



Chem

With

Com

Atomic Structure and Significant Figures

- Chapter 2.1 (Early Ideas in Atomic Theory)
- Chapter 2.3 (Atomic Structure and Symbolism)
- Chapter 3.6 (The Periodic Table)
- Chapter 1.5 (Significant Figures)

Atomic Structure

- Chapter 2.3 (Atomic Structure and Symbolism)
- Chapter 3.6 (The Periodic Table)

What are atoms? (and matter?)

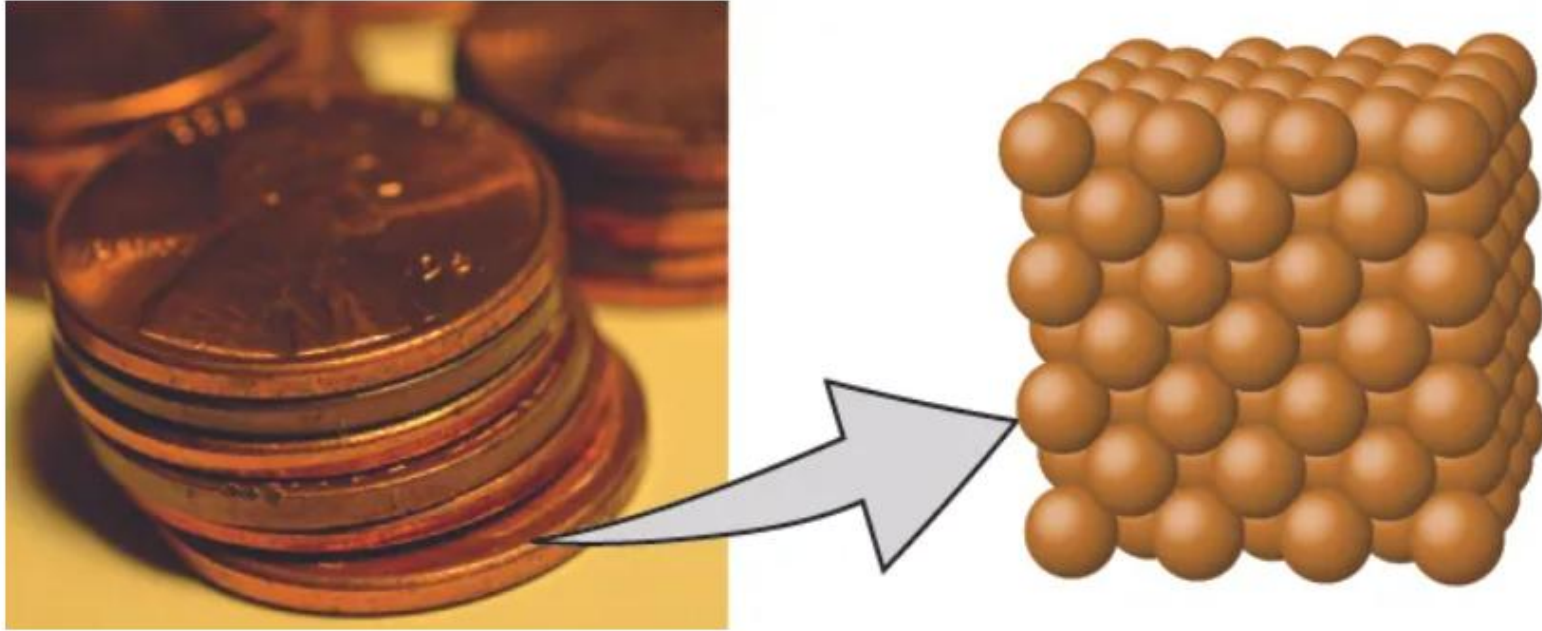


Figure 2.2 A pre-1982 copper penny (left) contains approximately 3×10^{22} copper atoms (several dozen are represented as brown spheres at the right), each of which has the same chemical properties. (credit: modification of work by "slgckgc"/Flickr)

Chemical Symbols



Figure 2.13 The symbol Hg represents the element mercury regardless of the amount; it could represent one atom of mercury or a large amount of mercury.

