

ELEMENTS of FAITH

REVISED & EXPANDED

A Creation-based Journey Through the Periodic Table



MASTERBOOKS® CURRICULUM

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About the Author:

Richard D. Duncan is a professional engineer with a Bachelor's Degree in Chemical Engineering from the University of Cincinnati. He has spent most of his career in the fields of water treatment and environmental engineering.

"As iron sharpens iron, so a man sharpens the countenance of his friend" (Prov. 27:17).

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Features: The suggested weekly schedule enclosed has easy-to-manage lessons that guide the reading, worksheets, and all assessments. The pages of this guide are perforated and three-hole punched so materials are easy to tear out, hand out, grade, and store. Teachers are encouraged to adjust the schedule and materials needed in order to best work within their unique educational program.

Lesson Scheduling: Students are instructed to read the pages in their book and then complete the corresponding section provided by the teacher. Assessments that may include worksheets, activities, quizzes, and tests are given at regular intervals with space to record each grade. Space is provided on the weekly schedule for assignment dates, and flexibility in scheduling is encouraged. Teachers may adapt the scheduled days per each unique student situation. As the student completes each assignment, this can be marked with an “X” in the box.



Approximately 30 to 45 minutes per lesson, five days a week



Includes answer keys for worksheets, quizzes, and final test



Provides experiments and additional research assignments



Quizzes and test are included to help reinforce learning and provide assessment opportunities



Designed for grades 7 to 9 in a one-year course

Course Objectives: Students completing this course will discover

- ✓ Information on all known elements of the Periodic Table of Elements and their significance
- ✓ Insights into chemistry and how it relates to the world all around us
- ✓ Analysis of the historical and scientific relevance of the chemical history
- ✓ An integrated time for personal reflection and response
- ✓ Biblical insights that demonstrate God’s wisdom in His amazing creation
- ✓ Spiritual applications for all of the major elements in the Periodic Table

Course Description: *Elements of Faith* examines the 118 current elements of the Periodic Table and finds meaningful insights and spiritual applications in each of them. A look at the elements can teach many lessons, from the awesomeness of God’s creation to the dedication of many God-fearing scientists who have been so influential in the history of science. Each week, students examine three new elements, conduct lab experiments or additional research assignments, and take a weekly quiz based on that week’s reading. The arrangement of the Periodic Table is explained, as well as the history of each element and an understanding of their names and abbreviations.

Weekly Instruction Guide

Days One through Three: Each week begins with three new elements, one per day. These are in order by the atomic number that is listed on the upper right-hand corner of the element as found on the Periodic Table of the Elements. A copy of the table is available in the back of the book and color-coded with each element page. Students read through the text and then answer the questions based on their reading.

Day Four: Each fourth day is a time to catch up on assignments, for review, for experiments, and for additional research and writing. Options are provided in the weekly schedule, and students and teachers are encouraged to use this time in the way they feel is best utilized. The following are options you may use on various days throughout the course:

Option A: If a student needs to catch up on the week's assignments, a teacher might decide that this is all the student needs to do on this day.

Option B: If a student needs time to review for the quiz, this day will work well. The quizzes are based on the week's study, so a student needs only to review the three elements from that week.

Option C: Each week a student studies three new elements. The fourth day can be used to create and study the three element flashcards for that week and the additional flashcards from prior weeks. On one side of the flashcard write the atomic number and element symbol and on the other side write the element name. At the end of the year, a student can take the optional Periodic Table final exam, based on the flashcard element information.

Option D: Some weeks have an experiment in the back of the book. Per the schedule, it is always based on elements that have been studied previously, either from that week or several weeks prior. These are optional and are provided as a hands-on way to learn more about the practical function of chemistry in action. A supply list is found in the back of the book as well.

Option E: A final option on the fourth day is a writing and research assignment, digging a little deeper into the world of chemistry, the individual elements, and/or the scientists who discovered them or developed additional usages for them. Students can research additional information at the library or online (with parental permission), writing a one-page report on their findings. (Note: This is not mentioned in the schedule.)

Day Five: The last day of the week is set up for a review assessment. The fifth-day quizzes are all based on that week's studies, the elements that were discussed on the first three days of the week. If a student studies their worksheets, they should do well on each quiz. The last day of the year is reserved for the final exam. This is comprehensive, and all based on the worksheets. An alternative final exam is available in the back of the book for students to use their flashcard studies to help them fill in the element symbols on the Periodic Table.

Grading: The following is only a suggested guideline based on the material presented through this course:

To calculate the percentage of the worksheets and quizzes, the parent/educator may use the following guide. Divide total number of questions correct by the total number of questions possible to calculate the percentage out of 100 possible. The suggested grade values are noted as follows:

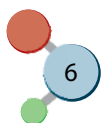
90 to 100 percent = A

80 to 89 percent = B

70 to 79 percent = C

60 to 69 percent = D

0 to 59 percent = F



First Semester Suggested Daily Schedule

Date	Day	Assignment	Due Date	✓	Grade
First Semester-First Quarter					
Week 1	Day 1	Read Hydrogen: Forming Water • Pages 15-16 Answer Questions • Page 16			
	Day 2	Read Helium: From the Sun • Pages 17-18 Answer Questions • Page 18			
	Day 3	Read Lithium: A Surprise Discovery in “Stone” • Pages 19-20 Answer Questions • Page 20			
	Day 4	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Experiment 1: Displacement of Helium • Page 313			
	Day 5	Quiz 1 • Pages 343-344			
Week 2	Day 6	Read Beryllium: A Bright & Beautiful Jewel • Pages 21-22 Answer Questions • Page 22			
	Day 7	Read Boron: The Cleanness of My Hands • Pages 23-24 Answer Questions • Page 24			
	Day 8	Read Carbon: Sir Humphry Davy/The Mine Safety Lamp Pages 25-26 • Answer Questions • Page 26			
	Day 9	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Start Your Element Collection with Helium and Boron Page 341			
	Day 10	Quiz 2 • Pages 345-346			
Week 3	Day 11	Read Nitrogen: The Three-fold Cord • Pages 27-28 Answer Questions • Page 28			
	Day 12	Read Oxygen: The Breath of Life • Pages 29-30 Answer Questions • Page 30			
	Day 13	Read Fluorine: The Modern Element • Pages 31-32 Answer Questions • Page 32			
	Day 14	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Experiment 2: Using Borax to Make Slime • Pages 315-316			
	Day 15	Quiz 3 • Pages 347-348			
Week 4	Day 16	Read Neon: Let Your Light Shine • Pages 33-34 Answer Questions • Page 34			
	Day 17	Read Sodium: The Salt of the Earth • Pages 35-36 Answer Questions • Page 36			
	Day 18	Read Magnesium: The Blessings of Humility • Pages 37-38 Answer Questions • Page 38			
	Day 19	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Continue Your Element Collection with Carbon and Sodium • Page 341			
	Day 20	Quiz 4 • Pages 349-350			
Week 5	Day 21	Read Aluminum: Laus Deo • Pages 39-40 Answer Questions • Page 40			
	Day 22	Read Silicon: As the Sand...on the Seashore • Pages 41-42 Answer Questions • Page 42			
	Day 23	Read Phosphorus: “All That Glitters Is Not Gold” • Pages 43-44 Answer Questions • Page 44			
	Day 24	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Experiment 3: Generating Carbon Dioxide • Pages 317-318			
	Day 25	Quiz 5 • Pages 351-352			

Date	Day	Assignment	Due Date	✓	Grade
Week 6	Day 26	Read Sulfur: Fire and Brimstone: God's Judgment • Pages 45-46 Answer Questions • Page 46			
	Day 27	Read Chlorine: The Miracle Element • Pages 47-48 Answer Questions • Page 48			
	Day 28	Read Argon: The Lazy Gas • Pages 49-50 Answer Questions • Page 50			
	Day 29	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Continue Your Element Collection with Aluminum and Phosphorus • Page 341			
	Day 30	Quiz 6 • Pages 353-354			
Week 7	Day 31	Read Potassium: Potash: First American Industry • Pages 51-52 Answer Questions • Page 52			
	Day 32	Read Calcium: Fearfully and Wonderfully Made • Pages 53-54 Answer Questions • Page 54			
	Day 33	Read Scandium: A Little Does a Lot • Pages 55-56 Answer Questions • Page 56			
	Day 34	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Experiment 4: Hydrogen Peroxide Solution • Pages 319-320			
	Day 35	Quiz 7 • Pages 355-356			
Week 8	Day 36	Read Titanium: The Strongest of Metals • Pages 57-58 Answer Questions • Page 58			
	Day 37	Read Vanadium: Treasures in Heaven • Pages 59-60 Answer Questions • Page 60			
	Day 38	Read Chromium: An Element of Many Colors • Pages 61-62 Answer Questions • Page 62			
	Day 39	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Continue Your Element Collection with Sulfur and Chlorine Page 341			
	Day 40	Quiz 8 • Pages 357-358			
Week 9	Day 41	Read Manganese: Iron's Next-Door Neighbor • Pages 63-64 Answer Questions • Page 64			
	Day 42	Read Iron: The Element of Salvation • Pages 65-66 Answer Questions • Page 66			
	Day 43	Read Cobalt: Goblins and Demons • Pages 67-68 Answer Questions • Page 68			
	Day 44	Options for the day: Extra Study Day, Review Day, Flashcard Day, Writing and Research Day, or Experiment 5: Carbonated Soft Drink • Pages 321-322			
	Day 45	Quiz 9 • Pages 359-360			
First Semester-Second Quarter					
Week 1	Day 46	Read Nickel: The Devil's Ore • Pages 69-70 Answer Questions • Page 70			
	Day 47	Read Copper: The Element of Judgment • Pages 71-72 Answer Questions • Page 72			
	Day 48	Read Zinc: The Element of Protection • Pages 73-74 Answer Questions • Page 74			
	Day 49	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Continue Your Element Collection with Argon • Page 341			
	Day 50	Quiz 10 • Pages 361-362			

Date	Day	Assignment	Due Date	✓	Grade
Week 2	Day 51	Read Gallium: The First Predicted Element • Pages 75-76 Answer Questions • Page 76			
	Day 52	Read Germanium: Leeuwenhoek: Father of Microscopy Pages 77-78 • Answer Questions • Page 78			
	Day 53	Read Arsenic: “and they shall drink poison and not die” Pages 79-80 • Answer Questions • Page 80			
	Day 54	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Experiment 6: The Electrolysis of Water • Pages 323-324			
	Day 55	Quiz 11 • Pages 363-364			
Week 3	Day 56	Read Selenium: The Moon Goddess • Pages 81-82 Answer Questions • Page 82			
	Day 57	Read Bromine: The “Smelly” Element • Pages 83-84 Answer Questions • Page 84			
	Day 58	Read Krypton: The Hidden Gas • Pages 85-86 Answer Questions • Page 86			
	Day 59	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Continue Your Element Collection with Iron • Page 341			
	Day 60	Quiz 12 • Pages 365-366			
Week 4	Day 61	Read Rubidium: “Just How Old Is That Rock?” • Pages 87-88 Answer Questions • Page 88			
	Day 62	Read Strontium: Sir Humphry Davy: The Faith of a Scientist Pages 89-90 • Answer Questions • Page 90			
	Day 63	Read Yttrium: The Key to Television • Pages 91-92 Answer Questions • Page 92			
	Day 64	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Experiment 7: Study of Calcium and Collagen in Bones Page 325			
	Day 65	Quiz 13 • Pages 367-368			
Week 5	Day 66	Read Zirconium: Zircon: Foundation Stone • Pages 93-94 Answer Questions • Page 94			
	Day 67	Read Niobium: The Element with Two Names • Pages 95-96 Answer Questions • Page 96			
	Day 68	Read Molybdenum and the Trace Minerals • Pages 97-98 Answer Questions • Page 98			
	Day 69	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Continue Your Element Collection with Nickel • Page 342			
	Day 70	Quiz 14 • Pages 369-370			
Week 6	Day 71	Read Technetium: Something New Under the Sun? Pages 99-100 • Answer Questions • Page 100			
	Day 72	Read Ruthenium and the Platinum Group • Pages 101-102 Answer Questions • Page 102			
	Day 73	Read Rhodium: The Catalytic Converter • Pages 103-104 Answer Questions • Page 104			
	Day 74	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Experiment 8: Generation of Chlorine Gas by Electrolysis Pages 327-328			
	Day 75	Quiz 15 • Pages 371-372			

