Syllabus

Chemistry, Semester A

Course Overview

Chemistry is the study of how a set of substances with particular physical properties—like solid paper and the oxygen in the air—can react with each other to form different substances with entirely different properties—like gaseous water and carbon dioxide. In most cases, these chemical changes result in an energy change as well, either giving off energy or absorbing energy.

Chemistry is considered one of the core scientific disciplines because it is so practical and widely useful in the modern world. The development of new types of materials, new methods of producing or storing energy, or new methods of interacting with genetic material all depend upon knowledge of chemistry.

In Chemistry A, you will learn some of the “basics” of chemistry: the atomic and molecular structures that result in different chemical properties and the concepts and tools that will enable you to predict chemical properties and chemical reactions.

Course Goals

By the end of this course, you will be able to do the following:

- Understand the difference between a chemical change and a physical change and understand the basics of atomic theory, which underlies the study of chemistry.
- Be able to use the periodic table to understand atomic structure and predict the chemical behavior of substances.
- Understand the different types of chemical bonding and how they may result in different molecular structures and different chemical properties.
- Understand how quantitative chemical results in the “real world” are based on reactions that occur on the atomic and molecular scale.
- Carry out activities used in real-world chemistry, including predicting the products of a chemical reaction and predicting the amounts of products you would expect from an initial quantity of chemical substances.
- Investigate the relationships between energy and matter, including phase changes and the effects of changing the volume, pressure, or temperature of a gas.

Math and Science Skills

Successful completion of Algebra 1 provides the mathematical skills you'll need for Chemistry A.
In addition, you should have a good working understanding of inquiry science methods, including:

- Experimental design, including the importance of experimental controls.
- Basic data analysis skills, including the ability to interpret mathematical patterns from data tables and graphs.
- The ability to use experimental results and/or real data sets to propose general rules.

General Skills

To participate in this course, you should be able to do the following:

- Complete basic operations with word processing software, such as Microsoft Word or Google Docs.
- Perform online research using various search engines and library databases.
- Communicate through email and participate in discussion boards.

For a complete list of general skills that are required for participation in online courses, refer to the Prerequisites section of the Plato Student Orientation document, found at the beginning of this course.

Credit Value

Chemistry A is a 0.5-credit course.

Course Materials

- Computer with Internet connection and speakers or headphones
- Microsoft Word or equivalent
- Test and Study References found at the end of this syllabus. They include a periodic table for testing purposes and a periodic table for student study.
- Notebook

Course Pacing Guide

This course description and pacing guide is intended to help you keep on schedule with your work. Note that your course instructor may modify the schedule to meet the specific needs of your class.

Unit 1: Matter and Atomic Structure

Summary

In this unit, you will be introduced to the concept of chemical change as opposed to physical change and you will review atomic theory, which underlies the study of chemistry.

Day	Activity/Objective	Type
1 day: 1	**Syllabus and Plato Student Orientation** *Review the Plato Student Orientation and Course Syllabus at the beginning of this course.*	Course Orientation
2 days: 2–3	**Types of Matter** *Learner will identify different types of matter.*	Lesson
2 days: 4–5	**Physical Changes Versus Chemical Changes** *Learner will identify physical and chemical properties and changes.*	Lesson
2 days: 6–7	**Models of the Atom** *Learner will describe the experimental basis for the atom and identify the parts of the atom.*	Lesson
2 days: 8–9	**Isotopes and Atomic Mass** *Learner will calculate average atomic mass from isotopic information.*	Lesson
2 days: 10–11	**Unit Activity and Discussion—Unit 1**	Unit Activity Discussion
1 day: 12	**Posttest—Unit 1**	Assessment

Unit 2: The Periodic Table

Summary
In this unit, you will explore the periodic table which helps us understand atomic structure and predict the chemical behavior of substances.

Day	Activity/Objective	Type
2 days: 13–14	**The Periodic Table** *Learner will use the periodic table to identify information about an element and to predict element properties.*	Lesson
2 days: 15–16	**Electron Configurations** *Learner will write electron configurations.*	Lesson
2 days: 17–18	**Periodic Trends** *Learner will identify and compare periodic trends from the periodic table.*	Lesson
2 days: 19–20	**Electromagnetic Radiation** *Learner will describe electromagnetic radiation and perform appropriate calculations.*	Lesson
2 days: 21–22	**Spectral Lines** *Learner will identify spectral lines for elements.*	Lesson
2 days: 23–24	**Unit Activity and Discussion—Unit 2**	Unit Activity Discussion
1 day: 25	**Posttest—Unit 2**	Assessment

Unit 3: Bonding

Summary
In this unit, you will learn about chemical bonding and explore how different types of bonds result in different molecular structures and different chemical properties.

