AP Chemistry Summer Packet

Dear Future AP Chemistry Students,

First I want to welcome you to AP Chemistry and look forward to our journey together in Chemistry next year. In preparation for the coming 2024-2025 school year, I have prepared a packet of practice material to gear you up for the first unit in the AP Chemistry curriculum. The packet contains practice problems on material you have already covered in Honors Chemistry last year in addition to helpful links on Youtube that will help you prepare for the upcoming AP Chemistry Material. I also included a couple of AP Chemistry workbooks that I have found helpful for preparing for the AP Chemistry Exam at the end of the year. Please feel free to email me with any questions about the material in the packet or about the upcoming course curriculum. The practice problems are due on the first day of class this Fall 2024 semester. Good luck and have a great summer break.
Sincerely,
Mrs. Kendrick

I. Mathematics in Chemistry:

Significant Figures and Unit Conversions:

Rules for Sig Figs

1. *Zeroes*
    a. Leading zeros NEVER count.
    b. Captive Zeroes ALWAYS count
    c. Trailing zeroes only count IF THEY FOLLOW A DECIMAL.
2. *All integers count*
3. *Exact Numbers* have unlimited sig figs: Determined by counting and not by using a measuring device
    a. Assumed to have an infinite number of significant figures
    b. Can arise from definitions
    c. Example - 2 in 2πr

- Example - 1.008 has four sig. figs.

Significant Figures in Calculations:

1. Addition/Subtraction, use the least number of decimal places in your answer.
2. Multiplicatio/Division, use the least number of significant digits in your answer

Scientific Notation:

Know how to convert any number to scientific notation. #.## x $10^{\#}$

- ALWAYS INCLUDE UNITS IN YOUR ANSWER AND USE CORRECT SIG FIGS!!!
- Know how to use scientific notation in your calculator.

Equivalence Statements:

- Know the definition of an Equivalence Statement and Unit Conversions:
- Know how to convert between units given an equivalence statement
- Mass Units, g and pounds
- Length Units: m, mm, cm, inches
- Volume, mL and L
- Density: Density = mass/volume, units: g/cm^3, g/mL, kg/L,
- Temperature: Kelvin(K), Celsius (°C) and Fahrenheit (°F)

Temperature:

Many of the formulas in chemistry rely on the Kelvin temperature scale. Please know how to convert to Kelvin.

Know how to convert from °C to °F and vice versa.

Know how to convert from °C to Kelvin and vice versa.

$$T(°C) = (T(°F)-32) \times (5/9) \quad \text{or} \quad T(°F) = [(T(°C)) \times (9/5)] + 32$$

$$T(K) = T(°C) + 273$$

Know your metric prefixes and their magnitudes:

• nano= 10^{-9} • micro= 10^{-6} • milli = 10^{-3}	• centi= 10^{-2} • deci= 10^{-1} • kilo= 1000 • mega= 10^{6}

Video Links: Check out Tyler DeWitt on Youtube.

- https://www.youtube.com/watch?v=5UjwJ9PIUvE
- https://www.youtube.com/watch?v=PNH7_nDE6SQ
- https://www.youtube.com/watch?v=7N0lRJLwpPI
- https://www.youtube.com/watch?v=LdZ00OFAfaQ

Practice Problems

1. Indicate the number of significant digits in each of the following measurements.

a. 23.500 g _____

b. 100.35 mL _____

c. 1.004 3 10^{-7} m _____

d. 0.00230 kg _____

2. Round off the following numbers to the indicated number of significant figures.

a. 0.0089346 kg (3 sig figs) _____

b. 96515 mL (3 sig figs) _____

c. 3.50492 m (3 sig figs) _____

3. Determine the result to the correct number of significant figures.

a. $\frac{3.2 \text{ cm} \times 1.23 \text{ cm} \times 0.5 \text{ cm}}{8.32 \text{ cm} \times 1.000 \text{ cm} \times 0.500 \text{ cm}} =$

b. $\frac{2.420 \text{ g} + 15.6 \text{ g}}{5.31 \text{ g}} =$

4. Perform the following conversions (1 lb= 453.59 g; 1 L = 1.0567 qt; 1 inch = 2.54 cm):

a. 100. km to miles (use at least 3 conversion factors).

b. A liquid has a critical temperature of 154.4 K; calculate the temperature in °F and °C.

c. The thickness of a human hair is approximately 70,000 nm; calculate the thickness in millimeters.

d. A typical soft drink container is 355 mL; determine the number of quarts of the soft drink container.

