SECTIONS D01 & D07

Week 2

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YALE UNIVERSITY

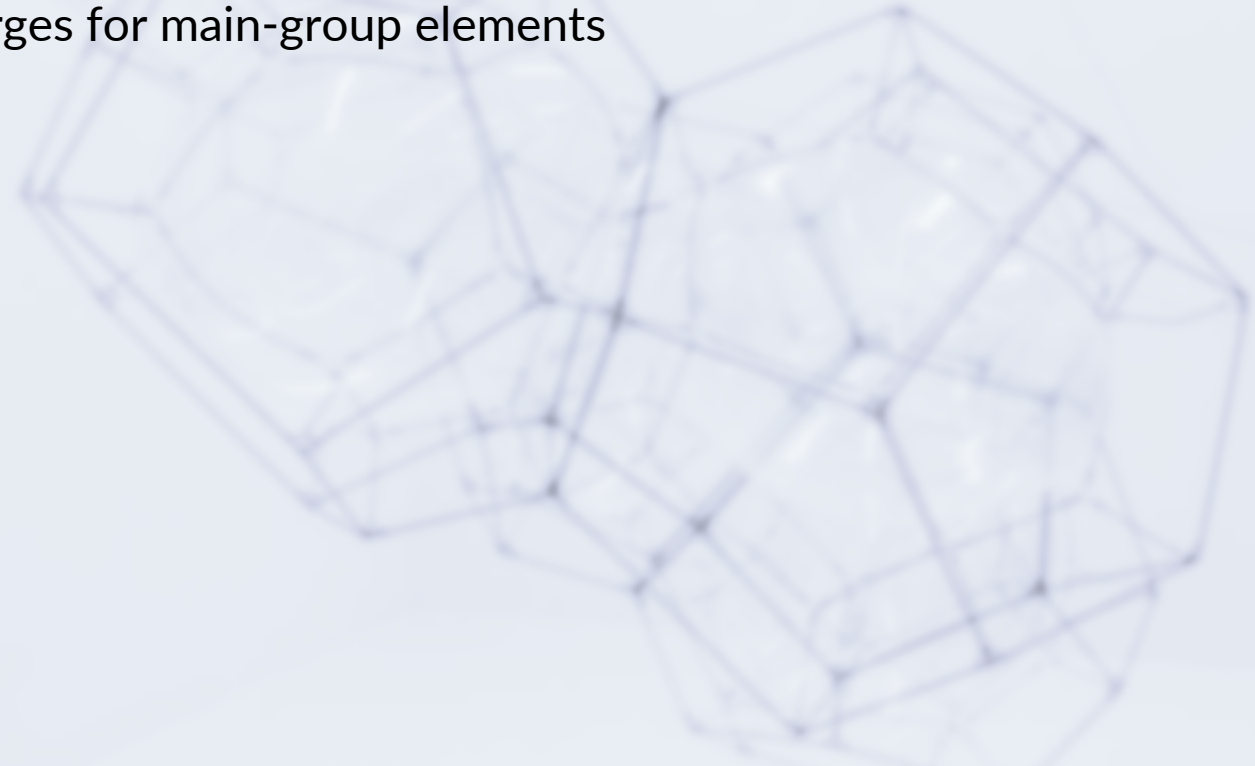
CHEMISTRY 161

FALL 2018

www.mioy.org/chem161

SOME ANNOUNCEMENTS

1. Periodic table provided and important equations/formulas
2. Need to memorize polyatomic ions (Table 2.3 and Table 2.4)
3. Exams require correct significant figures
4. Know charges for main-group elements