Day	Activity/Objective	Type
2 days: 26–27	**Ionic, Covalent, and Metallic Bonds** *Learner will Identify ionic, covalent, and metallic substances and describe their bonding.*	Lesson
2 days: 28–29	**Compound Names** *Learner will use rules for naming compounds.*	Lesson
2 days: 30–31	**Lewis Structures** *Learner will draw Lewis structures.*	Lesson

2 days: 32–33	**Electronegativity** *Learner will differentiate between ionic, polar covalent, and nonpolar covalent bonds.*	Lesson
2 days: 34–35	**Three-Dimensional Molecules** *Learner will predict the three-dimensional bond shape of a molecule.*	Lesson
3 days: 36–37	**Molecular Polarity** *Learner will predict molecular polarity.*	Lesson
2 days: 38–39	**Intermolecular Forces** *Learner will identify intermolecular forces.*	Lesson
3 days: 40–42	**Unit Activity and Discussion—Unit 3**	Unit Activity Discussion
1 day: 43	**Posttest—Unit 3**	Assessment

Unit 4: The Mole Concept

Summary
In this unit, you will learn about how quantitative chemical results in the “real world” are based on reactions occurring on the atomic and molecular scale.

Day	**Activity**/*Objective*	Type
2 days: 44–45	**Moles and Molar Mass** *Learner will identify a mole and calculate molar mass.*	Lesson
2 days: 46–47	**Mole Calculations** *Learner will calculate representative particles, mass, volume, and moles from given data.*	Lesson
2 days: 48–49	**Percent Composition** *Learner will calculate percent composition.*	Lesson
2 days: 50–51	**Empirical and Molecular Formulas** *Learner will determine empirical and molecular formulas.*	Lesson
2 days: 52–53	**Unit Activity and Discussion—Unit 4**	Unit Activity Discussion
1 day: 54	**Posttest—Unit 4**	Assessment

Unit 5: Chemical Reactions

Summary
In this unit, you will carry out activities used in real-world chemistry, including predicting the products of a chemical reaction and predicting the amounts of products you would expect from an initial quantity of chemical substances.

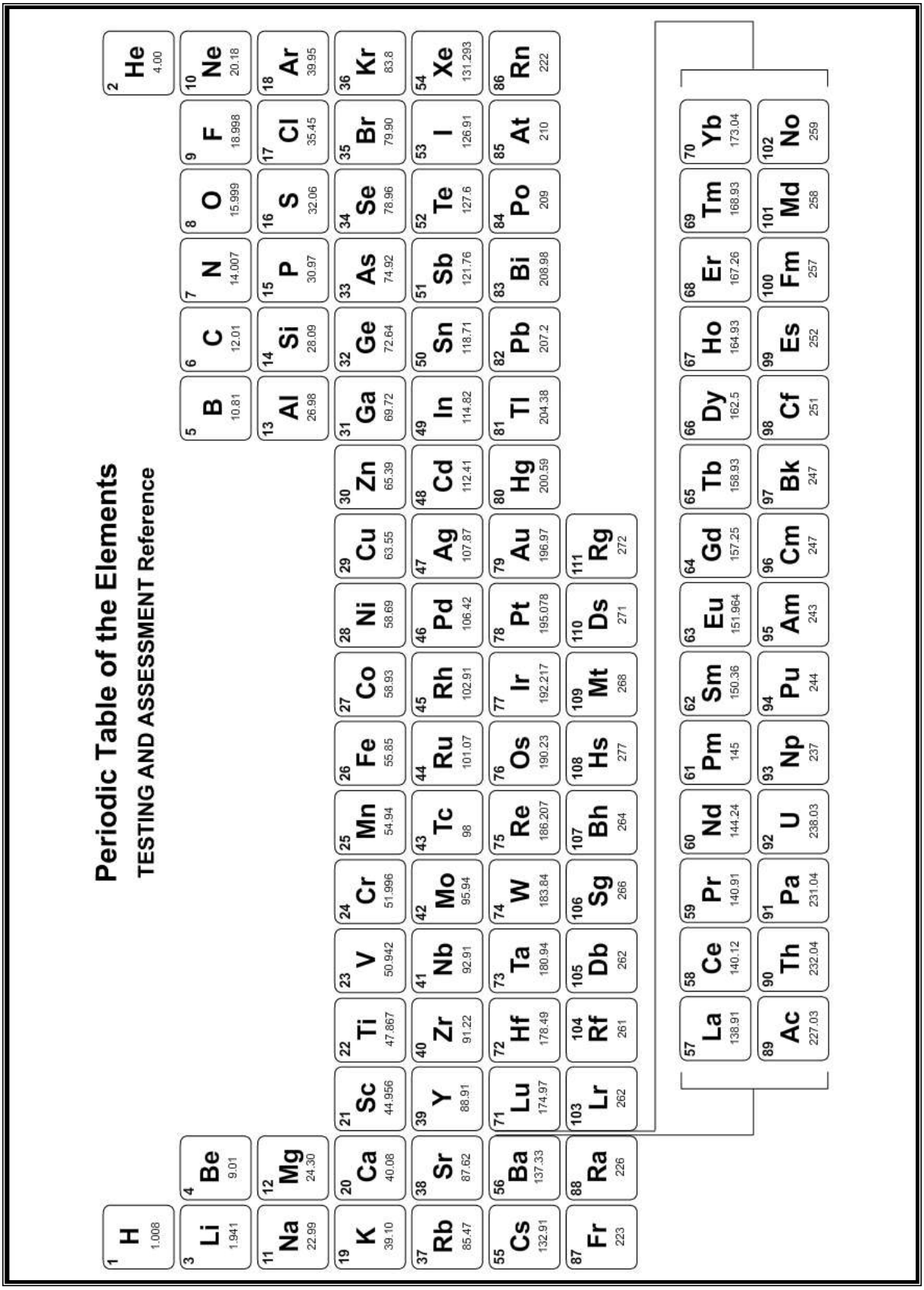
Day	**Activity**/*Objective*	Type
2 days: 55–56	**Balancing Chemical Equations** *Learner will balance chemical equations.*	Lesson
2 days: 57–58	**Types of Reactions** *Learner will identify different types of chemical reactions.*	Lesson
2 days: 59–60	**Predicting Chemical Products** *Learner will predict products for simple chemical reactions.*	Lesson
2 days: 61–62	**Mole Ratios and Stoichiometry** *Learner will determine mole ratios from balanced chemical equations and perform mole to mole stoichiometry problems.*	Lesson
2 days: 63–64	**Mass and Volume Stoichiometry** *Learner will calculate stoichiometry problems involving mass and volume.*	Lesson
2 days: 65–66	**Percent Yield** *Learner will calculate percent yield for chemical reactions.*	Lesson
3 days: 67–69	**Unit Activity and Discussion—Unit 5**	Unit Activity Discussion
1 day: 70	**Posttest—Unit 5**	Assessment

