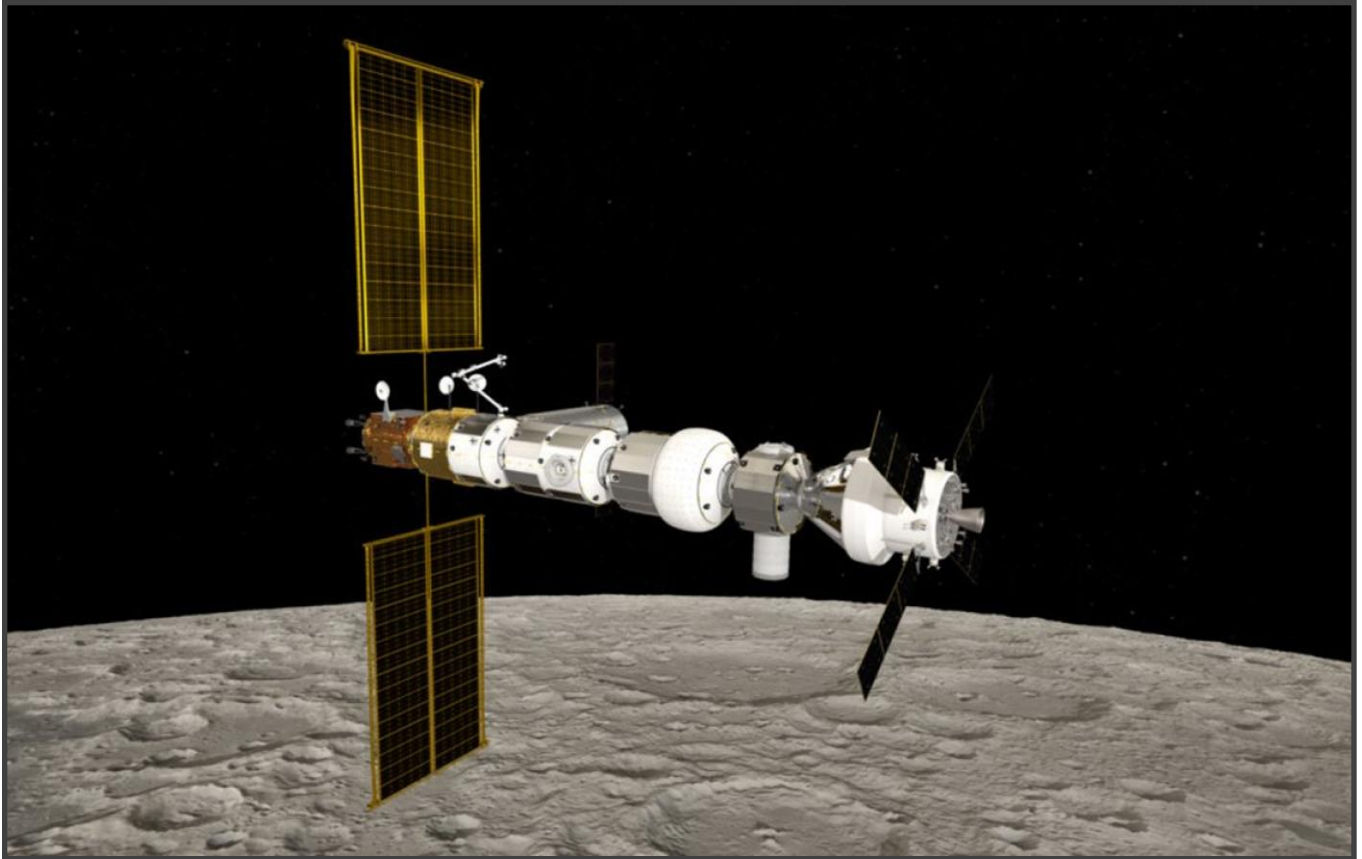


# Spacegate Station Season 4

## Episode 20



### Diving into Density

#### Resource Content

- Guided Notes
- Basic Density Work Sheet
- Density Work Sheet (8<sup>th</sup> grade)
- Density Work Sheet Advanced
- Density Inquiry Lab

## Spacegate Station Episode 20

### Diving into Density

#### Word Bank

0.00018 grams	0.00125 grams	0.93 grams	1 gram
Archimedes	calculating	compactness	cubic centimeters
density	displacement	expands	float
grams	heavier	introduction	less
milliliters	mix	periodic table	separated
size	space	submerged	

#### Introduction

\_\_\_\_\_ relates to the scientific concept of how much \_\_\_\_\_ an object or substance takes up in relation to the amount of matter in that object or substance.

