

BRIGHT SCHOLARS

COMPLETE COURSE WORKBOOK

MASTERING HIGH SCHOOL
CHEMISTRY

FULL COURSE Grades 10–11

A Complete Practice Workbook for Measurement, Atomic Structure, Bonding,
Reactions, Stoichiometry, Gases, Solutions, Acids and Bases, and Energy

Learn it. Practice it. Prove it.

MATTER • ATOMS • BONDING • REACTIONS • THE MOLE • GASES • SOLUTIONS • ACIDS • ENERGY

THIS BOOK BELONGS TO

Name _____

Class / Period _____

Teacher _____

School Year _____

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ANSWERS

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Periodic Table of the Elements

GROUP																	
Metal																	
Nonmetal																	
Metalloid																	
Metal–nonmetal border																	
– Atomic number																	
– Symbol																	
– Name																	
– Average atomic mass (u or g/mol)																	
6 C Carbon 12.01																	

Masses in brackets are mass numbers of the longest-lived isotope. Elements 104–118 are synthetic; their properties are not well known.

Matter and Measurement

? BIG QUESTION

How do chemists describe matter precisely enough that anyone, anywhere, can repeat their measurements and trust their results?

BY THE END OF THIS UNIT, I CAN

- ☐ classify matter as an element, a compound, or a homogeneous or heterogeneous mixture.
- ☐ use SI units, metric prefixes, and scientific notation.
- ☐ record measurements and calculate answers with the correct number of significant figures.
- ☐ solve problems with density and dimensional analysis.
- ☐ describe the states of matter with a particle model and classify physical and chemical changes.

UNIT ROADMAP

- 1.1 Chemistry and the Classification of Matter..... p. 14
- 1.2 Measurement, SI Units, and Scientific Notation p. 16
- 1.3 Significant Figures, Density, and Dimensional Analysis p. 17
- 1.4 States of Matter p. 19
- 1.5 Physical and Chemical Properties and Changes p. 21

Suggested time: 1 week

Standards: HS-PS1-3; SEP 4, 5

KEY VOCABULARY

matter element compound mixture
homogeneous heterogeneous SI unit
scientific notation significant figures
accuracy precision density
dimensional analysis intensive property
extensive property physical change
chemical change

Chemistry and the Classification of Matter

KEY TERMS chemistry • matter • pure substance • element • compound • mixture • homogeneous • heterogeneous

Chemistry is the study of matter, its properties, the changes it undergoes, and the energy involved in those changes. **Matter** is anything that has mass and takes up space. Chemistry is often called the *central science* because it connects physics, biology, earth science, medicine, and engineering. A doctor choosing a medicine, an engineer designing a battery, and a farmer testing soil are all using chemistry.

Chemists organize their work into branches. **Organic** chemistry studies carbon-based compounds such as fuels, plastics, and medicines. **Inorganic** chemistry studies metals, minerals, and most other compounds. **Analytical** chemistry identifies substances and measures how much is present. **Physical** chemistry studies energy, rates, and the physical laws behind reactions. **Biochemistry** studies the chemistry of living things.

To make sense of the millions of known substances, chemists first sort matter into groups. A **pure substance** has a fixed composition that is the same in every sample. An **element** is a pure substance made of only one kind of atom, such as copper (Cu) or oxygen (O₂). A **compound** is a pure substance made of two or more elements chemically combined in a fixed ratio, such as water (H₂O). A compound can be broken into its elements only by a chemical change.

A **mixture** is a physical blend of two or more substances whose proportions can vary. In a **homogeneous** mixture, also called a solution, the composition is uniform throughout: salt water, air, and brass look the same everywhere. In a **heterogeneous** mixture, the parts are visibly different, as in granite, sand in water, or a salad. Mixtures can be separated by physical methods such as filtration, evaporation, distillation, and chromatography.

