CHEMISTRY · UNIT 1 — TARGETED PRACTICE

Practice Workbook

Name _____ Date _____

Twelve sections, built on the things worth more practice. **You do not have to do this in one sitting** — each section stands alone, so do two or three at a time. Calculator yes, notes yes. Show your work: on the real exam the work is where the partial credit lives.
On every numeric answer, write the unit and check the significant figures before you move on.

Density reference (g/mL = g/cm³): 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

1. Units — what goes with what

18 items

1a. Fill in the table.

Quantity	Symbol	Units we use in this unit	How you measure it
Mass			balance
Volume (liquid)			graduated cylinder
Volume (regular solid)			ruler + formula
Volume (irregular solid)			water displacement
Length			ruler
Density			calculate: m ÷ V
Temperature			thermometer

1b. What unit does each calculation produce? (Write the unit only — no numbers needed.)

a) g + g = _____ b) g ÷ mL = _____ c) cm × cm = _____

d) cm × cm × cm = _____ e) (g/mL) × mL = _____ f) g ÷ (g/cm³) = _____

g) cm³ ÷ cm² = _____ h) mL − mL = _____ i) g ÷ cm³ = _____

1c. Convert.

a) 1 cm³ = _____ mL b) 45.0 cm³ = _____ mL c) 2.50 L = _____ mL

d) 1250 g = _____ kg e) 0.750 kg = _____ g f) 3.5 mL = _____ L

1d. Circle every quantity below that *could* be a density. Cross out the ones that could not, and say why in one word.

7.8 g/cm³ 12 cm³ 0.92 g/mL 25 g 19.3 g/mL 4.5 cm 1.00 g/mL

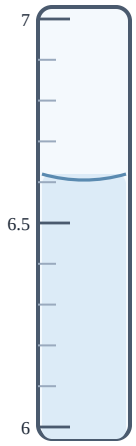
1e. Units as an error-detector.

A student calculating the thickness of aluminum foil ends up with **0.0018 g/cm**. Without redoing her arithmetic, how do you know she made a mistake? What step did she most likely skip?

2. Certain and uncertain digits

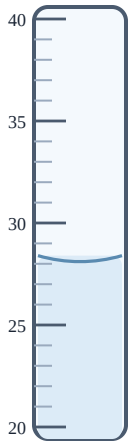
9 items

2a. Record each reading correctly. Then circle the uncertain digit in your answer.



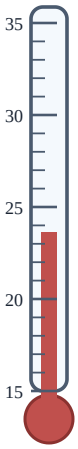
(i) 10-mL cylinder marked every 0.1 mL

_____



(ii) 50-mL cylinder marked every 1 mL

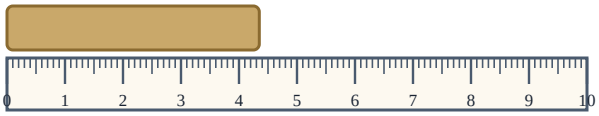
_____



°C, marked every 1°

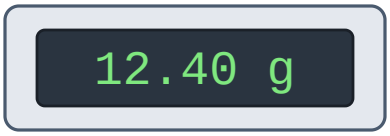
(iii) thermometer

_____



ruler marked in centimetres, smallest division 0.1 cm

(iv) length of the block = _____



electronic balance

(v) mass = _____ sig figs = _____

2b. A cylinder is marked every 1 mL. Which recordings are acceptable? Circle them, and say what is wrong with the others.

24 mL 24.3 mL 24.35 mL 24.0 mL

2c. A balance displays 8.50 g. Why is it wrong to write this down as 8.5 g?

2d. Two students measure the same object. One writes 6.7 cm, the other 6.70 cm. Can they both be right? Explain what each answer says about the ruler used.

3. Significant figures — adding and subtracting

10 items

> Rule to apply: the answer keeps the same number of **decimal places** as the measurement with the **fewest** decimal places.

a) 12.11 g + 18.0 g + 1.013 g = _____ b) 45.6 mL − 3.21 mL = _____

c) 0.250 m + 1.4 m = _____ d) 100.0 g + 25 g = _____

e) 7.939 s − 0.0031 s = _____ f) 2.5 cm + 2.5 cm = _____

g) 155.75 g + 8.6 g = _____ h) 0.0045 L + 0.00120 L = _____

i) 34.6 g − 34.1 g = _____ j) 1.0 mL + 2.00 mL + 3.000 mL = _____

Then answer: in part (i), how many *significant figures* does your answer have? _____ Why is that surprising?