#### Concepts of Density

When humans hold two objects in their hand, they can normally judge whether one object is \_\_\_\_\_ than the other or whether they weigh about the same.

When they compare the weights of two objects, they can only \_\_\_\_\_ determine their relative densities if they are roughly the same \_\_\_\_\_.

Mass is normally measured in \_\_\_\_\_ while volume is measured in either \_\_\_\_\_ if it is a solid or \_\_\_\_\_ if it is a liquid.

Remember though, that \_\_\_\_\_ is equal to \_\_\_\_\_ and they are therefore interchangeable regardless of the state of matter of the object.

**Equation for solving density:**

**Equation for solving volume:**

**Equation for solving mass:**

The \_\_\_\_\_ method can be used to accurately measure the volume of oddly shaped solid objects by measuring the volume of fluid displaced when the object is submerged in water.

When the object is completely \_\_\_\_\_ in water, the amount of water displaced in milliliters is equal to the volume of \_\_\_\_\_ the object, this is known as the \_\_\_\_\_ principle.

Density is the measure of the “\_\_\_\_\_” of a material. It refers to how close the atoms or molecules are to each other. Density means more than just “heaviness” but includes how much space an object takes up.

All substances have density including \_\_\_\_\_, \_\_\_\_\_, and \_\_\_\_\_.

Various rocks, woods, metals have a characteristic density specific to that substance. The density of objects can be found by either \_\_\_\_\_ it using the density equation or it can be found in various scientific reference materials. For example, the density for a specific element can be found on the \_\_\_\_\_.

Pure water has a density of \_\_\_\_\_ per cubic centimeter. For this reason, it is used as a standard because its density is easy for scientists and lay persons to remember, and water is a very common and plentiful compound on the earth.

The density of oil is \_\_\_\_\_ per cubic centimeter which is less than that of water. Since oil does not dissolve in water, it stays \_\_\_\_\_ from it.

Another such example can be seen in salad dressing where oil and vinegar \_\_\_\_\_ do not as vinegar is denser than oil.

Ice is \_\_\_\_\_ dense than water because when water freezes it \_\_\_\_\_. That same mass of water now takes up more space because the water molecules are further apart.

The density of air is \_\_\_\_\_ per cubic centimeter.

Helium gas is \_\_\_\_\_ dense than the air around it, the density of helium is per cubic centimeter. It is this \_\_\_\_\_ difference in the density of helium gas as compared to the air around it that makes it \_\_\_\_\_ in the air.

# DENSITY WORKSHEET (Basic)

Name: \_\_\_\_\_

Directions: Solve the problem! Show your Work! This is the basic problem given for understanding DENSITY. Remember that the formula for density is...

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}} \quad \text{Volume} = \frac{\text{Mass}}{\text{Density}} \quad \text{Mass} = \text{Density} \times \text{Volume}$$

## Solve for the unknown:

1. Mass = 40g      Volume = 20mL      What is the Density? \_\_\_\_\_

2. Mass = 35g      Density = 5 g/cm<sup>3</sup>      What is the Volume? \_\_\_\_\_

3. Density = 7 g/mL      Volume = 10mL      What is the Mass? \_\_\_\_\_

4. Mass = 22g      Volume = 2cm<sup>3</sup>      What is the Density? \_\_\_\_\_

5. Mass = 16g      Density = 2 g/cm<sup>3</sup>      What is the Volume? \_\_\_\_\_

6. Density = 2 g/mL      Volume = 20mL      What is the Mass? \_\_\_\_\_

7. Mass = 35g      Volume = 7cm<sup>3</sup>      What is the Density? \_\_\_\_\_

8. Mass = 70g      Density = 7 g/mL      What is the Volume? \_\_\_\_\_

9. Density = 11 g/cm<sup>3</sup>      Volume = 2cm<sup>3</sup>      What is the Mass? \_\_\_\_\_

10. Mass = 16g      Volume = 8mL      What is the Density? \_\_\_\_\_

## SOLIDS & DENSITY USING $L \times W \times H$

Directions: Solve the problem! Show your work! You must solve the VOLUME before you can solve the density. for SOLIDS is  $L \times W \times H = \text{Volume}$      $\text{Density} = \text{Mass}/\text{Volume}$