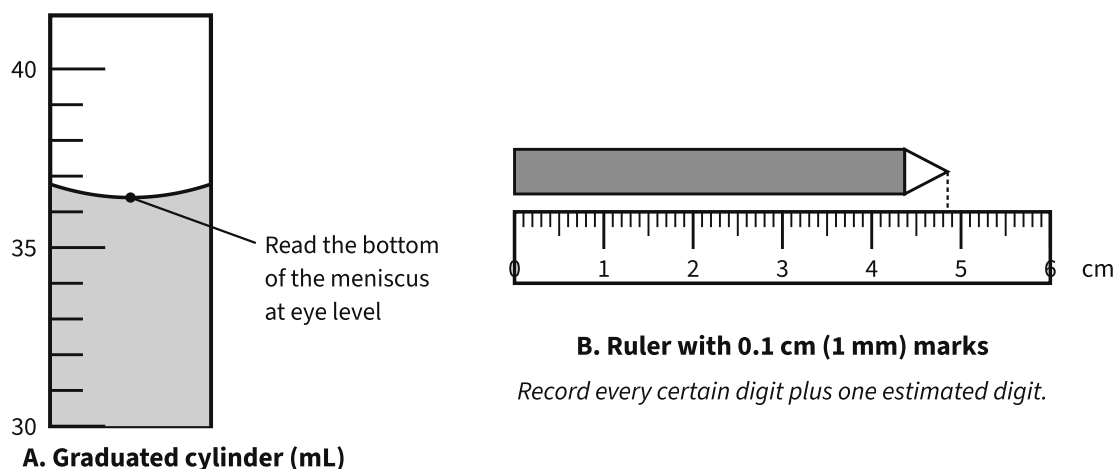


FIGURE 1.2 Reading instruments. Record all certain digits plus one estimated digit.

Rule	Example	Significant figures
All nonzero digits count.	4.52	3
Zeros between nonzero digits count.	7.02×10^3	3
Leading zeros never count; they only place the decimal.	0.00450	3
Trailing zeros count when there is a decimal point.	150.0	4
Trailing zeros without a decimal point are ambiguous.	4500	2 (write 4.500×10^3 to show 4)
Exact numbers (counts, defined values) have unlimited significant figures.	12 eggs; 1 L = 1000 mL	unlimited

Calculations. When you multiply or divide, round the answer to the **fewest significant figures** in the data. When you add or subtract, round to the **fewest decimal places**. Round only at the end of a problem.

Density is mass per unit volume: $d = m \div V$. It is a property of a substance, so it helps identify unknown materials. Water's density is about 1.00 g/mL; aluminum's is 2.70 g/cm³. Objects less dense than water float in it.

Dimensional analysis solves problems by multiplying by conversion factors so that unwanted units cancel. If the units of your answer come out right, the setup is almost always right.

WORKED EXAMPLE: DIMENSIONAL ANALYSIS WITH TWO FACTORS

Problem. A car travels at 72.0 km/h. What is its speed in m/s?

Setup. $72.0 \text{ km/h} \times (1000 \text{ m} \div 1 \text{ km}) \times (1 \text{ h} \div 3600 \text{ s})$

Answer. 20.0 m/s. Kilometers and hours cancel; three significant figures come from 72.0 (the conversion factors are exact).

Unit 1 Practice

MULTIPLE CHOICE

Fill in the bubble for the best answer.

- 1 Which of the following is a homogeneous mixture?
- (A) Granite (B) Salt water
(C) Copper (D) Carbon dioxide
- 2 Which property is intensive?
- (A) Mass (B) Volume
(C) Length (D) Density
- 3 Which shows 0.00620 written in scientific notation?
- (A) 6.20×10^{-3} (B) 6.20×10^3
(C) 0.620×10^{-2} (D) 62.0×10^{-4}
- 4 How many significant figures are in 0.04050?
- (A) 3 (B) 4
(C) 5 (D) 6
- 5 Which prefix means 10^{-6} ?
- (A) Milli (B) Centi
(C) Micro (D) Nano
- 6 Which is a chemical change?
- (A) Melting butter (B) Dissolving sugar in tea
(C) Iron rusting (D) Boiling water
- 7 A 25.0 mL sample of a liquid has a mass of 19.7 g. What is its density?
- (A) 0.788 g/mL (B) 1.27 g/mL
(C) 0.79 g/mL (D) 493 g/mL
- 8 Which is a physical change?
- (A) Burning propane (B) Souring milk
(C) Digesting food (D) Crushing an aluminum can