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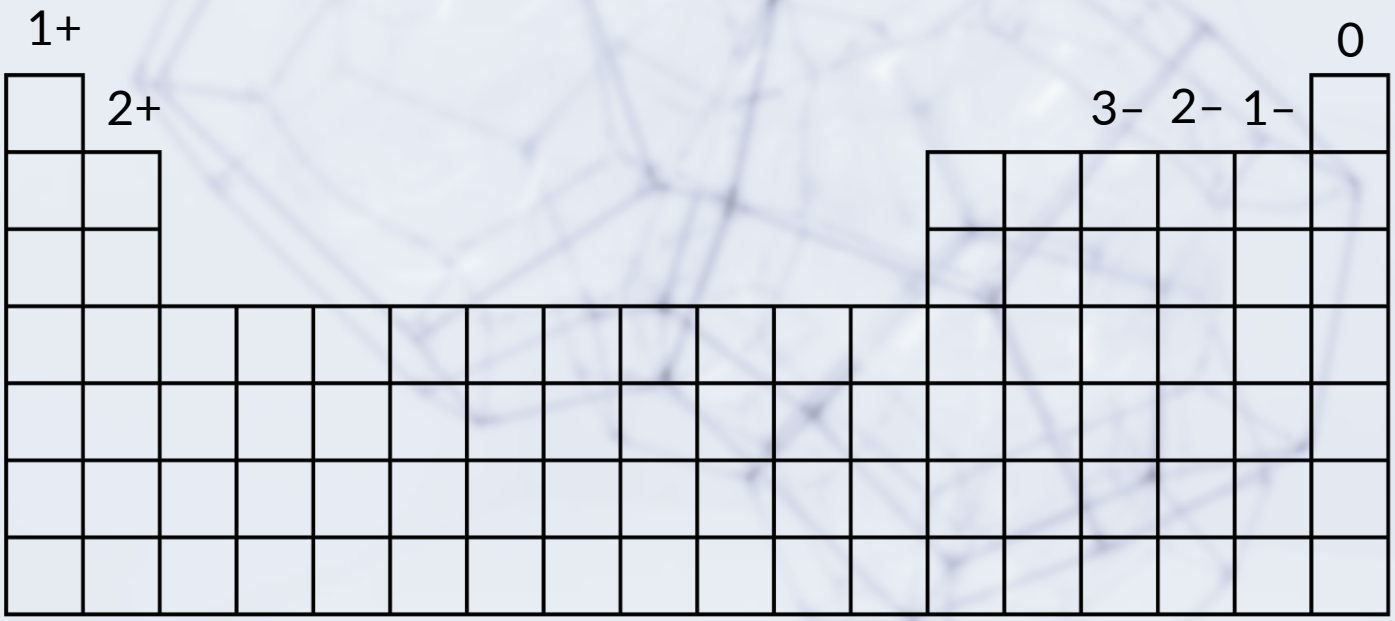

SUBATOMIC PARTICLES

PARTICLE	MASS	CHARGE
Electron	9.11×10^{-31} kg	1–
Proton	1.67×10^{-27} kg	1+
Neutron	1.67×10^{-27} kg	0

The nucleus is very dense:
A proton/neutron is ~2000 times heavier than an electron

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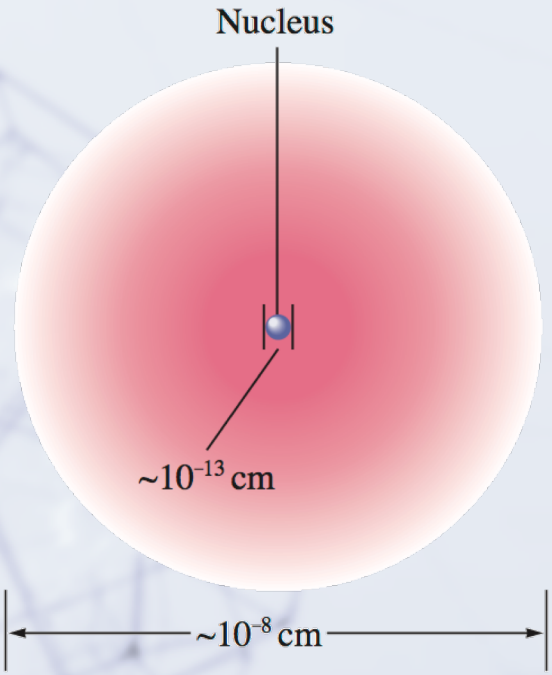