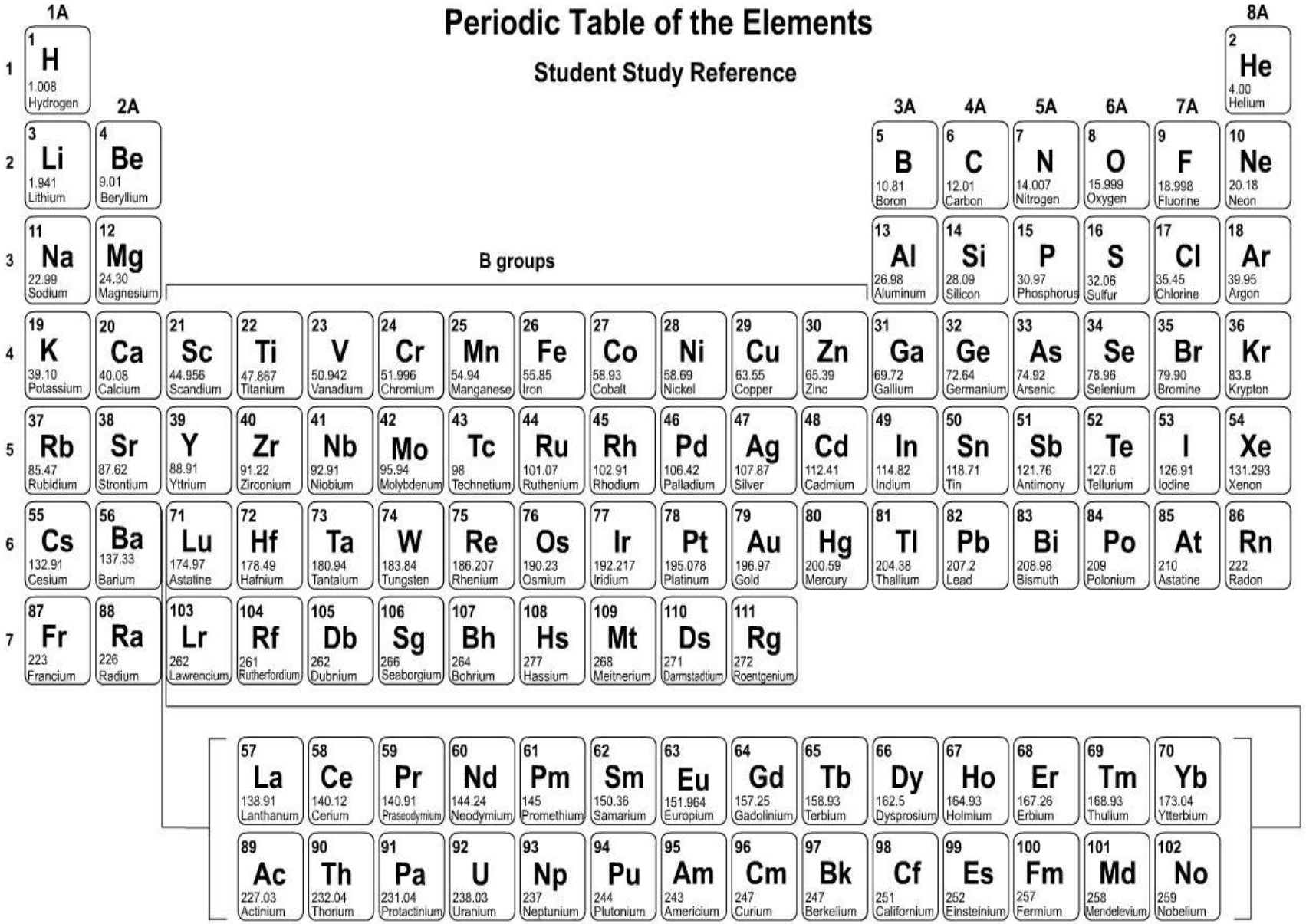
Unit 6: Kinetic Molecular Theory and Gas Law

Summary
In this unit, you will investigate the relationships between energy and matter, including phase changes and the effects of changing the volume, pressure, or temperature of a gas.