Element	Symbol	Element	Symbol
aluminum	Al	iron	Fe (from <i>ferrum</i>)
bromine	Br	lead	Pb (from <i>plumbum</i>)
calcium	Ca	magnesium	Mg
carbon	C	mercury	Hg (from <i>hydrargyrum</i>)
chlorine	Cl	nitrogen	N
chromium	Cr	oxygen	O
cobalt	Co	potassium	K (from <i>kalium</i>)
copper	Cu (from <i>cuprum</i>)	silicon	Si
fluorine	F	silver	Ag (from <i>argentum</i>)
gold	Au (from <i>aurum</i>)	sodium	Na (from <i>natrium</i>)
helium	He	sulfur	S
hydrogen	H	tin	Sn (from <i>stannum</i>)
iodine	I	zinc	Zn

The Periodic Table

Periodic Table of the Elements

Period	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8	Group 9	Group 10	Group 11	Group 12	Group 13	Group 14	Group 15	Group 16	Group 17	Group 18
1	1 H 1.008 hydrogen																	2 He 4.003 helium
2	3 Li 6.94 lithium	4 Be 9.012 beryllium											5 B 10.81 boron	6 C 12.01 carbon	7 N 14.01 nitrogen	8 O 16.00 oxygen	9 F 19.00 fluorine	10 Ne 20.18 neon
3	11 Na 22.99 sodium	12 Mg 24.31 magnesium											13 Al 26.98 aluminum	14 Si 28.09 silicon	15 P 30.97 phosphorus	16 S 32.06 sulfur	17 Cl 35.45 chlorine	18 Ar 39.95 argon
4	19 K 39.10 potassium	20 Ca 40.08 calcium	21 Sc 44.96 scandium	22 Ti 47.87 titanium	23 V 50.94 vanadium	24 Cr 52.00 chromium	25 Mn 54.94 manganese	26 Fe 55.85 iron	27 Co 58.93 cobalt	28 Ni 58.69 nickel	29 Cu 63.55 copper	30 Zn 65.38 zinc	31 Ga 69.72 gallium	32 Ge 72.63 germanium	33 As 74.92 arsenic	34 Se 78.97 selenium	35 Br 79.90 bromine	36 Kr 83.80 krypton
5	37 Rb 85.47 rubidium	38 Sr 87.62 strontium	39 Y 88.91 yttrium	40 Zr 91.22 zirconium	41 Nb 92.91 niobium	42 Mo 95.95 molybdenum	43 Tc [97] technetium	44 Ru 101.1 ruthenium	45 Rh 102.9 rhodium	46 Pd 106.4 palladium	47 Ag 107.9 silver	48 Cd 112.4 cadmium	49 In 114.8 indium	50 Sn 118.7 tin	51 Sb 121.8 antimony	52 Te 127.6 tellurium	53 I 126.9 iodine	54 Xe 131.3 xenon
6	55 Cs 132.9 cesium	56 Ba 137.3 barium	57-71 La-Lu *	72 Hf 178.5 hafnium	73 Ta 180.9 tantalum	74 W 183.8 tungsten	75 Re 186.2 rhenium	76 Os 190.2 osmium	77 Ir 192.2 iridium	78 Pt 195.1 platinum	79 Au 197.0 gold	80 Hg 200.6 mercury	81 Tl 204.4 thallium	82 Pb 207.2 lead	83 Bi 209.0 bismuth	84 Po [209] polonium	85 At [210] astatine	86 Rn [222] radon
7	87 Fr [223] francium	88 Ra [226] radium	89-103 Ac-Lr **	104 Rf [267] rutherfordium	105 Db [270] dubnium	106 Sg [271] seaborgium	107 Bh [270] bohrium	108 Hs [277] hassium	109 Mt [276] meitnerium	110 Ds [281] darmstadtium	111 Rg [282] roentgenium	112 Cn [285] copernicium	113 Nh [285] nihonium	114 Fl [289] flerovium	115 Mc [288] moscovium	116 Lv [293] livermorium	117 Ts [294] tennessine	118 Og [294] oganesson
			* 57 La 138.9 lanthanum	58 Ce 140.1 cerium	59 Pr 140.9 praseodymium	60 Nd 144.2 neodymium	61 Pm [145] promethium	62 Sm 150.4 samarium	63 Eu 152.0 europium	64 Gd 157.3 gadolinium	65 Tb 158.9 terbium	66 Dy 162.5 dysprosium	67 Ho 164.9 holmium	68 Er 167.3 erbium	69 Tm 168.9 thulium	70 Yb 173.1 ytterbium	71 Lu 175.0 lutetium	
			** 89 Ac [227] actinium	90 Th 232.0 thorium	91 Pa 231.0 protactinium	92 U 238.0 uranium	93 Np [237] neptunium	94 Pu [244] plutonium	95 Am [243] americium	96 Cm [247] curium	97 Bk [247] berkelium	98 Cf [251] californium	99 Es [252] einsteinium	100 Fm [257] fermium	101 Md [258] mendelevium	102 No [259] nobelium	103 Lr [262] lawrencium	