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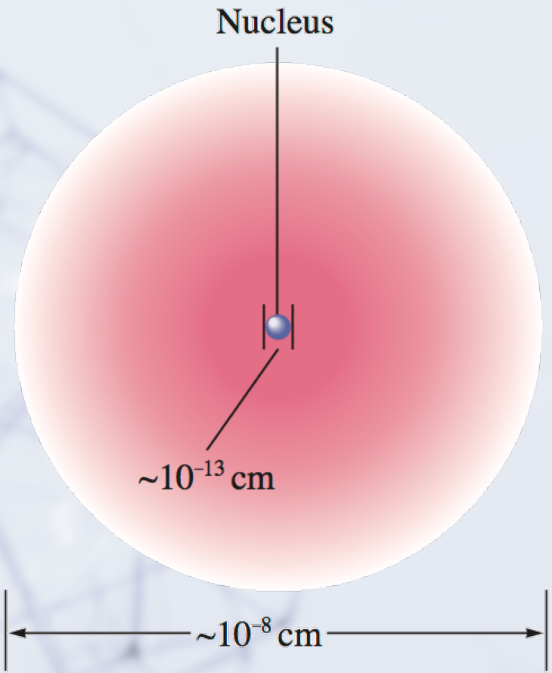
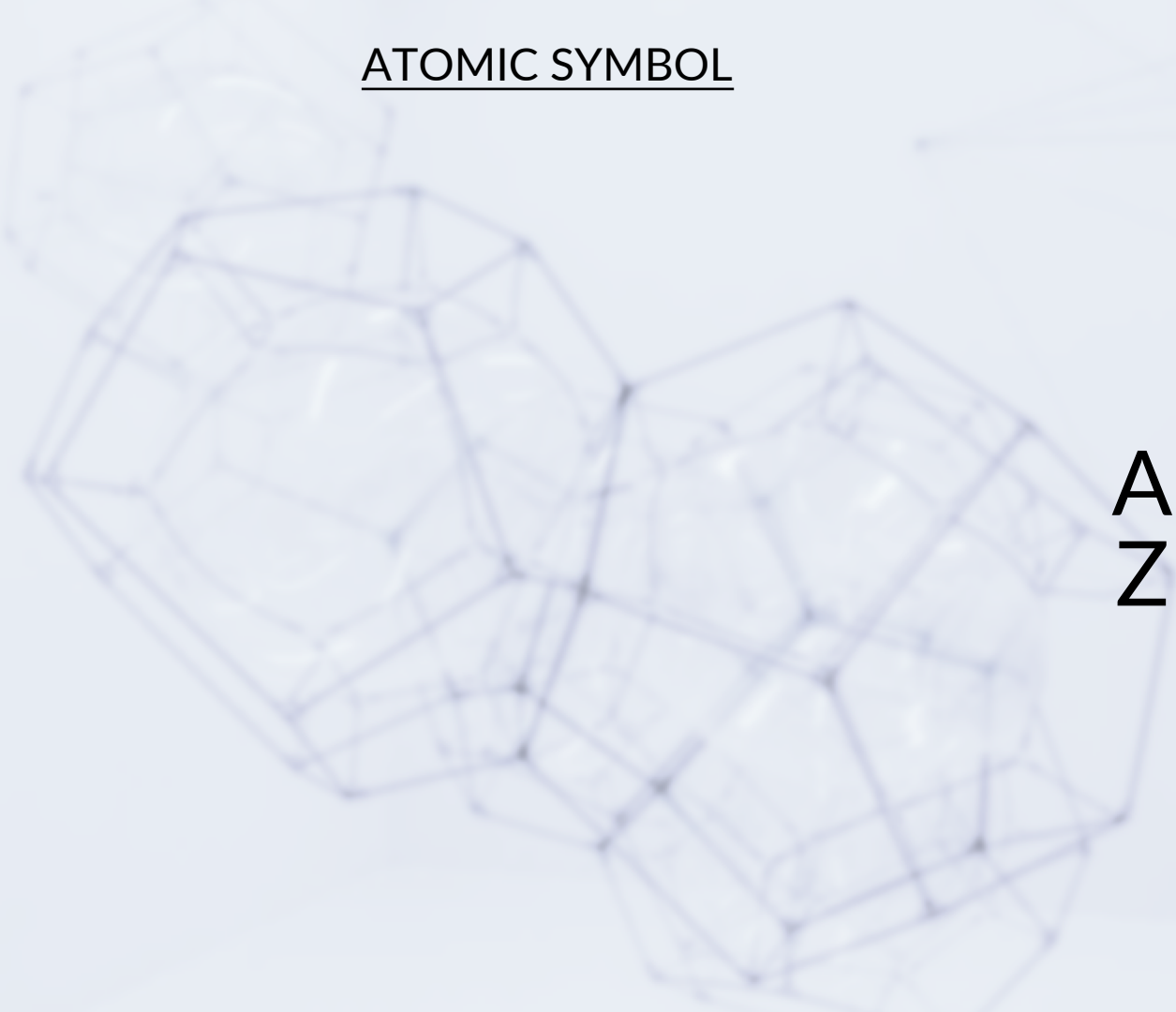


