Science - 7th grade - Matter - Density - Science Process, Inquiry

Overview

The main idea associated with these activities is density. Density, as it is developed within these activities threads most closely to two standards: Matter and Measurement. Density being a property of matter - a relationship between two other properties of matter - mass and volume. Concepts of mass, volume, measurement of mass and volume, the idea of thinking about matter as composed of small particles, and science processes how to use properties, variables, experimental evidence, reasoning, explanations, operational definitions, and conclusions.
These ideas are further defined and clarified beginning with the following curriculum mapping.

Big Idea - Physical science - Matter
All objects are made of matter - Properties of objects are determined by the elements from which they are made. Properties of matter include: color, texture, size, shape, mass, volume, density, temperature, chemical, energy, states of matter (solid, liquid, gas, plasma) and the ability to interact with other objects.
Concepts, Facts, and Generalizations
- Elements - the smallest particles that compose everything in the universe. Determined by the number of protons.
- Mass - the amount of matter in an object
- Volume - space an object occupies
- Density - relationship of mass and volume
- Some properties of matter change and some properties don't change.

Outcome - Matter **-** Describe the mass, volume, and structure of matter as determined by atoms and molecules.
Specific outcomes
1) Describe matter as having mass and volume. (3)
2) Describe matter as composed of atoms. (6, 8)
3) Describe atoms as too small to see. (6)
4) Describe arrangements of particles in physical states of matter (solid, liquid, gas). (3)
5) Describe the relationship of mass and volume as it relates to density. (8)
6) Describe density as a result of the structure of matter in terms mass and volume.

Big Idea - Unified Process - Properties
Properties can be used as variables in experiments, operational definitions, explanations...
Concepts, Facts, and Generalizations
- Properties are used to identify objects, elements, matter...
- Properties are characteristics of an object.
- Properties include: color, texture, size, shape, mass, volume, density, temperature, chemical, energy, and the ability to interact with other objects.
- Properties can be used to compare objects. (1)
- Properties of matter can be measured using tools such as rulers, balances, graduated cylinder, displacement, and thermometers. (4)
- Some properties of objects change and some properties don't change.
- Properties and change of properties can be quantified.
- Objects, properties, and events stay the same or change in similar ways.
- Properties are used to define all objects.
- Definitions include properties.
- Definitions can be changed by changing properties.
- Properties can usually be varied and used as variables to investigate with reasoning.

Outcome - Unified Process - Properties - Properties are characteristics of an object.
Specific outcomes

Describe properties as characteristics of an object.
Use properties to identify and describe objects.
Use properties to identify variables, create experiments, hypothesis, operational definitions, and explanations.

Big Idea - Unified Process - Constancy, Change, and Measurement
Measurement - Properties can be measured with scientific tools and compared to a standard unit (linear, time, temperature, mass, volume, and density).
Change **-** can be quantified. Change can be related to variables. Variables can be used to describe change. Evidence for interactions and subsequent change and the formulation of scientific explanations are often clarified through quantitative distinctions - measurement. Scale includes understanding that different characteristics, properties, or relationships within a system might change as its dimensions are increased or decreased. Rate involves comparing one measured quantity with another measure quantity (50 meters per second). Rate is also a measure of change for a part relative to the whole, (birth rate as part of population growth).
Concepts, Facts, and Generalizations - *Unified Process - Measurement*

- Properties can be measured.
- All measurement is relative to a unit, usually a standard unit.
- Change can be related to variables.
- Variables can be used to describe change.
- Measurement helps in making more accurate observation.
- Measurement helps in making better observations.
- A standard unit of measurement helps communication.
- Properties of matter can be measured using tools such as rulers, balances, and thermometers.
- Quantitative estimates of familiar lengths, weights, and time intervals can be confirmed by measurement.
- Volume is the measurement of space an object occupies. Common standard units of volume include: ml, l, cup, pint, quart, gallon.
- Measuring cups measure volume
- Volume can be calculated from linear measurements.
- Volume can be calculated from area and linear measurements.
- Area measures the surface of an object. Common standard units of area are square cm, m, km, ft. yd. mi.
- Mass is the measure of how much matter is in a particular object or particular space. Common standard units of mass include: g, kg, pounds, ounces, tons.
- Balance scales measure mass and weight.
- Measurement is a way of detecting measurement helps in making better observations.
- As a system gets more complicated we can gain understanding by using summaries of average, range, and describing the typical properties of the system.
- All measurement has error.
- Scale is a proportional relationship of characteristics, properties, or relationships within a system as its dimensions are increased or decreased.
- Rate involves a measure of change for a part relative to a whole (birth rate as part of population growth and comparing one measured quantity to another measured quantity (km per hour).

