Marine Debris Lesson Plans

Instructional Objectives

1. Students will be able to define and identify different types of marine debris.
2. Students will understand how marine debris gets into the environment.
3. Students will understand how marine debris can harm the ecosystem.
4. Students will discover methods to prevent marine debris from causing damage to the ecosystem.
5. Students will investigate the properties of density and buoyancy.
6. Students will understand how density affects the buoyancy of an object.
7. Students will investigate how salinity affects buoyancy.
8. Students will understand how the density of marine debris affects its placement in the water column.
9. Students will learn how organisms are negatively effected by marine debris in the water column.

Georgia Performance Standards:

S6CS1, S7CS1, S8CS1. Students will explore the importance of curiosity, honesty, openness, and skepticism in science and will exhibit these traits in their own efforts to understand how the world works.

S6CS4, S7CS4, S8CS4. Students will use tools and instruments for observing, measuring, and manipulating equipment and materials in scientific activities.

S6CS6, S7CS6, S8CS6. Students will communicate scientific ideas and activities clearly.

S6CS9, S7CS9, S8CS9. Students will investigate the features of the process of scientific inquiry.

S7L4. Students will examine the dependence of organisms on one another and their environments.

Ocean Literacy Principles:

Principle 1: Earth has one big ocean with many features.

Principle 5: The ocean supports a great diversity of life and ecosystems.

Principle 6: The ocean and humans are inextricably interconnected.

Marine Debris - What Is It?

Objective 1: Students will be able to define and identify different types of marine debris.
Objective 2: Students will understand how marine debris gets into the environment.
Objective 3: Students will understand how marine debris can harm the ecosystem.
Objective 4: Students will discover methods to prevent marine debris from causing damage to the ecosystem.

Materials:
- Computer or iPad with Internet access
- For alternative presentation: poster board, scissors, glue, construction paper

Duration: 60 minutes, plus additional time for presentations

Activity Procedure:
1. Conduct research and find out, at a minimum, the following information about marine debris:
    a. What is marine debris? (definition)
    b. Into what general categories is marine debris classified?
    c. Find 2-3 examples of marine debris that falls into each category
    d. Find 2-3 examples of marine debris that are found locally along the shorelines of coastal Georgia.
    e. How does marine debris get into the water? Find a 2-3 examples of origins of marine debris.
    f. How can marine debris harm the environment?
    g. What can citizens do to prevent marine debris from harming the ecosystem?
2. Create a short presentation to present information about marine debris:
    a. Use a computer or iPad to communicate the answers to the questions listed above. You may use any program or app that you think would be appropriate for presenting this information, including, but not limited to: ShowMe, PuppetPals, Animator, ComicBook!, StoryKit, Keynote, iMovie, GarageBand, Educreations
    b. You can also add additional interesting information that you found about marine debris to your presentation.

Alternatively: Create a poster that includes all of the above information and present from the poster

Resources
The following are websites that have information about marine debris. They are good places to *start* your research, but remember that there are *many* good websites that you can use to find information.
- http://oceanservice.noaa.gov/hazards/marinedebris/
- http://water.epa.gov/type/oceb/marinedebris/factsheet_marinedebris_debris.cfm

- http://marinedebris.noaa.gov/sites/default/files/Gen_Plastic-hi_9-20-11_1.pdf
- http://water.epa.gov/type/oceb/marinedebris/basicinfo.cfm
- http://education.nationalgeographic.com/education/encyclopedia/marine-debris/?ar_a=1
- http://marinedebris.noaa.gov/sites/default/files/101MDPstr.pdf
- http://marinedebris.noaa.gov/sites/default/files/101LandPstr.pdf
- http://marinedebris.noaa.gov/sites/default/files/101FishPstr.pdf
- http://marinedebris.noaa.gov/sites/default/files/101BoatPstr.pdf
- http://marinedebris.noaa.gov/sites/default/files/gpposter.pdf

Understanding Density

Objective 5: Students will investigate the properties of density and buoyancy.
Objective 6: Students will understand how density affects the buoyancy of an object.
Objective 7: Students will investigate how salinity affects buoyancy.
Objective 8: Students will understand how the density of marine debris affects its placement in the water column.
Objective 9: Students will learn how organisms are negatively effected by marine debris in the water column.

