

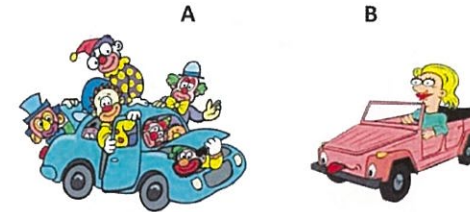
Glue to Notebook!

Name: Student Exemplar Period: _____ Date: _____

Calculating Density ($D = M/V$)

I can calculate density and identify unknown substances using the property of density.

Do First: Which car is denser? Why?



misconception:
• Students may say it weighs more
• ASK: That is weight what about dense?

Car A is denser / more dense. It is very crowded and has more people in a small space

ENGAGE: Answer the questions while watching the TED ED video on Archimedes.

1.) Who was Archimedes?

Archimedes was a Greek physicist, scientist, inventor.

2.) Why was Archimedes summoned by the king?

He was summoned to see if the Goldsmith cheated.

3.) What did Archimedes need to check to see if the crown was made of real gold?

He needed to ~~see~~ find its density to compare to real gold

4.) How did Archimedes find the volume of the crown?

He used the displacement method. He dunked it into water and measured

5.) What is Archimedes Principle?

Using water displaced ~~more~~ how much water was displaced. to measure volume of an object



EXPLORE: The following table shows the relationship between mass, volume, and density.

Mass	Volume	Density
10	5	2
30	6	5
100	25	4
?	10	8
60	?	10
75	5	15

1.) What patterns do you see?

mass ÷ volume = density

density × volume = mass

2.) What numbers do you think go in the empty spaces?

How did you figure that out?

6 and 15

for #1 → 60 divided by what equals 10?

for #2 → 75 divided by 5 is what

3.) Write in **WORDS** what is the relationship between mass, volume, and density?

When you divide mass by volume, you get the density

4.) Now write out a formula using the letters M, V, and D and math symbols!

$$D = \frac{m}{V} \quad \text{or} \quad D \times V = m$$

EXPLAIN: Calculating Density

- Density is a relationship between a substance's mass to volume and is represented by the formula **Density = mass / volume**. We can use a given mass and volume to solve for density. The unit for density of a solid object is g/cm³ and for the density of a liquid is g/mL.

Model: What is the density of an object that has a mass of 20 grams and volume of 4 cm³.

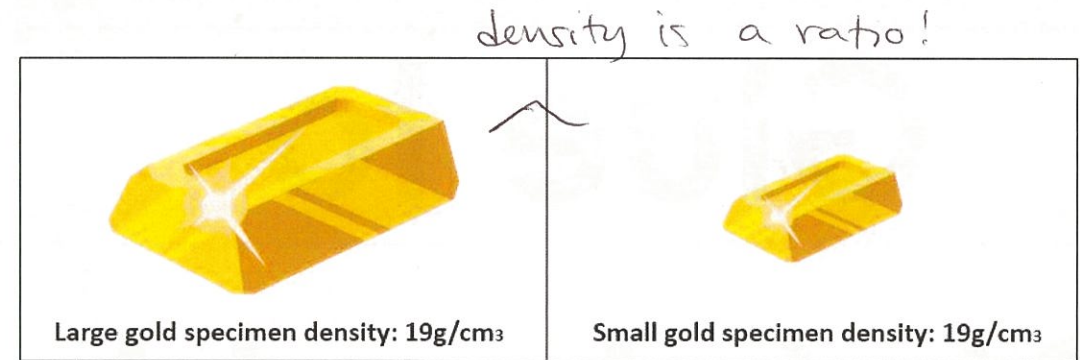
model units

D	?
m	20 g
V	4 cm ³

$$D = \frac{20g}{4cm^3} = 5 g/cm^3$$

1. make table
2. fill in knowns
3. plug into formula
4. solve!

- All substances have their own unique density, allowing density to be used to identify an object.
- Two amounts of the same substance, no matter their mass and volume, will have the same density. **Example:** A small piece of gold and large piece have the same density.



Model: The table below shows data collected from unknown substance. Using the data, identify the unknown substance by comparing the density you calculate to the table of substances with known densities.