Outcome - Unified Process - Constancy, Change, and Measurement
Accurately measure the properties of matter in different states.
Specific outcomes

- Select and use appropriate instruments to measure mass and volume of solids and liquids and record the data. (6)

- Predict the relative density of various solids and liquids (based on observations). (5)
- Calculate the density of different solids and liquids. (6)
- Design a procedure to measure mass and volume of gases. (3)

Big Idea - Science investigation / inquiry / experiment
Science investigation uses observation to answer questions. Observation that can be observed repeatedly to build confidence in understanding by connecting reasoning for why certain observations occur.
Concepts, Facts, and Generalizations
- **Variables** are conditions that change and can be measured.
- Variables can be identified and used to suggest causes and reasons for change.
- Variables l

Outcome - Science investigation / inquiry / experiment
Focus on variables relationship to understanding and the creation of hypothesis, investigations, operational definitions, and explanations.
A more comprehensive unpacking of science investigation is available at the HoB.
Specific outcomes
- Identify properties
- Recognize variables as properties that can change.
- Describe how to reason about variables.
- Describe how variables are used to focus an investigation. (6)
- Describe how variables are used in making hypothesis, operational definitions, and explanations.

Activities to provide sufficient opportunities for students to attain the targeted outcomes.

Possible Activity Sequence

1. Do Diet Pop Cans and Non Diet Pop Cans Float and Sink
2. Floating and Sinking Potatoes in Water
3. Sink and Float
4. Buoyancy Float
5. Measuring Mass and Volume
6. Metal Cubes
7. Density of Bread - Before and After ...
8. Can you make an egg float?
9. Density of Wood Blocks
10. Sphere density
11. Measuring liquid volume
12. Do Different Liquids Have Different Densities?
13. Density of Liquids
14. Plastic in different liquids
15. Gases density
16. Density of Liquids - Performance Test?

Exploration

The activities are designed and sequenced to provide the power of a Learning Cycle - exploration it may also be reasonable to provide a pre assessment - See Science Assessment DataBase for sample assessment questions. The questions are arranged by national science standard categories.

Use of Diagnostic assessment

Explain the assessment is to help understand what they know and don't know in the particular science categories and the results will NOT be used for student's grade.

Provide a copy of an assessment to each student. Have them complete it and check their answers.

Let students set goals for their coming investigations.

Activity - Do Diet Pop / Non Diet Pop Cans Float or Sink?

Concepts

Matter - density
Properties can be used as variables to explain observations.
Reasoning - Explanations for cause and effect can be described by discussing variables and how they could cause differences.

Outcomes

Use observations to predict the relative density of various solids and liquids.

Specific outcomes

Different kinds of matter are in different kinds of pop cans.
Properties that effect change are variables. Possible variables for the pop can differences are mass, weight, or density.
Identify properties that can be used as variables to operationalize how the observations occur.
Suggest explanations for cause and effect of variables and how they could cause the difference.

Prior knowledge

Different kinds of matter have different properties, mass, volume,

Material

One unopened can of the same brand and flavor of regular pop and diet pop. May also ad, caffeine free pop, and other if available. Container of water large enough to float or sink them. Other instruments as students request them - balance, over flow collector, calculator, ...

Procedure

Exploration

Ask the students what will happen when each can is placed in the container of water?
Why do you think they will or won't float?
What might explain why each sinks or floats?
How can we use science processes?
How does inquiry support our reasoning?

Invention - Formative

Collect data, Record data, Share data

Summative

If they mention both variables of mass and weight that is good for starting. The relationship between the two will come with further exploration. If they mention the word density ask them to explain what they mean by it. Ask them if they could define the variables related to the idea of density and how they operate to make and change density.
Introduce the idea that Nutra-sweet is 1000 times sweeter than sugar and ask how that might effect what is going on. If they mention density ask how they can figure out the density of each can (using water displacement and mass...) If they focus only on mass, that's okay. Suggest it is a variable and if effects whether things sink or float. You may or may not want to suggest there is more to understand.

Scoring guide

Accept anything that identifies a variable related to density and a logical explanation.

Name _______________

Lab notes - *Do Diet Pop / Non Diet Pop Cans Float or Sink?*

Procedures:

Write and draw what you saw for the diet pop

Write and draw what you saw for the non diet pop

Data:

Pop			
Diet			
Non diet			

Analysis:

What variables do you think might effect a difference?

What causes you to believe one of those variables could cause a difference?