🙃 *MOST OF THE UNIVERSE IS EMPTY SPACE???* 🙃

ATOMIC SYMBOL



$$^{A}_{Z}X$$

ATOMIC SYMBOL

MASS NUMBER (A)
protons + neutrons

ATOMIC NUMBER (Z)
# of protons
# of electrons

ATOMIC SYMBOL

MASS NUMBER (A)
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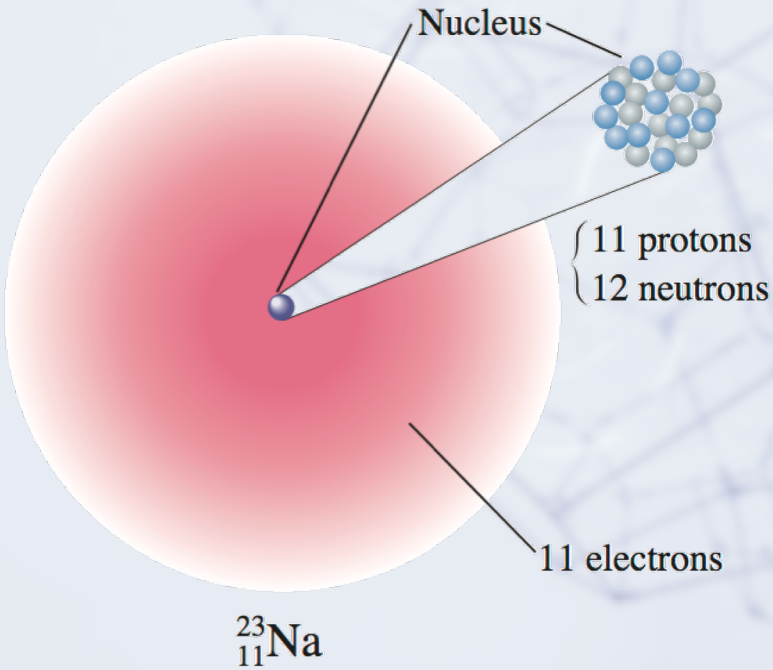
NEUTRONS
= A – Z

ATOMIC NUMBER (Z)
# of protons
# of electrons

ATOMIC SYMBOL



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# of protons
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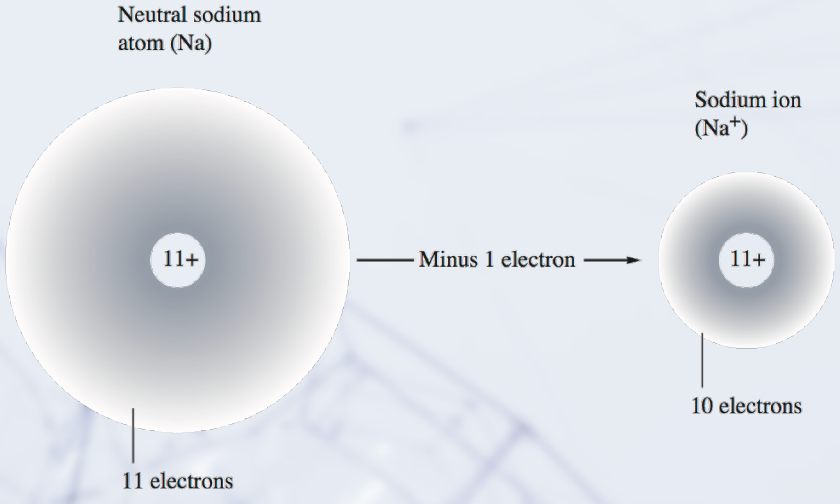
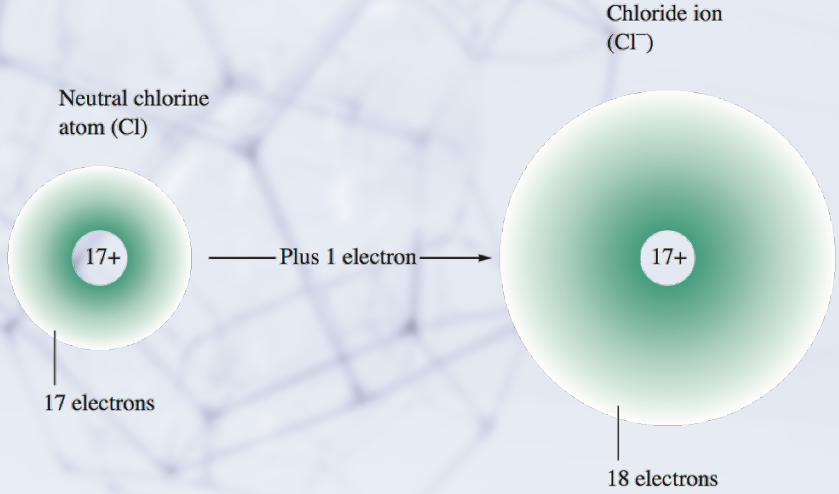
CATIONS