11. Mass = 48g

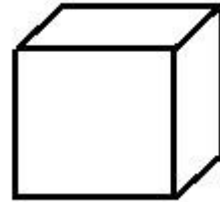
Height = 4 cm

Width = 3 cm

Length = 2 cm

What is the volume? \_\_\_\_\_

What is Density? \_\_\_\_\_



12. Mass = 60g

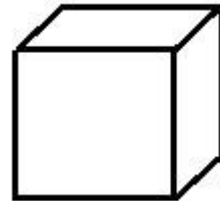
Height = 6 cm

Width = 5 cm

Length = 4 cm

What is the volume? \_\_\_\_\_

What is Density? \_\_\_\_\_



13. Mass = 63g

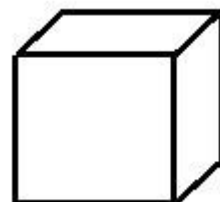
Height = 3 cm

Width = 7 cm

Length = 1 cm

What is the volume? \_\_\_\_\_

What is Density? \_\_\_\_\_

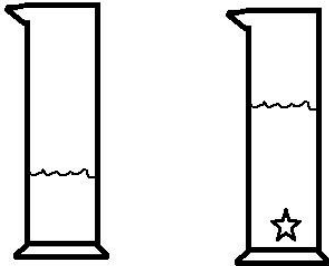


## SOLIDS & DENSITY USING WATER DISPLACEMENT

Directions: Solve the problem! Show your work! You must solve the VOLUME before you can solve the density. Displacement = Volume    Density = Mass/Volume

14. Mass = 25g

Start: 45mL      Final: 50mL



- What is the Volume?

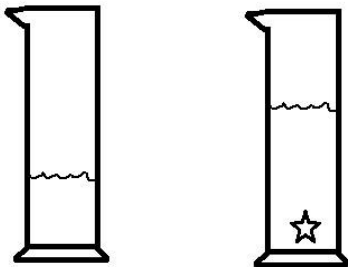
\_\_\_\_\_

- What is the Density?

\_\_\_\_\_

15. Mass = 10 g

Start: 30mL      Final: 50mL



- What is the Volume?

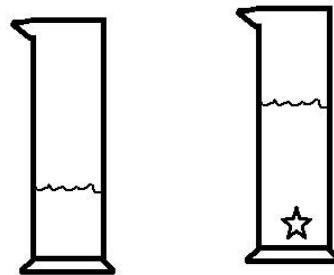
\_\_\_\_\_

- What is the Density?

\_\_\_\_\_

16. Mass = 60g

Start: 75 mL      Final: 90mL



- What is the Volume?

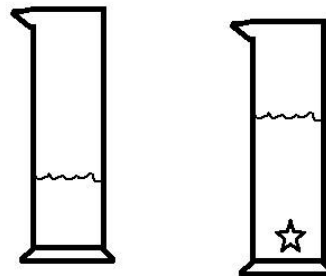
\_\_\_\_\_

- What is the Density?

\_\_\_\_\_

17. Mass = 60g

Start: 55 mL      Final: mL



- What is the Volume?

\_\_\_\_\_

- What is the Density?