Conclusions

Activity - Floating and Sinking Potatoes in Water

Concepts

Prior knowledge
Cause effect relationship, identification of variables, properties of matter, solution, use of models for explanations.

Outcomes
Accurately measure the characteristics of matter in different states.
Identify variables that affects sinking and floating potatoes.
Apply the idea or model of solutions (a mixture where a substance (solute) is uniformly distributed within another substance (solvent)) to an explanation as to why the potato floats or doesn't float in fresh and salt water.
Buoyancy diagnose for activity Cup Float

Materials
Potatoes, knife, container with one liter fresh water and container with one liter of salt water salty enough to float potato pieces or whole potato, and an empty container to hold a mixture of ¼ liter of fresh water and ¼ liter of salt water.

Procedure
Exploration
Don't tell the students what is in either container.
Ask students what will happen when the potato pieces are put into container A and B.
Have students write their prediction of what is going to happen and their explanation of what variables they think will determine or cause it.

Formative
Insert different sizes of potato pieces in each container.
Pour 250 ml of plain water into a third container, slowly pour 250 ml of salt water on top as if it would float on top of the plain water, and label it C
Ask the students to predict what will happen when potato pieces are inserted.
Discuss

Summative
Have the students write one or more sentences describing what they think is happening differently according to the variables that have been changed. (size of potato, purity of the water, …) Again if students use the word "Density" ask them to define it operationally (explain what variables are affecting it and how are they doing it. How does the purity of the water, water, the mixed water, and the salty water operate on the potato? The salt is lifting it and the more salt the greater the lift (buoyancy).

Name _______________

Lab notes - *Floating and Sinking Potatoes in Water*

Procedures:

Write and draw what you saw for the diet pop

Write and draw what you saw for the non diet pop

Data:

Kind of water			
Regular water			
Semi salty			
Most salty			

Analysis:
What variable do you think made a difference?

What causes you to believe that variable could cause a difference? How does the variable operate on the potato as it changes?

Hypothesis or relationship?

Conclusions

Activity - Sink and Float - Clay

Concepts
The shape of an object will affect if it sinks or floats. The greater the surface area of the object, the more likely it will float. The greater the surface area that rests on the water the better the water will hold up the material because the water can exert a greater force. Surface area is the area of the outer part or upper most part of a two-dimensional or three-dimensional object.

Prior knowledge
Certain materials sink and certain materials float

Outcomes
Divide clay into two equal amounts and use one part to create a shape that floats and the other part to create a shape that sinks.
Explain that the greater the surface area covered by the material, the more likely it will float, because there is more water pushing up on it or the object is spread out over more water so there is less weight above the surface area the water has to support.

Material
Clay, containers of water, towels, balances to mass clay, lab notes

Procedure
Exploration
Predict what will happen if a clay ball is dropped into water.
Ask if there is a way they can think to make the clay float.
Have students divide their clay into two lumps.
Challenge the students to take each lump and make a shape: one that sinks and one that floats.
Have them write in their lab books what they think will make the clay float.
Invention
Have them create their shapes, draw a picture, test them in the water, and explain why they think it sunk or floated.
Have students share their data and describe what they learned.
Chart floaters and sinkers
Ask what each group has in common.
How do you think shape makes a difference?
What names do scientist give this list of things (variables)? Describe how each could change the clay so it would sink or float.
Use a drawing as a bridge to demonstrate forces of water and mass of the clay for examples that would float and sink

Ask what advice would give a person that makes ships out of steel?
Explain how a ship floats.

Summative Evaluation
Draw and categorize shapes of clay that sunk and shapes of clay that floated.
Describe characteristics of the designs that caused them to float or sink.
Did you identify a variable and how it changes.
Did you describe a hypothesis as the greater the surface area the greater the buoyancy?
Or did you write an Operational definition to describe how the change in surface area changed how it sunk or floated?

Name _______________

Lab notes - *Sink and Float - Clay Boats*

Write and draw your understanding of sink.

Write and draw your understanding of float.

Procedures:
Take a clay ball.
Divide it into two equal pieces.
How do you know they are equal?
Make two shapes: one that sinks and one that floats.
Draw a picture of each.
Test them in the water.
Explain why they should sunk or float.

Data:
Draw your shapes

Analysis:
What variable do you think made a difference?

What causes you to believe that variable could cause a difference?
How does the variable operate on the clay as it changes?

Hypothesis, operational definition, or relationship?