- Positive charge (+)
- Lost electron
- Size decreases



ANIONS

- Negative charge (–)
- Gained electron
- Size increases



PROBLEM 6

SYMBOL	$^{137}_{55}Cs^{+}$	$^{56}_{26}Fe^{3+}$	$^{17}_{8}O^{2-}$
# Protons			
# Neutrons			
# Electrons			
Mass Number			

MASS NUMBER (A)
protons + neutrons

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# of protons
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PROBLEM 6

SYMBOL	$^{137}_{55}Cs^{+}$	$^{56}_{26}Fe^{3+}$	$^{17}_{8}O^{2-}$
# Protons	55		
# Neutrons			
# Electrons			
Mass Number	137		

MASS NUMBER (A)
protons + neutrons

$^{A}_{Z}X$

NEUTRONS
= A – Z

ATOMIC NUMBER (Z)
# of protons
# of electrons

PROBLEM 6

SYMBOL	$^{137}_{55}Cs^{+}$	$^{56}_{26}Fe^{3+}$	$^{17}_{8}O^{2-}$
# Protons	55		
# Neutrons	82		
# Electrons			
Mass Number	137		

MASS NUMBER (A)
protons + neutrons

NEUTRONS
= A – Z

$^{A}_{Z}X$

ATOMIC NUMBER (Z)
# of protons
# of electrons

PROBLEM 6

SYMBOL	$^{137}_{55}Cs^{+}$	$^{56}_{26}Fe^{3+}$	$^{17}_{8}O^{2-}$
# Protons	55		
# Neutrons	82		
# Electrons	54		
Mass Number	137		

MASS NUMBER (A)
protons + neutrons

$^{A}_{Z}X$

NEUTRONS
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ATOMIC NUMBER (Z)
# of protons
# of electrons

PROBLEM 6

SYMBOL	$^{137}_{55}Cs^{+}$	$^{56}_{26}Fe^{3+}$	$^{17}_{8}O^{2-}$
# Protons	55	26	
# Neutrons	82		
# Electrons	54		
Mass Number	137	56	

MASS NUMBER (A)
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NEUTRONS
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ATOMIC NUMBER (Z)
# of protons
# of electrons

PROBLEM 6

SYMBOL	$^{137}_{55}Cs^{+}$	$^{56}_{26}Fe^{3+}$	$^{17}_{8}O^{2-}$
# Protons	55	26	
# Neutrons	82	30	
# Electrons	54	23	
Mass Number	137	56	

MASS NUMBER (A)
protons + neutrons

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NEUTRONS
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ATOMIC NUMBER (Z)
# of protons
# of electrons

PROBLEM 6

SYMBOL	$^{137}_{55}Cs^{+}$	$^{56}_{26}Fe^{3+}$	$^{17}_{8}O^{2-}$
# Protons	55	26	8
# Neutrons	82	30	9
# Electrons	54	23	10
Mass Number	137	56	17

MASS NUMBER (A)
protons + neutrons

$^{A}_{Z}X$

NEUTRONS
= A – Z

ATOMIC NUMBER (Z)
# of protons
# of electrons

AVERAGE ATOMIC MASS

ISOTOPE: same # of protons, but different # of neutrons (mass number)