Day	**Activity**/*Objective*	Type
2 days: 71–72	**Energy and Chemical Reactions** *Learner will identify different forms of energy and how they relate to chemical reactions.*	Lesson
2 days: 73–74	**Endothermic and Exothermic Reactions** *Learner will differentiate between endothermic and exothermic processes.*	Lesson
2 days: 75–76	**Kinetic Theory** *Learner will describe the kinetic theory.*	Lesson
2 days: 77–78	**States of Matter** *Learner will differentiate between the states of matter.*	Lesson
2 days: 79–80	**Heating Curves and Phase Changes** *Learner will understand a heating curve and describe heat changes during phase changes.*	Lesson
2 days: 81–82	**Gas Law Calculations** *Calculate problems using gas laws.*	Lesson
2 days: 83–84	**Ideal Gas Law** *Learner will identify an ideal gas and use the ideal gas law.*	Lesson
2 days: 85–86	**Dalton's Law and Graham's Law** *Learner will use Dalton's law of partial pressures and Graham's law of effusion to describe gases.*	Lesson
2 days: 87–88	**Unit Activity and Discussion—Unit 6**	Unit Activity Discussion
1 day: 89	**Posttest—Unit 6**	Assessment
1 day: 90	**End of Semester Test**	Assessment

Test and Study References




Periodic Table of the Elements
Student Study Reference
1A
8A
2A
3A
4A
5A
6A
7A
B groups
1 H 1.008 Hydrogen
2 He 4.00 Helium
3 Li 1.941 Lithium
4 Be 9.01 Beryllium
5 B 10.81 Boron
6 C 12.01 Carbon
7 N 14.007 Nitrogen
8 O 15.999 Oxygen
9 F 18.998 Fluorine
10 Ne 20.18 Neon
11 Na 22.99 Sodium
12 Mg 24.30 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
19 K 39.10 Potassium
20 Ca 40.08 Calcium
21 Sc 44.956 Scandium
22 Ti 47.867 Titanium
23 V 50.942 Vanadium
24 Cr 51.996 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 65.39 Zinc
31 Ga 69.72 Gallium
32 Ge 72.64 Germanium
33 As 74.92 Arsenic
34 Se 78.96 Selenium
35 Br 79.90 Bromine
36 Kr 83.8 Krypton
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 95.94 Molybdenum
43 Tc 98 Technetium
44 Ru 101.07 Ruthenium
45 Rh 102.91 Rhodium
46 Pd 106.42 Palladium
47 Ag 107.87 Silver
48 Cd 112.41 Cadmium
49 In 114.82 Indium
50 Sn 118.71 Tin
51 Sb 121.76 Antimony
52 Te 127.6 Tellurium
53 I 126.91 Iodine
54 Xe 131.293 Xenon
55 Cs 132.91 Cesium
56 Ba 137.33 Barium
71 Lu 174.97 Astatine
72 Hf 178.49 Hafnium
73 Ta 180.94 Tantalum
74 W 183.84 Tungsten
75 Re 186.207 Rhenium
76 Os 190.23 Osmium
77 Ir 192.217 Iridium
78 Pt 195.078 Platinum
79 Au 196.97 Gold
80 Hg 200.59 Mercury
81 Tl 204.38 Thallium
82 Pb 207.2 Lead
83 Bi 208.98 Bismuth
84 Po 209 Polonium
85 At 210 Astatine
86 Rn 222 Radon
87 Fr 223 Francium
88 Ra 226 Radium
103 Lr 262 Lawrencium
104 Rf 261 Rutherfordium
105 Db 262 Dubnium
106 Sg 266 Seaborgium
107 Bh 264 Bohrium
108 Hs 277 Hassium
109 Mt 268 Meitnerium
110 Ds 271 Darmstadtium
111 Rg 272 Roentgenium
57 La 138.91 Lanthanum
58 Ce 140.12 Cerium
59 Pr 140.91 Praseodymium
60 Nd 144.24 Neodymium
61 Pm 145 Promethium
62 Sm 150.36 Samarium
63 Eu 151.964 Europium
64 Gd 157.25 Gadolinium
65 Tb 158.93 Terbium
66 Dy 162.5 Dysprosium
67 Ho 164.93 Holmium
68 Er 167.26 Erbium
69 Tm 168.93 Thulium
70 Yb 173.04 Ytterbium
89 Ac 227.03 Actinium
90 Th 232.04 Thorium
91 Pa 231.04 Protactinium
92 U 238.03 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

Syllabus

Chemistry, Semester B

Course Overview

Chemistry is the study of how a set of substances with particular physical properties—like solid paper and the oxygen in the air—can react with each other to form different substances with entirely different properties—like gaseous water and carbon dioxide. In most cases, these chemical changes result in an energy change as well, either giving off energy or absorbing energy.