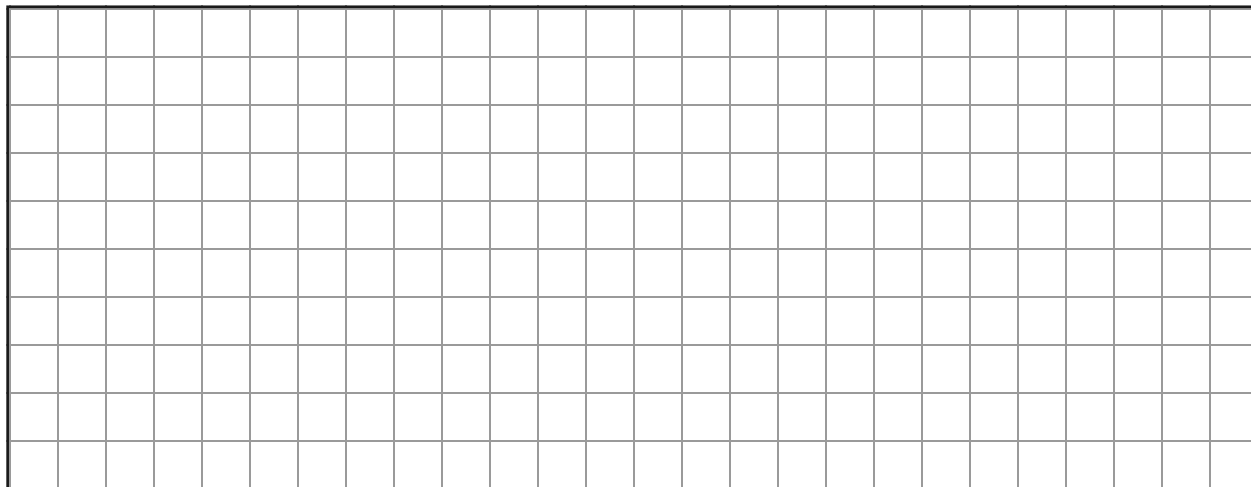
Data Lab: Identifying a Metal by Its Density

A student was given five pieces of the same unknown metal. She measured each piece's mass on a balance and its volume by water displacement.

DATA SET A: MASS AND VOLUME OF FIVE SAMPLES

Sample	1	2	3	4	5
Mass (g)	10.8	21.5	32.6	43.0	54.1
Volume (mL)	4.0	8.0	12.1	15.9	20.0

Graph mass (y-axis) against volume (x-axis). Title the graph, label both axes with units, and draw a best-fit straight line.



- 1 Why should the best-fit line pass through the origin (0, 0)?

- 2 Calculate the slope of your best-fit line. Include units. What property does the slope represent?

SHOW YOUR WORK

Slope: _____

CASE STUDY

Case Study: When Units Go Wrong

CASE STUDY

On July 23, 1983, Air Canada Flight 143, a new Boeing 767, ran out of fuel at about 41,000 feet over Ontario. Canada was switching to the metric system, and this was one of the airline's first planes to measure fuel in kilograms instead of pounds. The flight needed 22,300 kg of fuel. Ground crew measured 7682 L already in the tanks and converted it to mass using 1.77, the number of *pounds* per liter of jet fuel, instead of the correct 0.803 *kilograms* per liter. They then added the fuel they thought was missing. Both engines failed in flight. The pilots glided the plane to a former air force base at Gimli, Manitoba, and landed safely. All 69 people on board survived, and the plane became known as the "Gimli Glider."

In 1999, NASA lost the Mars Climate Orbiter for a similar reason. One team's software reported thruster data in pound-force seconds, while the navigation team's software expected newton-seconds (1 pound-force second is about 4.45 newton-seconds). Small errors added up over months, and the spacecraft passed far too close to Mars and was lost.