MASS NUMBER (A)
protons + neutrons

ATOMIC NUMBER (Z)
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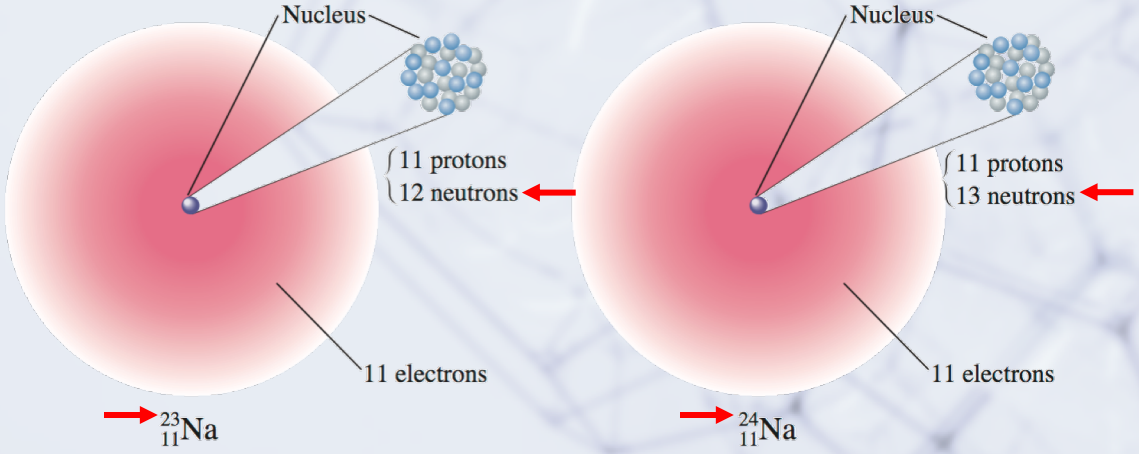
ISOTOPE: same # of protons, but different # of neutrons (mass number)



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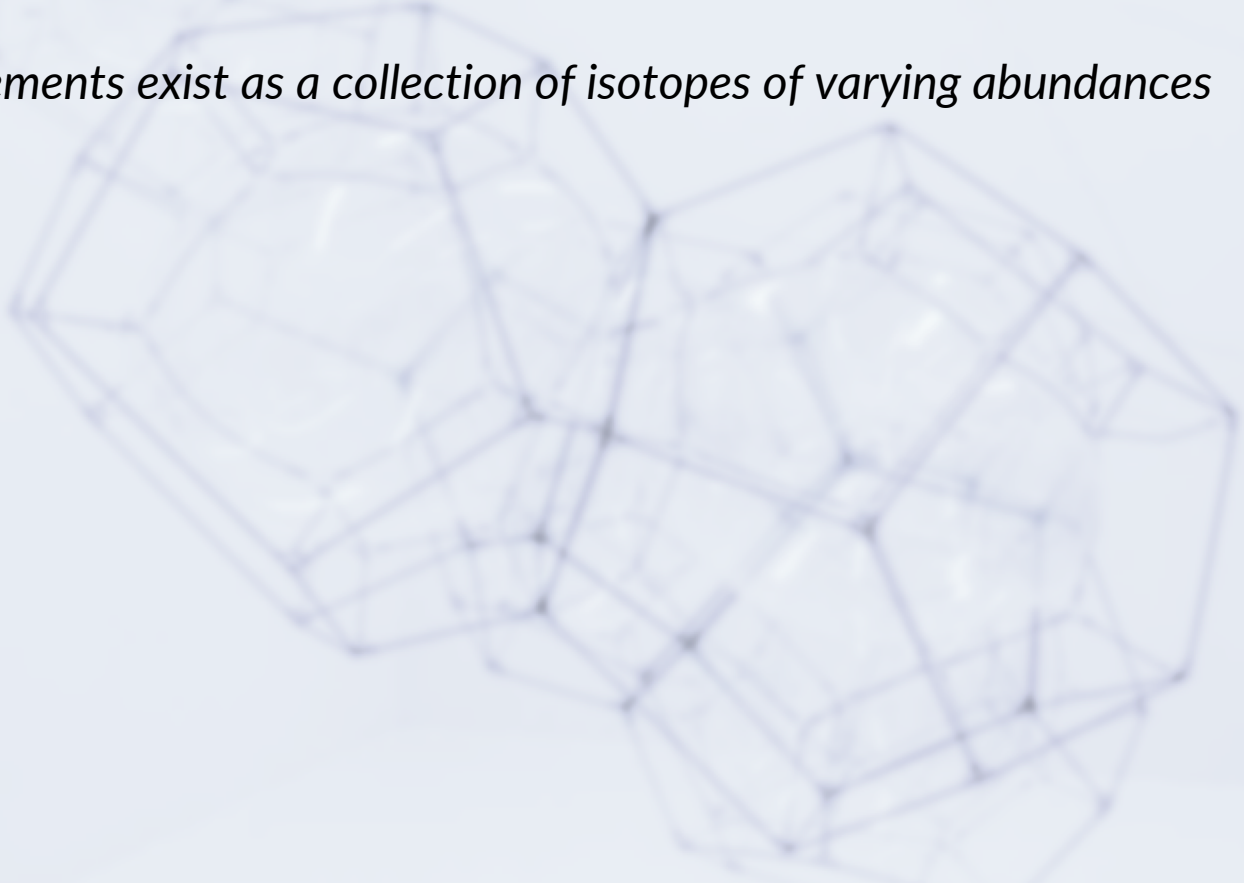
Elements exist as a collection of isotopes of varying abundances