Chemistry is considered one of the core scientific disciplines because it is so practical and widely useful in the modern world. The development of new types of materials, new methods of producing or storing energy, or new methods of interacting with genetic material all depend upon knowledge of chemistry.

In Chemistry B, you will learn about key types of chemical relationships and reactions, including solutions, reversible reactions, acid-base reactions, thermochemical systems, and electrochemical systems. You will use your knowledge to analyze new situations and make qualitative and quantitative predictions. Finally, you will extend your chemical knowledge into the areas of nuclear chemistry, organic chemistry, and biochemistry.

Course Goals

By the end of this course, you will be able to do the following:

- Describe the dissolving process and be able to apply your understanding of the mechanisms, variables, and calculations associated with chemical solutions.
- Describe the variables that affect reaction rates and apply your understanding quantitatively for reactions in one direction as well as reversible reactions and systems in chemical equilibrium.
- Describe acids and bases by their properties and from a theoretical perspective and be able to make quantitative calculations and predictions about acids, bases, and the reactions between them.
- Analyze and use key thermochemical values (heat, entropy, enthalpy, and free energy) to make predictions about chemical interactions.
- Apply your knowledge of oxidation and reduction to analyze and make predictions about potential chemical interactions.
- Apply your knowledge of nuclear reactions and nuclear forces to solve real-world problems. You will also learn to recognize, name, and understand the properties of basic organic and biochemical structures and molecules.

Math and Science Skills

Successful completion of Algebra 1 provides the mathematical skills you'll need for Chemistry B.
Successful completion of Chemistry A (or its equivalent) is required for Chemistry B. This includes an understanding of the atomic and molecular structures of matter and the concepts and tools that enable you to predict chemical properties and chemical reactions.
You should also have a good working understanding of inquiry science methods, including:

- Experimental design, including the importance of experimental controls.
- Basic data analysis skills, including the ability to interpret mathematical patterns from data tables and graphs.
- The ability to use experimental results and/or real data sets to propose general rules.

General Skills

To participate in this course, you should be able to do the following:

- Complete basic operations with word processing software, such as Microsoft Word or Google Docs.
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Credit Value

Chemistry B is a 0.5-credit course.

Course Materials

- Computer with Internet connection and speakers or headphones
- Microsoft Word or equivalent
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- Notebook

Course Pacing Guide

This course description and pacing guide is intended to help you keep on schedule with your work. Note that your course instructor may modify the schedule to meet the specific needs of your class.

Unit 1: Solutions

Summary

In this unit, you will be able to describe the dissolving process and be able to apply your understanding of the mechanisms, variables, and calculations associated with chemical solutions.

Day	**Activity**/*Objective*	Type
1 day: 1	**Syllabus and Plato Student Orientation** *Review the Plato Student Orientation and Course Syllabus at the beginning of this course.*	Course Orientation
2 days: 2–3	**The Dissolving Process** *Learner will Describe the dissolving process.*	Lesson
2 days: 4–5	**Rate of Dissolution** *Learner will identify factors that affect rate of dissolution.*	Lesson
2 days: 6–7	**Degrees of Saturation** *Learner will identify different types of solutions based on degrees of saturation.*	Lesson
2 days: 8–9	**Molarity of a Solution** *Learner will calculate concentrations for solutions in terms of molarity.*	Lesson
2 days: 10–11	**Dilution and Stoichiometry Calculations** *Learner will use concentrations to perform dilutions and solution stoichiometry.*	Lesson
2 days: 12–13	**Colligative Properties of a Solution** *Learner will identify and describe colligative properties of solutions.*	Lesson
2 days: 14–15	**Unit Activity and Discussion—Unit 1**	Unit Activity Discussion
1 day:	**Posttest—Unit 1**	Assessment

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Unit 2: Reaction Rates

Summary
In this unit, you will be able to describe the variables that affect reaction rates and apply your understanding quantitatively for reactions in one direction as well as reversible reactions and systems in chemical equilibrium.

Day	**Activity**/*Objective*	Type
2 days: 17–18	**Reaction Rates** *Learner will describe reaction rates and identify factors that affect them.*	Lesson
2 days: 19–20	**Activation Energy** *Learner will understand activation energy and describe how catalysts affect it.*	Lesson
2 days: 21–22	**Chemical Equilibrium** *Learner will describe chemical equilibrium.*	Lesson
2 days: 23–24	**Equilibrium Constants** *Learner will write and evaluate equilibrium constant expressions.*	Lesson
2 days: 25–26	**Le Chatelier's Principle** *Learner will identify Le Chatelier's principle and explain how stressors affect chemical equilibrium.*	Lesson
2 days: 27–28	**Rate Law for a Reaction** *Learner will write a rate law for a reaction based on experimental data.*	Lesson
2 days: 29–30	**Unit Activity and Discussion—Unit 2**	Unit Activity Discussion
1 day: 31	**Posttest—Unit 2**	Assessment

Unit 3: Acids and Bases

Summary
In this unit, you will be able to describe acids and bases by their properties and from a theoretical perspective. You will also be able to make quantitative calculations and predictions about acids, bases, and reactions between them.