Date	Day	Assignment	Due Date	✓	Grade
Week 7	Day 76	Read Palladium: The Hydrogen Sponge • Pages 105-106 Answer Questions • Page 106			
	Day 77	Read Silver: The Element of Redemption • Pages 107-108 Answer Questions • Page 108			
	Day 78	Read Cadmium and the Heavy Metals • Pages 109-110 Answer Questions • Page 110			
	Day 79	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Continue Your Element Collection with Copper • Page 342			
	Day 80	Quiz 16 • Pages 373-374			
Week 8	Day 81	Read Indium: The Purple Thread • Pages 111-112 Answer Questions • Page 112			
	Day 82	Read Tin: The Key to the Bronze Age • Pages 113-114 Answer Questions • Page 114			
	Day 83	Read Antimony: "I Will Set Your Stones in Antimony" Pages 115-118 • Answer Questions • Pages 117-118			
	Day 84	Options for the day: Extra Study Day, Review Day, or Flashcard Day			
	Day 85	Quiz 17 • Pages 375-376			
Week 9	Day 86	Read Tellurium: The Heartbreak of Tellurium Breath Pages 119-122 • Answer Questions • Page 121			
	Day 87	Read Iodine: The Element of Health • Pages 123-126 Answer Questions • Page 125			
	Day 88	Read Xenon: The Strangest Gas • Pages 127-128 Answer Questions • Page 128			
	Day 89	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Writing and Research Day			
	Day 90	Quiz 18 • Pages 377-378			
		Mid-Term Grade			

Second Semester Suggested Daily Schedule

Date	Day	Assignment	Due Date	✓	Grade
Second Semester-Third Quarter					
Week 1	Day 91	Read Cesium: Robert Bunsen: Teacher, Inventor, Genius Pages 129-130 • Answer Questions • Page 130			
	Day 92	Read Barium: The Mis-Named Element? • Pages 131-134 Answer Questions • Pages 133-134			
	Day 93	Read Lanthanum: Hidden Elements with Hidden Specialties Pages 135-138 • Answer Questions • Pages 137-138			
	Day 94	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Experiment 9: Fluoride Protection • Pages 329-330			
	Day 95	Quiz 19 • Pages 379-380			
Week 2	Day 96	Read Cerium: Dividing the Lanthanides • Pages 139-142 Answer Questions • Page 141			
	Day 97	Read Praseodymium: The Twin Elements 1 • Pages 143-146 Answer Questions • Page 145			
	Day 98	Read Neodymium: The Twin Elements 2 • Pages 147-150 Answer Questions • Page 149			
	Day 99	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Continue Your Element Collection with Zinc Page 342			
	Day 100	Quiz 20 • Pages 381-382			
Week 3	Day 101	Read Promethium: Prometheus and the Gift of Fire Pages 151-154 Answer Questions • Page 153			
	Day 102	Read Samarium: The Good Samaria • Pages 155-158 Answer Questions • Page 158			
	Day 103	Read Europium: “Rare Earths” on the Moon • Pages 159-162 Answer Questions • Page 161			
	Day 104	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Experiment 10: Finding Iron Particles in Your Nutritious Breakfast Cereal • Page 331			
	Day 105	Quiz 21 • Pages 383-384			
Week 4	Day 106	Read Gadolinium: Raymond Damadian: The Creationist Who Changed Medicine • Pages 163-166 Answer Questions • Pages 165-166			
	Day 107	Read Terbium: Good Vibrations • Pages 167-168 Answer Questions • Page 168			
	Day 108	Read Dysprosium: The “Hard-to-Get” Element Pages 169-172 • Answer Questions • Pages 171-172			
	Day 109	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Continue Your Element Collection with Silver Page 342			
	Day 110	Quiz 22 • Pages 385-386			

Date	Day	Assignment	Due Date	✓	Grade
Week 5	Day 111	Read Holmium: Scandinavia and the Elements of the North Pages 173-174 Answer Questions • Page 174			
	Day 112	Read Erbium: Pretty in Pink • Pages 175-178 Answer Questions • Pages 177-178			
	Day 113	Read Thulium: The “Worthless Servant”? • Pages 179-182 Answer Questions • Pages 181-182			
	Day 114	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Writing and Research Day			
	Day 115	Quiz 23 • Pages 387-388			
Week 6	Day 116	Read Ytterbium: O Little Town of Ytterby • Pages 183-186 Answer Questions • Page 185			
	Day 117	Read Lutetium: The Last Lanthanide • Pages 187-190 Answer Questions • Page 189			
	Day 118	Read Hafnium: Copenhagen: The Merchant’s Haven Pages 191-194 • Answer Questions • Pages 193-194			
	Day 119	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Experiment 11: Using Electroplating to Coat a Quarter with a Thin Layer of Copper • Pages 333-334			
	Day 120	Quiz 24 • Pages 389-390			
Week 7	Day 121	Read Tantalum: Element of Convenience • Pages 195-198 Answer Questions • Pages 196-197			
	Day 122	Read Tungsten: Metal that Lit the World • Pages 199-202 Answer Questions • Pages 201-202			
	Day 123	Read Rhenium: Ida Tacke-Noddack: Seeker of Elements Pages 203-204 • Answer Questions • Page 204			
	Day 124	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Writing and Research Day			
	Day 125	Quiz 25 • Pages 391-392			
Week 8	Day 126	Read Osmium: The History of Writing — Part 1 Pages 205-206 • Answer Questions • Page 206			
	Day 127	Read Iridium: The History of Writing — Part 2 Pages 207-210 • Answer Questions • Pages 209-210			
	Day 128	Read Platinum: The Platinum Standard • Pages 211-214 Answer Questions • Pages 213-214			
	Day 129	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Continue Your Element Collection with Tin and Neodymium • Page 342			
	Day 130	Quiz 26 • Pages 393-394			
Week 9	Day 131	Read Gold: Gold in the Bible • Pages 215-218 Answer Questions • Pages 217-218			
	Day 132	Read Mercury: The Element of Discovery • Pages 219-222 Answer Questions • Pages 221-222			
	Day 133	Read Thallium: Getting Away With Murder • Pages 223-226 Answer Questions • Page 225			
	Day 134	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Writing and Research Day			
	Day 135	Quiz 27 • Pages 395-396			

Date	Day	Assignment	Due Date	✓	Grade
Second Semester-Fourth Quarter					
Week 1	Day 136	Read Lead: "They Sank Like Lead in the Mighty Waters" Pages 227-230 • Answer Questions • Pages 229-230			
	Day 137	Read Bismuth: A Good Element from a Rough Neighborhood Pages 231-232 • Answer Questions • Page 232			
	Day 138	Read Polonium: Polonium Halos • Pages 233-236 Answer Questions • Pages 235-236			
	Day 139	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Experiment 12: Study a "Hygroscopic" Zirconium Compound • Page 335			
	Day 140	Quiz 28 • Pages 397-398			
Week 2	Day 141	Read Astatine: Unstable • Pages 237-240 Answer Questions • Pages 239-240			
	Day 142	Read Radon: "Is There a Killer in Your House?" Pages 241-244 • Answer Questions • Pages 243-244			
	Day 143	Read Francium: Pasteur: The Genius of France Pages 245-248 • Answer Questions • Pages 247-248			
	Day 144	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Continue Your Element Collection with Tungsten and Platinum • Page 342			
	Day 145	Quiz 29 • Pages 399-400			
Week 3	Day 146	Read Radium: The Deadly Fad • Pages 249-252 Answer Questions • Pages 251-252			
	Day 147	Read Actinium: Actinium and the Actinides • Pages 253-254 Answer Questions • Page 254			
	Day 148	Read Thorium: J.J. Berzelius: Man of Science • Pages 255-256 Answer Questions • Page 256			
	Day 149	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Experiment 13: Iodine: Counterfeit Detection Page 337			
	Day 150	Quiz 30 • Pages 401-402			
Week 4	Day 151	Read Protactinium: The Founding Mothers of the Periodic Table • Pages 257-260 • Answer Questions • Page 259			
	Day 152	Read Uranium: The Story of the Sower • Pages 261-264 Answer Questions • Page 263			
	Day 153	Read Neptunium: "Every Man Cried Out to His God..." Pages 265-268 • Answer Questions • Page 267			
	Day 154	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Continue Your Element Collection with Gold and Mercury • Page 342			
	Day 155	Quiz 31 • Pages 403-404			

Date	Day	Assignment	Due Date	✓	Grade
Week 5	Day 156	Read Plutonium: The Girl Who Named a Planet and an Element • Pages 269-272 • Answer Questions • Page 271			
	Day 157	Read Americium: A Surprising Element of American Ingenuity Pages 273-274 • Answer Questions • Page 274			
	Day 158	Read Curium: In Honor of a Great Physicist • Pages 275-278 Answer Questions • Pages 277-278			
	Day 159	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Experiment 14: Examining Tungsten Filaments Pages 339-340			
	Day 160	Quiz 32 • Pages 405-406			
Week 6	Day 161	Read Berkelium: UC Berkeley “Let There Be Light” Pages 279-282 • Answer Questions • Pages 281-282			
	Day 162	Read Californium: Using Isotopes to Fight Cancer Pages 283-286 • Answer Questions • Pages 285-286			
	Day 163	Read Einsteinium: Albert Einstein: Intelligent Design Pages 287-290 • Answer Questions • Pages 289-290			
	Day 164	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Writing and Research Day			
	Day 165	Quiz 33 • Pages 407-408			
Week 7	Day 166	Read Fermium: Enrico Fermi: Hitler and the Jews Pages 291-294 • Answer Questions • Pages 293-294			
	Day 167	Read Mendelevium: The Periodic Table: The Genius of Mendelev • Pages 295-298 • Answer Questions Pages 297-298			
	Day 168	Read Nobelium: Alfred Nobel: The Man Who Knew No Peace • Pages 299-302 • Answer Questions • Page 301			
	Day 169	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Finish Your Element Collection with Lead • Page 342			
	Day 170	Quiz 34 • Pages 409-410			
Week 8	Day 171	Read Lawrencium: “David Prevailed . . . with a Sling and a Stone” • Pages 303-306 • Answer Questions • Pages 305-306			
	Day 172	Read Rutherfordium and Beyond: The Transactinides, The End of the Periodic Table? • Pages 307-312			
	Day 173	Answer Rutherfordium and Beyond Questions • Page 311			
	Day 174	Options for the day: Extra Study Day, Review Day, Flashcard Day, or Writing and Research Day			
	Day 175	Quiz 35 • Pages 411-412			
Week 9	Day 176	Option 1: Review First Quarter Worksheets for Final Exam Option 2: Review Flashcards for Periodic Table Final Exam			
	Day 177	Option 1: Review Second Quarter Worksheets for Final Exam Option 2: Review Flashcards for Periodic Table Final Exam			
	Day 178	Option 1: Review Third Quarter Worksheets for Final Exam Option 2: Review Flashcards for Periodic Table Final Exam			
	Day 179	Option 1: Review Fourth Quarter Worksheets for Final Exam Option 2: Review Flashcards for Periodic Table Final Exam			
	Day 180	Option 1: Final Exam • Pages 413-414 Option 2: Periodic Table Final Exam • Pages 415-416			
		Final Grade			

H

1.00794

Hydrogen

HYDROGEN: FORMING WATER

"And the Spirit of God moved upon the face of the waters,"
(Gen. 1:2 KJV).

gas

- Hydrogen is the most abundant element in the universe, making up over 90 percent of it.
- It was discovered in 1766 by the English chemist Henry Cavendish, who later in 1781 showed that water was formed by the combustion of hydrogen in air.
- The word hydrogen comes from two Greek words: *hydros* and *genes*, meaning "water forming."
- As a gas, hydrogen is a diatomic molecule with the formula $H\cdot H$ or H_2 .
- The formula for water is H_2O .