Materials:
- 2 - 100 mL graduated cylinders
- 1 - 250 mL beaker
- 1 mL set of measuring spoons OR 1 - 10 mL graduated cylinder
- Corn syrup
- Food coloring
- Ice
- Rubbing alcohol
- Salt
- Stirrers
- Vegetable oil
- Water
- **How Salinity Affects Density Demonstration** handout (**How Salinity Affects Density Demonstration Answer Key** for teachers)
- **Creating Density Columns Activity** handout (**Creating Density Columns Activity Answer Key** for teachers)
- **Plastics in the Water Column Activity** handout (**Plastics in the Water Column Activity Answer Key** for teachers)
- **Coastline Water Column Drawing** handout (**Coastline Water Column Drawing Answer Key** for teachers)

Duration: 30-45 minutes (depending on age group)

Activity Procedure:
3. Ask students to answer the following questions: *1) What is density? 2) What is buoyancy?* Either pose this independent work where students can look for definitions using the Internet or books and then share answers OR have students share what they think the definitions are in a discussion format, writing answers on the board an arriving at an appropriate definition as a class. Wrap this up by coming up with as a class or providing to the class an appropriate definition of each word; have students record the correct definitions. *Time: 5 minutes*

4. Have students set up the **How Salinity Affects Density Demonstration** in groups of 2-3.

5. Have students conduct the **Creating Density Columns Activity** in groups of 2-3. *Time: 20 minutes*

6. Discuss student answers to **Creating Density Columns Activity** as a class. *Time: 5 minutes*

7. Have students observe the **How Salinity Affects Density Demonstration**. Answer questions as a class discussion, making sure that students record the answers to their questions on their paper. *Time: 15 minutes*

8. Have students complete the **Plastics in the Water Column Activity**. *Time: 30 minutes*

9. Discuss students answers to **Plastics in the Water Column Activity**. *Time: 5 minutes*

10. Have students complete the **Coastline Water Column Drawing** independently.

How Salinity Affects Density Demonstration

Purpose
- Students will investigate the relationship between density and salinity of water.

Materials
- 1 - 250 mL beaker
- 1 mL set of measuring spoons OR 1 - 10 mL graduated cylinder
- Food coloring
- Ice
- Salt
- Stirrer
- Water

Directions
1. Pour 100 mL of water into a 250 mL beaker.
2. Measure and add 10 mL of salt to the water
3. Stir until the salt is dissolved.
4. Add 2-3 drops of green or blue food coloring to the water.
5. Stir until the color is distributed evenly throughout the salt water.
6. Add a layer of crushed ice to cover the top of the salt water.
7. Wait until the ice melts to make observations.

Questions
1. Draw a picture that shows what happened to the liquids in your beaker after the ice melted. Please label the different liquids in your drawing.

2. Which liquid is more dense, salt water or fresh water? Explain your answer.

Using your knowledge from this demonstration, consider the following questions:
3. On marine coastlines and tidal marshes and estuaries, where fresh water from rivers mixes with salt water from the ocean, how does salinity change in the water column? Explain your answer.

4. Draw a picture of the water column in a marine coastline or tidal marsh, where fresh and salt water combine. Label the following areas within the water column: more saline, less saline, higher density, lower density.

Using your knowledge from this demonstration and the Creating Density Columns Activity, consider the following questions:
5. How might the density of the water column affect the type of marine debris in the water?

How Salinity Affects Density Demonstration. Answer Key

Purpose

- Students will investigate the relationship between density and salinity of water.

Materials

- 1 - 250 mL beaker
- 1 mL set of measuring spoons OR 1 - 10 mL graduated cylinder
- Food coloring
- Ice
- Salt
- Stirrer
- Water

Directions

1. Pour 100 mL of water into a 250 mL beaker.
2. Measure and add 10 mL of salt to the water
3. Stir until the salt is dissolved.
4. Add 2-3 drops of green or blue food coloring to the water.
5. Stir until the color is distributed evenly throughout the salt water.
6. Add a layer of crushed ice to cover the top of the salt water.
7. Wait until the ice melts to make observations.

Questions

1. Draw a picture that shows what happened to the liquids in your beaker after the ice melted. Please label the different liquids in your drawing.