Day	**Activity**/*Objective*	Type
2 days: 32–33	**Properties of Acids and Bases** *Learner will identify properties of acids and bases.*	Lesson
2 days: 34–35	**Types of Acids and Bases** *Learner will differentiate among the three types of acids and bases.*	Lesson
2 days: 36–37	**The pH Scale** *Learner will describe the auto ionization of water and calculate ph.*	Lesson
2 days: 38–39	**Strong and Weak Acids and Bases** *Learner will identify strong and weak acids and bases.*	Lesson
2 days: 40–41	**Neutralization Reactions** *Learner will identify and describe neutralization reactions.*	Lesson
2 days: 42–43	**Titration Calculations** *Learner will use titrations to calculate concentrations.*	
2 days: 44–45	**Unit Activity and Discussion—Unit 3**	Unit Activity Discussion
1 day: 46	**Posttest—Unit 3**	Assessment

Unit 4: Energy

Summary
In this unit, you will learn about key thermochemical values (heat, entropy, enthalpy, and free energy) and use these values to make predictions about chemical interactions.

Day	**Activity**/*Objective*	Type
2 days: 47–48	**Entropy** *Learner will describe the concept of entropy.*	Lesson

2 days: 49–50	**Thermochemical Calculations** *Learner will use calorimetry and thermochemical equations to solve problems involving heat.*	Lesson
2 days: 51–52	**Energy Diagrams for Reactions** *Learner will draw an energy profile for a reaction.*	Lesson
2 days: 53–54	**Hess's Law** *Learner will calculate enthalpy changes using Hess's law.*	Lesson
2 days: 55–56	**The Gibbs Free Energy Equation** *Learner will describe the Gibbs free energy equation.*	Lesson
2 days: 57–58	**Unit Activity and Discussion—Unit 4**	Unit Activity Discussion
1 day: 59	**Posttest—Unit 4**	Assessment

Unit 5: Reduction Reactions Oxidation-

Summary

In this unit, you will use your knowledge of oxidation and reduction to analyze and make predictions about potential chemical interactions.

Day	**Activity**/*Objective*	Type
2 days: 60–61	**Oxidation and Reduction** *Learner will describe the process of oxidation and reduction.*	Lesson
2 days: 62–63	**Redox Reactions** *Learner will identify and describe oxidation-reduction reactions.*	Lesson
2 days: 64–65	**Standard Reduction Potentials** *Learner will describe and calculate standard reduction potentials.*	Lesson
2 days: 66–67	**Voltaic and Electrochemical Cells** *Learner will describe voltaic and electrochemical cells.*	Lesson
2 days: 68–69	**Standard Cell Potentials** *Learner will relate standard cell potentials to Gibbs free energy and equilibrium constants*	Lesson
3 days: 70–72	**Unit Activity and Discussion—Unit 5**	Unit Activity Discussion