ANALYSIS

In all of nature, there is nothing quite so beautiful and yet so simple as water. Science gives us a special appreciation for it. Two tiny hydrogen atoms and a single oxygen atom combine to form the most abundant compound on earth, so common we may be tempted to take it for granted. From a delicate crystal snowflake to the mightiest ocean wave . . . from the clouds of a blazing sunset to a raging waterfall . . . all of these wonders of creation owe their beauty to the unique boomerang shape of the humble little molecule, H_2O .



WHAT MAKES WATER UNIQUE?

Water, made up of just three small atoms, is considered to be a "light" molecule. Most molecules of similar size (methane [CH_4], ammonia [NH_3], carbon dioxide [CO_2], etc.) are gases at normal temperatures on earth. But water is a liquid. Why? It is largely due to a phenomenon scientists call the "hydrogen bond," although it is hardly a bond at all. It is just a fleeting attraction among water molecules as they pass each other.

WHAT ARE HYDROGEN BONDS? Although the three atoms in a water molecule share their ten electrons, that sharing is not equal. It is like a very large person and a very thin person sharing a bed on a cold night — the larger one is likely to get more than his share of the blanket. Likewise, in H_2O , the oxygen atom

"hogs" more than its share of electrons, giving it a slight negative charge and leaving each positively charged hydrogen nucleus partially exposed. This distribution of charge, along with water's boomerang shape, causes a "tug" between the oxygen in one molecule and the hydrogen in another. This causes water to stick together and remain liquid when other light molecules would evaporate. Without hydrogen bonding, water would boil away at about 150°F below zero! This and other unique properties of water caused by hydrogen bonding allow life to exist.

WHY DOES ICE FLOAT? Hydrogen bonds cause water molecules to arrange themselves in a certain way as the temperature nears freezing, making ice lighter than liquid water, causing it to float. (Water is one of the few substances in which the solid form is lighter than the liquid; another is bismuth, element no. 83.) Without ice's buoyancy, lakes and rivers in cold climates would freeze solid and remain frozen much of the year, killing everything in them.

WHY IS WATER BLUE? Hydrogen bonds absorb certain wavelengths of light to make large quantities of water appear blue.

When we experience the coolness of a drink of water or the comfort of a warm bath, the graceful waves of the sea or the beauty of a sunset, let us never cease to marvel at the wisdom of our Maker, the Creator of the hydrogen bond.



LIVING WATER

Today we have many varieties of water to choose from: bottled water, tap water, mineral water, softened water, imported water, and more. But there is a type of water that will never be bought or sold: living water.

Jesus met a woman at a well in Samaria. He told her that His followers would receive “living water” that would give them eternal life. He said, “. . . whoever drinks of this water [Greek: *hydro*] will thirst again, but whoever drinks of the water that I shall give him will never thirst. But the water that I shall give him will become in him a fountain of water springing up into everlasting life,” (John 4:13–14).

Later, John explains (in John 7:39) that living water is actually the Holy Spirit, the same Spirit that moved

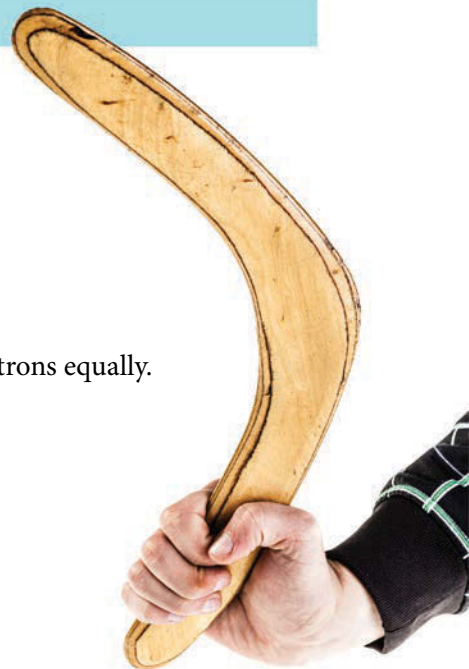
upon “the face of the waters” in Genesis 1:2. And at the other end of the Bible, in Revelation, we read that living water is free and available to all, when Jesus invites us to . . .

“Come. And let him that is athirst come. And whosoever will, let him take the water of life freely,” (Rev. 22:17; KJV).

Just as physical water is needed for biological life, “living water” is vital for our life and growth as Christians. No athlete can compete without consuming enough water, and we cannot expect to grow and prosper in our Christian lives unless we have a healthy amount of the “water of life” in our spiritual diets. All we have to do is ask.



1. What force causes water molecules to be attracted to each other?
a. gravity b. magnetism c. hydrogen bonding d. diffusion
2. Which of the following best describes the shape of a water molecule?
a. cross b. barbell c. boomerang d. triangle
3. TRUE or FALSE: The hydrogen and oxygen atoms in a water molecule share their electrons equally.
4. The Greek word for “water” is _____.
5. Hydrogen makes up more than _____ percent of the universe.

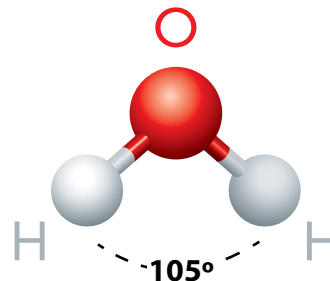


MY RESPONSE



“Heavenly Father, thank You for the beauty of our created world. Thank You for the enjoyment we can receive from even the simplest of Your gifts, water itself.”

“Give me the gift of living water, so that my soul will be satisfied, and so that I will have the strength each day to do the work You have set before me. Amen.”



The water molecule is shaped like a boomerang.

2
He
4.002602
Helium

HELIUM: From the Sun

"Then the righteous will shine forth as the sun [Greek: helios] in the kingdom of their Father. He who has ears to hear, let him hear!" (Matt. 13:43).

gas



- In 1868, when French astronomer Pierre Janssen studied the spectrum of sunlight through a prism, he noticed the spectral line of an unknown element that he presumed was a metal. He named it "helium," from the Greek word *helios* meaning "sun." The "-ium" ending indicated his belief that it was a metal.
- In 1895, Scottish chemist Sir William Ramsay found a previously undiscovered gas on earth with the same spectrum as Janssen's "metal," proving that helium was actually a gas.
- Helium is the only element ending with "-ium" that is nonmetallic.
- Helium is believed to form in the sun by the fusion of hydrogen nuclei.



The name of the gas helium comes from the Greek word *helios*, meaning "the sun." Helios was also the name of the Greek sun god.

Like many pagans of Bible times, the Greeks and Romans worshiped the sun. They believed that the sun was a blazing chariot that the god Helios drove across the sky every day. In one of their many sun myths, Phaethon, the son of Helios, stole his father's sun chariot and went on a tragic joyride. The boy could not control the chariot and nearly caused heaven and earth to be burned up (in the process creating the Sahara Desert!). Zeus, the king of the gods, was forced to kill Phaethon with a bolt of lightning to end his wild ride.

In Egypt, a land of almost constant sun and little rain, sun worship was central to everyday life. Their sun god, Amon-Re, was born anew every morning; he grew and became strong in the heat of the day; then he faded away and died each night. They believed Amon-Re was the first king of Egypt. The center of Egyptian sun worship was the city of On, which the

Greeks called Heliopolis, "City of the Sun."

Sun worship also existed in ancient India, Africa, Mesopotamia, England, and among the Maya, the Aztecs, and the Incas of the Americas.

But the ancient Jews were different. As God's chosen people, they were taught that the sun was not to be worshiped. Like all other forces in the universe, the sun is a creation of Yahweh, the one true God. The Jews were not to bow down to "anything that is in heaven above, or that is in the earth beneath" (Exod. 20:4). The sun and other heavenly bodies were created for man's benefit, not to be worshiped: to determine times and seasons (Gen. 1:14), night and day (Gen 1:5; Jer. 31:35), and the points of the compass (Ps. 89:12; Ps. 103:12). The Bible tells us that the sun also serves to symbolize God's character: His watchfulness (Ps. 19:4–6), His dependability (Ps. 72:4–5), His healing (Mal. 4:2), and His protection:

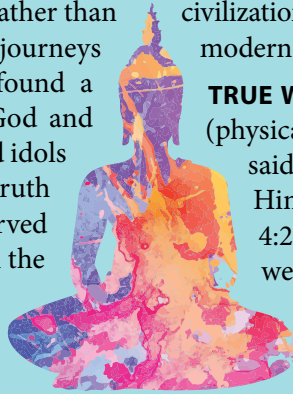
"For the LORD God is a sun and shield; the LORD will give grace and glory" (Ps. 84:11).



TRUE AND FALSE WORSHIP

Idol worship or idolatry is the act of worshiping something that is created (whether by man or by God) rather than the Creator. During Paul's missionary journeys into the Greek and Roman world, he found a civilization that had forgotten the true God and worshiped forces of nature, like the sun and idols created by man. "[They] exchanged the truth of God for the lie, and worshiped and served the creature [or created things] rather than the Creator, who is blessed forever. Amen," (Rom. 1:25).

What is the result of this false worship? Paul says that it leads to a long list of societal and individual sins: sexual immorality, wickedness, envy, murder, strife, law breaking, etc. (Rom. 1:26-32).

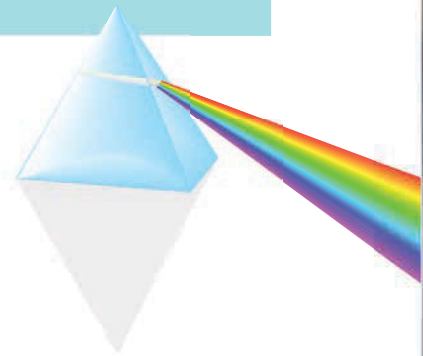


He paints a picture of the sinful conditions that history tells us led to the downfall of the Greek and Roman civilizations. Paul's picture is frighteningly reflective of modern society as well.

