

Practice Exam

Name _____ Date _____ Every question type comes in three levels. Do **Level 1** to check the idea, **Level 2** to practice at exam difficulty, **Level 3** to be ready for anything. Calculator allowed. Watch your significant figures on every numeric answer.

Substance	Density (g/mL = g/cm ³)
Water	1.00
Aluminum	2.70
Zinc	7.13
Iron	7.87
Copper	8.96
Silver	10.50
Lead	11.35
Mercury	13.6
Gold	19.3

Before you start — the two rules that cost the most points:

- **Add / subtract:** the answer keeps the fewest *decimal places*.
- **Multiply / divide:** the answer keeps the fewest *significant figures*.

Write every measured number with all certain digits *plus one estimated digit*.

Skip-list: your teacher marked the 5% rule and “is the y-intercept negligible?” as skipped on the Unit 1 Review (#6b, #6c, #7c). Those are not on this practice exam either.

Q1. Mass vs. Volume — definitions and units

Learning Target: 1

LEVEL 1 · WARM-UP Fill in the blanks.

Mass measures _____ and is measured in _____.

Volume measures _____ and is measured in _____.

LEVEL 2 · EXAM LEVEL A student writes: “Mass is the weight of something.” Explain what is wrong with that sentence, then write a correct definition of mass.

LEVEL 3 · STRETCH Two blocks take up exactly the same amount of space, but block A has a larger mass than block B.

1. Which block is denser? How do you know?
2. An astronaut carries both blocks to the Moon. What happens to each block's *mass*? To its *weight*? Explain.

Q2. Reading instruments & uncertainty

Learning Target: 5

LEVEL 1 · WARM-UP A graduated cylinder is marked every 1 mL. The bottom of the meniscus sits between the 26 and 27 marks, about four-tenths of the way up. Record the volume. Volume = _____ How many sig figs?

LEVEL 2 · EXAM LEVEL A 100-mL graduated cylinder is marked every 1 mL. The meniscus is just past the 52 mark, about eight-tenths of the way to 53.

1. Record the volume: _____
2. Which digit in your answer is the *uncertain* (estimated) one? _____
3. Why can't you write 52.83 mL? _____

LEVEL 3 · STRETCH Balance A displays **12.7 g**. Balance B displays **12.68 g** for the same object.

1. Which balance has the greater uncertainty? Explain.
2. Which is more precise?
3. You need a mass good to the nearest 0.01 g. Which balance do you use, and why?

Q3. Counting significant figures

Learning Target: 6

LEVEL 1 · WARM-UP How many sig figs?

- a) 45.2 _____ b) 0.0067 _____ c) 3200 _____ d) 5.010 _____

LEVEL 2 · EXAM LEVEL How many sig figs?

- a) 0.003040 _____ b) 100.0 _____ c) 2.50×10^4 _____ d) 8000. _____

LEVEL 3 · STRETCH How many sig figs? Then explain (c) in one sentence.

- a) 0.0100500 _____ b) 1.0×10^{-3} _____ c) exactly 12 eggs in a dozen _____

Q4. Rounding to a given number of sig figs

Learning Target: 6

LEVEL 1 · WARM-UP a) 5.6789 to 3 sig figs _____ b) 0.0034567 to 2 sig figs _____

LEVEL 2 · EXAM LEVEL a) 2.4995 to 3 sig figs _____ b) 1,349 to 2 sig figs _____

LEVEL 3 · STRETCH a) 9.9987 to 3 sig figs _____ b) 0.049996 to 3 sig figs _____

Careful on Level 3: rounding can push a 9 up and change how many digits are in front of the decimal point.

