**Matter**

**Lesson #4:** **Density**

**Time Frame:** 60 minutes

**Learning Standards:**

*Science*

Physical Science: Observable Properties of Objects and States of Matter

1. Sort objects by observable properties such as size, shape, color, weight, and texture.
2. Compare and contrast solids, liquids, and gases based on the basic properties of each of these states of matter.

Skills of Inquiry

1. Ask questions and make predictions that can be tested.
2. Select and use appropriate tools and technology in order to extend observations.
3. Keep accurate records while conducting simple investigations or experiments.
4. Conduct multiple trials to test a prediction. Compare the result of an investigation or experiment with the prediction.
5. Recognize simple patterns in data and use data to create a reasonable explanation for the results of an investigation or experiment.
6. Record data and communicate findings to others using graphs, charts, maps, models, and oral and written reports.

**Student will be able to:**

1. Experiment to determine the similarities and differences between two types of solid balls.
2. Model, observe, and explain density.
3. Define and describe the characteristics of solids.
4. Define and describe the characteristics of liquids.
5. Experiment with liquids and explain how liquids are similar and different.

**Resources and Materials:**

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| **Item** | **Amount** |
| Science notebooks |  |
| Black balls comparison charts | 50 (in bin) |
| Ball properties station instructions | 1 per station (in bin from lesson #1) |
| Black balls (half marked with a white line) | 10 pairs (in bin) |
| Clear containers with lids | 2 (in bin) |
| Water (not provided) | (in classroom) |
| Retractable tape measures | 3 (in bin) |
| Made balances  Washers and paper clips  Hooks and pins (to hang balances) | 3 (in bin)  1 container (in bin)  1 container (in bin) |
| Meter stick (not provided) | (in classroom) |
| Loops of rope  Big loop  Medium loop  Small loop | 3 (in bin)  1 (in bin from lesson #3)  1 (in bin)  1 (in bin) |
| Masking tape | 1 (in bin) |
| Beaker | 1 (in bin) |
| Corn syrup | 3-4 bottles (in bin) |
| Corn oil | 1-2 bottles (in bin) |
| Alcohol | 2 (in bin) |
| Food coloring | 5 boxes (in bin) |
| Different types of balls | 10 balls (in bin from lesson #1) |

**Focus Activity:** Have students draw Venn diagrams in their science notebooks to organize similarities and differences between solids and liquids.  Then discuss properties of solids and liquids as a class.

**Introduction:** Show the class the set of small black balls.  Tell them that the balls may look similar but you want them to test them to see if they really are the same.  Write this question on the board:  Are the black balls the same or different?  Explain that today they will be in charge of testing the properties of these solid balls.  Emphasize that the balls are solid by reviewing the characteristics of solids.

**Activity:**

1. Have the students work in pairs.  Give each group a pair of black balls. One of the balls will be marked and the other will be unmarked, so that students can keep track of which ball they are testing.  Tell students that they will observe and test the properties of each ball and record their findings on the “Black Balls Comparison Chart”.  Tell students that they can add other testable properties to the chart.
2. The classroom should be set up to weigh the balls, measure circumferences, check for buoyancy, measure bounce height, etc. Encourage students to do multiple trials when they check the bounce height.  Students should have freedom to test their own ideas during the experimentation phase.  Make sure that all the groups record their results on their charts.
3. End the experimentation phase and ask students to think about their results.  Groups that conducted multiple bounce trials should calculate the average bounce height or use the median result.  Tell the students to write a few sentences in their science notebooks explaining how the two balls are similar and how they are different.
4. Lead a class discussion of the results and conclusions that students drew from this experiment.  Encourage groups to compare and contrast their findings with other groups.  You may record some of the class data in a chart on the board.  Make sure to note when results do not agree.  Try to account for these discrepancies.  Ask students to share their conclusions, and use leading questions to try to push their understanding of how two balls can be the same size but behave differently.  How much did each weigh?  Which one bounced higher, the heavier or the lighter ball?
5. Introduce the concept of *density* to the class.  Write the word on the board with the definition below.  Ask students to relate the idea of density to the black balls.  Did they take up the same amount of space or different amounts of space? (What was their size?)  What does this tell you about the molecules in Ball #1 compared to the molecules in Ball #2?  Are there more or less?  Are they closer together or more spread out?  Relate this to how the balls bounced and how much they weighed.