A. The picture should show salt water on the bottom and fresh water (from the melted ice on the top).

2. Which liquid is more dense, salt water or fresh water? Explain your answer.

A. Salt water is more dense than fresh water because fresh water floats on top of salt water (salt water sinks compared to fresh water).

Using your knowledge from this demonstration, consider the following questions:

3. On marine coastlines and tidal marshes and estuaries, where fresh water from rivers mixes with salt water from the ocean, how does salinity change in the water column? Explain your answer.

A. In areas where fresh and salt water combine, deeper water will be more saline (more salty) than fresh water. This is because salt water is denser than fresh water, thus is will sink to the bottom of the water column while fresh water will float to the top of the water column.

4. Draw a picture of the water column in a marine coastline or tidal marsh, where fresh and salt water combine. Label the following areas within the water column: more saline, less saline, higher density, lower density.

A. The water column should show "more saline" and "higher density" at the bottom and "less saline" and "lower density" at the top.

Using your knowledge from this demonstration and the Creating Density Columns Activity, consider the following questions:

5. How might the density of the water column affect the type of marine debris in the water?

A. Different types of marine debris have different densities. Those with lower densities may end up suspended in the top of the water column, while those with higher densities may sink to the bottom.

Creating Density Columns Activity

Part 1

Purpose

- Students will investigate the properties of density and buoyancy.

Materials

- 2 - 100 mL graduated cylinders
- Corn syrup
- Food coloring
- Rubbing alcohol
- Vegetable oil
- Water

Directions

1. Pour 20 mL of corn syrup into a 100 mL graduated cylinder (graduated cylinder A).
2. Measure 20 mL of water in a different graduated cylinder (graduated cylinder B).
3. Add 1-2 drops of food coloring to water.
4. Pour this colored water into graduated cylinder A (on top of the corn syrup). *This works best if you pour the water into the graduated cylinder **slowly** and **down the inside** of the tube.*
5. Measure 20 mL of vegetable oil in graduated cylinder B.
6. Add 20 mL of vegetable oil to graduated cylinder A (on top of the corn syrup and colored water). *This works best if you pour the vegetable oil into the graduated cylinder **slowly** and **down the inside** of the tube.*
7. Measure 20 mL of rubbing alcohol in graduated cylinder B.
8. Add 1-2 drops of food coloring to rubbing alcohol.
9. Add 20 mL of rubbing alcohol to graduated cylinder A (on top of the vegetable oil, corn syrup, and colored water). *This works best if you pour the vegetable oil into the graduated cylinder **slowly** and **down the inside** of the tube.*

Questions

1. Reflecting on the discussion your class had at the beginning of this lesson, define density and define buoyancy.

2. Draw a picture that shows what happened to the liquids when you poured them into the graduated cylinder. Please label the different liquids in your drawing.

3. Does the top or bottom of your graduated cylinder hold the most dense liquids? Explain why this is the case.

4. Does the top or bottom of your graduated cylinder hold the most buoyant liquids? Explain why this is the case.

5. How might density of marine debris affect its place in the water column?

6. How might the placement of marine debris in the water column affect where it ends up on land, how long it takes to get there, or which type of organisms might encounter it in the water?

Creating Density Columns Activity. Answer Key

Part 1

Purpose

- Students will investigate the properties of density and buoyancy.

Materials

- 2 - 100 mL graduated cylinders
- Corn syrup
- Food coloring
- Rubbing alcohol
- Vegetable oil
- Water

Directions

1. Pour 20 mL of corn syrup into a 100 mL graduated cylinder (graduated cylinder A).
2. Measure 20 mL of water in a different graduated cylinder (graduated cylinder B).
3. Add 1-2 drops of food coloring to water.
4. Pour this colored water into graduated cylinder A (on top of the corn syrup). *This works best if you pour the water into the graduated cylinder **slowly** and **down the inside** of the tube.*
5. Measure 20 mL of vegetable oil in graduated cylinder B.
6. Add 20 mL of vegetable oil to graduated cylinder A (on top of the corn syrup and colored water). *This works best if you pour the vegetable oil into the graduated cylinder **slowly** and **down the inside** of the tube.*
7. Measure 20 mL of rubbing alcohol in graduated cylinder B.
8. Add 1-2 drops of food coloring to rubbing alcohol.
9. Add 20 mL of rubbing alcohol to graduated cylinder A (on top of the vegetable oil, corn syrup, and colored water). *This works best if you pour the vegetable oil into the graduated cylinder **slowly** and **down the inside** of the tube.*

Questions

1. Draw a picture that shows what happened to the liquids when you poured them into the graduated cylinder. Please label the different liquids in your drawing.