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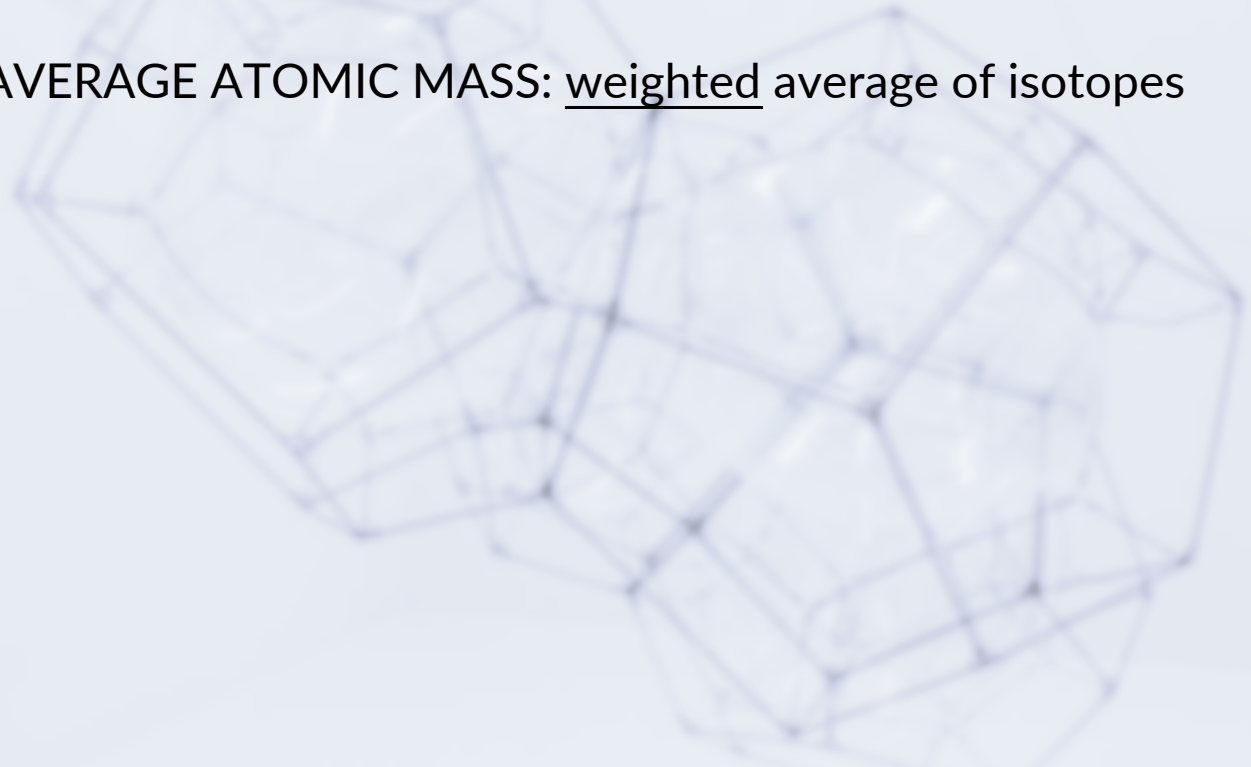
AVERAGE ATOMIC MASS: weighted average of isotopes