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4. Significant figures — multiplying and dividing

10 items

> Rule to apply: the answer keeps the same number of **significant figures** as the measurement with the **fewest** significant figures.

a) 3.14 cm × 2.0 cm = _____ b) 45.0 g ÷ 9.00 mL = _____

c) 0.0025 kg × 400. = _____ d) 12.5 m × 3.0 m = _____

e) 144 g ÷ 12 mL = _____ f) 6.022 g × 2.0 = _____

g) 98.6 g ÷ 3.00 mL = _____ h) 0.500 cm × 0.500 cm = _____

i) 7.0 cm × 8.0 cm × 2.0 cm = _____ j) 1.00 g ÷ 3.00 mL = _____

5. When the answer comes out to 10, 100 or 1000

11 items

> **Why this section exists.** Written on its own, **10** has only *one* significant figure — the zero is a placeholder. So if your calculation deserves two sig figs and the answer is ten, writing "10" is *wrong*. You have two legal ways to fix it:
>
> • add a decimal point: **10.** • use scientific notation: **1.0×10^{1}**
>
> Scientific notation is always safe. And note that at 100 the decimal-point trick can only give you *three* sig figs (100.) — so if your answer is a hundred and needs only **two**, scientific notation is the only way to write it.

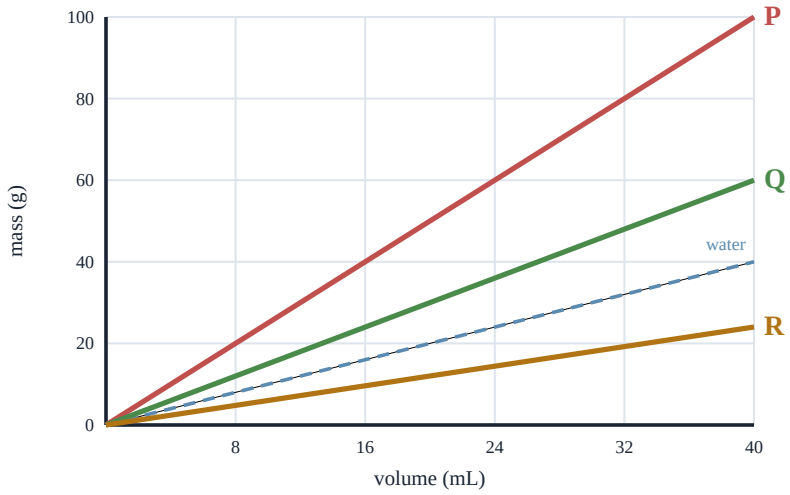
For each one: give the answer, state how many sig figs it must show, and write it so that it actually shows them.

Calculation	Calculator says	How many sig figs must it show?	Written correctly
5.0 × 2.0			
25 × 4.0			
2.50 × 4.00			
round 9.96 to 2 sig figs			
round 99.7 to 2 sig figs			
9.8 g + 0.2 g			
12.4 mL − 2.4 mL			
$(2.0 \times 10^{3}) \times (5.0 \times 10^{-2})$			
1000.0 ÷ 100.00			
round 0.00998 to 2 sig figs			
8.00 cm + 2.00 cm			

6. Mass vs. volume graphs

5 parts

6a. Three substances P, Q and R are plotted below, with water shown as a dashed line.



i) Rank P, Q and R from most dense to least dense. _____

ii) Which of them would float in water? _____ How does the graph tell you? _____

iii) Find the slope of line P using two points. Show your work, and state what the slope means in words.

iv) What is the mass of 20.0 mL of Q? _____

v) What volume of R has a mass of 12 g? _____

vi) Equal *volumes* of P and R are placed on a two-pan balance. Which side drops, and why?

6b. A different class fits the line M = 8.96V − 0.30 (M in g, V in cm³). The largest mass they measured was about 180 g.

i) What is the density, and what substance is it? _____

ii) Predict the mass of a 15.0 cm³ sample. Show your work.

iii) Would it sink or float in water? Defend it with a number. _____

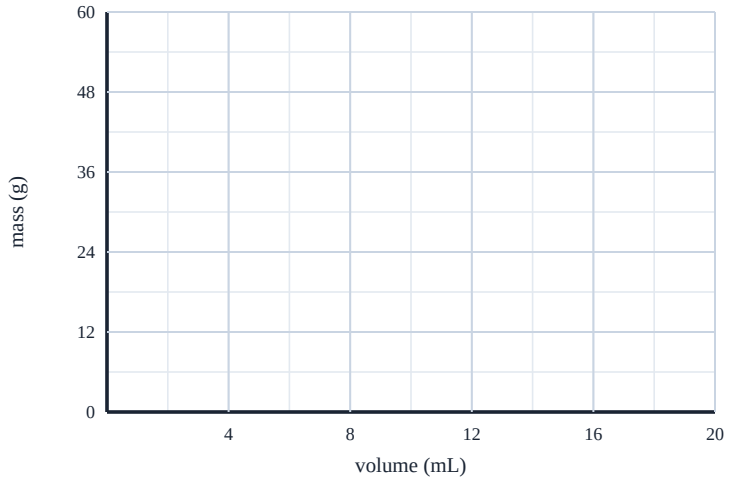
iv) Use the 5% rule to decide whether the −0.30 g intercept is negligible. Show the comparison.