5. Perform the following conversion: The density of water is 1.00 g/cm3. Convert to pounds/foot^3.

II. Balancing Equations Practice

Youtube Videos: Tyle Dewitt Channel on Balancing Equations in Chemistry
https://www.youtube.com/watch?v=yA3TZJ2em6g
https://www.youtube.com/watch?v=eNsVaUCzvLA

Practice Problems: Balance the following equations:

1. $Ca(OH)_2(aq) + H_3PO_4(aq) \rightarrow H_2O(l) + Ca_3(PO_4)_2(s)$

2. $Al(OH)_3(s) + HCl(aq) \rightarrow AlCl_3(aq) + H_2O(l)$

3. $AgNO_3(aq) + H_2SO_4(aq) \rightarrow Ag_2SO_4(s) + HNO_3(aq)$

4. $KO_2(s) + H_2O(l) \rightarrow KOH(aq) + O_2(g) + H_2O_2(aq)$

5. $Fe_2O_3(s) + HNO_3(aq) \rightarrow Fe(NO_3)_3(aq) + H_2O(l)$

6. $C_{12}H_{22}O_{11}(s) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

7. $Fe(s) + O_2(g) \rightarrow Fe_2O_3(s)$

8. $FeO(s) + O_2 \rightarrow Fe_2O_3(s)$

9. $SiO_2(s) + C(s) \rightarrow Si(s) + CO(g)$

10. $C_{12}H_{22}O_{11}(aq) + H_2O(l) \rightarrow C_2H_5OH(aq) + CO_2(g)$

III. Nomenclature : Naming Compounds and Writing Chemical Formulas

1. Ionic Compound Empirical Formula Video Review

https://www.youtube.com/watch?v=URc75hoKGLY

Be familiar with the element names and charges
Be familiar with the following polyatomic ions

TABLE 3.4 ■ Some Common Polyatomic Ions

Name	Formula	Name	Formula
Acetate	$C_2H_3O_2^-$	Hypochlorite	ClO^-
Carbonate	CO_3^{2-}	Chlorite	ClO_2^-
Hydrogen carbonate (or bicarbonate)	HCO_3^-	Chlorate	ClO_3^-
Hydroxide	OH^-	Perchlorate	ClO_4^-
Nitrite	NO_2^-	Permanganate	MnO_4^-
Nitrate	NO_3^-	Sulfite	SO_3^{2-}
Chromate	CrO_4^{2-}	Hydrogen sulfite (or bisulfite)	HSO_3^-
Dichromate	$Cr_2O_7^{2-}$	Sulfate	SO_4^{2-}
Phosphate	PO_4^{3-}	Hydrogen sulfate (or bisulfate)	HSO_4^-
Hydrogen phosphate	HPO_4^{2-}	Cyanide	CN^-
Dihydrogen phosphate	$H_2PO_4^-$	Peroxide	O_2^{2-}
Ammonium	NH_4^+		

Practice Problems: Practice writing the Chemical Formula for the following compounds.

1. Lithium Sulfide _____
2. Rubidium chloride _____
3. Aluminum sulfide_____
4. Barium sulfide _____
5. Aluminum nitride _____
6. Calcium oxide _____
7. Gallium phosphide _____
8. Strontium oxide _____
9. Cesium iodide _____
10. Aluminum nitrate _____
11. Sodium phosphate _____
12. Potassium chlorate _____
13. Gallium nitrate _____
14. Lithium carbonate _____
15. Sodium bicarbonate _____
16. Iron (III) fluoride _____

17. Gold(II) nitride _____ 18. Lead(II) nitrate _____

Part 2: Practice naming the following compounds

1. $NaCl$_____ 10. NH_4NO_3_____
2. KBr_____ 11. NaI_____
3. $MgCl_2$_____ 12. Li_3PO_4_____
4. $AlCl_3$_____ 13. Na_2CO_3_____
5. $AlBr_3$_____ 14. CsF_____
6. $Fe(NO_3)_2$_____ 15. $AgCl$_____
7. $Fe(NO_3)_3$_____ 16. RbI_____
8. KNO_3_____ 17. BaF_2_____
9. $CaBr_2$_____ 18. $CuSO_4$_____

IV. Periodic Table Review

Vocabulary: Define the following..