Q5. Calculating with significant figures

Learning Target: 6

LEVEL 1 · WARM-UP a) $14.2 \text{ g} + 3.56 \text{ g} =$ _____ b) $3.0 \text{ cm} \times 4.25 \text{ cm} =$ _____

LEVEL 2 · EXAM LEVEL a) $100.00 \text{ mL} - 27.3 \text{ mL} =$ _____ b) $45.62 \text{ g} \div 7.0 \text{ mL} =$ _____

LEVEL 3 · STRETCH a) $0.0045 \text{ m} + 1.2 \text{ m} =$ _____ b) $(2.50 \times 10^3) \times (4.0 \times 10^{-2}) =$ _____

- c) Two steps — watch the rule change halfway through: $(18.72 \text{ g} - 2.5 \text{ g}) \div 5.00 \text{ mL} =$ _____

Q6. Conservation of mass

Learning Target: 3

LEVEL 1 · WARM-UP A sealed jar holds 5.0 g of ice. The ice melts completely. What is the mass of the water? Why?

LEVEL 2 · EXAM LEVEL A 12.0 g piece of steel wool is burned in open air. Afterward it has a mass of 14.5 g.

1. Was mass created? Explain what actually happened.
 2. Where did the extra 2.5 g come from?
 3. What would the total mass be if the burning happened inside a sealed container?
-
-

LEVEL 3 · STRETCH 10.0 g of sugar is stirred into 100.0 g of water in a sealed flask.

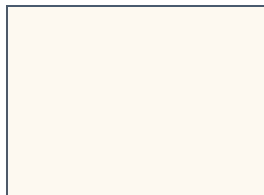
1. Predicted mass of the sealed flask contents afterward? _____
 2. A class measures 109.8 g. Give the **best** explanation — and say why “some mass disappeared” is not it.
-
-

Q7. Particle diagrams for solids, liquids, and gases

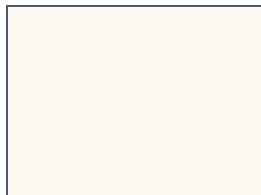
Learning Target: 10

LEVEL 1 · WARM-UP

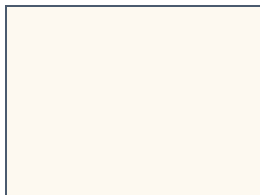
Draw the same substance in all three phases. Use the same number of particles in each box.



SOLID



LIQUID



GAS

Then answer:

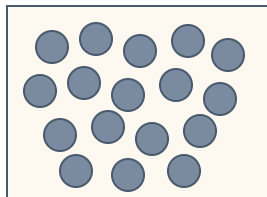
- Which phase has the largest volume?

- Which has the greatest density?

- Does the *mass* change between boxes?

LEVEL 2 · EXAM LEVEL

The box at left shows atoms of liquid aluminum. In the box at right, draw the **same atoms** as a solid. Then explain, in one sentence, what you changed and why.



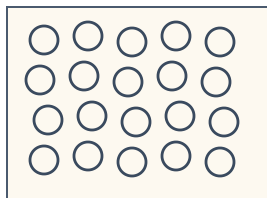
LIQUID (given)



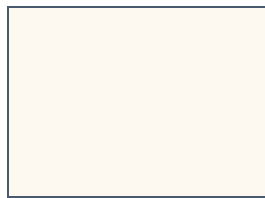
SOLID (draw)

LEVEL 3 · STRETCH

The box at left shows iron atoms in steel wool. Draw the particles **after** the steel wool is strongly heated in air, and explain how your drawing is consistent with the mass increasing.



BEFORE (given)



AFTER (draw)

Q8. Histograms and what scatter means

Learning Target: 2

LEVEL 1 · WARM-UP A class measures the same object and records: 24.6, 24.7, 24.7, 24.8, 24.7, 24.6, 24.7 g. Which value would be the tallest bar on a histogram? _____ What is the best single estimate of the true mass?

LEVEL 2 · EXAM LEVEL A class dissolves sugar in water and plots the *change* in mass. The bars run from -0.07 g to $+0.01$ g, with the tallest bar at about -0.04 g. The class concludes: “mass decreases slightly when sugar dissolves.”