Conclusions

Activity - Buoyancy Cup Float

Concepts
An object will float if it displaces (pushes away) a mass of liquid less than or equal to its mass.
Variables can be identified and described as to how they vary.
Operational definition - describes how the variables operate or change. uses variables mass and volume to explain floating.
Mass can be used to explain sinking and floating.
An object will displace a volume of water equal to its volume if it is submerged.
The volume of water an object displaces depends on its ***mass not its volume***. Think this through. This does not say mass determines displacement. Think of a cup. Volume will stay the same. As pennies are added the mass will increase and as it does it displaces more water. Operational definition - what is the format? While the mass determines how much water is displaced the volume of that water is equal to the volume that is submerged. Can you draw a picture of this?
Objects sink if they displace a mass of liquid that is less than the mass of the object.
Objects sink if the mass of the object is greater than the liquid they displace.
Shape is a variable that determines how much liquid an object can displace. Shape that takes up more volume can displace more water. That doesn't mean that it will. Depends on mass - remember?

Prior knowledge
Certain materials sink and certain materials float. The shape of the material will affect if it sinks or floats. The greater the surface area of the material, the more likely it will float. The greater the surface area that rests on the water the better the water will hold up the material because the water can exert a greater force (buoyancy).

Outcomes
Add pennies to styrofoam cups of different sizes and record how the increase of mass displaces an increased mass of water.
Explain that the greater the mass in the cups the greater the mass of the water displaced.
Explain that the styrofoam boat floated as long as there was an equal mass of water to be displaced. If there is an equal force of water pushing up on it, then it will float.
Explain a variable is a property that changes.
Explain how variables can be used to describe how something operates (operational definition).

Material
Styrofoam cup, containers of water, towels, balances to mass pennies, boats, and water, science notebook

Procedure
Exploration
As students to predict what will happen if a styrofoam cup is put into the water.
Ask what will happen as pennies are added to the cup?
Diagnosis
May want to have a grand conversation about how to set up the experiment, what data to collect, and so forth. Or just give students the challenge and let them begin and see what they decide is important or not to record.
Challenge students to make styrofoam boats that are ¼ of a cup, ½ of a cup, ¾ of a cup, and 1 cup, float each, add pennies until they sink, and record the information in their lab notes.

Possible variable information to record. Mass of pennies, number of pennies, volume of cup, volume of container, volume of displaced water, mass of displaced water.

Invention
Have students investigate
Ask the students to write in their lab notes what happened to the styrofoam boat as pennies were added, what happened when the styrofoam cups floated, and when they sunk. Students create their boats (shapes), draw a picture, test them in the water, and explain why they think it sunk or floated.

Share their data and describe what they learned.
The data students collected may or may not be sufficient to answer these questions. Ask them and decide if it is important or not to redo parts and collect the data.
Chart size of boats and the number of pennies each held when sank.
Ask if the found the volume of water each cup holds (measure with graduated cylinder).
Ask if they found the mass of displaced water (measure by lowering cup into full container of water and collecting the over flow and measure it in a graduated cylinder).
Ask what the surface area of each cup is.
Ask what each group has in common for each cup.
How do you think shape makes a difference?
Use a drawing as a bridge to demonstrate forces of water and mass of the boat and the mass of the displaced water as the pennies are added.

Summative Evaluation
Draw a picture of a cup that has the amount of pennies that sunk it.
Draw and label the amount of water that it displaced when it was floating, just before it sunk.

Draw the cup in water without the pennies. **Draw** and label it just before it sunk.

What variables were included in the drawing?
Did the drawing show the relationship between the number of pennies and amount of water displaced.
Did students collect measurable evidence of for variables?
Were the variables mass of pennies, displaced water mass, or volume of displaced water?
As a conclusion did students include variables and describe how they operated?

Is there data to support
How shape made a difference?
How mass of the pennies related to the mass of displaced water?

Name _______________

Lab notes - *Buoyancy Cup Float*

Write and draw your understanding of buoyancy

Procedures:

Data:

Cup			
Quarter			
Half			
Three-quarters			
Whole			

Analysis:
What variables were measured?

When variables are measured that implies they are measured to describe change. How did a variable change?

How do you think that change made a difference?

What causes you to believe that variable could cause a difference? Select a variable and describe how the variable operates on the cup as it changes?

Hypothesis or relationship?

Conclusions

Activity - Measuring Mass and Volume

Concepts
Mass is the amount of matter in an object.
Volume is the amount of space an object occupies.

Outcomes
Measure mass and volume of common objects.