\_\_\_\_\_

## ANSWERS

1.  $2 \text{ g/cm}^3$

2.  $7 \text{ cm}^3$

3.  $70 \text{ g}$

4.  $11 \text{ g/cm}^3$

5.  $8 \text{ cm}^3$

6.  $40 \text{ g}$

7.  $5 \text{ g/cm}^3$

8.  $10 \text{ mL}$

9.  $22 \text{ g}$

10.  $2 \text{ g/cm}^3$

11.  $V=24 \text{ cm}^3$   $D= 2 \text{ g/cm}^3$

12.  $V=120\text{cm}^3$   $D= 0.5 \text{ g/cm}^3$

13.  $V=21 \text{ cm}^3$   $D=3 \text{ g/cm}^3$

14.  $V=5 \text{ mL}$   $D= 5 \text{ g/cm}^3$

15.  $V=20\text{mL}$   $D= 0.5 \text{ g/cm}^3$

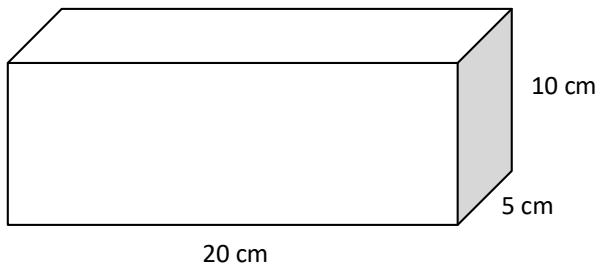
16.  $V=15 \text{ mL}$   $D=4 \text{ g/cm}^3$

17.  $V=30 \text{ mL}$   $D=0.33 \text{ g/cm}^3$

## DENSITY CALCULATIONS WORKSHEET (8<sup>th</sup> grade)

NAME: \_\_\_\_\_

- 1) A student measures the mass of an  $8 \text{ cm}^3$  block of brown sugar to be 12.9 g. What is the density of brown sugar?
- 2) A chef fills a 50 mL container with 43.5 g of cooking oil. What is the density of the oil?
- 3) Calculate the mass of a liquid with a density of 2.5 g/mL and a volume of 15 mL.
- 4) Calculate the volume of a liquid with a density of 5.45 g/mL and a mass of 65 g.
- 5) A machine shop worker records the mass of an aluminum cube as 176 g. If one side of the cube measures 4 cm, what is the density of the aluminum?
- 6) A teacher performing a demonstration finds that a piece of cork displaces 23.5 mL of water. The piece of cork has a mass of 5.7 g. What is the density of the cork?
- 7) A carver begins work on the following block of granite that weighs 2700 g. What is the density of granite?



- 8) A piece of PVC plumbing pipe displaces 60 mL when placed into a container of water. If the pipe has a mass of 78 g, what is the density of PVC?



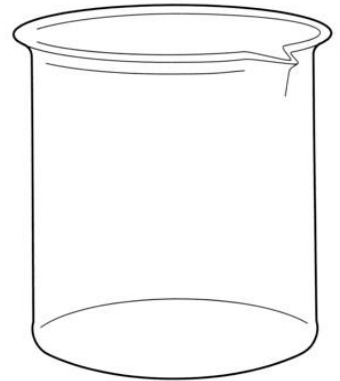
- 9) A solid magnesium flare has a mass of 1300 g and a volume of 743 cm<sup>3</sup>. What is the density of magnesium?
- 10) A graduated cylinder has a mass of 50 g when empty. When 30 mL of water is added, the graduated cylinder has a mass of 120 g. If a rock is added to the graduated cylinder, the water level rises to 75 mL and the total mass is now 250 g. What is the density of the rock?
- 11) A student performs an experiment with three unknown fluids and obtains the following measurements:

Fluid A:  $m = 2060 \text{ g}$ ,  $V = 2000 \text{ mL}$

Fluid B:  $m = 672 \text{ g}$ ,  $V = 850 \text{ mL}$

Fluid C:  $m = 990 \text{ g}$ ,  $V = 1100 \text{ mL}$

Draw how the fluids would be layered if they were combined in a beaker.



- 12) Use your density skills to find the identity of the following mystery objects.

Table of Densities			
Solids	Density g/cm <sup>3</sup>	Solids	Density g/cm <sup>3</sup>
Marble	2.56	Copper	8.92
Quartz	2.64	Gold	19.32
Diamond	3.52	Platinum	21.4



While digging in the backyard, you think you have found a find an old coin. Its mass is 26.76g and its volume is 3 cm.

What is the coin made of? \_\_\_\_\_



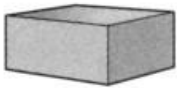
You think you have found a diamond. Its mass is 5.28 g and its volume is 2 cm<sup>3</sup>.

What did you find? \_\_\_\_\_



You find a ring with a mass of 107 g. You fill a graduated cylinder up with 10 mL of water and put the ring into the cylinder. The water rises to the 15 mL mark.