A. The picture should show the following liquids from bottom to top: corn syrup, water, vegetable oil, rubbing alcohol

2. Does the top or bottom of your graduated cylinder hold the most dense liquids? Explain why this is the case.

A. Liquids at the bottom of the graduated cylinder are more dense than liquids at the top. This is because denser objects (including liquids) sink compared to objects that are less dense.

3. Does the top or bottom of your graduated cylinder hold the most buoyant liquids? Explain why this is the case.

A. Liquids at the top of the graduated cylinder are more buoyant than liquids at the bottom. This is because more buoyant objects (including liquids) float compared to objects that are less buoyant.

4. How might density of marine debris affect its place in the water column?
   Marine debris that has a density greater than salt water will sink; marine debris that is less dense than salt water will float.

5. How might the placement of marine debris in the water column affect where it ends up on land, how long it takes to get there, which type of organisms might encounter it in the water?
   Marine debris that sinks will either be suspended in the water column (and can be mistaken as food or entangle marine animals like sea turtles and fish) or will sink to the bottom of the sea floor. Marine debris that floats can be suspended in the water and and can be mistaken for food or can cause entanglement and it will wash up to beaches. Marine debris that is the least dense will stick out of the water more than slightly less dense material and will have high windage - which means that it will catch moving air quickly and move more rapidly through the water, possibly ending up on beaches faster.

Plastics in the Water Column

Purpose

- Students will determine where different types of plastics might be suspended in the water column.
- Students will infer which types of plastics are more likely to cause harm to specific marine organisms, based on their habitat.

Materials

- 1 - 1000 mL beaker
- Salt
- Small pieces of plastic representing the 7 most common types, marked with their plastic code
- Stirrer
- Water

Part 1 - Directions

1. Pour 1000 mL of salt water into a 1000 mL beaker.
2. Measure and add 35 mL of salt to the water
3. Stir this solution until the salt is dissolved. This solution represents ocean water which has an average salinity of 35 ppt.
4. Place a piece of plastic with recycling code 1 in the water.
5. Record where the plastic settled in the water column in the data table.
6. Repeat steps 5-6 using pieces of plastic with recycling codes 2 - 7.
7. Use the following link to find a few examples of each type of plastic: http://www-tc.pbs.org/strangedays/pdf/StrangeDaysSmartPlasticsGuide.pdf. Record this information in the data table.

Data Table

Plastic Name	SPI Code	Sink, Float, or Suspended in the Water Column?	Examples
PETE	1		
HDPE	2		
PVC	3		
LDPE	4		
PP	5		

PS	6		
Other	7		

Questions

1. Draw a picture that shows where the different types of plastic settled in the water column. Identify the types of plastics in your drawing.

2. Identify a few examples of plastic items that might be found floating on the ocean's surface, a few examples of plastic items that might be suspended in the water just under the ocean's surface, and a few examples of plastic items that might sink to the ocean floor.

Part 2 - Directions

1. Read the document called **Marine Animals in Coastal Georgia** to find out information about some animals that can be negatively affected by marine debris.

Questions

1. Which of those animals feed on the ocean's surface?

2. Which of those animals feed in the pelagic region (below the surface)?

3. Which of those animals feed in the benthic region (on the sea floor)?

4. Choose two of the animals on the Marine Animals in Coastal Georgia sheet. For both animals, answer the following questions: Which general type(s) of plastics could affect this animal? Why?

5. What are some specific ways that plastics in the ocean can harm marine life?

Marine Animals in Coastal Georgia

Manatees are large, aquatic mammals that weight between 800 and 1200 pounds. In the United States, they live in shallow coastal waters off of the coast of Florida north to South Carolina and west to Texas. Because they are mammals, they must come to the surface to breathe, so they stay in shallow water. Manatees are slow moving, herbivorous animals that must consume 10-15% of their body weight on a daily basis; their diet consists primarily of submerged or floating plants.