Mass	13.5 grams
Volume	5 cm ³

Substance	Density
Silicon	2.3 g/cm ³
Aluminum	2.7 g/cm ³
Radium	5.5 g/cm ³
Tin	7.3 g/cm ³

D	?
m	13.5
V	5

$$D = \frac{m}{V}$$

$$D = \frac{13.5g}{5cm^3} = 2.7 g/cm^3$$

Why? Because all substances have unique density!

remind kiddos to use calculator!

Identity of Unknown Substance: Aluminum

Directions: Complete the density problems below using the formula **Density = Mass/Volume**.

1. What is the density of a material if its mass is 32 grams and its volume is 8 milliliters?

D	?
m	32g
v	8 mL

$$D = \frac{m}{v} = \frac{32g}{8\text{ mL}} = \boxed{4\text{ g/mL}}$$

2. Mercury metal is poured into a graduated cylinder that holds exactly 20 mL. The mercury used to fill the cylinder has a mass of 260g. From this information, calculate the density of mercury.

D	?
m	260g
v	20 mL

$$D = \frac{m}{v} = \frac{260g}{20\text{ mL}} = \boxed{13\text{ g/mL}}$$

3. A piece of gold has a mass of 197 grams and a volume of 10 cm³. What is the density of the piece of gold?

D	?
m	197g
v	10 cm ³

$$D = \frac{m}{v} = \frac{197g}{10\text{ cm}^3} = \boxed{19.7\text{ g/cm}^3}$$

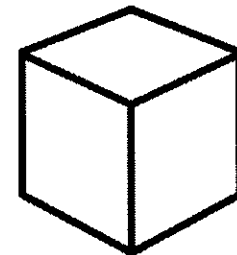
4. An object has a mass of 12 grams and a volume of 4 cm³. Calculate the density of the object.

D	?
m	12g
v	4 cm ³

$$D = \frac{m}{v} = \frac{12g}{4\text{ cm}^3} = \boxed{3\text{ g/cm}^3}$$

5. Consider the following data. To find the volume of the cube multiply length x width x height.

Property	Measurement
Mass	600 g
Volume	100 cm ³



* Student will swap $v \div m$ to put larger # first

Volume of Cube: L x W x H

From this information, calculate the density of the cube.

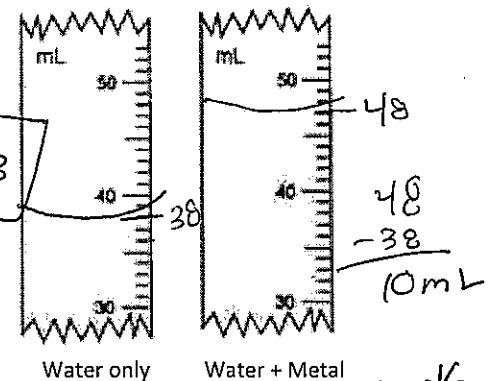
D	?
m	600g
v	100 cm ³

$$D = \frac{m}{v} = \frac{600g}{100\text{ cm}^3} = \boxed{6\text{ g/cm}^3}$$

6. Edgar is asked to determine the density of a metal. Edgar determines the mass of the metal to be 180g and then determines the volume of the sample using water displacement. Find the volume, then use the mass and volume to calculate the density of the metal.

D	?
m	180g
v	10 mL

$$D = \frac{m}{v} = \frac{180g}{10\text{ cm}^3} = \boxed{18\text{ g/cm}^3}$$



Students don't check units

Independent Practice: Calculating Density

7. Jazmine was conducting an experiment to determine the density of iron rod. She collects the following data.

mass	128 g
starting volume of water	29 mL
Volume of water and metal	45 mL

Subtract

$$\begin{array}{r} 45 \\ -29 \\ \hline 16 \end{array}$$

From this information, calculate the density of the iron rod.

D	
m	128g
V	16 mL

$$D = \frac{m}{V} = \frac{128g}{16 \text{ cm}^3} = 8 \text{ g/cm}^3$$

8. Ms. Chan was performing an experiment to determine the density of an unknown liquid. Her data table is included below.