1. Element _____
2. Atomic Number _____
3. Atomic Mass _____
4. Compound _____
5. Cation _____
6. Anion _____
7. Molecule _____

Metals: Of the 118 elements, 92 are metals

1. Where are metals found on the periodic table: elements to the _____ of the “zig zag” line are metals.

   Examples:

A._____

B._____

C._____

2. Physical Properties of Metals (most of them at least)
    a. Color?_____
    b. Shiny? _____
    c. Dense? _____
    d. Conduct electricity? _____
    e. Melting Point (high, low)? _____
    f. Can they be drawn into a wire (ductile)? _____
    g. Can they be hammered into thin sheets (malleable)? _____
    h. Good/poor conductors of heat? _____

3. Chemical Properties
    a. Most metals react with water and/or oxygen which causes them to corrode, oxidize (rust)
    b. A few metals like _____ and _____ don't rust (Noble metals)
    c. Metals like to _____ (donate/ accept) electrons to nonmetals.

Nonmetals - The next largest group of elements on the periodic table (18 of 118)

1. They are found to the _____ of the "zig zag" line
2. Examples:
    a. _____
    b. _____
    c. _____
    d. _____

3. Physical properties

a. Color? _____

b. Luster? _____

c. Ductile or Brittle? _____

d. Conduct electricity? _____

e. Can be solid, liquid or gas but most are _____

4. Chemical Properties

a. Elements in the _____ group are non-reactive, also called the _____.

b. Non-metals like to _____ (donate/accept) from elements that lose electrons.

Metalloids- smallest group of elements (8 of 118)

Metalloids are found on the "zig zag" line. Also called semi-metals because they are found in between the metals and nonmetals.

The Metalloids:

Atomic #	Element Name	Atomic #	Element Name
5	_____	14	_____
32	_____	33	_____
51	_____	52	_____
84	_____	85	_____

Which element is missing that looks like it should be on the list? _____--it's a metal!

Properties of Metalloids:

a. All metalloids are (solids, liquids or gases)?_____

b. Shiny or dull?_____

c. Metalloids conduct heat and electricity better than nonmetals but not as well as metal. They are semiconductors such as Silicon and Germanium.

d. Brittle or malleable?_____

V. Electron Configurations

Electron configuration is a valuable tool for chemists in describing the electronic structure of an atom. Please review the methods used for writing electron configurations and complete the following practice problems.
Helpful links:
Bozeman Science: https://www.youtube.com/watch?v=2AFPfg0Como
Leah4Sci: https://www.youtube.com/watch?v=igxUYzbQO7s

Practice: What is the electron configuration for the following?

1. H
2. Ne
3. Li
4. B
5. N
6. O
7. F
8. P
9. Ca
10. Br

VI. Lewis Structures and VSEPR

General Rules for Writing Lewis Structures:

1. Sum the valence electrons from all the atoms in the molecule
2. Decide the basic structure with the central atom identified. Usually the central atom is the leaset electronegative.
3. Use a pair of electrons to form a bond between each pair of bound atoms
4. Arrange the remaining electrons to satisfy the duet rule for hydrogen and the octet rule for the second-row elements

To review Lewis structures watch “Lewis Diagrams Made Easy” video by Ketzbook
https://www.youtube.com/watch?v=cIuXl7o6mAw

Practice Problems: Draw the Lewis structures for the following molecules:

1. CF_4
2. N_2
3. O_2
4. F_2
5. CH_2O
6. NH_3
7. CO_2
8. CO_3^{2-}
9. SO_4^{2-}
10. NO_3^-

11. Molecular Geometry:

The shape and structure of molecules are critical to understanding properties of those chemicals. In AP chemistry, we will relate the shape and structure of molecules to properties such as boiling point, melting point, vapor pressure etc. Please review and practice identify the molecular shapes using VSEPR theory.
For more information try watching the VSEPR Video by Tyler Dewitt,
https://www.youtube.com/watch?v=nxebQZUVvTg

Practice Problems: What are the molecular geometries of the molecules above and identify whether they are polar or nonpolar.