TRUE WORSHIP False worship focuses on created (physical) things, but true worship is spiritual. Jesus said: "God is Spirit; and those who worship Him must worship in spirit and truth," (John 4:24). Worship does not depend on how well we dress or the cost of the church's sound system. It doesn't depend on a church building or choir. These things can even detract from worship when we focus on our surroundings rather than listening to God's Spirit and truly submitting ourselves to Him.

1. Except for helium, elements with names ending in -um or -ium are?
a. gases b. radioactive c. metallic d. poisonous
2. The Greek word for "sun" is _____.
3. A French astronomer, Pierre Janssen, discovered the existence of helium on the surface of the sun. Who was the first person to prove that helium was actually a gas?

4. Worship of the sun or anything other than God is considered to be _____.
5. Which ancient culture worshiped the sun as a god?
a. Egyptian b. Greek c. Roman d. All of the above



MY RESPONSE

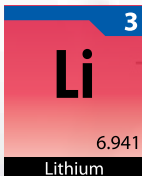


"Little children, keep yourselves from idols. Amen," (1 John 5:21).

The Bible tells us to examine ourselves, to make sure that there is nothing in our lives that we place above our relationship with God. The world offers many physical temptations or idols to distract us from worshiping "in spirit and in truth." The love of money and power (Matt. 6:24), immoral entertainment (Ps. 101:2-4), and sinful desires of the flesh (1 Pet. 2:11-12) are just a few.

"Lord, help me to worship only You this day. Help me to put away all idols and anything that distracts me from true and deeper worship, and help me to remember to praise You in all things. Amen."





LITHIUM: A Surprise Discovery in “Stone”

“He who is without sin among you, let him throw a stone [Greek: *lithos*] at her first,” (John 8:7).

solid



- Lithium is the lightest metal; it is soft and silvery-white in its pure form.
- Lithium is highly reactive and quickly forms a gray oxide layer when exposed to air, but it is less reactive than other alkali (Group I) metals.
- Lithium was discovered in 1817 by the Swedish chemist Johan Arfvedson.
- Arfvedson took its name from the Greek word *lithos*, meaning “stone.”
- Lithium is used to make strong batteries. Since lithium is the lightest metal, batteries made with it are lightweight as well.



In the early 1800s, the brilliant British scientist Sir Humphry Davy discovered several new elements. In 1807 he discovered two more: sodium and potassium. These elements had similar characteristics, such as their appearance and the way they combined with oxygen in a certain ratio. Davy referred to these elements as “alkali metals.”

In 1817 the Swedish chemist Johan Arfvedson discovered a new metallic element in a mineral found near Stockholm. His new element had properties similar to the alkali metals Davy had discovered ten years earlier. This was unexpected because Davy’s alkalis were both derived from plant sources (trees for potassium and seaweed for sodium). Arfvedson was so surprised to find this new element in a mineral or rock that he named it after the Greek word, *lithos* meaning “stone.”

“STONE” AND “ROCK” IN THE NEW TESTAMENT

Like English, biblical Greek had two words for stone and rock: *lithos* and *petra*.

Lithos refers to individual stones, like those common in the Holy Land. John the Baptist said that God could raise up “children of Abraham” from these stones

(Matt. 3:9) and Jesus said the stones would cry out in praise if His worshipers were silenced (Luke 19:40). These were also the stones that would have been hurled at the woman caught in adultery had Jesus not rescued her (John 8:7). Sometimes the word means “building stones.” When Christ called Himself “the stone the builders rejected” (Luke 20:17), *lithos* was the word He used.

On the other hand, *petra* referred to larger types of rock: foundations of buildings (the wise man’s house in Matt. 7:24), outcrops of rock (Luke 8:6), or even mountains (Rev. 6:15). It is also the meaning of Peter’s name (Matthew 16:18).

In one important verse, both words are used. After Jesus was crucified, Joseph of Arimathea took Jesus’ body down from the cross and “. . . laid him in a tomb which had been hewn out of the rock [*petra*], and rolled a stone [*lithos*] against the door of the tomb” (Mark 15:46).

After three days, the disciples returned to the tomb and were amazed to find that “. . . the stone [*lithos*] had been rolled away — for it was very large” (Mark 16:4).

Just like Johan Arfvedson, Jesus’ disciples made a surprising discovery “in stone.”



FOUNDATION

Some of the parables, or teaching stories, of Jesus were hard to understand.

However, most of them were very simple and straightforward. For example, Jesus' parable of the wise man who "built his house on the rock" (from Matt. 7:24–29) is so easily understood that it is used in children's Sunday school classes. Yet it carries a lot of meaning.

When you build a house, you can fill it with the finest furniture. You can paint it with beautiful colors. You can have the prettiest floors, windows, and walls. But if the foundation is weak, your house will not stand the test of time. Storms will come and the wood will rot and the floors will warp. All of your hard work will be in vain.



A person's life is a lot like a house. You may have a good education or lots of money or good looks. Your life may seem great in the good times, but tragedies and hard times, like storms, come into all of our lives. If you build your life on the foundation of Christ and His Word, it will withstand whatever comes your way. As the old song says, "On Christ the solid rock I stand. All other ground is sinking sand."

Each day of your life can also be like building a house. Reading God's Word and praying each morning are good ways to build a firm foundation for the day ahead. If you do this, you will find that your accomplishments will be lasting (1 Cor. 3: 9–15).

- Lithium is the _____ of all the metals.
a. hardest b. lightest c. most dangerous d. densest
- What are the Greek words for the following terms?
a. Stone (individual pieces of stone) _____
b. Rock (massive, like a cliff or foundation) _____
- Which of the disciples' names meant "rock"?
a. Matthew b. John c. Judas d. Peter
- Lithium, sodium, and potassium are all found in the same column of the Periodic Table. Metals in this column are called _____ metals.
- Every building needs to be built on a firm _____.

MY RESPONSE



"Lord, help me to be like the wise man who built his house upon the rock and not the foolish man who built on the sand. Let my life and all I have, whether it be my education, my job, or my hobbies, be built on the best foundation of all — Christ, the solid rock. Amen."



Be

9.012182

Beryllium

4

BERYLLIUM: A Bright & Beautiful Jewel

solid

"I lifted my eyes and looked, and behold, a certain man clothed in linen, whose waist was girded with gold of Uphaz! His body was like beryl, his face like the appearance of lightning, his eyes like torches of fire . . ." (Dan. 10: 5–6).



- Beryllium is named after the precious stone “beryl,” in which the element was discovered. Beryl is still the ore from which most beryllium is derived.
- Beryllium (pronounced “ber-ill-ium”) was discovered in 1797 by the French chemist L.N. Vauquelin.
- Emerald, aquamarine, morganite, and heliodor are varieties of beryl in various colors.
- Beryl appears in the Old Testament as one of the gems representing the 12 tribes of Israel (Exod. 28:17–21) and in the New Testament as one of the foundation stones representing the 12 “apostles of the Lamb” (Rev. 21:14–21).



The prophet Daniel saw God in an intense vision (Dan. 10:4–7). He was so overwhelmed by what he saw that he passed out. When he woke up, Daniel was unable to speak for a time. When he wrote down what he had seen, he could only describe the fantastic vision in terms of the most brilliant things he knew: gold, fire, lightning, and the dazzling gem, beryl! Today, geologists know beryl by its chemical formula: $\text{Be}_3\text{Al}_2\text{Si}_6\text{O}_{18}$ or “beryllium aluminum silicate.”

Beryl represents God’s presence.

The dazzling appearance of precious gems was used to represent God’s presence elsewhere in the Bible as well. When Ezekiel had his vision of the four living creatures (actually angels), he described their appearance as being like the blazing gem beryl (Ezek. 1:16 and 10:9).

In the New Testament, John had his own vision of heaven. He described God’s appearance in terms of several precious stones: God sitting on His throne was said to be like jasper, sardius, and emerald to look upon (Rev. 4:3). (Emerald is a green variety of beryl.)

Just as precious stones represented God’s presence, they can illustrate spiritual qualities as well:

PEARLS REPRESENT GOD’S KINGDOM. Christ referred to pearls twice in Matthew’s Gospel. In the Sermon on the Mount, Christ compared His teachings about the Kingdom to pearls (Matt. 7:6). And in the parable of the “Pearl of Great Price,” Christ compared the kingdom of heaven to a pearl merchant seeking and finding one perfect pearl and selling all that he owned to obtain it (Matt. 13:45–46), just as God the Father would give His most precious possession (His only begotten Son) to redeem you and me from our sins. Also, Revelation tells us that the very gates of the kingdom of heaven are made of pearl (Rev. 21:21).

RUBIES REPRESENT WISDOM. The brilliant red ruby was a highly valued stone, but as Job said, the worth of precious gems should not even be “mentioned” in the same breath as “wisdom,” for its price is “above rubies” (Job 28:18). The Proverbs also tell us that rubies come in a distant second when compared to godly wisdom (Prov. 3:14–15, 8:11, and 20:15). Likewise, a virtuous wife is far more valuable than rubies (Prov. 31:10).



GOD'S GEMS

The Old Testament Book of Malachi talks about two groups of people who lived during a difficult period in Israel's history. One group of Israelites was called "arrogant." They complained about keeping God's commandments. These people turned away from their faith and said, "It is useless to serve God" (Mal. 3:14).

But another group was faithful to the Lord. They met together and talked about their situation. They drew up a "Scroll of Remembrance"



and committed themselves to fear and honor the name of the Lord. Malachi said that God heard the prayers of these faithful believers. God called them His "jewels" and promised that they would be spared in the difficult days to come.

"They shall be Mine," says the LORD of hosts, "on the day that I make them My jewels. And I will spare them as a man spares his own son who serves him," (Mal. 3:17).

- Which of the following is not a form of the gem beryl?
 - emerald
 - ruby
 - aquamarine
 - heliodor
- Which chemist discovered beryllium?
 - Davy
 - Boyle
 - Curie
 - Vauquelin
- Beryl is the main _____ from which most beryllium is derived.
- In the Bible, what gem is frequently associated with "wisdom"?
 - ruby
 - diamond
 - emerald
 - onyx
- In Malachi chapter 3, God speaks of His faithful followers as _____.

MY RESPONSE



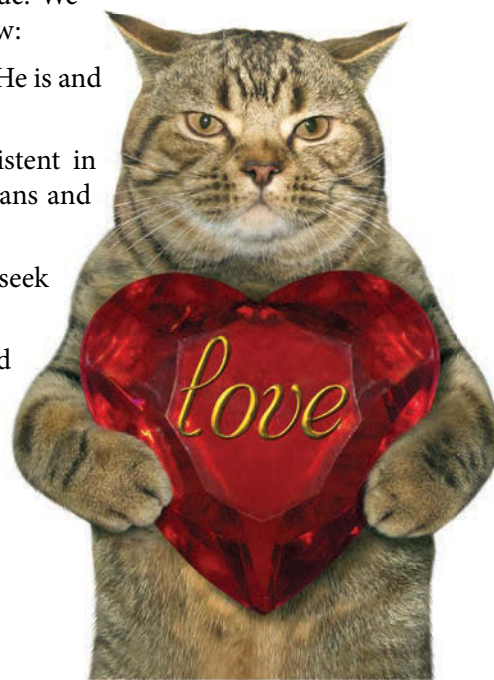
Today, as in Malachi's time, many people are turning away from the Lord. But whatever the unbelieving and mocking world does, we can stay true. We can be God's gems and receive His blessings. Malachi 3:16 tells us how:

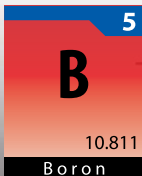
FEAR THE LORD: We must always recognize and honor God for who He is and put Him in the proper place in our lives.