Background information
Mass describes how much matter is present and is measured by comparing one object to a known mass.
Mass is measured on a triple beam balance and the metric unit of measurement is the gram.
A gram has about the same mass as a large paper clip.
Volume is how much space something takes up and is measured in three ways.
Operational definitions for measuring…
1. Mass can be calculated as a product of l * w * h for cubic or rectangular shapes,
2. Mass can be measured by water displacement particularly for irregularly shaped objects.
3. Mass can be measured directly for liquids.

Liters or milliliters are the metric unit for volume and a milliliter of water has the same volume as one cubic centimeter of water.

Prior knowledge
Measure linear, measure mass on a balance, measure liquid in a graduated cylinder

Material
Balances, graduated cylinders, containers, rulers, overflow cups (optional) Objects to measure such as wooden blocks, clay pieces, marbles, rocks, glass of colored water, spheres, (May want to have a group of materials for students so there is something in common to discuss and share. May also want to have two objects that are different sizes, but made from the same material.)

Procedure
Exploration
Focus the students by holding up 3 different shapes of 1 liter (or larger equal size) containers. Ask if they hold the same amount or have the same volume. Ask them to predict the order of volume of water the containers would hold.
Fill one of the containers with water and demonstrate by pouring the water from it to a a measuring cup or graduated cylinder to see if the volumes are the same (or not).
Continue pouring from one flask to the other until they have all been compared.
Ask if students can suggest three ways to measure volume.

Formative
Operational definitions for measuring…
1. Mass can be calculated as a product of l * w * h for cubic or rectangular shapes,
2. Mass can be measured by water displacement particularly for irregularly shaped objects.
3. Mass can be measured directly for liquids.

Do a few problems as examples.
Show students an object they will measure and ask them to make a prediction of it's mass and volume.
Make measurements
Record them

Write the results on the board for each object and compare their findings.

Summative
Ask if there is any relationship to objects mass and volume. (properties and variables)
Don’t push the idea of calculating density unless students suggest it. Opportunities later.

Name _______________

Lab notes - Measuring Mass and Volume

Write and draw your understanding of mass

Write and draw your understanding of volume

Procedures:
Find the masses of several objects using the triple beam balance. (Remember - If the substance is in a container, you must subtract the mass of the container from the mass of the substance and the container.) Record your results.

Find the volume of the objects. Decide with your group which method of finding volume will be used. Record your results.Describe with your group a method to measure volume. Write directions to determine volume. (operational definition)

Record the volume and mass of the objects below.

Data:

Object	Mass	Method of finding volume	Volume

Analysis:
1. Compare your result to others. If there are differences what should be done?
Is there more than one way to decide?

2. How did your results compare to others?

3. Which way of measuring volume seems most accurate?   Why?

4. What is the relationship between a cubic centimeter and a milliliter?

5. What is a way you can remember what mass is?

6. What is a way you can remember what volume is?

Conclusions:

Activity - Metal Cubes

Concepts
Mass is the amount of matter in an object.
Volume is the amount of space an object occupies.
Density is the relationship between mass and volume.

Outcomes
Measure mass and volume and use it to explain density.

Background information
Densities of different materials can be found in engineering and machinists manuals. After students calculate their densities find a reference book and let students compare their calculations.

Prior knowledge
Volume, mass, a sense of density as related to mass and volume - not necessarily as a proportion or ratio between them, how to measure in metrics.

Material
Density block sets, aluminum, steal, brass, lead. (they are the same size and volume), metric ruler, triple beam balances, calculator, worksheet

Procedure
Exploration
Ask how to find the mass and volume of each cube. If necessary, review procedures for finding mass and volume.
Record the data on the chart.
Are mass and volume variables? (yes/no - Aren't for each object, but are when comparing one object to another.)
Are they properties of matter?
Why divide mass and volume?
Can you use your data to calculate density
If need be have the students review their notes on matter.
Invention - Formative
Have students collect measurements to find the density of the four different metal cubes.
Share the data with the class
Discuss results.
Why are the measurements different and the same?
Why are the densities different?
What is this thing labeled density?
What does it mean to compare 2 variables to describe a third variable?
How can you use the ideas of particles and atoms to explain the difference?
Get students to talk about atoms packed in differently to visualize a model of density.
Ask them if they could draw a picture as a model to show how objects of the same size (volume) can have different densities.

Summative
Draw pictures of the four different cubes

Scoring guide
Student data should be in the ball park and appropriate units.

Name _______________

Lab notes - Metal Cubes

What is your prediction on the density for the different cubes. (How would you arrange them in order of their densities?)

If you could see the particles that make up these metal cubes how would they look?

Procedures:
Measure and record the mass of each cube on the chart.
Measure the volume of each cube and record it on the chart. Remember that the formula for volume is length x with x height.
Calculate the density of each cube.

