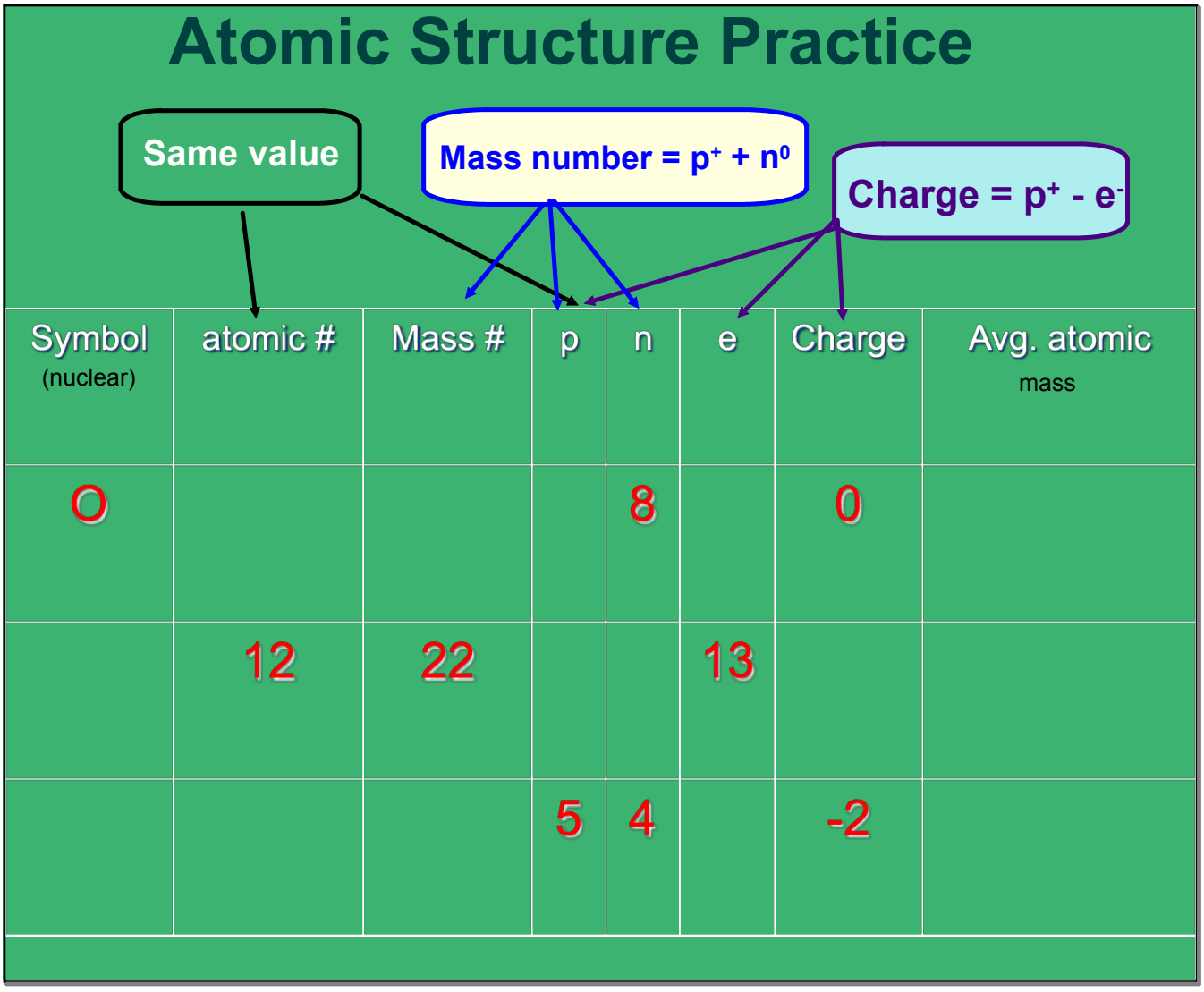
Atomic Structure Practice



Symbol (nuclear)	atomic #	Mass #	p	n	e	Charge	Avg. atomic mass
O				8		0	
	12	22			13		
			5	4		-2	

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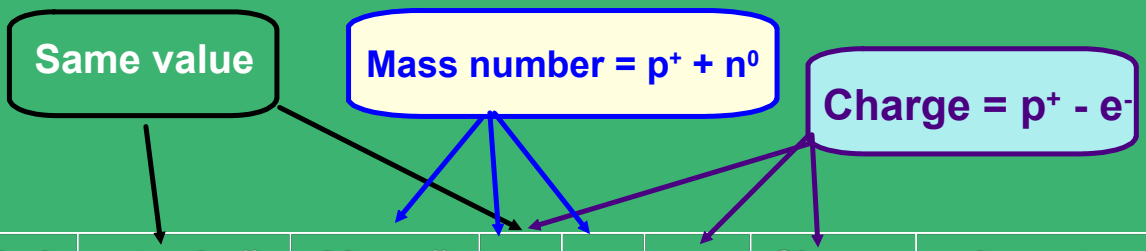
Atomic Structure Practice