SPEAK OFTEN ONE TO ANOTHER: We must be faithful and consistent in fellowship with other believers, always including the Lord in our plans and committing ourselves to Him.

THINK UPON HIS NAME: Focus on God. Spend time in prayer. And seek God's wisdom in the love letter that He left for us: the Bible.

"Heavenly Father, help me to not be affected by the unbelieving world around me. I want to fear You and honor Your Son. I want to be a shining jewel in Your kingdom. Help me to be faithful until I stand before You like Daniel and see Your face, shining as 'gold and beryl, lightning and fire.' Amen."





BORON: The Cleanness of My Hands

"The Lord rewarded me according to my righteousness; according to the cleanness [Hebrew: bor] of my hands He has recompensed me," (Ps. 18:20).

solid



- Boron compounds have been used for thousands of years, especially "borax" ($\text{Na}_2\text{B}_4\text{O}_7$), which is used for glass-making, ceramics, and detergents.
- The English chemist Sir Humphry Davy and two French chemists (L. J. Gay-Lussac and L. J. Thenard) isolated boron from boric acid (H_3BO_3) at about the same time in 1808.
- The name boron is derived from borax. The "-on" ending indicates its similarity to carbon and silicon.
- The origin of the word *borax* is Arabic, but the root "bor-" is found in Hebrew as well. Forms of the Hebrew word appear in the Bible as "cleanness" (*bor*, as in the verse above) and "soap" (*borit*, in Jer. 2:22 and Mal. 3:2).



Dr. Joseph Lister (1827–1912) is considered the father of modern surgery. He was responsible for many medical advances, including drainage tubes for wounds and "catgut" sutures, which dissolve in the human body. But his most important innovation was the use of "antiseptic techniques." Before the 1870s, surgeons did not wear gloves or gowns. Often, they made no attempt to even clean up between surgeries. Many considered it a status symbol to be covered with blood from previous operations. As a result, about 50 percent of patients who had major surgery died from infections, often after otherwise successful operations. In the days before the discovery of germs, doctors believed that infections arose spontaneously and that there was no way to stop them.

By 1860, Lister was already a successful surgeon when he began corresponding with the French chemist Louis Pasteur, a lifelong friend and fellow Christian. Pasteur's work had shown that the spoiling of milk and wine resulted from germs in the air. Lister concluded that such germs might also cause human infection. If so, there might be ways to prevent germs from reaching his patients. Lister began looking for ways to do just that.

Lister experimented with several chemical solutions he called "antiseptics" in his operating rooms to clean wounds and soak bandages. He even sprayed them in the air to kill bacteria before they could reach the patient. The results were remarkable. His patients had practically no infections. However, after repeated exposures, these antiseptics were harmful to Lister and the surgeons who worked with him, bleaching and numbing the skin and causing vision and breathing problems.

Lister eventually found a chemical that was very effective yet safe for medical personnel; it became a standard antiseptic in operating rooms for decades. This chemical was *boric acid* (H_3BO_3). Just like David in the verse quoted above, the Lord rewarded Dr. Lister according to the "cleanness (*bor*) of his hands."

Like so many of the giants in the history of science, Dr. Lister was a faithful Christian. According to the *Encyclopedia Britannica*, "[Lister] was a gentle, shy, unassuming man, firm in his purpose because he humbly believed himself to be directed by God."¹

Note: Boric acid is still widely used in medicine. For example, it is used in eye drops to prevent eye infections.

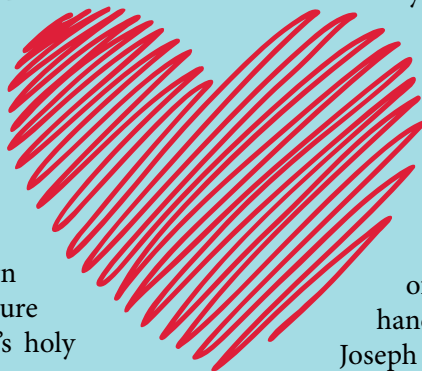
1 "Joseph Lister" *Encyclopedia Britannica* (www.britannica.com), last updated February 6, 2019, accessed Feb 26, 2019.



CLEAN HANDS/CLEAN HEART

In the Bible, references to the hands often have symbolic meaning. Your hands represent the “work”

that you do, just as your heart represents your “thoughts and feelings.” And to have clean hands means to resist evil and to do good things for God. Our theme verse, Psalm 18:20, says that God will reward us if we have a clean heart (righteousness) and clean hands (good works). In Psalm 24:3–4, we learn that only those with clean hands and pure hearts are able to “stand in the Lord’s holy place.”



In the New Testament, James tells us much about the importance of “good works.” “Cleanse your hands, you sinners; and purify your hearts, you double-minded,” (James 4:8).

This idea also comes through in probably the best-known verse in James: “Faith [a clean heart] without works [clean hands] is dead,” (James 2:20).

In Scripture, a person’s profession is often referred to as the “work of one’s hands.” By cleaning his own hands, Joseph Lister revolutionized the medical profession and ultimately led to the saving of millions of lives.

1. Dr. Joseph Lister is considered to be the Father of Modern _____.
2. Boron is the main element in _____ a compound used in glass-making, ceramics, and detergents.
3. The Hebrew word **bor** means _____.
a. cleanness b. blood c. germs d. work
4. Dr. Joseph Lister used _____ acid as an antiseptic during surgery.
a. hydrochloric b. boric c. hydrobromic d. amino
5. Dr. Joseph Lister was friends with what great French scientist and fellow Christian? _____

MY RESPONSE



“Come into my heart, Lord, and make it clean, a place fit for You to live. Help me to keep it clean for the sake of the gospel and Your kingdom. Lord, clean my hands as well for the sake of my family and to show Your love to my fellow man. Help me to find ways to honor You in all I do and to seek Your will daily. Amen.”

How can I, like Joseph Lister, honor God with the cleanliness of my hands and heart this day?



CARBON: Sir Humphry Davy/The Mine Safety Lamp

solid

"Your word is a lamp to my feet and a light to my path,"
(Ps. 119:105).



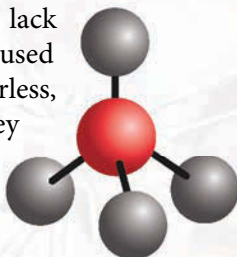
- Elemental carbon has been known in three forms since antiquity: diamond, graphite, and charcoal.
- In 1772, the Frenchman Antoine Lavoisier (1743–1794) proved that all three of these forms were composed of the same element, which he called *carbone* from the French word for charcoal. In English, the word became carbon.
- Later it was learned that carbon forms the molecular backbone of all living things and is found in all organic matter.
- Combustion ($C + O_2 \rightarrow CO_2 = \Delta H$, where ΔH stands for “the release of energy”) is the most basic and essential chemical reaction in biological life and human civilization.
- Anthracite, the purest form of coal, is up to 96 percent carbon.



In the 1800s, the Industrial Revolution was well underway in England, and wood was the fuel that sustained it. But as forests dwindled due to the demands of progress, the English turned to a new energy source to heat their homes and power their factories: coal.

England had many coal deposits on the surface. But as miners dug into them, they found that they became underground coal seams that ran for miles. New mining techniques were devised to follow the coal, which led to new dangers for miners. Many were lost due to two main factors: lack of oxygen, and mine explosions caused by high concentrations of an odorless, highly flammable gas, which they called “firedamp.” Today we call it methane or natural gas (CH_4).

Oxygen could be monitored with canaries and other caged birds, which would succumb to low oxygen levels and warn the miners. The other danger remained for many years. Oil lamps were the only light source available at that time, and the lamp flames led to numerous deadly explosions. Eventually, the nation



turned to Sir Humphry Davy (1778–1829), the brilliant chemist who had already isolated several elements. They asked Davy to develop a light source that could be used safely in the mines.

Davy created an oil lamp with a wire screen mesh that covered the flame. The mesh spread out the heat of the flame and reduced the flame temperature to a level beneath the ignition point of natural gas. Davy’s invention reduced the loss of life dramatically and increased his already great popularity. It came to be known as the “mine safety lamp” or simply “Davy’s Lamp.”

Davy’s Lamp quickly became the industry standard and was used all over the world. Despite its great success, Davy had no interest in profiting from his invention. In 1816, in response to a friend who suggested that he patent it, Davy wrote, “No, my good friend, I never thought of such a thing; my sole object was to serve the cause of humanity, and if I succeeded I am amply rewarded in the gratifying reflection of having done so.”¹ Sir Humphry Davy was a Bible-believing Christian, whose invention of the mine safety lamp was just one example of service to his fellow man.

¹ John Ayrton Paris, *The Life of Sir Humphry Davy* (Cambridge: Cambridge University Press, 1831), p. 344.



GOD'S LIGHT OF SALVATION

Lamps in the Bible burned olive oil and were the primary light source for homes and public buildings like the temple. Some lamps were portable and were used like lanterns. Lamps were also used in celebrations, as in Jesus' parable of "the wise and foolish virgins" (Matt. 25:1-13).

A miner in Humphry Davy's day had a special appreciation for his lamp:

- Like the "five wise virgins," a miner had to make sure to have enough oil to last in his dark environment.



- David described God's Word as "a lamp to my feet" (Ps. 119:105), and Peter called it a "light [lamp] that shines in a dark place" (2 Peter 1:19), reminding us of the miner's need to "light his path" in the dark mineshaft.

- Isaiah 62:1 tells us that "salvation [is] a lamp that burns." To the miner who benefited from Davy's Lamp, having a safe light that would not ignite the dangerous gases around him was a type of "salvation" indeed.

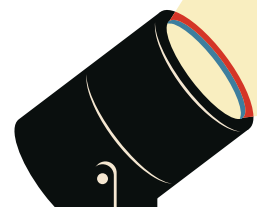
1. What historical event caused a great demand for coal in 19th-century England?
2. Nineteenth-century coal miners often encountered a dangerous gas, which they called "firedamp." The gas was colorless, odorless, and explosive. Today we call it natural gas or _____. Its chemical formula is CH_4 .
3. Diamonds, graphite, and charcoal are all forms of elemental _____.
a. coal b. carbon c. jewels d. metals
4. What British scientist invented the famous "mine safety lamp" to protect coal miners?
a. Davy b. Lister c. Newton d. Pasteur
5. In Psalm 119:105, David said that God's Word is _____.
a. a heavy burden b. like lightning c. a lump of coal d. a lamp to my feet

MY RESPONSE



"For You are my lamp, O LORD; the LORD shall enlighten my darkness," (2 Sam. 22:29).