Units of the periodic table

- grams/mole (g/mol)
- atomic mass units (amu)

The Periodic Table

Periodic Table of the Elements

Period

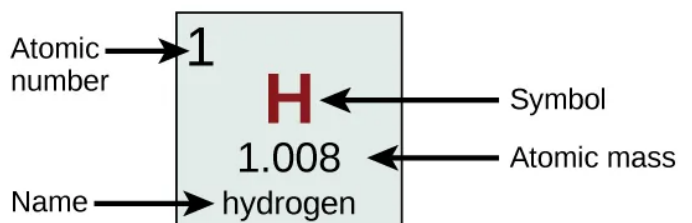
Group
1

18

Units of the periodic table

- grams/mole (g/mol)
- atomic mass units (amu)

1																	2							
1	1 H 1.008 hydrogen																	2 He 4.003 helium						
2	3 Li 6.94 lithium	4 Be 9.012 beryllium																	5 B 10.81 boron	6 C 12.01 carbon	7 N 14.01 nitrogen	8 O 16.00 oxygen	9 F 19.00 fluorine	10 Ne 20.18 neon
3	11 Na 22.99 sodium	12 Mg 24.31 magnesium	3	4	5	6	7	8	9	10	11	12	13 Al 26.98 aluminum	14 Si 28.09 silicon	15 P 30.97 phosphorus	16 S 32.06 sulfur	17 Cl 35.45 chlorine	18 Ar 39.95 argon						
4	19 K 39.10 potassium	20 Ca 40.08 calcium	21 Sc 44.96 scandium	22 Ti 47.87 titanium	23 V 50.94 vanadium	24 Cr 52.00 chromium	25 Mn 54.94 manganese	26 Fe 55.85 iron	27 Co 58.93 cobalt	28 Ni 58.69 nickel	29 Cu 63.55 copper	30 Zn 65.38 zinc	31 Ga 69.72 gallium	32 Ge 72.63 germanium	33 As 74.92 arsenic	34 Se 78.97 selenium	35 Br 79.90 bromine	36 Kr 83.80 krypton						
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Color Code	
 Metal	Solid
 Metalloid	Liquid
 Nonmetal	Gas

The Periodic Table

Period

Group

1

Units of the periodic table

- grams/mole (g/mol)
- atomic mass units (amu)

18

1

1	H 1.008 hydrogen
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2

2

3	Li 6.94 lithium
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4	Be 9.012 beryllium
---	---------------------------------

5	B 10.81 boron
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6	C 12.01 carbon
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7	N 14.01 nitrogen
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8	O 16.00 oxygen
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9	F 19.00 fluorine
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10	Ne 20.18 neon
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2	He 4.003 helium
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Atomic Structure

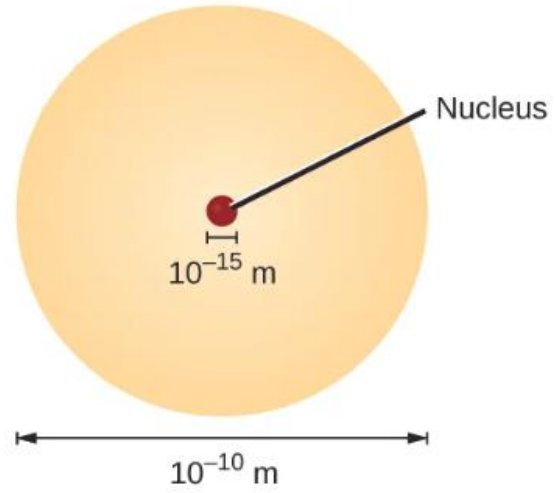


Figure 2.11 If an atom could be expanded to the size of a football stadium, the nucleus would be the size of a single blueberry. (credit middle: modification of work by "babyknight"/Wikimedia Commons; credit right: modification of work by Paxson Woelber)