12. CF_4

13. N_2

14. O_2

15. F_2

16. CH_2O

17. NH_3

18. CO_2

19. CO_3^{2-}

20. SO_4^{2-}

21. NO_3^-

22. One concept in molecular geometry that we covered briefly is *Resonance*. Look up the definition of resonance from a google search and explain in your own words what resonance is in relation to molecular geometry and bonding.

_____

_____

_____

_____

VI. Types of Reactions

Balance the following equations and then identify these reactions as either precipitation, acid-base, or oxidation-reduction.

1. If the reaction is a precipitation reaction, circle the precipitate.
2. If the reaction is an acid-base reaction, identify the acid and base reactants.
3. If the reaction is an oxidation-reduction reaction, indicate which species is reduced and which species is oxidized

a. $K_2SO_4(aq) + Ba(NO_3)_2(aq) \rightarrow BaSO_4(s) + KNO_3(aq)$

b. $HCl(aq) + Zn(s) \rightarrow H_2(g) + ZnCl_2(aq)$

c. $HCl(aq) + AgNO_3(aq) \rightarrow HNO_3(aq) + AgCl(s)$

d. $HCl(aq) + KOH(aq) \rightarrow H_2O(l) + KCl(aq)$

e. $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

f. $NaH_2PO_4(aq) + NaOH(aq) \rightarrow Na_3PO_4(aq) + H_2O(l)$

g. $Ca(OH)_2(aq) + H_2SO_4(aq) \rightarrow CaSO_4(aq) + H_2O(l)$

h. $ZnCl_2(aq) + Mg(s) \rightarrow Zn(s) + MgCl_2(aq)$

i. $BaCl_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + HCl(aq)$

VII. Periodic trends

Periodic Trends are an important concept in AP Chemistry. The trends are related to the structure of the atom, specifically the electron and proton attraction forces and electron-eletron repulsive forces. A good video review is by Bozeman Science at https://www.youtube.com/watch?v=0tP6bV89log

Describe the trend for atomic radius from left to right across a period. Use atomic structure (e.g. energy levels, nuclear charge, attraction) to help support your answer.

_____

_____

_____

_____

_____

Describe the trend for atomic radius down a group. Use atomic structure (e.g. energy levels, nuclear charge, attraction) to help support your answer.

_____

_____

_____

_____

_____

Practice: Please circle the atom with the larger atomic radius.

1. Lithium or Nitrogen
2. Rubidium or Cesium
3. Magnesium or Chlorine
4. Tin or Lead

VIII. Mol Calculations

Tyler Dewitt Videos on YouTube
https://www.youtube.com/watch?v=HMAOrGpkTsQ
https://www.youtube.com/watch?v=hY7IzRBylSk

Complete the following table and show your work on space below or your own paper:

Formula	M, Molar Mass (g/mol)	m, Mass of Sample (g)	n, Moles of Sample (mol)	N, Number of Atoms, Molecules or Formula Units
H_20			5.50	
CH_4				$4.55x10^{24}$
KI		10		
NaCl			5.50	
H_2SO_4		20		
Si			12.5	
HNO_3		10		
H_3PO_4				$3.15x10^{24}$
Ga_2O_3		15		
PCl_5			6.5	
C_2H_5OH		20		

IX. Stoichiometry

Mole Calculations and Conversions

To convert from Grams to Moles

1. Determine the molar mass of of the atom or molecular mass of the molecule
2. Divide the mass of the sample by the molar mass to get moles of sample

Ex. Find the number of moles of $CaCl_2$ in a 20.0 g sample.