Cube	Mass	Volume =	Density = mass/ volume
Black iron			
Dark Gray iron			
Silver aluminum			
Gold brass or copper			

Conclusions

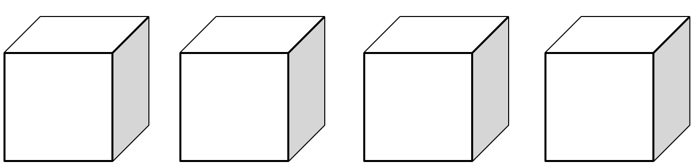
1.How are the blocks the same?

2.How are the blocks different?

3.Which do you think might be used for building airplanes?
Why?

4.Why do you think that the shiny silver cube is used to make pop cans?

5.Label and draw a representation of the particles that make up these cubes.



6. Why would a scientist or engineer want to use two variables to create a third?

Activity - Changing the Density of Bread - Before and After …

Concepts
Properties of matter include mass, volume, and density.

Outcomes
1. Accurately measure the properties of matter (mass and volume) in different states.
   Specific outcomes
   a. Select and use appropriate instruments to measure mass and volume of solids and liquids and record the data.
   b. Predict the relative density of various solids and liquids (based on observations).
   c. Calculate the density of different solids and liquids.
   d. Describe the relationship of mass and volume as it relates to density.
   e. Design a procedure to measure mass and volume of gases.
2. Plan, do, and report a scientific investigation
   Specific outcome
   Compute and record the starting mass, volume, and density; plan and conduct an experiment; record the finishing mass, volume, and density; and report the results.

Background information
Given the tools they will come up with a plan of how to change the density of bread. It might be to squish the bread or toast it.

Prior knowledge
Mass, volume, density, investigative procedures

Material
Slice of bread, balance, metric ruler, calculator, plastic knife, worksheet

Procedure
Exploration
Show students a slice of bread and ask them what its density is, how they can determine it, and how they can change it.
Should not need to provide much assistance. Students should be good with devising and conducting experiments.

Formative
Collect data
Record data
Share data

Summative
Describe mass, volume, and density as a variable and how they varied from before to after.
Draw a model to represent each - before and after - and how each changed or did not change.
Write an operational definition that describes the change. As the bread is smashed it decreases the volume while the mass remains the same which results in a greater density. While the bread is toasted water evaporates decreasing the mass and not the volume remains the same (or a tad bit less, but not as less as the mass) resulting in a decrease of density.
Scoring guide

Name _______________

Lab notes - Changing the Density of Bread - Before and After ...

How can you change the density of a slice of bread?

Materials: One slice of bread, balance, metric ruler, calculator, plastic knife.

Prediction: The density of a slice of bread can be changed by

Procedure:

Cut the slice of bread to a square or other convenient shape.

Measure and record the following data:

Data:

Starting information

Mass

Measurements

Volume

Density

Hypothesis

If the bread is _________________ (what was done to it)

the ____________________ (what variable was changed)

will be _________________ (changed in this way)

This will result in a change of ______________ by ________________ it.

Take the bread and

After information

Mass

Measurements

Volume

Density

The density changed because

Can you think of other ways to change the density?

Draw a picture to show the particles in the bread before and after you changed it.

Conclusion: (two things you learned)

Activity - Can you make an egg float?

Concepts
Density -
Investigation - manipulating and controlling variables - diagnose what students suggest about the amount of water and salt used to float the egg.

Outcomes
Adding salt to water increases the density of the water, which effects how an egg floats or doesn't float in it.

Prior knowledge
Mass, volume, experimental procedures

Material
Hard boiled egg, container, water, measuring spoon, 1-2 cups of salt, worksheet

Procedure
Exploration
Ask students how they might use an egg, water, and salt to demonstrate a change of density.
Formative
If students don't have suggestions, model how to create an experiment by thinking out loud. Allow a lot of wait time before saying the bolded words.
If I put an egg into a glass of water, I can see if it **floats** or **sinks**. If it doesn't float it will **sink**.
I might be able to make if **float**. If I change (either the **density** of the water or add **salt to change the density)**.
If salt is added, that should make the **water salt solution** more **massive or dense**.
I can add one tablespoon and stir, then I can see what happens and continue to add salt until **the egg floats**.
How should we set it up and conduct it? Should suggest: set up, how to conduct it add salt, measure what and when, record data, and possible results.
Might suggest to mass the water and salt before and after or if they don't suggest it, then might want to go ahead and let the logical consequence play out - lack of data - redo or do without.
Ask how the amount of salt relates to the amount of water.
If the investigation was done in groups, then share all the results and discuss why there are differences?