Loggerhead Sea Turtles are aquatic reptiles who live in a very wide range of ocean habitats, including coastal Georgia. These sea turtles lay their eggs on the shore and can also be found swimming in the open ocean. An adult loggerhead sea turtle typically weighs about 250 pounds and is approximately 3 feet long. Loggerhead sea turtles are carnivores and eat a diet that includes jellyfish, crabs, fish, and seaweed.

Bottlenose Dolphins inhabit a wide range, including coastal Georgia. These marine mammals typically live in groups or pods of 10-30 dolphins. Adult dolphins typically grow to be about 8 feet long and weigh between 500 and 600 pounds. They are carnivores that eat fish, squid, and crustaceans.

Blue Crabs also inhabit a large range, including the waters of coastal Georgia. The size of blue crabs is dependent upon the temperature of the water they live in, although a typical size for a mature blue crab is about 7 inches. They are benthic (bottom) feeders and eat a wide variety of organisms, including fish, shellfish, worms, insects, and other crabs.

Atlantic Stingrays are benthic feeders that live along the coast of the eastern United States. They eat by foraging on the sandy seafloor in shallow waters.

Laughing Gulls are common on shorelines in coastal Georgia. They also can be found following fishing boats out at sea. Laughing gulls eat aquatic invertebrates, insects, and sometimes fish from the surface of the water.

Brown Pelicans are common on coastal shorelines in the Atlantic Ocean south of North Carolina, including coastal Georgia. The brown pelican is a large bird that consists on a diet of fish. Its beak contains a large pouch that holds up to 3 gallons of fish!

Plastics in the Water Column Answer Key

Purpose

- Students will determine where different types of plastics might be suspended in the water column.
- Students will infer which types of plastics are more likely to cause specific marine organisms, based on their habitat.

Materials

- 1 - 1000 mL beaker
- Salt
- Small pieces of plastic representing the 7 most common types, marked with their plastic code
- Stirrer
- Water

Part 1 - Directions

6. Pour 1000 mL of salt water into a 1000 mL beaker.
7. Measure and add 35 mL of salt to the water
8. Stir this solution until the salt is dissolved. This solution represents ocean water which has an average salinity of 35 ppt.
9. Place a piece of plastic with recycling code 1 in the water.
10. Record where the plastic settled in the water column in the data table.
11. Repeat steps 5-6 using pieces of plastic with recycling codes 2 - 7.
12. Use the following link to find a few examples of each type of plastic: http://www-tc.pbs.org/strangedays/pdf/StrangeDaysSmartPlasticsGuide.pdf. Record this information in the data table.

Data Table

Plastic Name	SPI Code	Sink, Float, or Suspended in the Water Column?	Examples
PETE	1	sinks	soda bottles, salad dressing bottles, water bottles
HDPE	2	floats	milk jugs, household cleaner containers
PVC	3	sinks	shampoo bottles, medical equipment
LDPE	4	floats	shopping bags, squeezable bottles
PP	5	floats	ketchup bottles, straws, medicine containers

PS	6	sinks or floats	styrofoam cups & plates, meat/food packaging, egg cartons
Other	7	sinks or floats	various items

Questions

1. Draw a picture that shows where the different types of plastic settled in the water column. Identify the types of plastics in your drawing.

Top/Surface: 2, 4, 5, 6, 7
Suspended/Pelagic: 2, 4, 5, 6, 7
Bottom/Benthic: 1, 3, 6, 7

2. Identify a few examples of plastic items that might be found floating on the ocean's surface, a few examples of plastic items that might be suspended in the water just under the ocean's surface, and a few examples of plastic items that might sink to the ocean floor.

Floating & suspended: plastic bags (4), milk jugs (2), styrofoam cups (6)
Bottom: water bottles (1), shampoo bottles (3), CD/DVD cases (6)

Part 2 - Directions

1. Read the document called **Marine Animals in Coastal Georgia** to find out information about some animals that can be negatively affected by marine debris.