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$$m_X = a_1m_1 + a_2m_2 + a_3m_3 + \ldots$$

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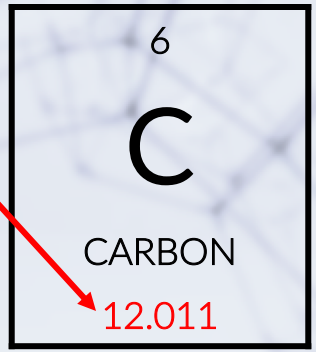
average atomic mass

natural abundance

isotope mass



AVERAGE ATOMIC MASS OF CARBON

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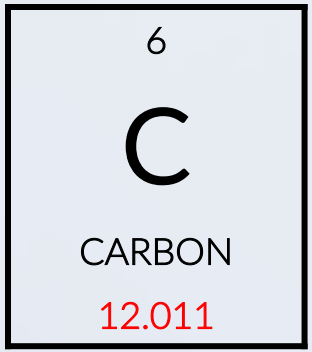
average atomic mass — natural abundance — isotope mass



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average atomic mass — natural abundance — isotope mass

6
C
CARBON
12.011

ISOTOPE	MASS ($m_{\#}$)	ABUNDANCE ($a_{\#}$)
^{12}C	12.000000 amu	
^{13}C	13.003354 amu	

AVERAGE ATOMIC MASS OF CARBON

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Considering the average atomic mass of C, which isotope do you guess to be more abundant?

AVERAGE ATOMIC MASS OF CARBON

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$$m_X = a_1m_1 + a_2m_2 + a_3m_3 + \ldots$$

average atomic mass — natural abundance — isotope mass

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C
CARBON
12.011

ISOTOPE	MASS ($m_\#$)	ABUNDANCE ($a_\#$)	
^{12}C	12.000000 amu	98.90%	(0.9890)
^{13}C	13.003354 amu	1.100%	(0.01100)

Considering the average atomic mass of C, which isotope do you guess to be more abundant?

AVERAGE ATOMIC MASS OF CARBON

AVERAGE ATOMIC MASS: weighted average of isotopes

$$m_X = a_1m_1 + a_2m_2 + a_3m_3 + \ldots$$

average atomic mass — natural abundance — isotope mass

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^{12}C	12.000000 amu	98.90%	(0.9890)
^{13}C	13.003354 amu	1.100%	(0.01100)

$$m_C = a_1m_1 + a_2m_2$$
$$= (0.9890)(12.000000\ amu) + (0.01100)(13.003354\ amu)$$
$$= 12.011$$

IONIC

- Metal + Nonmetal
- Cation + Anion
- Must be neutral overall!

MOLECULAR

- Nonmetal + Nonmetal

IONIC

- Metal + Nonmetal
- Cation + Anion
- Must be neutral overall!

Naming:

- Cation + Anion Root + “-ide”
  NaCl → Sodium Chloride

MOLECULAR

- Nonmetal + Nonmetal

Naming:

- 1st element: full name
- 2nd element: root + “-ide”
- Use prefixes (Table 2.2)
  BF_3 → Boron Trifluoride

IONIC

- Metal + Nonmetal
- Cation + Anion
- Must be neutral overall!

Naming:

- Cation + Anion Root + "-ide"
  NaCl → Sodium Chloride

More exotic rules

- Transition metals require charge
  Hint: Find charge of anion first!
- Cation + Charge + Anion Root + "-ide"
  $FeCl_2$ → Iron (II) Chloride
  PbO_2 → Lead (IV) Oxide
- Polyatomics are "one ion" (Table 2.3)
  AgCN → Silver (I) Cyanide

MOLECULAR

- Nonmetal + Nonmetal

Naming:

- 1st element: full name
- 2nd element: root + "-ide"
- Use prefixes (Table 2.2)
  BF_3 → Boron Trifluoride

More exotic rules

- Don't use "mono-" for first atom
  NO → Nitrogen Monoxide
- Drop "extra" vowels
  N_2O_5 → Dinitrogen Pentoxide
- Oxoanions: -ate has more O's than -ite
  NO_3^- → Nitrate
  NO_2^- → Nitrite