1. What is the flaw in that conclusion?
2. Write a better conclusion.

LEVEL 3 · STRETCH Name two specific changes to the experiment that would make the histogram narrower, and say why each one helps.

Q9. Mass vs. volume graphs

Learning Target: 7

LEVEL 1 · WARM-UP A straight line through the origin passes through (10.0 mL, 25.0 g).

1. Slope, with units: _____
2. What physical property is that slope? _____

LEVEL 2 · EXAM LEVEL On one mass-vs-volume graph, substance A is a steeper line than substance B, and the dashed line for water lies between them.

1. Which substance is denser? Explain using the word *slope*.
2. Which substance floats in water? How does the graph tell you?
3. Equal *volumes* of A and B are placed on a two-pan balance. Which pan drops? Why?

LEVEL 3 · STRETCH A class measures several samples of one substance and the software fits the line $M = 2.65V - 0.310$, where M is in grams and V is in cm^3 .

1. What does the slope tell you? Include units.
2. The y-intercept is -0.310 g. What *should* it be, and what does a nonzero value suggest about the experiment?
3. Predict the mass of a 45.0 cm^3 piece of this substance. Show your work.
4. Would this substance sink or float in water? Defend your answer with a number.

Q10. Calculating density from measurements

Learning Target: 7, 8

LEVEL 1 · WARM-UP An object has a mass of 24.0 g and a volume of 3.0 mL. Density = _____

LEVEL 2 · EXAM LEVEL A student finds an object's mass to be 33.4 g. She fills a graduated cylinder to 31.2 mL, drops the object in, and the water rises to 45.2 mL. Find the density. Show every step.

LEVEL 3 · STRETCH A metal cube measures 2.50 cm on every side and has a mass of 164 g.

1. Volume, in cm^3 and in mL: _____
 2. Density: _____
 3. Using the table on page 1, what metal is it? _____
-
-

Q11. Density as a conversion factor (mass $\leftrightarrow$ volume)

Learning Target: 9

LEVEL 1 · WARM-UP Aluminum has a density of 2.70 g/mL. What is the mass of 5.00 mL of aluminum?

LEVEL 2 · EXAM LEVEL Mercury has a density of 13.6 g/mL. What volume is occupied by 250.0 g of mercury?

LEVEL 3 · STRETCH A thin layer of gold plating is applied to a metal tray measuring 20.15 cm by 12.40 cm. The plating increases the tray's mass by 0.0385 g. The density of gold is 19.32 g/ cm^3 . Calculate the **thickness** of the plating in cm.

Hint — three moves: mass $\rightarrow$ volume (using density), then area of the tray, then thickness = volume $\div$ area.

Q12. Density as a fingerprint — identify it or catch a fake

Learning Target: 8

LEVEL 1 · WARM-UP An unknown metal has a density of 8.96 g/mL. Using the table, what is it? _____

LEVEL 2 · EXAM LEVEL A cube of gold-colored metal has a volume of 25.0 cm³ and a mass of 445 g. The density of gold is 19.3 g/cm³. Is this sample pure gold? Show the number that decides it, then answer in a sentence.

LEVEL 3 · STRETCH An irregular chunk of metal has a mass of 56.8 g. A graduated cylinder holds 12.00 mL of water; after the chunk is added the level reads 17.00 mL.

1. Volume of the chunk: _____
 2. Its density: _____
 3. Most likely identity, and how confident are you? _____
- _____
- _____

Q13. Multi-step challenge — putting it all together

Learning Target: 9

LEVEL 3 · STRETCH A rectangular piece of aluminum foil measures 15.0 cm by 10.0 cm and has a mass of 0.746 g. The density of aluminum is 2.70 g/cm³. Find the **thickness** of the foil.

This is the aluminum-foil activity from class, in exam form. If you can do this one cleanly, you can do any density problem on the Beta.

Unit 1 Practice Exam — built from the official AMTA Unit 1 Review, the class sig-fig worksheet, and the Unit 1 learning targets.