6c. A class collected this data for one substance.

Volume (mL)	2.00	4.00	6.00	8.00
Mass (g)	15.7	31.5	47.2	63.0
Density (g/mL)				

Fill in the density row, then answer: are these all the same substance? Which one? Why do the four numbers not come out exactly equal?

6d. On the grid below, sketch and label two lines: one for water (1.00 g/mL) and one for aluminum (2.70 g/mL). Plot at least two points for each before you draw.



6e. Another class fits M = 0.92V + 1.4, and their largest mass was 25 g.

Use the 5% rule on the intercept. Is it negligible this time? If not, give a specific experimental reason a class might get a *positive* intercept of about 1.4 g.

7. Conservation of mass — open vs. closed systems

12 items

7a. For each situation, predict what the balance reading does and give the reason in a few words.

What happens	Open or closed?	Reading goes UP / DOWN / SAME	Why
Ice melts in a sealed jar	closed		
Steel wool is burned in open air	open		
Steel wool is burned inside a sealed flask	closed		
An antacid tablet fizzes in an open cup of water	open		
The same tablet fizzes in a sealed bottle	closed		
Sugar dissolves in an open beaker of water	open		
Water evaporates from an open dish over a week	open		
An iron nail rusts in open air over a month	open		

7b. Numbers.

i) 15.0 g of steel wool is burned in open air. Afterward it has a mass of 20.7 g. What mass of oxygen combined with the iron? _____

ii) 4.20 g of antacid is dropped into 100.00 g of water in an **open** cup. The final reading is 102.15 g. What mass of gas escaped? Show your work.

iii) The same 4.20 g of antacid and 100.00 g of water react in a **sealed** bottle. What will the balance read? _____ Explain in one sentence.

7c. In the boxes, draw particle diagrams for water in a sealed jar, before and after it is warmed until half of it has evaporated. Then explain how your drawing shows that mass is conserved.

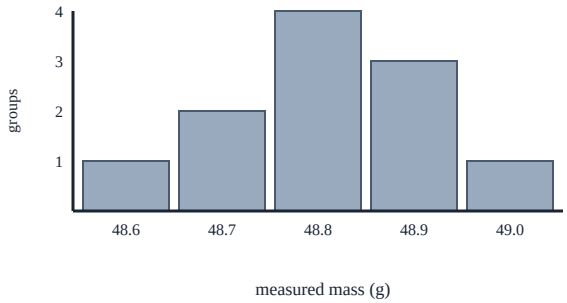
BEFORE

AFTER

8. Histograms

8 items

8a. A class measured the mass of the same metal cube. Their results are below.



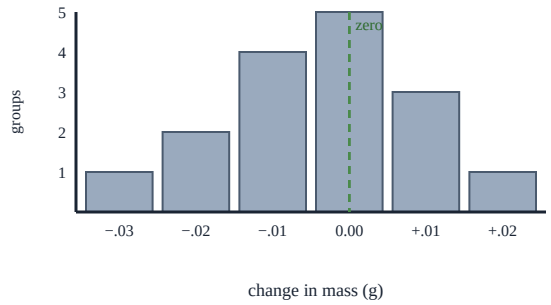
i) Which value came up most often? _____

ii) What is the best single estimate of the true mass? _____

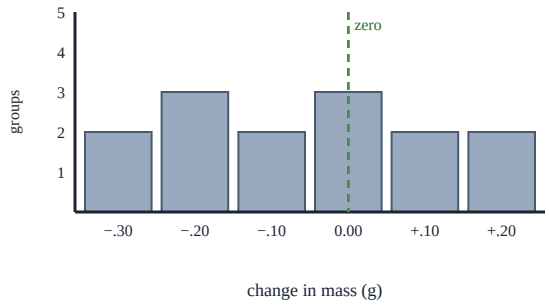
iii) What is the full spread of the data? _____

iv) Roughly what is the uncertainty of the balance they used? _____

8b. Two classes did the same conservation-of-mass experiment. Their histograms are below.



Class A



Class B

i) Which class had the more precise measurements? _____ How can you tell from the shape?

ii) Do both classes support the law of conservation of mass? Explain.

iii) Give two specific changes Class B could make to narrow their histogram.

8c. Sketch the histogram you would expect in each case, and say where it would be centred.

i) A sealed flask, mass measured before and after a reaction, good balances.

ii) An open cup where a gas is produced and escapes.