"Heavenly Father, thank You for being my lamp and helping me to find my way in this world. Like a miner with an important job to do in a dangerous environment, You have sent me into a dark world to share the light of the gospel with others. Help me to learn the lessons You have for me in Your Word. Amen."



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Nitrogen

NITROGEN: The Three-fold Cord

"Though one may be overpowered by another, two can withstand him. And a threefold cord is not quickly broken," (Eccles. 4:12).

gas

- Nitrogen makes up 78.1 percent of the earth's atmosphere.
- Like all other elemental gases (except the noble gases), nitrogen occurs as a diatomic molecule N_2 . However, the nitrogen atoms are connected by a triple bond ($N \equiv N$). This powerful bond makes nitrogen an extremely inert gas.
- Nitrogen was discovered in 1772 by the English chemist Daniel Rutherford.
- Nitrogen means "niter forming." Niter is an old name for saltpeter or potassium nitrate (KNO_3).



Nitrogen (N_2) makes up nearly four-fifths of the earth's atmosphere. It is vitally important for all life, yet atmospheric nitrogen is useless to plants and animals (at least directly) due to its powerful triple bond.

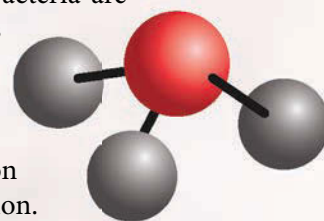
Animals can break apart the double bonds of oxygen (O_2 or $O=O$) with the help of the hemoglobin molecule in their blood. Green plants use the chlorophyll molecule to overcome both the double bonds of oxygen in "respiration" and of carbon dioxide (CO_2 or $O=C=O$) in "photosynthesis." But neither animals nor plants can break down the strong triple bond of nitrogen (N_2 or $N \equiv N$).

Yet all living things need nitrogen. It is found in proteins, nucleic acids, vitamins, and many other organic chemicals. Since its ultimate source is the atmosphere, how does nitrogen enter our food supply? What force has the power to break its triple bond? Actually, God has provided two forces in nature to do just that.

1. LIGHTNING. Electrical storms split nitrogen molecules in the atmosphere into individual atoms. These free nitrogen atoms then quickly react with oxygen to form nitrogen dioxide (NO_2), which falls to earth dissolved in rain. Plants are able to absorb this

diluted NO_2 through their roots and use it to form amino acids and proteins. However, lightning is not a reliable source for usable forms of nitrogen, so the Creator in His wisdom has provided another means.

2. NITROGEN-FIXING BACTERIA. These bacteria grow in tiny nodules on the roots of plants called legumes, which provide a stable environment for the bacteria. In return, the bacteria provide a generous supply of nitrogen in the form of ammonia (NH_3) to the plant. Exactly how these tiny bacteria are able to break nitrogen's triple bond is still a mystery to science, but all human and animal life on earth depend on this symbiotic phenomenon.



Legumes include plants whose seeds grow in pods (beans, peas, peanuts, etc.) and forage crops (like clover and alfalfa). Farmers grow legumes in rotation with other crops to ensure that sufficient nitrogen gets into the soil. Legumes provide high-quality proteins and are an important part of a healthy diet. So, when you're eating your vegetables, keep in mind God's providence and His tiny little helpers, the nitrogen-fixing bacteria.



SPIRITUAL BONDS

Ecclesiastes 4:12 tells us that a “three-fold cord is not quickly broken.”

The Bible also speaks of other “triple bonds.” These are spiritual bonds that unite believers when we act in accordance with God’s Word. Jesus told His disciples in Matthew 18:19–20, “If two of you agree on earth concerning anything . . . it will be done for them by My Father in heaven. For where two or three are gathered together in My name, I am there in the midst of them.” This is a wonderful promise to us as Christians. Even just two believers, united in prayer and God’s will, have a special bond with Christ.



In the marriage of two Christians, this is especially true. The Bible says that a husband and wife join together as “one flesh” in the eyes of God and become “members of His [Christ’s] body, of His flesh and of His bones” (Eph. 5:30–32). Marriage has often been described as a triangle with the husband and wife at the bottom corners and Jesus Christ at the top. As each spouse draws closer to Jesus through prayer and obedience, they also grow closer to each other.

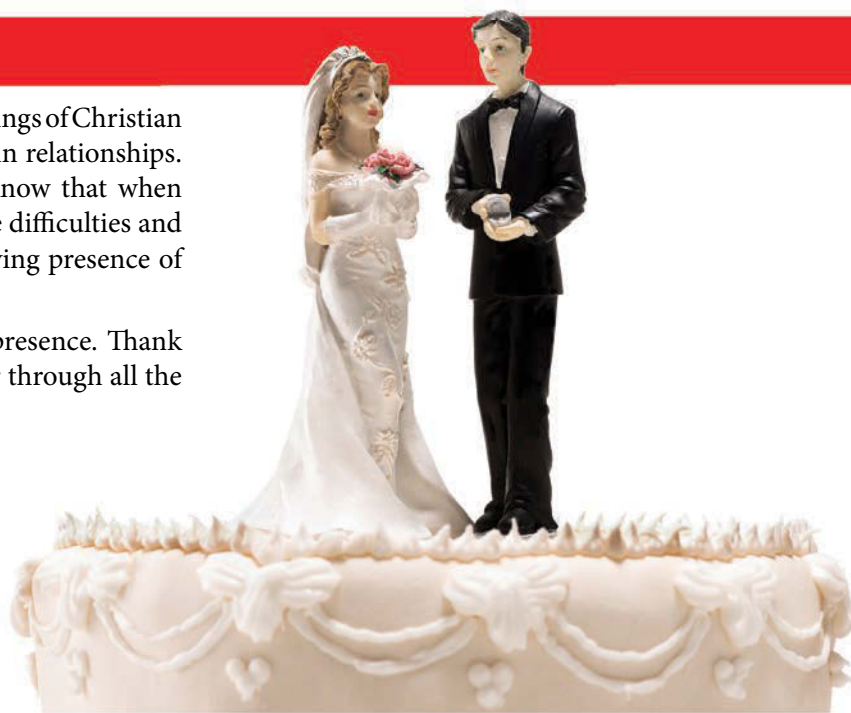
1. Nitrogen makes up _____ of the earth’s atmosphere.
a. most b. about half c. a small portion d. hardly any
2. Like oxygen, hydrogen, and the halogen gases, nitrogen is a diatomic molecule; but unlike these gases, the nitrogen molecule is held together by a powerful _____ bond.
a. hydrogen b. ionic c. triple d. magnetic
3. Most of the nitrogen found in the soil is produced by what type of life-form?
4. What type of plants are associated with “nitrogen fixation” in the soil?
5. Which of the following nutrients contains nitrogen?
a. sugar b. protein c. carbohydrate d. fat

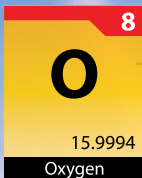
MY RESPONSE



How tragic it is to neglect the blessings of Christian unity — whether in a church or in relationships. On the other hand, what a blessing it is to know that when we are joined in marriage for help in facing the difficulties and challenges in life, we can be assured of the loving presence of our Savior!

“Lord, thank You for reminding me of Your presence. Thank You for Your Holy Spirit that binds us together through all the trials and triumphs of life. Amen.”





OXYGEN: The Breath of Life

"And the Lord God formed man of the dust of the ground, and breathed into his nostrils the breath of life; and man became a living being," (Gen. 2:7).

gas



- Oxygen makes up about 21 percent of the volume of the air, occurring mostly as O_2 .
- The name is from two Greek words: *oxy* and *genes* meaning, "acid forming" (because many acids are oxygen compounds).
- Many experts who study the history of science now give the credit for the discovery of oxygen to three famous chemists from three different countries: Joseph Priestley (1733–1804) of England, Carl Wilhelm Scheele (1742–1786) of Sweden, and Antoine Lavoisier (1743–1794) of France. All of them had discovered oxygen in the early 1770s.
- Priestley was the first to publish his discovery in 1774.



One Hebrew word for "breath" is *ruach*, which is often translated as "spirit" elsewhere in the Old Testament. The Bible makes it clear in many other verses that a man's life "is in his breath" and his breath comes from God (Job 12:10; Ezek. 37:5; Ps. 146:4; Acts 17:25; etc.).

Genesis 1:2 tells us that God's "Spirit" or breath (*ruach*) moved "over the face of the waters" during creation. This verse seems to describe God's activity of breathing life into our world (by creating the proper mixture of oxygen and other gases in our atmosphere) just as He breathed life into Adam's nostrils.

THE DELICATE BALANCE. As astronomers have advanced in their ability to study other planets and their moons, it has become clear that oxygen (O_2) is a rare substance in the universe, found only in traces in the rest of our solar system. But on earth it exists in abundance. Most importantly, it is found in just the right proportion: 21 percent of our atmosphere.

If the oxygen content were, say, 16 percent instead of 21 percent, life at sea level would compare to trying to breathe at the top of a mountain two miles high.

Elevations higher than sea level would be largely uninhabitable by humans. Low oxygen levels would also reduce the protective ozone (O_3) layer in the upper atmosphere, allowing harmful ultraviolet rays to reach the surface.

On the other hand, higher oxygen levels would have serious consequences as well. If the concentration were 30 percent, then oxidation would occur 50 percent more rapidly, and forest fires would rage across continents. All organic matter would be highly flammable.

Other gases in our atmosphere exist in just the right levels, too. For example, carbon dioxide (CO_2) constitutes a mere 0.04 percent of our air, but its function as a so-called greenhouse gas is essential to keeping the earth at a habitable temperature. CO_2 levels also help to keep a proper pH balance in our oceans and cause plants to grow at the proper rate.

These facts and many others about our atmosphere confirm the biblical statement that on the day God "breathed" our earthly atmosphere into existence (Gen. 1:2), it was truly "very good."



SPIRIT

In the Book of John, we find a story of Jesus that reminds us very much of what God did in Genesis 1:2 and 2:7: conveying life through His own breath.

Immediately after the Crucifixion, the disciples were scared, lonely, and in hiding. They were afraid that at any time the authorities who had killed Jesus would come and take them away as well. Their rabbi, friend, and spiritual leader was gone. They had lost hope.

It was at this lowest of low points that Jesus appeared to them in the flesh. He said:

"Peace to you! As the Father has sent Me, I also send

you." And when He had said this, He breathed on them, and said to them, "Receive the Holy Spirit," (John 20:21-22).

Just as in the beginning when God breathed life into the world and into Adam's nostrils, Jesus Christ "breathed" life (the Holy Spirit) into His Church. That life continues today in every believer.

As the old hymn says: "Breathe on me, breath of God. Fill me with life anew, that I may love what Thou dost love, and do what Thou wouldst do."



1. Earth's atmosphere is _____ oxygen.
a. 7 percent b. 14 percent c. 21 percent d. 42 percent
2. The Hebrew word *ruach* means "spirit" or _____.
a. strength b. anger c. light d. breath
3. Triatomic oxygen or O_3 is an unstable, more reactive form of oxygen, also known as _____.
4. TRUE or FALSE: Oxygen was discovered about the same time by three different chemists in three different countries.
5. If the oxygen content of the earth's atmosphere were significantly less, human life would be impossible at _____.
a. sea level b. high elevations c. low temperatures d. the equator

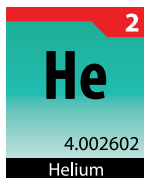
MY RESPONSE



"God, who made the world and everything in it . . . gives to all life, breath, and all things," (Acts 17:24-25).