Summative
If your younger brother was not a good swimmer, where would you encourage him to swim, in the Great Salt Lake or in a swimming pool? Why?

Scoring guide: Check student sheet or notes for
1. Completed worksheet. Describes how more salt increased mass or density until there was enough to support (float) the egg.
2. Completed worksheet. Described density as a relationship of mass and volume (not proportional).
3. Completed worksheet. Says adding more salt caused the egg to float, but not reason as to how.
4. Includes amount of water and salt. Mentions salt and water, but not how it changed in a way to float the egg. Or Parts of the worksheet are not complete.

Name _______________

Lab notes - Egg Float

Introduction: How can you make a hard boiled egg float?

Materials: hard boiled egg, container with water, tablespoon, salt, graduated cylinder.

Prediction: How can you make the boiled egg float?

Procedure:
Decide how you will set up, conduct, and record the data from this investigation.

Data:
1. How much water did you use?

2. How much salt did it take to float the egg?

3.How much mass was added?

4. How much did the volume change?

5. How does the amount of salt compare to the amount of water?

Analysis:
1. Why does the egg not float to begin with?

2. Why does the egg float at the end?

Conclusion: (two things you learned)
Check your answers with others in the room. Why are the amounts of salt different?

If your younger brother was not a good swimmer, where would you encourage him to swim, in the Great Salt Lake or in a swimming pool? Why?

Activity - Density of Wood Blocks

Concepts
Mass is the amount of matter in an object.
Volume is the amount of space an object occupies.
Density is the relationship between mass and volume.

Outcomes
Measure mass and volume and use it to explain density.

Background information
Densities of different materials can be found in engineering and machinists manuals. After students calculate their densities find a reference book and let students compare their calculations.

Prior knowledge
Metric measuring, density, triple beam use, and scientific method.

Material
Wood blocks of different sizes and different types (a wood shop is a great place to find them good samples are oak, pine, ash, balsa, ebony (really need ebony to show not all wood floats) metric ruler, balance beam, worksheet

Procedure
Exploration
Discuss how to decide on what accuracy is appropriate (round to tenths)

Formative
Collect data
Record data
Share data and compare densities
Ask why are most of them the same?
Why are there a few different densities for some of the blocks?
What variables are different from group to group?
How did those differences affect the data?
What can you predict will happen when placed in water?
Draw a picture to show how they will be positioned in the water.
Summative

Scoring guide
Full credit if all of the data is recorded and the densities are within the ball park. Check for units and answers supported with observation.

Name _______________

Lab notes - Density of Wood

What observable measurements can be collected and used to support the idea that different kinds of wood have different densities?

Materials: 5 different types of wood, balance, ruler

Procedure:
1. Find the volume of each block (l * w * h) in cm.
2. Find the mass of each in g.
3. Calculate the densities.

Prediction: (list the different types in order of their densities)

Data:

Wood	Length	Width	Height	Volume	Mass	Group Density	Class average

Analysis:
1. What density did the class get for each wood? Averages of the class's results:
2. List the wood in order by their densities.

3. Can two pieces of wood of different sizes have the same density?

4. If two objects have the same density are they the same thing?
   Why?

5. If two woods have the same density are they the same kind of wood?
   why

5. The density of water is 1 g/cc. Why does wood float on water?

6. Predict what they would look like when put in water. Draw it. Try it what data was observed?

Conclusion: write at least 2 things you learned.

Activity - Sphere Density

Concepts
Mass is the amount of matter in an object.
Volume is the amount of space an object occupies.
Density is the relationship between mass and volume.

Outcomes
Measure mass and volume and use it to explain density.

Background information
Densities of different materials can be found in engineering and machinists manuals. After students calculate their densities find a reference book and let students compare their calculations.

Outcomes
Measure the characteristics of matter in different states.
Determine mass and volume of solids and liquids.
Calculate the density of various solids and liquids.
Record data
Predict the relative density of various solids and liquids (using observations).
Describe the relationship between mass and volume to density.

Background information
Volume can be measured by submerging each sphere in a container of water and measuring the water displaced by collecting it or marking a starting point and ending point, and finding the difference.
Diameter can be measure and used to calculate the radius (½ diameter)
Calculate the volume of a sphere (Volume = pi * radius squared).