9. What is this metal? 10 items

Density reference (g/mL = g/cm³): 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

For each one: find the density, then name the metal. Show the calculation and watch your sig figs.

a) A sample has a mass of 52.5 g and a volume of 5.00 mL.

b) A chunk has a mass of 89.6 g. Water rises from 20.0 mL to 30.0 mL when it is added.

c) A cube measures 2.00 cm on every edge and has a mass of 21.6 g.

d) A rectangular block measures 4.00 cm × 2.00 cm × 1.50 cm and has a mass of 85.6 g.

e) A sample has a mass of 227.0 g and a volume of 20.00 mL.

f) A class plots mass vs. volume for a metal and gets a straight line with slope 7.87 g/cm³.

g) A small bar has a mass of 38.6 g and a volume of 2.00 mL.

h) A sample has a mass of 95.0 g and a volume of 10.0 mL. (Careful — think before you name it.)

i) Two pieces of the *same* metal: piece A is 15.74 g and 2.00 mL; piece B is 39.35 g and 5.00 mL. Find both densities. What metal is it, and what does this pair of results demonstrate about density?

j) A student says “this sample has a mass of 54.0 g, so it must be a heavy metal like lead.” Its volume is 20.0 mL. Is she right? What is it actually?

10. Thickness problems — flat things (2-D)

4 items

a flat sheet is a very thin box: V = L × W × t

The three moves, every time:
1. mass → volume **V = m ÷ D**
2. area of the flat face **A = L × W**
3. thickness **t = V ÷ A**

Carry all your digits through the middle steps and round only at the end.

a) A piece of aluminum foil measures 12.0 cm × 8.00 cm and has a mass of 0.518 g. Find its thickness.

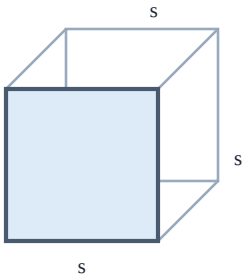
b) A tray measuring 15.0 cm × 10.0 cm is gold plated, which adds 0.0290 g. Find the thickness of the plating.

c) A square copper sheet 20.0 cm on each side has a mass of 35.84 g. Find its thickness.

d) Silver leaf is 5.00 cm × 5.00 cm and 1.00×10^{-5} cm thick. Find its **mass**. (This one runs the three moves backwards.)

11. Cubes and blocks (3-D)

7 items



Cube facts you will need:

Volume of a cube $\mathbf{V = s \times s \times s = s^3}$

To go backwards from volume to edge length, take the **cube root**: $\mathbf{s = \sqrt[3]{V}}$ (on most calculators: **V ^ (1÷3)**)

Surface area of a cube $\mathbf{A = 6s^2}$ — a cube has six faces.

a) A cube of aluminum has a mass of 21.6 g. Find its volume, then the length of one edge.

b) A cube of lead has a mass of 306.45 g. Find the length of one edge.

c) A cube of copper has a mass of 573.44 g. Find the length of one edge.

d) An iron cube measures 1.50 cm on each edge. Find its mass.

e) A rectangular block of zinc measures 5.00 cm × 3.00 cm × 2.00 cm. Find its mass.

f) A silver cube has an edge of 1.20 cm. Find its mass.

g) A cube 2.00 cm on each edge is coated all over with gold, which adds 0.0464 g. Find the thickness of the coating. *(Remember a cube has six faces.)*

12. Multi-step challenges

4 problems

These are exam-final-question difficulty. Work them in stages and label each stage — if you get stuck on part (c), parts (a) and (b) still earn their points.

Challenge 1 — identify, then predict

An unknown metal cylinder has a mass of 89.6 g. A graduated cylinder holds 22.0 mL of water; after the metal is added the level reads 32.0 mL.

a) Find the volume of the metal. b) Find its density and identify it. c) If you made a cube of this same metal 3.00 cm on each edge, what would it weigh? d) Would that cube sink or float? Defend it with numbers.

Challenge 2 — foil, and then a stack of it

A sheet of aluminum foil measures 30.0 cm × 25.0 cm and has a mass of 2.03 g.

a) Find the volume of the sheet. b) Find its area. c) Find its thickness in cm. d) How many sheets would you have to stack to reach a height of 1.00 mm? *(Careful with the unit — convert first.)*

Challenge 3 — conservation meets density

A sealed flask with a capacity of 100.0 mL contains 50.0 g of water (which occupies 50.0 mL) and a 20.0 g piece of zinc.

a) What is the total mass of the contents? b) What volume does the zinc occupy? c) Is there room for both, or does the flask overflow? Show the numbers. d) The sealed flask is left on a shelf for a week. What does the balance read now, and why?

Challenge 4 — from a graph to an identification

A class plots mass vs. volume for an unknown metal and the software fits **$M = 2.70V - 0.20$**. The largest mass they measured was 40 g.

a) What is the density, and what is the metal? b) Predict the mass of a 12.0 cm^3 sample. c) Use the 5% rule on the intercept. d) Would this metal sink or float in water?