**Density:**the amount of matter in a certain space

1. Tell the students that they will now model the density of different objects. Each student represents one molecule in an object.  Ask the students what the mass of this object will be? (The number of students in the class will be the mass of the object.)  This mass will not change throughout the experiment.  Move aside the desks and tape 3 different sizes of looped string into squares on the floor.  Tell the students that these squares represent objects of different sizes.
   1. First, ask the students to stand in the smallest square.  They should be packed very closely together.  Explain and discuss that this is how molecules behave in a dense object.
   2. Then, ask the students to stand in the medium square.  They should have more room to spread out.  Explain and discuss that this is how molecules behave in a less dense object.
   3. Then, ask the students to stand in the big square.  They should be quite spread out.  Explain and discuss that this is how molecules behave in an object that is not very dense.
   4. Convert the small square into a circle.  Ask the students how they would model the different densities of the two black balls.  Try to guide students to the idea that although the balls were the same size, there were more molecules in the heavier ball and fewer molecules in the lighter ball, making it less dense.
2. Tell students that liquids, like solids, also have different densities. Demonstrate different densities of liquids by mixing water, corn syrup, and oil.  (Alcohol is included as an optional fourth liquid to add to the mix.) Ask students to write their predictions about what will happen when the three liquids are mixed together in a beaker.  Students may make a drawing of their predictions.
3. Pour some of each of the three liquids into the beaker.  Color the water using food coloring so that the layers can be distinguished.  Let the mixture of liquids sit, undisturbed, and ask the students to observe what happens and record their results in their science notebooks.  Then, answer the following questions: Were your predictions right?  Why or why not?  Why did the liquids form different layers?  Discuss as a class and relate to density.  (Objects can also be placed in this experiment and different objects will float between different layers.)

**Closure:** You can also relate the idea of density to buoyancy from the first lesson.  More dense objects sink in water and less dense objects float in water. You can do a simple demonstration in front of the class to explain this point.  Ask the students questions about how molecules behave differently in objects that sink versus objects that float.  Are they spread out or packed together?  How can you tell? As an extension, you can give the students objects to see if they will sink or float in the different liquids.  You can try marbles, coins, erasers, corks, rocks, etc.  An object may float in a more dense liquid but sink in a less dense liquid.  The students can make predictions and record their results as time permits.  Discuss these ideas as a class when this experiment is over.

**Assessment:** Science notebook responses, black balls comparison charts, participation in density activities, and participation in class discussions

**Color**

What color is your ball?

* Record the color in your chart.

**Texture**

How does your ball feel?

Rough? Smooth?

Bumpy? Soft? Hard?

* Record the texture in your chart.

**Size**

How big around is your ball?

* Use the measuring tape to measure around your ball in centimeters.
* Record the measurement in your chart.

**Weight**

How much does your ball weigh?

* Place your ball in a cup on the balance.
* Slowly add washers and/or paper clips to the other cup until the balance is even.
* Record the number of washers and paper clips in your chart.

**Bounce Height**

How high does your ball bounce?

* Use the meter stick taped to the wall.
* Hold the ball at the very top (100 cm) and drop the ball.
* Measure how high the ball bounces in centimeters.
* Record the measurement in your chart.

**Sink/Float**

Does your ball sink or float?

* Get your same ball from the basket.
* Drop the ball in the water and see if it sinks or floats.
* Dry the ball and put it back in the basket.
* Record if your ball sinks or floats in your chart.