- 1 Calculate the actual mass of fuel, in kilograms, in the 7682 L already in the tanks.

SHOW YOUR WORK

Actual mass: _____

- 2 The crew multiplied 7682 L by 1.77. What mass did they believe was in the tanks? What unit did that number really have?

SHOW YOUR WORK

Believed mass: _____

- 3 The crew added 4917 L more. Using the correct factor, estimate the total mass of fuel on board. What fraction of the 22,300 kg needed was this?

Answer Key

Calculations show the setup and the answer with correct significant figures; answers may differ in the last digit if you round at a different step. Accept any chemically accurate wording for written answers. Multiple-choice answers are in bold.

Unit 1: Matter and Measurement

Lesson 1.1 Chemistry and the Classification of Matter (p. 14)

1. Helium: element. Table sugar: compound. Vinegar: homogeneous mixture (a solution of acetic acid in water). Cereal with milk: heterogeneous mixture.
2. It links many other sciences. Example: biochemistry connects chemistry and biology by explaining how enzymes, DNA, and metabolism work at the level of molecules.

Lesson 1.2 Measurement, SI Units, and Scientific Notation (p. 16)

1. $4500 \text{ mg} \times (1 \text{ g} \div 1000 \text{ mg}) = 4.5 \text{ g}$. (4500 has two significant figures, so the answer is 4.5 g.)
2. 60,200 and 6.20×10^{-3} .

Lesson 1.3 Significant Figures, Density, and Dimensional Analysis (p. 17)

1. (a) 4 (b) 4 (c) 3
2. 39.06 rounds to 39.1 cm^2 (three significant figures).
3. A: about 36.4 mL (36.3 to 36.5 mL is reasonable). B: about 4.85 cm (4.84 to 4.86 cm is reasonable). Each has one estimated digit.

Lesson 1.4 States of Matter (p. 19)

1. **B**
2. Gas particles are far apart with mostly empty space between them, so pushing them closer reduces the volume a lot. Liquid particles are already touching, so there is almost no space to remove.

Lesson 1.5 Physical and Chemical Properties and Changes (p. 21)

1. Rusting: chemical (a new substance, iron oxide, forms). Melting: physical (still water, only the state changes). Burning: chemical (new substances, CO_2 and H_2O , plus heat and light). Evaporating salt water: physical (water changes state; the salt is unchanged and can be recovered).

Unit 1 Practice (p. 22)

MULTIPLE CHOICE

1. **B**
2. **D**
3. **A**
4. **B**. The leading zeros do not count; 4, 0, 5, and the trailing 0 do.
5. **C**
6. **C**
7. **A**. $19.7 \text{ g} \div 25.0 \text{ mL} = 0.788 \text{ g/mL}$ (three significant figures).
8. **D**
9. **A**
10. **C**

TRUE OR FALSE

1. **F**. A compound can be broken into its elements only by a chemical change.
2. **T**
3. **F**. Leading zeros are placeholders and are never significant.
4. **T**
5. **F**. Bubbles also form during boiling, a physical change; evidence must be judged in context.
6. **T**

FILL IN THE BLANK

1. kelvin
2. meniscus
3. homogeneous
4. precision
5. extensive
6. plasma
7. element
8. density

CALCULATIONS AND SHORT ANSWER

1. $2.75 \text{ L} \times (1000 \text{ mL} \div 1 \text{ L}) = 2750 \text{ mL}$, or $2.75 \times 10^3 \text{ mL}$ to show three significant figures.
2. $d = 18.6 \text{ g} \div 6.20 \text{ mL} = 3.00 \text{ g/mL}$.
3. $3.75 \text{ km} \times (1000 \text{ m} \div 1 \text{ km}) \times (100 \text{ cm} \div 1 \text{ m}) = 3.75 \times 10^5 \text{ cm}$.
4. 15.867 g rounds to 15.9 g, because 3.1 g is known only to the tenths place.