What is the ring made of? \_\_\_\_\_



There is a block on your desk that acts as a paperweight. Its measurements are 3 cm by 4 cm by 6 cm. The block has a mass of 184.32 g.

What is the block made of? \_\_\_\_\_

## Advanced Density Practice Problem Worksheet

1. A block of aluminum occupies a volume of 15.0 mL and a mass of 40.5 g. What is its density?
2. Mercury metal is poured into a graduated cylinder that to exactly 22.5 mL. The mercury used to fill the cylinder weighs 305.4 g. From this information, calculate the density of mercury.
3. What mass of the ethyl alcohol exactly fills a 200.0 mL container? The density of ethyl alcohol is 0.789 g/mL.
4. A rectangular block of copper metal weighs 1896 g. The dimensions of the block are 8.4 cm by 5.5 cm by 4.6 cm. From this data, what is the density of copper?
5. Calculate the density of sulfuric acid if 35.4 mL of the acid weighs 65.14 g.
6. Find the mass of 250.0 mL of benzene. The density of benzene is 0.8765 g/mL.
7. A block of lead has dimensions of 4.50 cm by 5.20 cm by 6.00 cm. The block weighs 1587 g. From this information, calculate the density of lead.
8. 28.5 g of iron shot is added to a graduated cylinder containing 45.50 mL of water. The water level rises to the 49.10 mL mark, from this information, calculate the density of iron.

## Answers

1 Density = 2.70 g/mL

2. Density = 13.6 g/mL

3. Mass = 158 g

4. Volume = 212.52 cm<sup>3</sup>

5. Density= 1.84 g/mL

6. Mass = 219.1 grams

7. Density = 11.3 g/cm<sup>3</sup>

8. Density = 7.92 g/mL

## Density Inquiry Lab

The density of pure water at room temperature is 1.0 g/mL. In this lab you can have students compare their findings with their classmates.

Encourage students to get a large enough piece of aluminum foil (the size of a sheet of notebook paper works well). If the foil sheet is too small, it will be difficult to get an accurate reading of its mass (depending on how sensitive your balances are).

Some students have tried to fold up their sample of aluminum foil and then calculate length x width x height. Discuss where errors can occur with this method.

### Supplies

#### Station 1

- graduated cylinder
- plastic cup
- water
- plastic pipet
- balance

Station 2 (in this lab you can replace the metal cubes with objects made of different materials)

- 6 metal cubes
- ruler
- balance

#### Station 3

- sheet of aluminum foil
- ruler
- balance

## Density Inquiry Lab

Name: \_\_\_\_\_

In this lab, you will be working on three different stations that put the formula for density to work. If you recall, the formula for density is:

$$\text{Density} = \text{Mass} / \text{Volume}$$

You may complete these stations in any order. For full credit, describe the procedures you chose to follow to solve the problems, and answer the questions.

Station 1: In this station, you are asked to determine the density of water at room temperature. You have the following materials at your disposal:

- graduated cylinder
- plastic cup
- water
- plastic pipet
- balance

The density of water at room temperature is: \_\_\_\_\_.

Describe the procedures you followed to determine the density of water.

Station 2: In this station, you are asked to determine the density of six metal cubes and to arrange them in order of increasing density. You have the following materials at your disposal:

- 6 metal cubes or objects
- ruler
- balance

The metals (or objects), in order of increasing density are:

# \_\_\_\_\_ (density = \_\_\_\_\_ g/mL)

# \_\_\_\_\_ (density = \_\_\_\_\_ g/mL)

# \_\_\_\_\_ (density = \_\_\_\_\_ g/mL)

# \_\_\_\_\_ (density = \_\_\_\_\_ g/mL)

# \_\_\_\_\_ (density = \_\_\_\_\_ g/mL)

# \_\_\_\_\_ (density = \_\_\_\_\_ g/mL)

Describe the procedures you followed to determine the density of the six cubes.

Station 3: In this station, you are asked to determine the thickness of a piece of aluminum foil. Remember that the volume of an object is equal to the product of its mass, its length, and its height. The density of aluminum is 2.70 g/mL. Remember that 1 mL = 1 cubic centimeter. You have the following materials at your disposal:

- sheet of aluminum foil
- ruler
- balance

What is the thickness of the aluminum foil?

Describe the procedures you followed to determine the thickness of the aluminum foil.