Molar mass of $CaCl_2$ = (40.08 g Ca/mol) +2(35.45 g Cl/mol) = 110.98 g $CaCl_2$/mol

Moles of $CaCl_2$ = 20.0 g $CaCl_2$ / (110.98 g$CaCl_2$/mol) = 0.180 mol $CaCl_2$

To convert from moles to grams

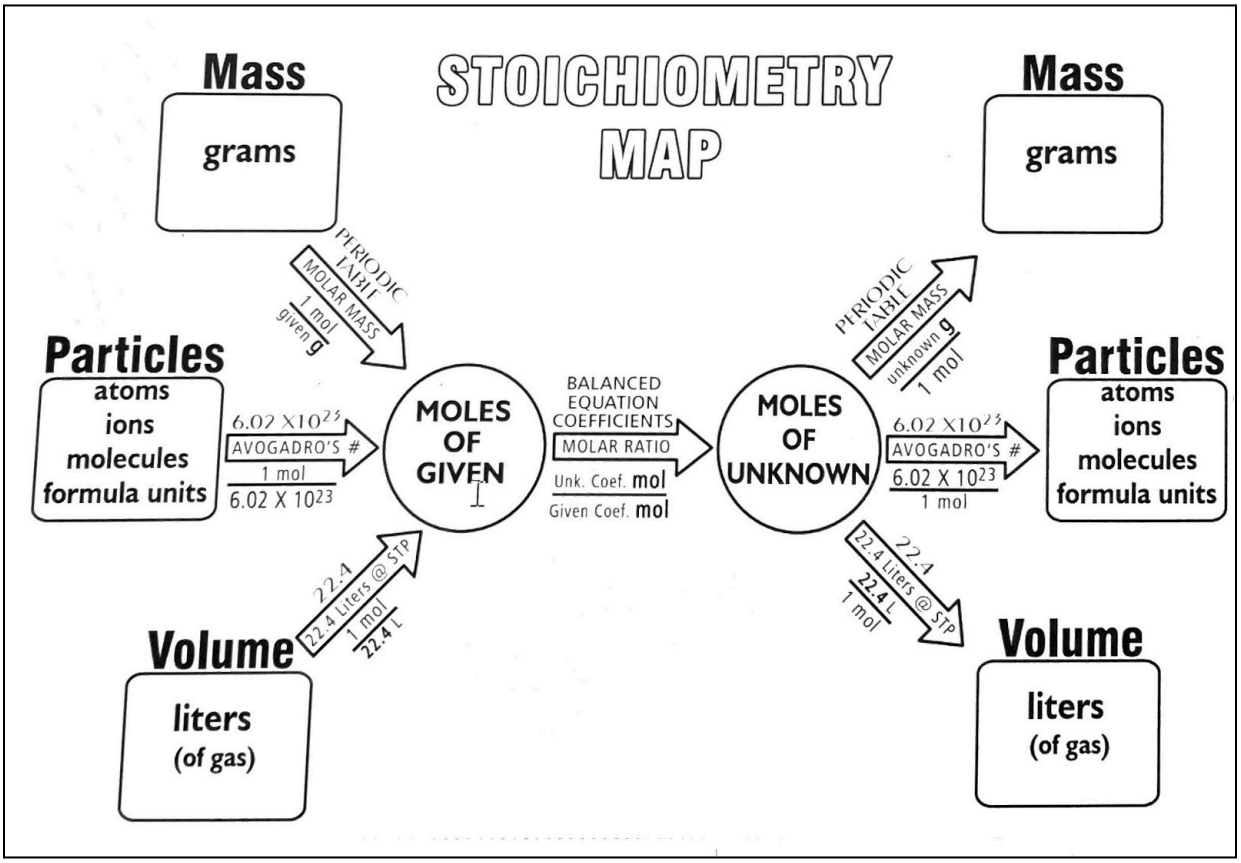
1. Determine the molar mass of of the atom or molecular mass of the molecule
2. Multiply the moles of the sample by the molar mass to get grams of sample

Ex: Find the mass of 20 moles of CO.

Mass CO = (20 mol CO)(12 g C/mo + 16 g O/mol) = 560 g CO

Review Videos

https://www.youtube.com/watch?v=nZOVR8EMwRU&t=90s
https://www.youtube.com/watch?v=Mlu_v8rE1TY



Stoichiometry Practice

1. Consider the following unbalanced equation for the neutralization of acetic acid.

   $$HC_2H_3O_2\ (aq) + Ba(OH)_2(aq) \rightarrow H_2O(l) + Ba(C_2H_3O_2)_2(aq)$$

   Balance the equation and determine how many grams of $Ba(OH)_2(aq)$ are required to completely neutralize 0.461 moles of $HC_2H_3O_2$ (aq).