Questions

1. Which of those animals feed on the ocean's surface?

manatees, laughing gulls, brown pelicans

2. Which of those animals feed in the pelagic region (below the surface)?

loggerhead sea turtles, bottlenose dolphins

3. Which of those animals feed in the benthic region (on the sea floor)?

blue crabs, Atlantic stingrays

4. Choose two of the animals on the Marine Animals in Coastal Georgia sheet. For both animals, answer the following questions: Which general type(s) of plastics could affect this animal? Why?
   - manatees, laughing gulls, brown pelicans: affected by any of the floating plastics: 2, 4, 5, some 6, some 7 because these plastics will be floating on the surface and these animals are feeding on the surface.
   - loggerhead sea turtles, bottlenose dolphins: affected by any of the floating plastics: 2, 4, 5, some 6, some 7 because these plastics will be floating on the surface and these animals are feeding on the surface.

- blue crabs, Atlantic stingrays: affected by any of the sinking plastics: 1, 3, some 6, some 7 because these plastics will be on the sea floor where these animals are feeding.

5. What are some specific ways that plastics in the ocean can harm marine life?

ingestion and entanglement

Coastline Water Column Drawing

Purpose

- Students will understand where different types of plastic might exist in the water column in Georgia coastlines.

Background

Brackish water is a mix of salt water and fresh water. Salinity affects the density of water. Fresh water has a density of approximately 1.0 g/cm^3. The higher the salinity of ocean water, the greater its density. For this activity, assume ocean water has a density of approximately 1.025 g/cm^3.

Procedure

1. Create a data table to show:
    - Name and resin number of plastic
    - Specific examples of items made with this type of plastic/resin
    - Approximate density of each type of plastic
    - Whether each type of plastic floats or sinks in fresh water
    - Whether each type of plastic floats or sinks in salt water
2. Draw a water column for fresh water and ocean water and identify where different types of plastic would fall within the water column.

Questions

1. Are there types of plastic that, according to their density and the approximate densities of fresh water and ocean water given in this document, will float in one type of water and sink in another? If so, what type(s) of plastics are these? If so, what items could these be?

2. According to the data provided in the reference section, what are examples of plastic items that will float in ocean water? According to the data provided in the reference section, what are examples of plastic items that will sink in ocean water?

3. In thinking about marine debris, why does it matter if a plastic item floats or sinks?

References

http://www.malvernplasticsgroup.com/plastics-resins-identification-system-plastic-resin.html

Resin	Density (g/cm^3)
PETE	1.35
HDPE	0.94-0.965
PVC	1.35
LDPE	0.91-0.925
PP	0.89-0.91
PS	1.0-1.1
Nylon	1.35

Coastline Water Column Drawing. Answer Key

Purpose

- Students will understand where different types of plastic might fall in the water column in Georgia coastlines.

Background

Brackish water is a mix of salt water and fresh water. Salinity affects the density of water. Salinity affects the density of water. Fresh water has a density of approximately 1.0 g/cm^3. The higher the salinity of ocean water, the greater its density. For this activity, assume ocean water has a density of approximately 1.025 g/cm^3.

Procedure

1. Create a data table to show:
    - Name and resin number of plastic
    - Specific examples of items made with this type of plastic/resin
    - Approximate density of each type of plastic
    - Whether each type of plastic floats or sinks in fresh water
    - Whether each type of plastic floats or sinks in salt water
2. Draw a water column for fresh water and ocean water and identify where different types of plastic would fall within the water column.

Questions

1. Are there types of plastic, according to their density and the approximate densities of fresh water and ocean water given in this document, that will float in one type of water and sink in another? If so, what type(s) of plastics are these? If so, what items could these be?

Resin	Density (g/cm^3)	Float or sink in fresh water?
PETE	1.35	sink
HDPE	0.94-0.965	float
PVC	1.35	sink
LDPE	0.91-0.925	float
PP	0.89-0.91	float
PS	1.0-1.1	sink
Nylon	1.35	sink

Multiple answers to types of items that these plastics could be

2. According to the data provided in the reference section, what are examples of plastic items that will float in ocean water? According to the data provided in the reference section, what are examples of plastic items that will sink in ocean water?

Resin	Density (g/cm^3)	Float or sink in ocean water?
PETE	1.35	sink
HDPE	0.94-0.965	float
PVC	1.35	sink
LDPE	0.91-0.925	float
PP	0.89-0.91	float
PS	1.0-1.1	sink/float
Nylon	1.35	sink

Multiple answers to types of items that these plastics could be

3. In thinking about marine debris, why does it matter if a plastic item floats or sinks?
Items that float will be more likely to wash up on shorelines, to be mistaken for food by marine animals, and to cause entanglement.