Volume of Unknown Liquid	2.0 mL
Mass of Empty Graduated Cylinder	15.3 g
Mass of Empty Graduated Cylinder + Unknown Liquid	19.5 g

You need to find the mass of the liquid.

Subtract

4.2

may need to pause and make

When she completed his experiment, she compared his results to the list of possible liquids.

Liquid	Density
Rubbing Alcohol	0.80 g/mL
Glycerin	2 g/mL
Mercury	13.2 g/mL
Bromine	3.1 g/mL

What is the most likely identity of his unknown liquid?

Glycerin

$$D = \frac{m}{V} = \frac{4.2g}{2.0 \text{ mL}} = 2.1 \text{ g/mL}$$

9. The data table below represents the data from an experiment in which Roosevelt was trying to determine the identity of an unknown metal. Using the data below, help Roosevelt determine the identity of the metal. Support your identification with the appropriate calculations.

Property	Measurement
Mass (g)	13.6
Volume of Water (mL)	14.7
Volume of Water and Metal (mL)	16.6

Metal	Density
Zinc	7.15
Copper	8.9
Lead	11
Mercury	13.59

$$D = \frac{m}{V} = \frac{13.6 \text{ g}}{1.9 \text{ mL}} = 7.15 \text{ g/mL}$$

$V = 1.9$

Identity of the Metal: Zinc

Exit Ticket: Calculating Density

1.) A student is given an unknown substance and has to calculate the density. Which physical properties must first be determined?

$$D = \frac{\text{mass}}{\text{volume}}$$

- a) Shape and size
- b) Volume and length
- c) Mass and volume
- d) Color and texture

2.) When scientists begin working with a new chemical, they first research important information about the properties of a substance. To do this, they often look at a Material Safety Data Sheet or MSDS. Below is a portion of an MSDS about the physical and chemical properties of a substance.

SECTION 9 — PHYSICAL AND CHEMICAL PROPERTIES

Soft, ductile, lustrous-white solid, Odorless.
Solubility: Soluble in nitric or hot sulfuric acid.

Boiling point: 2162 °C
Melting point: 961 °C
Density : 10.

Which of the following could be a sample of the substance described above?

a)

Mass	Volume
100 grams	20 cm ³

$$D = \frac{m}{V} = \frac{100g}{20 \text{ cm}^3} = 5g/\text{cm}^3 \quad \text{X}$$

b)

Mass	Volume
40 grams	4 cm ³

$$D = \frac{m}{V} = \frac{40g}{4 \text{ cm}^3} = 10g/\text{cm}^3 \quad \checkmark$$

c)

Mass	Volume
50 grams	25 cm ³

$$D = \frac{m}{V} = \frac{50g}{25 \text{ cm}^3} = 2g/\text{cm}^3 \quad \text{X}$$

d)

Mass	Volume
60 grams	10 cm ³

$$D = \frac{m}{V} = \frac{60g}{10 \text{ cm}^3} = 6g/\text{cm}^3 \quad \text{X}$$

Exit Ticket: Calculating Density

3.) What is the density of an unknown substance that has a mass of 30 g and a volume of 10 mL?

- a) 1 g/mL
- b) 3 g/mL
- c) 30 g/ml
- d) 300 g/mL

$$\begin{array}{r|l} D & ? \\ \hline m & 30g \\ \hline V & 10mL \end{array}$$

$$D = \frac{m}{V} = \frac{30g}{10mL} =$$

3 g/mL

Density of Four Objects

Object	Mass of Object (g)	Volume of Object (cm ³)	Density of Object (g/cm ³)
Q	200	50	4
R	600	60	10
S	400	20	20
T	500	100	5

4.) A student finds a 300-gram object that has a volume of 30 cm³. Which object has the same density as the object the student found?

- a) Object Q
- b) Object R
- c) Object S
- d) Object T

mass

volume

$$\begin{array}{r|l} D & ? \\ \hline m & 300g \\ \hline V & 30 \text{ cm}^3 \end{array}$$

$$D = \frac{m}{V} = \frac{300g}{30 \text{ cm}^3} =$$

10 g/cm³