Atomic Structure

Properties of Subatomic Particles

Name	Location	Charge (C)	Unit Charge	Mass (amu)	Mass (g)
electron	outside nucleus	-1.602×10^{-19}	1-	0.00055	0.00091×10^{-24}
proton	nucleus	1.602×10^{-19}	1+	1.00727	1.67262×10^{-24}
neutron	nucleus	0	0	1.00866	1.67493×10^{-24}

Table 2.2

grams/mole (g/mol)

atomic mass units (amu)

atomic number (Z) = number of protons

mass number (A) = number of protons + number of neutrons

$A - Z$ = number of neutrons

Atomic Structure

grams/mole (g/mol)
atomic mass units (amu)

Name	Location	Unit Charge	Mass (amu)
electron	outside nucleus	1-	0.00055
proton	nucleus	1+	1.00727
neutron	nucleus	0	1.00866

Table 2.2

1. What is the charge of an electron?
2. What is the charge of a proton?
3. What is the charge of a neutron?
4. What has more mass, an electron or proton?
5. T or F, a proton is about the same size as a neutron?
6. Where are electrons located?
7. Where are protons located?
8. Where are neutrons located?
9. What particle defines the element or gives that element its specific properties?
10. What is an atomic number?
11. What is a mass number?
12. What are the two different units of mass on the periodic table?

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Isotopes and Significant Figures

- Chapter 2.3 (Atomic Structure and Symbolism)
- Chapter 3.6 (The Periodic Table)
- Chapter 1.5 (Significant Figures)

Isotope Practice

- Write the symbol, mass number, and atomic number for the following isotopes:
 - carbon with 6 neutrons
 - chlorine with 18 neutrons
 - silver with 62 neutrons

The Periodic Table

Period	Group	1	2	13	14	15	16	17	18
1		1 H 1.008 hydrogen							2 He 4.003 helium
2		3 Li 6.94 lithium	4 Be 9.012 beryllium	5 B 10.81 boron	6 C 12.01 carbon	7 N 14.01 nitrogen	8 O 16.00 oxygen	9 F 19.00 fluorine	10 Ne 20.18 neon

Isotopes

Nuclear Compositions of Atoms of the Very Light Elements

grams/mole (g/mol)
atomic mass units (amu)

Element	Symbol	Atomic Number	Number of Protons	Number of Neutrons	Mass (amu)	% Natural Abundance
hydrogen	${}^1_1\text{H}$ (protium)	1	1	0	1.0078	99.989
	${}^2_1\text{H}$ (deuterium)	1	1	1	2.0141	0.0115
	${}^3_1\text{H}$ (tritium)	1	1	2	3.01605	— (trace)
helium	${}^3_2\text{He}$	2	2	1	3.01603	0.00013
	${}^4_2\text{He}$	2	2	2	4.0026	100
lithium	${}^6_3\text{Li}$	3	3	3	6.0151	7.59
	${}^7_3\text{Li}$	3	3	4	7.0160	92.41
beryllium	${}^9_4\text{Be}$	4	4	5	9.0122	100

Significant Figures

Significant

- Nonzero numbers
- Zeros between nonzero numbers
- Right-end zeros only if there is a decimal anywhere in the number

Not Significant

- Everything else

Significant Figures

Significant

- Nonzero numbers

- Zeros between nonzero numbers

- Right-end zeros only if there is a decimal anywhere in the number

Examples

111

924.19

0.3527

10000001

909

80980

1100

0.070580

0.0000010

of Sig Figs

3

5

4

8

3

5?

2

5

2

Significant Figures

Check Your Learning

Round the following to the indicated number of significant figures:

- (a) 0.424 (to two significant figures)
- (b) 0.0038661 (to three significant figures)
- (c) 421.25 (to four significant figures)
- (d) 28,683.5 (to five significant figures)

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Atomic Mass and Math with SigFigs

- Chapter 2.3 (Atomic Structure and Symbolism)
- Chapter 3.6 (The Periodic Table)
- Chapter 1.5 (Significant Figures)

- Chemistry can be difficult but you can do it and you will be successful if you can commit the required time to it.
- It requires time, consistent practice, repetition, and patience with yourself.

