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STANDARDS

- **CCSS**: RST.9-10.1, 2, 3, 4, 5, 7, 8, 10; RST.11-12.1, 2, 3, 4, 8, 10; SL.9-10.1, 6; SL.11-12.1, 6; HSN.Q.A.1; HSA.CED.A.1, 4
- **NGSS**: ESS 2.A, ESS 2.C, ESS 2.D, HS-LS2-2, HS-LS2-6
- **OLP**: 1.B.1, 1.C.1, 1.C.7, 1.C.8, 1.C.9, 1.C.11

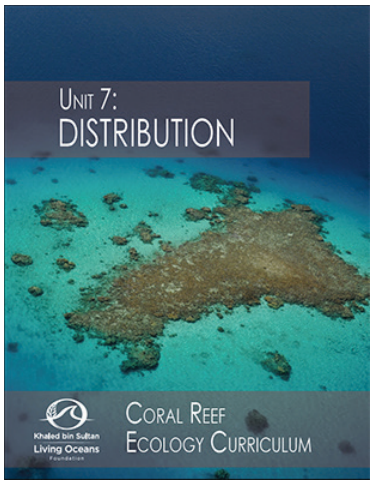
ONLINE CONTENTS

- Distribution Quiz
- *Where Are Coral Reefs Found?* Video Although corals are found throughout the planet, most reef-building corals are found in the tropics and subtropics where thousands of animals make these reefs their home.

DISTRIBUTION

This lesson is a part of the *Distribution* unit, which explains the two major drivers of coral distribution: salinity and temperature. Below is a summary of what is included in the entire unit.

UNIT CONTENTS



A. Background Information
   - Where are Corals Found?
   - What is a Current?
   - What is Density?
   - Salinity, Temperature, and Ocean Circulation

B. Lessons

Watch it! Where are Corals Found?
- A worksheet to accompany the *Where are Corals Found?* video

Density 101
- A lab to calculate and compare densities of liquids

Inquiring about Density 1
- A lab to create a procedure to determine relative densities

Inquiring about Density 2
- A lab to create a procedure to determine actual densities

Go With the Flow
- A worksheet to accompany a teacher demonstration on how salinity and temperature affect water density

Read it! Galapagos Ocean Currents
- A worksheet to accompany the *Galapagos Ocean Currents* field blog

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LESSON 1 TEACHER'S NOTES

AUTHOR

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LEARNING OBJECTIVES

- Define density.
- Describe how density relates to an object's mass and volume.
- Learn how to measure mass and volume.
- Be able to calculate density using mass and volume.
- Illustrate the density of different liquids.

KEYWORDS

- Density
- Mass
- Volume

MATERIALS

- 5 unknown liquids
- Food coloring (optional)
- 100 mL graduated cylinder
- Scale
- Safety goggles
- **Lesson 1: Density 101** student worksheet

INTEGRATING SUBJECTS

- Math

PRIOR KNOWLEDGE

- Students should already know how to use a scale and read the volume of a liquid in a graduated cylinder.

EXTENSION

- While teaching the *Background Information* on density, explain the difference between intensive and extensive properties. To show that density is intensive, demonstrate to students that shape and quantity do not affect density.

EVALUATION

- Give students a worksheet with density problems to complete for homework.

STANDARDS

- CCSS: RST.9-10.3, 4, 5, 7; RST.11-12.3, 4; HSN.Q.A.1; HSA.CED.A.1, 4
- NGSS: HS-LS2-2
- OLP: 1.B.1, 1.C.7

PROCEDURE

1. Create five stations, one for each unknown liquid.
2. Prepare unknown liquids and label them prior to conducting the activity. Use food coloring to distinguish between the unknown liquids. There are a variety of liquids that can be used for this activity. The least expensive is to use salt water with different amounts of salt. In the teacher answer key, you will find an example using fresh water, apple juice, diet soda, salt water, and soapy water.
3. Teach *Background Information* section *C) What is Density?*
4. Hand out **Lesson 1: Density 101** student worksheet.
5. Review the procedure with students. The procedure is on the student worksheet.
6. Have student's complete activity and fill out *Part A* on the corresponding **Lesson 1: Density 101** student worksheet. **NOTE**: Make sure to use a scale that provides data to at least a tenth of a gram. If scales that are more precise are available, ask students to go to hundredths of a gram. This information is not included on the student worksheet. Tell the students how many decimal places they need to use.
7. After completing *Part A* on the student worksheet, instruct students to complete *Part B*.

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LESSON 1 DENSITY 101

OBJECTIVE:
Find the density of the unknown liquids.