2. Calculate how many moles of NO_2 form when 2.87 kg N_2O_5 react in the following unbalanced reaction. You must balance the reaction first!

   $$N_2O_5(g) \rightarrow NO_2(g) + O_2(g)$$

3. For the following reaction, determine the limiting reactant for each of the following initial amounts of reactants and calculate the amount of product in moles. I suggest that you can use RICE table to show your work because a RICE Table will be very important when we start limiting reactant and equilibrium problems:
   $2Na(s) + Br_2(g) \rightarrow 2NaBr_2(s)$
   a. 2 mole of Na and 2 mole of Br_2

   b. 1.8 mol Na and 1.4 mol Br_2

   c. 30 g Na and 50 g Br_2

X. Empirical and Molecular Formulas

Understanding molar ratios in empirical formulas

If you have an empirical formula, the subscripts of each atom in the formula indicate the mole ratio of the compound.

Ex: In 1 mole of the compound C_2H_6, there are 2 mol of C and 6 mol of H. They always have the same ratio according to the Law of Constant Composition.

Ex: How many moles of carbon are in Calcium Carbonate?

1. Find the empirical formula for Calcium carbonate. Carbonate is a polyatomic ion with the following formula and charge CO_3^{2-}. Calcium cation has a 2+ charge.
    a. $CaCO_3$ is the formula
2. There is 1 mol of C for every 1 mol of $CaCO_3$ according to the formula
3. Likewise, there are 3 mol of O for every mole of $CaCO_3$.
4. How many moles of Ca are there in the formula? 1 mol Ca

Ex: Calculate the amount of Calcium in grams in 1 mole of $CaCO_3$.

Since there is 1 mol of Ca in 1 mol $CaCO_3$, then the amount of grams in 1 mol of Ca (40.08 g/mol) is 40.08 g.

Ex: Calculate the amount of Oxygen in grams in 1 mol $CaCO_3$.

Since there are 3 mol of oxygen in 1 mol of $CaCO_3$, then there will be
(3 mol O)(16g O/mol) = 48 g of O in 1 mol $CaCO_3$

Helpful Links: Tyler Dewitt Youtube: https://www.youtube.com/watch?v=wnRaBWvhYKY

Practice Problems:

1. Assuming a 100.0 g sample, lab data has shown the sample to contain 69.94 g is iron and the remainder oxygen. Calculate the empirical formula.

2. A 0.1507 g sample of a hydrocarbon called menthol is combusted and produced 0.4243 g of CO_2 and 0.1738 g H_2O. Determine the empirical formula of the menthol.

XI. Summer Prep Help:

Some Helpful links: In addition to Tyler Dewitt's Youtube channel, I also recommend Khan Academy and Bozeman Science Videos on Youtube

<u>Here are some Helpful AP Chemistry Test Prep Books</u>

- The Princeton Review AP Chemistry Premium Prep
- 5 Steps to a 5 (McGraw-Hill)
- Barron's AP Chemistry Premium, 2022-2023
- AP Chemistry Practice Questions (Sterling Test Prep)
- Crash Course AP Chemistry

Periodic Table of the Elements — Chemistry Reference Sheet — California Standards Test

	1 1A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A
1	1 H Hydrogen 1.01	2 2A																2 He Helium 4.00
2	3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
3	11 Na Sodium 22.99	12 Mg Magnesium 24.31	3 3B	4 4B	5 5B	6 6B	7 7B	8	9 8B	10	11 1B	12 2B	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
4	19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
5	37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29
6	55 Cs Cesium 132.91	56 Ba Barium 137.33	57 La Lanthanum 138.91	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
7	87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (266)	107 Bh Bohrium (264)	108 Hs Hassium (269)	109 Mt Meitnerium (268)									

Key: 11 Na Sodium 22.99 — Atomic number; Element symbol; Element name; Average atomic mass*

58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97
90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)

* If this number is in parentheses, then it refers to the atomic mass of the most stable isotope.