**YOU CAN
DO IT!!!**



Isotopes

Nuclear Compositions of Atoms of the Very Light Elements

grams/mole (g/mol)
atomic mass units (amu)

Element	Symbol	Atomic Number	Number of Protons	Number of Neutrons	Mass (amu)	% Natural Abundance
hydrogen	${}^1_1\text{H}$ (protium)	1	1	0	1.0078	99.989
	${}^2_1\text{H}$ (deuterium)	1	1	1	2.0141	0.0115
	${}^3_1\text{H}$ (tritium)	1	1	2	3.01605	— (trace)
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	${}^4_2\text{He}$	2	2	2	4.0026	100
lithium	${}^6_3\text{Li}$	3	3	3	6.0151	7.59
	${}^7_3\text{Li}$	3	3	4	7.0160	92.41
beryllium	${}^9_4\text{Be}$	4	4	5	9.0122	100

Atomic Mass

The average mass of all of the isotopes of an element

grams/mole (g/mol)

atomic mass units (amu)

$$\text{average mass} = \sum (\text{fractional abundance} \times \text{isotopic mass})_i$$

Element	Symbol	Atomic Number	Number of Protons	Number of Neutrons	Mass (amu)	% Natural Abundance
boron	$^{10}_5\text{B}$	5	5	5	10.0129	19.9
	$^{11}_5\text{B}$	5	5	6	11.0093	80.1

$$\text{boron average mass} = (0.199 \times 10.0129 \text{ amu}) + (0.801 \times 11.0093 \text{ amu})$$

PEMDAS

Parentheses

Exponents

Multiplication

Division

Addition

Subtraction

$$\frac{\text{part}}{\text{whole}} \times 100\% = \text{percent}$$

Significant Figures

Addition/Subtraction

- Use the least amount of DECIMALS in the problem

Multiplication/Division

- Use the least amount of SIG FIGS in the problem

Significant Figures

Addition/Subtraction

- Use the least amount of DECIMALS in the problem

Multiplication/Division

- Use the least amount of SIG FIGS in the problem

Has both?

- Use both!
- Use an overline to keep track of the significant figures and keep going
- Round – if digit to the right of the last sigfig is 5 or greater, round up, if 4 or below, round down. *other rounding rules in the future!!

Significant Figures

Addition/Subtraction

- Use the least amount of DECIMALS in the problem

Multiplication/Division

- Use the least amount of SIG FIGS in the problem

Significant Figures

Addition/Subtraction

- Use the least amount of DECIMALS in the problem

Multiplication/Division

- Use the least amount of SIG FIGS in the problem

Has both? Use both!

- Use an overline to keep track of the significant figures and keep going
- Round – if digit to the right of the last sigfig is 5 or greater, round up, if 4 or below, round down. *other rounding rules in the future!!

Significant Figures

Addition/Subtraction

- Use the least amount of DECIMALS in the problem

Multiplication/Division

- Use the least amount of SIG FIGS in the problem

Math and Sig Figs

Check Your Learning

(a) Add 2.334 mL and 0.31 mL.

(b) Subtract 55.8752 m from 56.533 m.

Math and Sig Figs

Check Your Learning

(a) Multiply 2.334 cm and 0.320 cm.

(b) Divide 55.8752 m by 56.53 s.

Math and Sig Figs

Check Your Learning

(a) $2.334 \text{ cm} \times (0.320 \text{ cm} - 0.12 \text{ cm})$

(b) $(55.8752 \text{ m} + 6.22 \text{ m}) / 56.53 \text{ s}$

Atomic Mass

grams/mole (g/mol)
atomic mass units (amu)

Element	Symbol	Atomic Number	Number of Protons	Number of Neutrons	Mass (amu)	% Natural Abundance
boron	$^{10}_5\text{B}$	5	5	5	10.0129	19.9
	$^{11}_5\text{B}$	5	5	6	11.0093	80.1

$$\text{boron average mass} = (0.199 \times 10.0129 \text{ amu}) + (0.801 \times 11.0093 \text{ amu})$$

$$\text{average mass} = \sum_i (\text{fractional abundance} \times \text{isotopic mass})_i$$

Atomic Mass

Check Your Learning

A sample of magnesium is found to contain 78.70% of ^{24}Mg atoms (mass 23.98 amu), 10.13% of ^{25}Mg atoms (mass 24.99 amu), and 11.17% of ^{26}Mg atoms (mass 25.98 amu). Calculate the average mass of a Mg atom.

What is atomic mass?

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