"Lord, thank You for reminding us of Your love and providence, with even the air that we breathe. Just as You breathed life into the world on its first day and into Adam on his first day, give me Your Holy Spirit today and every day, so that I will be able to serve You. Amen."





EXPERIMENT 1: Displacement of Helium



Day 4

Caution: This experiment requires adult supervision. It has been specifically designed for educational purposes, with materials that are readily available. At its conclusion, please appropriately dispose of any by-products or food items included in the experiment.

■ MATERIALS:

- ☐ Helium balloon
- ☐ Moving vehicle

■ PROCEDURE:

Tie the string of a helium-filled balloon securely in your car.

What will happen when your car comes to a rapid stop?

■ OBSERVATION:

Observe the behavior of a helium-filled balloon in a decelerating vehicle.

When you come to a stop, you may have to brace yourself to keep your body from going forward in your car. Likewise, any object in your vehicle may move toward the front.

And when your vehicle accelerates rapidly, your body is forced into your seat.

But helium balloons behave just the opposite.

As your vehicle decelerates rapidly, unlike everything else inside, the helium balloon will drift to the rear. (The phenomenon only occurs with the windows and vents closed.)

Deceleration forces the air inside the vehicle to the front, just like the people and objects in the car. But helium is lighter than air, so it is displaced by the heavier moving air and drifts toward the rear.



*“The wind blows where it wishes, and you hear the sound of it,
but cannot tell where it comes from and where it goes.
So is everyone who is born of the Spirit,” (John 3:8).*



EXPERIMENT 2: Using Borax to Make Slime



Day 14

Caution: This experiment requires adult supervision. It has been specifically designed for educational purposes, with materials that are readily available. At its conclusion, please appropriately dispose of any by-products or food items included in the experiment.

■ MATERIALS:

- ☐ Borax laundry conditioner
- ☐ Four-ounce bottle of white glue, such as Elmer's glue (Most so-called school glues don't work well in this experiment.)
- ☐ Water
- ☐ Food coloring (optional)
- ☐ Two bowls or large measuring cups

■ PROCEDURE:

1. Pour four ounces of glue into bowl.
2. Fill empty glue bottle with water. Add water to bowl.
3. At this point, add food coloring, unless you want your slime to be white. (A teaspoon of food coloring should be about right, but you can use more or less.)
4. Mix the glue, water, and food coloring thoroughly.
5. In a separate container, stir one teaspoon of borax into one cup of water.
6. Slowly pour the diluted glue into the bowl containing the borax solution.
7. Reach into the bowl and remove the mass of "slime." Don't worry about the excess water in the bowl.
8. Knead the slime slowly with your hands to make it firmer.
9. Play with your gooey creation. (Note: Afterward, store your slime in a resealable sandwich bag in your refrigerator, to keep it from going bad.)

■ OBSERVATION:

How does borax create slime?

The chemical formula for borax is $\text{Na}_2\text{B}_4\text{O}_7$. Glue is a collection of long, stringy, and sticky molecules mixed with water. The borax molecules connect the glue molecules together into a "mesh" or "network" that holds water molecules inside like a sponge. The borax keeps the glue from sticking to your skin, and the water, trapped inside the network, makes the slime feel wet.

■ LET'S TAKE IT FURTHER:

Try these modifications:

1. Add more water to the glue.
2. Add less water to the glue or none at all.
3. Try mixing more borax into the slime.
4. Substitute blue gel glue (available from drug stores) instead of white glue.

■ SLIME STORAGE NOTES:

After a while, your slime may develop dark blotches or smell funny. If this happens, it is time to throw your slime away. (You can always make more!)

*“And when she could no longer hide him,
she took for him an ark of bulrushes,
and daubed it with slime and with pitch,
and put the child therein,” (Exod. 2:3).*

(From the story of Moses in the King James Version)

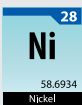
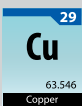
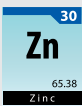
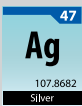
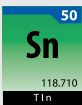
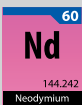
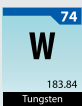
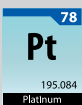
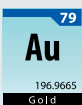
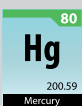
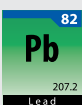


Start Your Own Element Collection



Creating your own collection of the elements is a fun and educational activity. Samples of many elements can be purchased from your local hardware store or camping store.

✓	Tile	Name	Information
☐		Helium	A small Mylar® balloon from the local dollar store can give a helium sample that will last a long time.
☐		Boron	Pure boron is very brittle and not generally available because it has no uses. But the chemical, borax, contains boron and can be bought in many grocery stores in the laundry section.
☐		Carbon	Carbon can be collected in the form of pencil lead (called graphite), charcoal, or even a diamond!
☐		Sodium	The simplest and safest form of sodium to collect is table salt, sodium chloride (NaCl).
☐		Aluminum	Most kitchens have a roll of aluminum foil for wrapping up foods. You can also buy aluminum nails at a hardware store.
☐		Phosphorus	A box of matches contains plenty of phosphorus. Match heads are made of about 50% phosphorus. (We don't recommend that you collect phosphorus the way Hennig Brand first did it back in the 1600s!)
☐		Sulfur	Fairly pure sulfur (90%) can be bought at any garden center.
☐		Chlorine	(Safety Note: This activity should only be done under careful adult supervision.) For a chlorine sample, put a cotton ball in the bottom of a small glass bottle. Then drop in a couple of drops of unscented chlorine bleach. Then close the lid on the bottle.
☐		Argon	Any incandescent light bulb is essentially a container of argon.
☐		Iron	Cheap carbon steel nails, nuts, and bolts are an alloy of iron and carbon.

☐		Nickel	A U.S. nickel is a good sample of nickel metal, but it is actually 75% copper and 25% nickel.
☐		Copper	Copper can be bought in any hardware store in the form of copper plumbing fittings or copper wire or find some older pennies.
☐		Zinc	Samples of galvanized steel (such as galvanized nails and screws) are really just regular steel covered with a coating of zinc. Also a U.S. penny is actually pure zinc inside with a coating of copper. To demonstrate this, cut a penny in half with a tool called a tin snip.
☐		Silver	Silver coins and silver jewelry are, of course, collectible but expensive!
☐		Tin	Nowadays sinkers used for fishing are usually made of tin. (However, lead sinkers are still sold). Lead-free solder used for plumbing is mostly made of tin.
☐		Neodymium	High strength, neodymium magnets can be bought at your local hardware store. (They are actually made of a neodymium-iron-boron alloy.)
☐		Tungsten	The filament in an incandescent light bulb is a sample of tungsten.
☐		Platinum	Platinum jewelry, like silver, is expensive.
☐		Gold	Gold is also collectible as jewelry, but it is also expensive.
☐		Mercury	An old-style mercury thermometer contains mercury in the base but it needs to be handled carefully to prevent breakage.
☐		Lead	Lead weights are available at your local tire shop in the form of lead balancing weights.

	<i>Elements of Faith</i>	Quiz 1 Elements 1-3				Total score: ____ of 100	Name
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- Which ancient culture worshiped the sun as a god?
 - Egyptian
 - Greek
 - Roman
 - All of the above
- TRUE or FALSE: The hydrogen and oxygen atoms in a water molecule share their electrons equally.
- Lithium is the _____ of all the metals.
 - hardest
 - lightest
 - most dangerous
 - densest
- What force causes water molecules to be attracted to each other?
 - gravity
 - magnetism
 - hydrogen bonding
 - diffusion
- Which of the disciples' names meant "rock"?
 - Matthew
 - John
 - Judas
 - Peter
- Which of the following best describes the shape of a water molecule?
 - cross
 - barbell
 - boomerang
 - triangle
- Except for helium, elements with names ending in -um or -ium are _____.
 - gases
 - radioactive
 - metallic
 - poisonous

Choose the correct answer:

alkali

helios

hydro

8. The Greek word for “water” is _____.
9. Lithium, sodium, and potassium are all found in the same column of the Periodic Table. Metals in this column are called _____ metals.
10. The Greek word for “sun” is _____.

WORKSHEET ANSWERS

1. Hydrogen

1. c
2. c
3. false
4. hydro
5. 90

2. Helium

1. c
2. helios
3. Sir William Ramsay
4. idolatry
5. d

3. Lithium

1. b
2. a. lithos, b. petra
3. d
4. alkali
5. foundation

4. Beryllium

1. b
2. d
3. ore
4. a
5. jewels

5. Boron

1. surgery
2. borax
3. a
4. b
5. Louis Pasteur

6. Carbon

1. The Industrial Revolution
2. methane
3. b
4. a
5. d

7. Nitrogen

1. a
2. c
3. nitrogen-fixing bacteria OR bacteria
4. legumes and forage crops
5. b

8. Oxygen

1. c
2. d
3. ozone
4. true
5. b

9. Fluorine

1. d
2. reactive
3. b
4. the halogen family or halogen
5. martyrs

10. Neon

1. b
2. a
3. new
4. by letting our "light shine before men"
5. William Ramsay

11. Sodium

1. a
2. d
3. b
4. salt, earth
5. d

12. Magnesium

1. Humphry Davy
2. d
3. laxative
4. spa
5. seven

13. Aluminum

1. c
2. Fredrick Wohler
3. d
4. the Civil War
5. Laus Deo

14. Silicon

1. silica OR quartz
2. Jons Berzelius
3. Paul
4. c
5. arenologists

15. Phosphorus

1. d
2. c
3. gold
4. fool's gold
5. it glows in the dark

QUIZ AND FINAL EXAM ANSWERS

Quiz 1 – Elements 1-3

1. all of the above
2. false
3. lightest
4. hydrogen bonding
5. Peter
6. boomerang
7. metallic
8. hydro
9. alkali
10. helios

Quiz 2 – Elements 4-6

1. cleanness
2. boric
3. Vauquelin
4. carbon
5. lamp to my feet
6. ruby
7. Davy
8. borax
9. surgery
10. ore

Quiz 3 – Elements 7-9

1. true
2. triple
3. all of the above
4. 21 percent
5. uranium
6. most
7. breath
8. protein
9. true
10. high elevations

Quiz 4 – Elements 10-12

1. a silvery metal that oxidizes quickly
2. NaCl
3. Epsom
4. reddish orange
5. Humphry Davy
6. noble gas
7. making potato chips
8. laxative
9. new
10. spa

Quiz 5 – Elements 13-15

1. sand comes in every shade from white to black
2. all of the above
3. a shiny metal
4. third-most
5. urine
6. gold
7. arenologists
8. fool's gold
9. praise God
10. silica

Quiz 6 – Elements 16-18

1. Samaria
2. typhoid fever
3. safe to inhale its vapors
4. proteins
5. incandescent lightbulbs
6. one
7. titanium
8. halogen
9. lazy
10. brimstone

Quiz 7 – Elements 19-21

1. 1.5
2. burning
3. true
4. less than 1 percent
5. soil
6. aluminum
7. hardwood trees
8. metallurgy
9. dairy
10. yeast or leaven

Quiz 8 – Elements 22-24

1. silvery color
2. chromium
3. emerald
4. strong alloys
5. sodium
6. Jewish
7. strongest
8. galvanized
9. chroma
10. rust

Quiz 9 – Elements 25-27

1. remission
2. bones
3. blue
4. neighbors
5. B-12
6. nickel
7. kobaldis
8. Tubal-Cain
9. magnets
10. Sparta

SUPPLY LIST

Caution: These experiments require adult supervision. They have been specifically designed for educational purposes, with materials that are readily available. At the conclusion of each experiment, please appropriately dispose of any by-products or food items included in the experiment.