Symbol (nuclear)	atomic #	Mass # p+n	p	n	e	Charge	Avg. atomic on periodic table
$^{16}_{8}O$	8	16	8	8	8	0	16.0
$^{22}_{12}Mg$	12	22	12	10	13	-1	24.3
$^{9}_{5}B$	5	9	5	4	7	-2	10.8

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Practice

if not written as isotope, use mass number closest to the average atomic mass

Element/ Ion	Atomic Number	Average Atomic Mass	Mass Number	Protons	Neutrons	Electrons
H						
H^+						
$^{12}_{6}C$						
$^{7}_{3}Li^+$						

Oct 17-8:38 AM

Practice

if not written as isotope, use mass number closest to the average atomic mass

Element/ Ion	Atomic Number	Average Atomic Mass	Mass Number	Protons	Neutrons	Electrons
H	1	1.00794	1	1	0	1
H^+	1	1.00794	1	1	0	0
$^{12}_{6}C$	6	12.0107	12	6	6	6
$^{7}_{3}Li^+$	3	6.941	7	3	4	2

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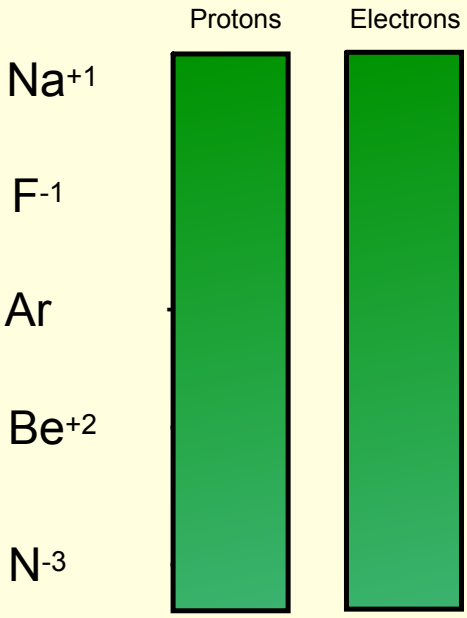
How many protons and electrons are in the following atoms/ions?

(hint: always find proton number first)



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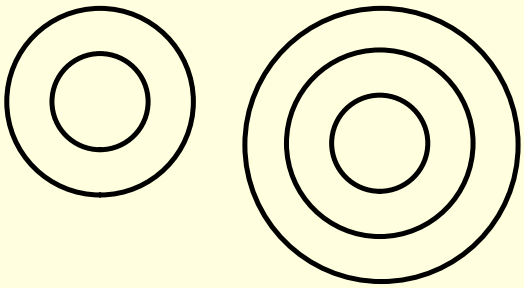
Drawing Bohr models:



Number of electrons in each shell:
1st shell:
2nd shell:
3rd shell:

Na

Na^{+1}

F

F^{-1}

N^{-3}

N

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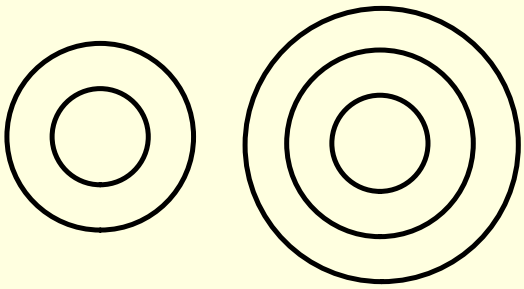
Drawing Bohr models:

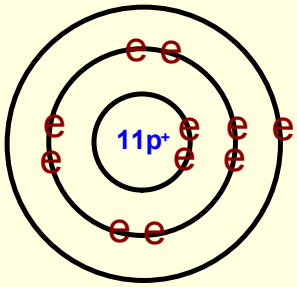
Number of electrons in each shell:
- 1st shell: 2
- 2nd shell: 8
- 3rd shell: 8



e

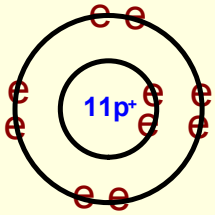
Na

11p+
11e-



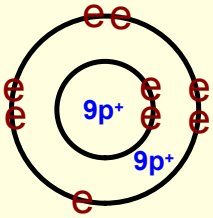
Na^{+1}

11p+
10e-



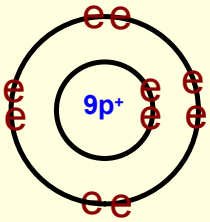
F

9p+
9e-



F^{-1}

9p+
10e-



N

N^{-3}

Drawing Lewis Structures:

only showing valence
(outer shell) electrons

Na	Na^{+1}
F	F^{-1}
Ar	Ar
Be	Be^{+2}
N	N^{-3}

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Drawing Lewis Structures:

only showing valence (outer shell) electrons

Na·	Na^{+1}
	
	
Be:	Be^{+2}
	

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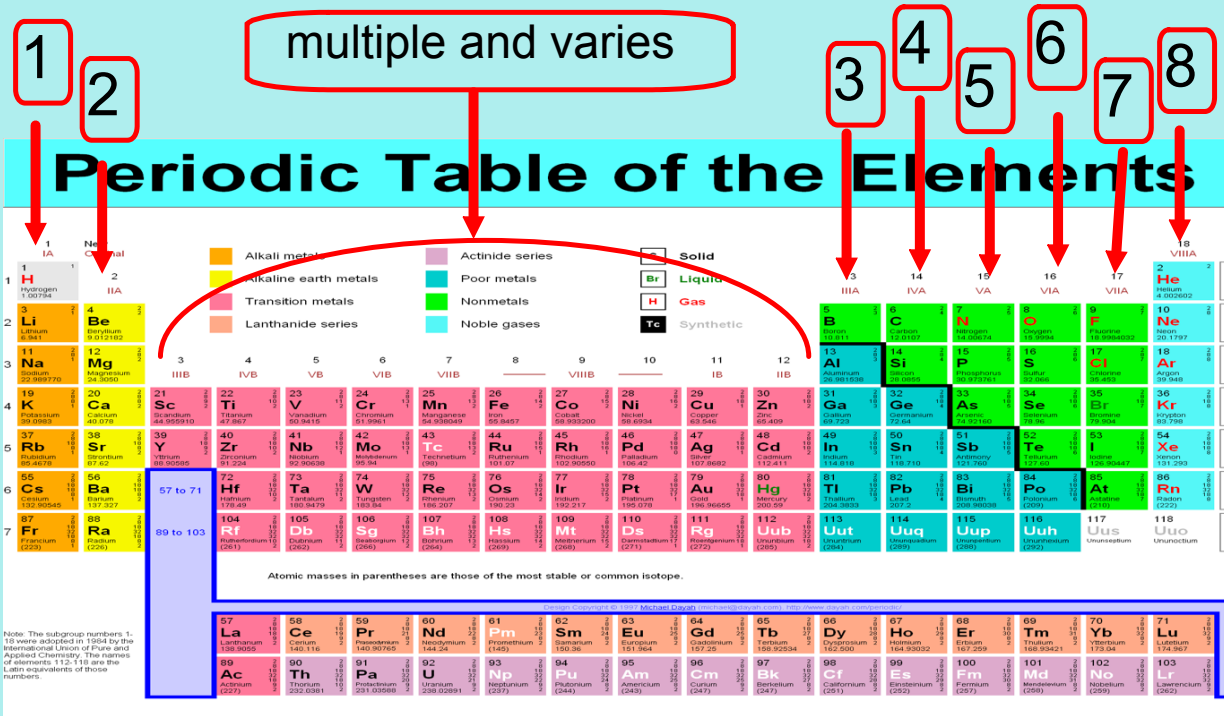
Octet Rule and Stability

valence electrons: electrons in the outermost shell

How many valence electrons?



SYMBOL nuclear	ATOMIC NUMBER	MASS NUMBER	$^{0}_{1}n$	e^-	Charge	P^+
O			8	8		8
	9	18			0	
			8		-1	16
U			80		+1	
		209			0	95

Draw a Bohr diagram of Calcium Draw a Lewis structure of Calcium

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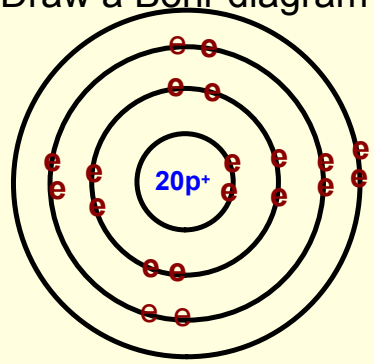
SYMBOL nuclear	ATOMIC NUMBER	MASS NUMBER	$^{0}_{1}n$	e^-	Charge	P^+
$^{16}_{8}O$	16	16	8	8	0	8
$^{18}_{9}F$	9	18	9	9	0	9
$^{16}_{24}S$	16	24	8	17	-1	16
$^{172}_{92}U$	92	172	80	91	+1	92
$^{209}_{95}Am$	95	209	114	95	0	95

Draw a Bohr diagram of Calcium



Draw a Lewis structure of Calcium

Ca:

Vocabulary:

1. isotope
2. cation
3. anion
4. ion
5. charge
6. atomic number
7. average atomic mass
8. nuclear symbol
9. mass number
10. Bohr diagram
11. Lewis structure

Sep 29-8:41 PM

Element/ Ion	Atomic Number	Atomic Mass	Mass Number	Protons	Neutrons	Electrons
H	1	1.0	1	1	0	1
H^+	1	1.0	1	1	0	0
$^{12}_{6}C$	6	12.0	12	6	6	6
$^{7}_{3}Li^+$	3	6.9	7	3	4	2
$^{35}_{17}Cl^-$	17	35.5	35	17	18	18
$^{39}_{19}K$	19	39.1	39	19	20	19
$^{24}_{12}Mg^{2+}$	12	24.3	24	12	12	10
As^{3-}	33	74.9	75	33	42	36
Ag	47	107.9	108	47	61	47
Ag^{+1}	47	107.9	108	47	61	46
S^{-2}	16	32.1	32	16	16	18
U	92	238.0	238	92	146	92

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