MATERIALS:
- 5 unknown liquids
- 100 mL graduated cylinder
- Scale
- Safety goggles

PROCEDURE:
1. There are 5 stations. Each station has a different unknown liquid labeled #1-5. Follow the same procedure for each of the liquids. Record all data in *Table 1*.
2. Measure and record the mass of the empty graduated cylinder in grams.
3. Put 10 mL of the liquid in the graduated cylinder. Record the exact volume of the liquid.
4. Measure and record the mass of the graduated cylinder and liquid together.
5. Subtract the mass of the empty graduated cylinder from the mass of the graduated cylinder and liquid. This will give you the mass of the liquid.
6. In order to find the density, use the equation D = m/V.

   REMEMBER: All measurements need to be recorded in the units listed below.

TABLE 1:

	Unknown #1 Fresh Water	Unknown #2 Apple Juice	Unknown #3 Diet Soda	Unknown #4 Salt Water	Unknown #5 Soapy Water
Volume of liquid (mL)					
Mass of the empty graduated cylinder (g)					
Mass of the graduated cylinder and liquid (g)					
Mass of the liquid (g)					
Show density calculation (include units)					
Density of the liquid (g/mL)					

PART A:

INSTRUCTIONS: Answer each of the following questions based on your results.

1. Which liquid has the greatest density?

2. Which liquid has the least density?

3. Do the graduated cylinders contain the same liquids? Why?

4. Based on your results, draw a diagram that represents each of the different densities of the liquids. Use figure 7-3 in the *Background Information* as an example. The diagram does not need to be an exact representation.

UNKNOWN #1:

UNKNOWN #2:

UNKNOWN #3:

UNKNOWN #4:

UNKNOWN #5:

PART B:

INSTRUCTIONS: Solve each of the density word problems below. Show all work and remember to include units of measurement.

1. Calculate the density of a liquid if 50.00 mL of the liquid has a mass of 78.26 g.

2. What is the volume of 50.00 g of honey, if honey has a density of 1.36 g/mL?

3. Calculate the mass of vinegar if it has a density of 1.01 g/mL and a volume of 111 mL.

4. 30.0 mL of methanol has a mass of 23.7 g and 30.0 mL of benzene has a mass of 26.29 g. Which liquid is more dense? Is there a relationship between density and mass when there is a fixed volume?

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LESSON 1 Density 101

OBJECTIVE:
Find the density of the unknown liquids.

MATERIALS:
- 5 unknown liquids
- 100 mL graduated cylinder
- Scale
- Safety goggles

PROCEDURE:
1. There are 5 stations. Each station has a different unknown liquid labeled #1-5. Follow the same procedure for each of the liquids. Record all data in *Table 1*.
2. Measure and record the mass of the empty graduated cylinder in grams.
3. Put 10 mL of the liquid in the cylinder. Record the exact volume of liquid.
4. Measure and record the mass of the graduated cylinder and liquid together.
5. Subtract the mass of the empty graduated cylinder from the mass of the graduated cylinder and liquid. This will give you the mass of the liquid.
6. In order to find the density, use the equation D = m/V.

   REMEMBER: All measurements need to be recorded in the units listed below.

TABLE 1: Results may vary with different liquids.

	Unknown #1 Fresh Water	Unknown #2 Apple Juice	Unknown #3 Diet Soda	Unknown #4 Salt Water	Unknown #5 Soapy Water
Volume of liquid (mL)	10.0 mL	10.0 mL	10.0 mL	10.0 mL	10.0 mL
Mass of the empty graduated cylinder (g)	40.3 g	40.3 g	40.3 g	40.3 g	40.3 g
Mass of the graduated cylinder and liquid (g)	50.9 g	51.3 g	50.8 g	51.0 g	51.6 g
Mass of the liquid (g)	50.9 g-40.3 g = 10.6 g	51.3 g-40.3 g = 11.0 g	50.8 g-40.3 g = 10.5 g	51.0 g-40.3 g = 10.7 g	51.6 g-40.3 g = 11.3 g
Show density calculation (include units)	D = m/V D = 10.6 g / 10.0 mL	D = m/V D = 11.0 g / 10.0 mL	D = m/V D = 10.5 g / 10.0 mL	D = m/V D = 10.7 g / 10.0 mL	D = m/V D = 11.3 g / 10.0 mL
Density of the liquid (g/mL)	1.06 g/mL	1.10 g/mL	1.05 g/mL	1.07 g/mL	1.13 g/mL

PART A:

INSTRUCTIONS: Answer each of the following questions based on your results. **Answers may vary.**