1 day: 73	**Posttest—Unit 5**	Assessment

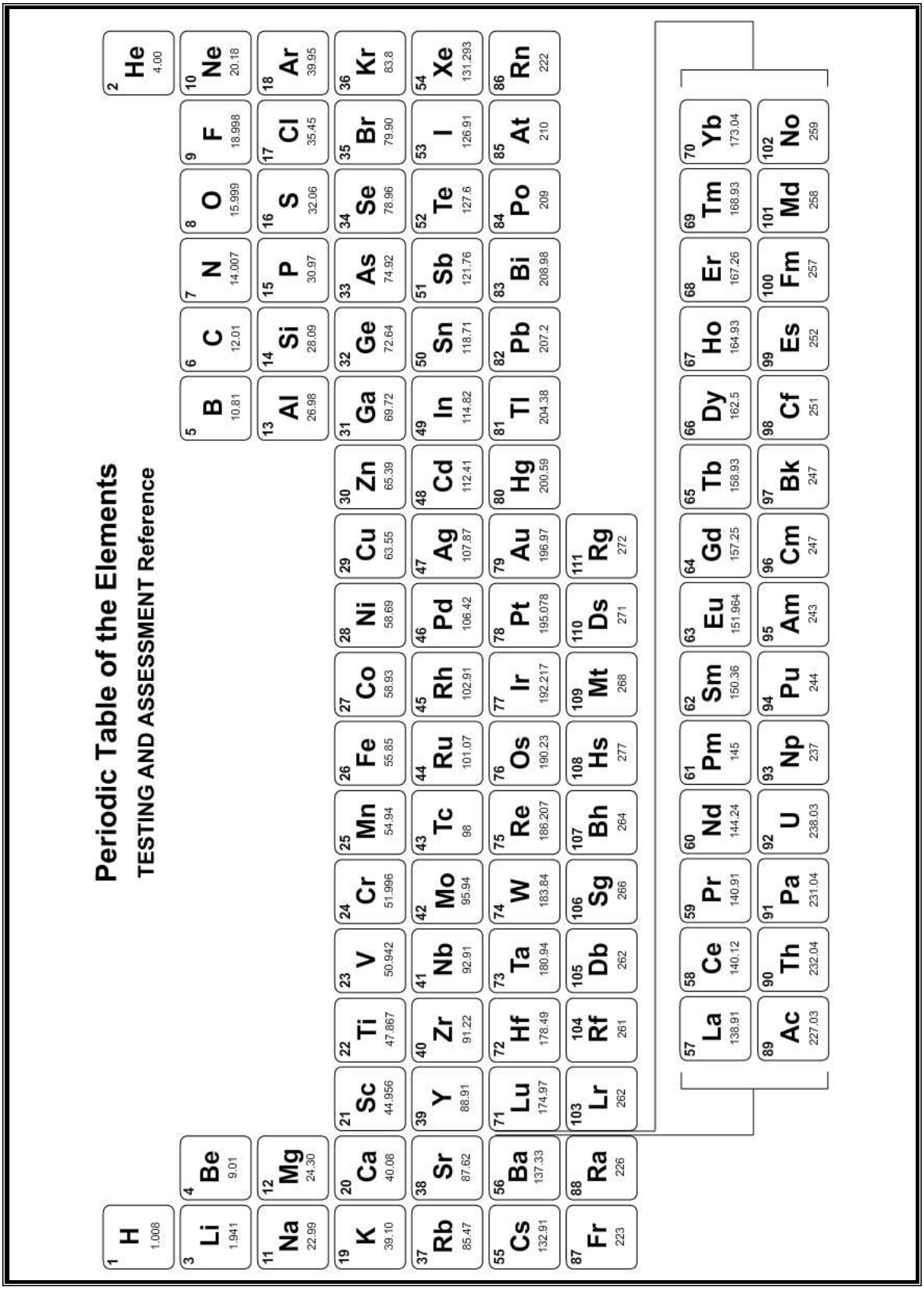
Unit 6: Nuclear Chemistry and Biochemistry