Experiment 1 – Requires adult supervision

- ☐ Helium balloon
- ☐ Moving vehicle

Experiment 2

- ☐ Borax laundry conditioner
- ☐ Four-ounce bottle of white glue, such as Elmer's glue (most so-called school glues don't work well in this experiment)
- ☐ Water
- ☐ Food coloring (optional)
- ☐ Two bowls or large measuring cups

Experiment 3 – Requires adult supervision

- ☐ Baking soda (bicarbonate of soda)
- ☐ Vinegar
- ☐ Large measuring cup (two- or four-cup size)
- ☐ Candle
- ☐ Lighter or matches

Experiment 4 – Requires adult supervision

- ☐ Hydrogen peroxide solution
- ☐ Connecting wires with alligator clips (packages of 10 or so can be purchased from an electronics store for less than \$10.00)
- ☐ Glass container (one- to two-cup Pyrex® measuring cup recommended)
- ☐ 9-volt batteries: 3 or 4 (the type of battery used in a smoke detector)
- ☐ Leads for mechanical pencils: 2 (the thicker, the better, and available from an office supply store or art supply store. We will refer to these leads as “electrodes” in the experiment.)
- ☐ Cloth tape or other water-resistant adhesive tape

Experiment 5 – Requires adult supervision

- ☐ Connecting wires with alligator clips (packages of 10 or so can be purchased from an electronics store for less than \$10.00)
- ☐ Glass container (one- to two-cup Pyrex® measuring cup recommended)
- ☐ 9-volt batteries: 3 or 4 (the type of battery used in a smoke detector)
- ☐ Leads for mechanical pencils: 2 (the thicker, the better, and available from an office supply store or art supply store. We will refer to these leads as “electrodes” in the following experiment.)
- ☐ Cloth tape or other water-resistant adhesive tape
- ☐ Carbonated soft drink

Experiment 6 – Requires adult supervision

- ☐ Connecting wires with alligator clips (packages of 10 or so can be purchased from an electronics store for less than \$10.00)
- ☐ Glass container (one- to two-cup Pyrex® measuring cup recommended)
- ☐ 9-volt batteries: 3 or 4 (the type of battery used in a smoke detector)
- ☐ Leads for mechanical pencils: 2 (the thicker, the better, and available from an office supply store or art supply store. We will refer to these leads as “electrodes” in the following experiment.)
- ☐ Cloth tape or other water-resistant adhesive tape

Experiment 7

- ☐ Several chicken leg bones
- ☐ Vinegar

Experiment 8 – Requires adult supervision

- ☐ Connecting wires with alligator clips (packages of 10 or so can be purchased from an electronics store for less than \$10.00)

- ☐ Glass container (one- to two-cup Pyrex® measuring cup recommended)
- ☐ 9-volt batteries: 3 or 4 (the type of battery used in a smoke detector)
- ☐ Leads for mechanical pencils: 2 (the thicker, the better, and available from an office supply store or art supply store. We will refer to these leads as “electrodes” in the following experiment.)
- ☐ Cloth tape or other water-resistant adhesive tape
- ☐ 1 cup of liquid chlorine bleach
- ☐ Table salt

Experiment 9 – Requires adult supervision

- ☐ Three or more raw eggs
- ☐ One bottle of fluoride dental rinse
- ☐ Vinegar

Experiment 10

- ☐ One cup of iron-fortified flaked breakfast cereal (nutrition information on box should say “100 percent of daily requirement” for iron)
- ☐ Gallon-sized plastic food storage bag
- ☐ Rolling pin
- ☐ Strong magnet
- ☐ 8½ x 11 sheet of white paper

Experiment 11

- ☐ Connecting wires with alligator clips (packages of 10 or so can be purchased from an electronics store for less than \$10.00)
- ☐ Glass container (one- to two-cup Pyrex® measuring cup recommended)
- ☐ 9-volt batteries: 3 or 4 (the type of battery used in a smoke detector)
- ☐ A small piece of copper (for example, a half-inch copper “elbow” from the plumbing section of a hardware store)
- ☐ Vinegar
- ☐ Cloth tape or other water-resistant adhesive tape (the sticky part of a bandage works well)

Experiment 12 – Requires adult supervision

- ☐ Solid antiperspirant containing aluminum zirconium trichlorohydrate
- ☐ Aluminum foil
- ☐ Large bowl
- ☐ Water and ice

Experiment 13

- ☐ Counterfeit detection pen (available from office supply store)
- ☐ U.S. Currency (bills of various denominations)
- ☐ Copy paper

Experiment 14 – Requires adult supervision

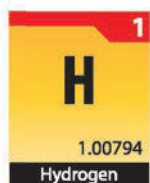
- ☐ *Incandescent light bulbs (various wattages)
- ☐ Hand-held magnifying glass
- ☐ Old bath towels
- ☐ Hammer (standard sized hammer is preferred)
- ☐ Scissors

*Note: This activity requires the use of incandescent light bulbs. Be sure not to purchase LED light bulbs (which do not use tungsten filaments) or CFL light bulbs (which contain small amounts of poisonous mercury vapor). 150 watt and 300 watt bulbs are better for this demonstration. Clear bulbs are recommended.

PERIODIC TABLE

GROUP ► 1
IA

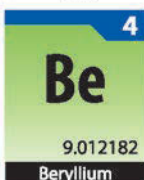
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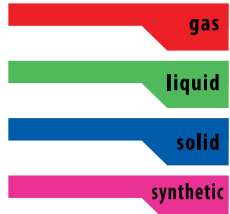
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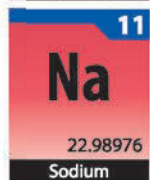
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IIA



At room temperature
the element is:



3



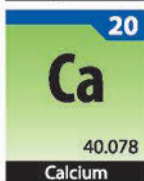
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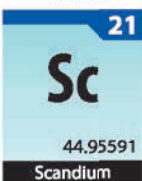
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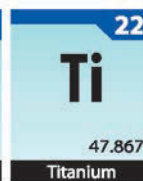
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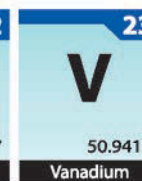
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IIIB



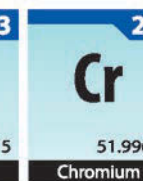
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IVB



5
VB



6
VIB



7
VIIB



8



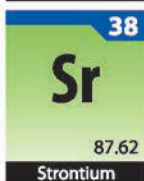
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VIIIB



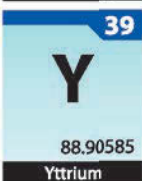
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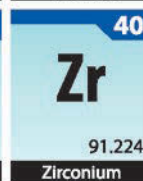
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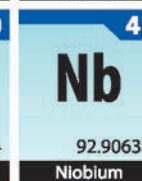
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40



41



42



43



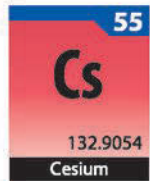
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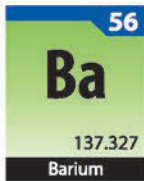
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6



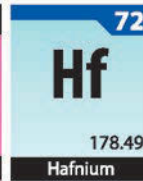
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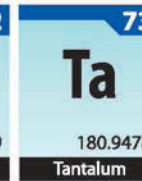
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72



73



74



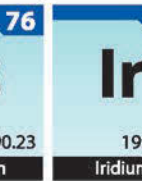
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76



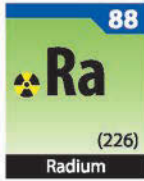
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7



88



89 - 103



104



105



106



107



108



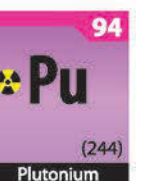
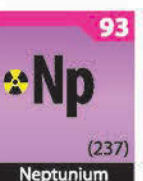
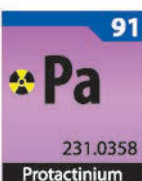
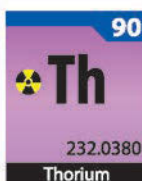
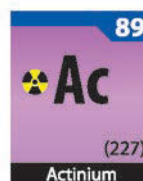
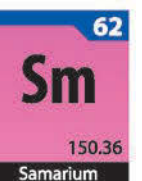
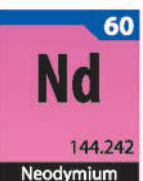
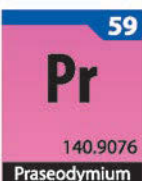
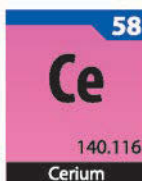
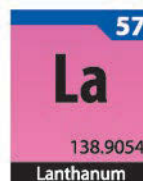
109



NOTE:

For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parenthesis.

* Unknown chemical properties



OF THE ELEMENTS

Categories of Elements (color of background)

- Alkali Metal
- Lanthanide
- Transition Metal
- Alkaline Earth Metal
- Actinide
- Post-transition Metal
- Metalloid
- Polyatomic Nonmetal
- Diatomic Nonmetal
- Noble Gas
- Unknown Chemical Properties

										18 VIIIA
										2
										He
										4.002602 Helium
										10
										Ne
										20.1797 Neon
										18
										Ar
										39.948 Argon
10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA			
28	29	30	31	32	33	34	35	36		
Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
58.6934	63.546	65.38	69.723	72.64	74.92160	78.96	79.904	83.798		
Nickel	Copper	Zinc	Gallium	Germanium	Arsenic	Selenium	Bromine	Krypton		
46	47	48	49	50	51	52	53	54		
Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
106.42	107.8682	112.441	114.818	118.710	121.760	127.60	126.9044	131.293		
Palladium	Silver	Cadmium	Indium	Tin	Antimony	Tellurium	Iodine	Xenon		
78	79	80	81	82	83	84	85	86		
Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn		
195.084	196.9665	200.59	204.3833	207.2	208.9804	(209)	(210)	(222)		
Platinum	Gold	Mercury	Thallium	Lead	Bismuth	Polonium	Astatine	Radon		
110	111	112	113	114	115	116	117	118		
Ds	Rg	Cn	Nh	Fl	Mc	Lv	Ts	Og		
*(281)	*(272)	*(285)	*(286)	*(289)	*(288)	*(292)	*(294)	*(294)		
Darmstadtium	Roentgenium	Copernicium	Nihonium	Flerovium	Moscovium	Livermorium	Tennessine	Oganesson		

63	64	65	66	67	68	69	70	71		
Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu		
151.964	157.25	158.9253	162.500	164.9303	167.259	168.9342	173.054	174.9668		
Europium	Gadolinium	Terbium	Dysprosium	Holmium	Erbium	Thulium	Ytterbium	Lutetium		
95	96	97	98	99	100	101	102	103		
Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr		
(243)	(247)	(247)	(251)	(252)	(257)	(258)	(259)	(262)		
Americium	Curium	Berkelium	Californium	Einsteinium	Fermium	Mendelevium	Nobelium	Lawrencium		