1. Which liquid has the greatest density?

   Soapy water

2. Which liquid has the least density?

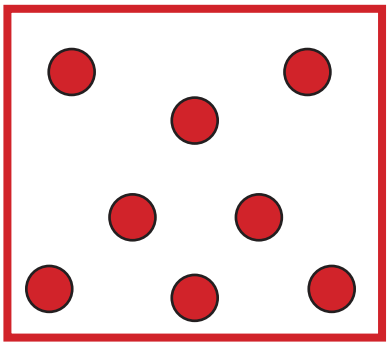
   Diet soda

3. Do the graduated cylinders contain the same liquids? Why?

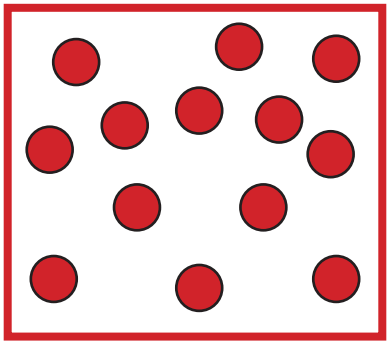
   No, the liquids are not all the same. Each liquid has a different mass and therefore a different density.

4. Based on your results, draw a diagram that represents each of the different densities of the liquids. Use figure 7-3 in the *Background Information* as an example. The diagram does not need to be an exact representation.

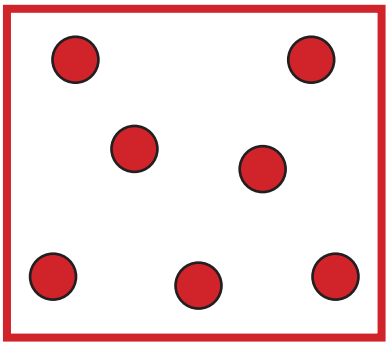
UNKNOWN #1: **Fresh Water**



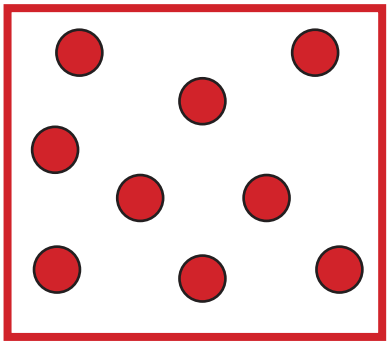
UNKNOWN #2: **Apple Juice**



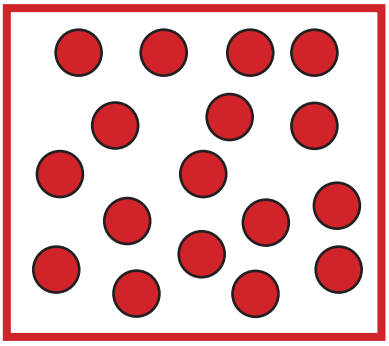
UNKNOWN #3: **Diet Soda**



UNKNOWN #4: **Salt Water**



UNKNOWN #5: **Soapy Water**



PART B:

INSTRUCTIONS: Solve each of the density word problems below. Show all work and remember to include units of measurement.

1. Calculate the density of a liquid if 50.00 mL of the liquid has a mass of 78.26 g.

D = ?

m = 78.26 g

V = 50.00 mL

$$D = \frac{78.26\ g}{50.00\ mL}$$

D = 1.565 g/mL

2. What is the volume of 50.00 g of honey, if honey has a density of 1.36 g/mL?

D = 1.36 g/mL

m = 50.00 g

V = ?

$$\frac{1.36\ g}{mL} = \frac{50.00\ g}{(V)}$$

Cross multiply

$$1.36\ g\ (V) = 50.00\ g \times mL$$

$$\frac{1.36\ g\ (V)}{1.36\ g} = \frac{50.00\ g \times mL}{1.36\ g}$$

V = 36.76 mL

3. Calculate the mass of vinegar if it has a density of 1.01 g/mL and a volume of 111 mL.

D = 1.01 g/mL

m = ?

V = 111 mL

$$\frac{1.01\ g}{mL} = \frac{(m)}{111\ mL}$$

Cross multiply

$$\frac{111\ mL}{1} \times \frac{1.01\ g}{mL} = \frac{(m)}{111\ mL} \times \frac{111\ mL}{1}$$

m = 112 g

4. 30.0 mL of methanol has a mass of 23.7 g, and 30.0 mL of benzene has a mass of 26.29 g. Which liquid is more dense? Is there a relationship between density and mass when there is a fixed volume?

Methanol

D = ?

m = 23.7 g

V = 30.0 mL

$$D = \frac{23.7\ g}{30.0\ mL}$$

D = .790 g/mL

Benzene

D = ?

m = 20.1 g

V = 30.0 mL

$$D = \frac{26.29\ g}{30.00\ mL}$$

D = .876 g/mL

Methanol is more dense than benzene.

Mass and density have a direct relationship. The greater the mass, the greater the density.