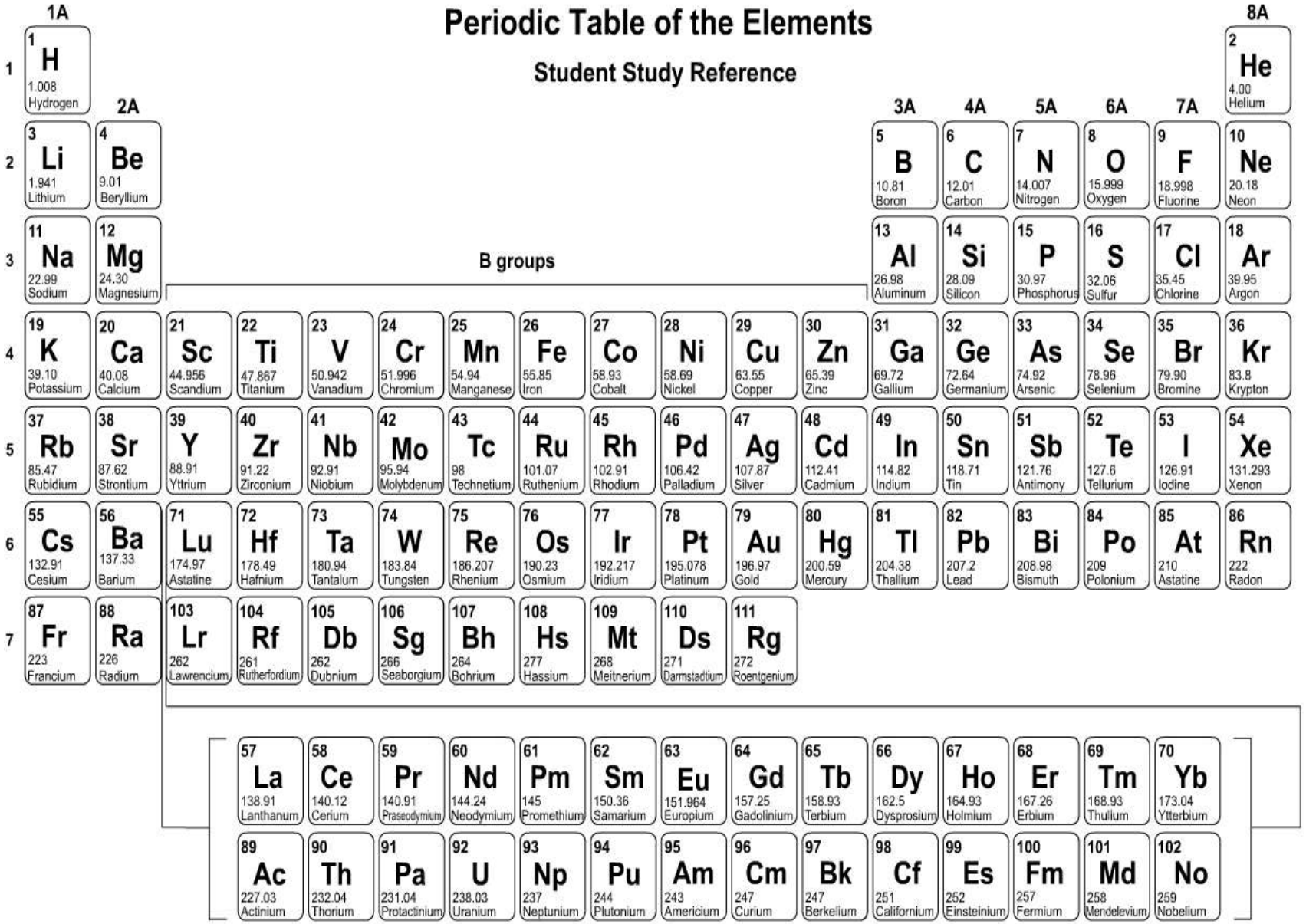
Summary

In this unit, you will apply your knowledge of nuclear reactions and nuclear forces to solve real-world problems. You will also learn to recognize, name, and understand the properties of basic organic and biochemical structures and molecules.

Day	**Activity**/*Objective*	Type
2 days: 74–75	**Nuclear Forces** *Learner will describe nuclear forces.*	Lesson
2 days: 76–77	**Radioactive Decay** *Learner will identify naturally occurring radioactive isotopes and the ways that they decay.*	Lesson
2 days: 78–79	**Nuclear Fission and Fusion** *Learner will describe nuclear fission and fusion.*	Lesson
2 days: 80–81	**Hydrocarbons** *Learner will use proper nomenclature to name basic hydrocarbons and organic molecules.*	Lesson
2 days: 82–83	**Organic Functional Groups** *Learner will identify organic functional groups.*	Lesson
2 days: 84–85	**Biochemical Molecules** *Learner will describe and identify basic organic molecules important to life.*	Lesson
3 days: 86–88	**Unit Activity and Discussion—Unit 6**	Unit Activity Discussion
1 day: 89	**Posttest—Unit 6**	Assessment
1 day: 90	**End of Semester Test**	Assessment

Test and Study References

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9 F 18.998 Fluorine
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12 Mg 24.30 Magnesium
13 Al 26.98 Aluminum
14 Si 28.09 Silicon
15 P 30.97 Phosphorus
16 S 32.06 Sulfur
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20 Ca 40.08 Calcium
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23 V 50.942 Vanadium
24 Cr 51.996 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 65.39 Zinc
31 Ga 69.72 Gallium
32 Ge 72.64 Germanium
33 As 74.92 Arsenic
34 Se 78.96 Selenium
35 Br 79.90 Bromine
36 Kr 83.8 Krypton
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 95.94 Molybdenum
43 Tc 98 Technetium
44 Ru 101.07 Ruthenium
45 Rh 102.91 Rhodium
46 Pd 106.42 Palladium
47 Ag 107.87 Silver
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49 In 114.82 Indium
50 Sn 118.71 Tin
51 Sb 121.76 Antimony
52 Te 127.6 Tellurium
53 I 126.91 Iodine
54 Xe 131.293 Xenon
55 Cs 132.91 Cesium
56 Ba 137.33 Barium
71 Lu 174.97 Astatine
72 Hf 178.49 Hafnium
73 Ta 180.94 Tantalum
74 W 183.84 Tungsten
75 Re 186.207 Rhenium
76 Os 190.23 Osmium
77 Ir 192.217 Iridium
78 Pt 195.078 Platinum
79 Au 196.97 Gold
80 Hg 200.59 Mercury
81 Tl 204.38 Thallium
82 Pb 207.2 Lead
83 Bi 208.98 Bismuth
84 Po 209 Polonium
85 At 210 Astatine
86 Rn 222 Radon
87 Fr 223 Francium
88 Ra 226 Radium
103 Lr 262 Lawrencium
104 Rf 261 Rutherfordium
105 Db 262 Dubnium
106 Sg 266 Seaborgium
107 Bh 264 Bohrium
108 Hs 277 Hassium
109 Mt 268 Meitnerium
110 Ds 271 Darmstadtium
111 Rg 272 Roentgenium
57 La 138.91 Lanthanum
58 Ce 140.12 Cerium
59 Pr 140.91 Praseodymium
60 Nd 144.24 Neodymium
61 Pm 145 Promethium
62 Sm 150.36 Samarium
63 Eu 151.964 Europium
64 Gd 157.25 Gadolinium
65 Tb 158.93 Terbium
66 Dy 162.5 Dysprosium
67 Ho 164.93 Holmium
68 Er 167.26 Erbium
69 Tm 168.93 Thulium
70 Yb 173.04 Ytterbium
89 Ac 227.03 Actinium
90 Th 232.04 Thorium
91 Pa 231.04 Protactinium
92 U 238.03 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