Prior knowledge
Mass, volume, density, formula for a sphere volume, density of water

Material
5-7 spheres. (metal, ping pong, super ball, wood, Styrofoam, marble, plastic), calculators, overflow containers and graduated cylinder to measure water volume, container of water, metric rulers and string if you want to use the diameter for the volume formula, balance beam, container to test the balls, worksheet

Procedure
Exploration
Arrange the ball in order according to how well you would predict their ability to float or sink.
How can you measure the mass of the spheres?
How can you calculate the volume of the spheres?
How can you calculate the density of the spheres?
What order of densities would you predict?
Float them and observe.
Formative
Calculate the mass and volume of the sphere
Summative
Scoring guide

Name ______________

Lab notes - Will the Sphere Float or Sink?

Materials:
Spheres:

Procedure

Predict the order of densities and draw how you think they will float.

Data:

Ball	Prediction	Mass g	Volume ml	Density g/ml	Float, Sink or Flink
1					
2					
3					
4					
5					
6					
7					
8					

Analysis:
Did any of the balls surprise you? Which one and why did you think it would not do that?

Conclusion
What other kind of ball would you like to test? Why?

What do you thin would happen to a whiffle ball? Why?

Activity: Measuring Liquid Volume

Concepts
Review primary pigment colors (red, blue, yellow) and mixing them to create secondary colors (green, purple, orange) and practice measuring liquid volume in milliliters with a graduated cylinder.
Sometimes more than one variables can be used to describe a relationship to other variables.
Hypothesis can be created by describing a relationship between variables.
Multiple variables can be used to describe a relationship.

Outcomes
Measure mass and volume and use it to explain density.

Background information
Volume is the space an object occupies. Volume can be measured with a graduated cylinder. Many students believe volume and mass are the same thing.

Materials:
- 3 large containers of red, yellow, and blue water - distilled water colored with food coloring
- 3 small containers or cups per student group
- 6 test tubes or small medicine containers and 1 test tube rack (if use test tubes) per student group
- 1 10 mL or 25 mL graduated cylinder per student group

Procedures
1. Students follow a written procedure to create six colors of the rainbow from three primary colors.
2. Put students into groups and give each group three small containers or cups, a graduated cylinder, and six medicine containers or a test tube rack with six test tubes.
3. Ask students to follow the procedure on the Lab Notes page.
4. When the students have the six colored liquids, then ask them to conduct an inquiry activity to create and write their own "recipes" for making cool colors in the medicine cups or test tubes.
5. Allow the students to explore with their colors and see what they create.
6. Be sure to emphasize that all color combinations or recipes must be carefully measured and recorded in their Lab notes so they can explain to the other groups how they might create those colors or how they can keep the company secret recipe to make more.

Results after mixing the colored liquids:

Test Tube	Color Action	Total Volume of Water (mL) and Color
A	9.5 mL - 4.0 mL to B =	5.5 mL red
B	+ 4.0 mL from A + 1.5 mL from C =	5.5 mL orange
C	9.0 ml - 2.0 mL to D - 1.5 mL to B	5.5 mL yellow
D	2.0 ml from C + 3.5 mL from D =	5.5 mL green
E	9.0 mL - 3.5 ml to D =	5.5 mL blue
F	2.0 mL Blue + 3.5 Red =	5.5 mL purple

Hypothesis

Increase color __________ with __________ makes it ________________.
Increase color ______________ and color ___________ makes it ______
_________.

NOTICE how variables combine to affect a third variable. (formal operational characteristic)

Name _______________

Lab notes - Measuring Liquid Volume with a Graduated Cylinder

Purpose: In this activity you will use a graduated cylinder to measure volume in the metric system.

Materials:
Red, blue, and yellow water, created with red, blue, and yellow food coloring, 3 cups, 6 small containers or test tubes with test tube holder, small graduated cylinder, eye dropper

Procedure:
1. Label each container A, B, C, D, E, or F
2. Pour about 25 mL of each or the three colors (blue, yellow, and red) of water into three cups.
3. Measure 9.5 mL of red water into container A
4. Measure 9 mL of yellow water into container C
5. Measure 9 mL of blue water into container E
6. Measure 2 mL from container C and pour pour it into container D
7. Measure 3.5 mL from container E, pour it to test tube D, and mix
8. Measure 2 mL of blue water into container F, 3.5 mL of red water into container F, and mix
9. Measure 4 mL of water from container A and pour it into container B
10. Measure 1.5 mL of water from container C and pour it into container B, and mix.

Observations and Data:
Measure the total amount of water in each medicine container or test tube. Record it and the final color in the chart below.

Test Tube	Color of Water	Total Volume of Water (mL)
A		
B		
C		
D		
E		
F		

Conclusion: Write two things you learned from this lab.

Name _______________

Lab notes - Creating More Colors

Purpose:
Continue your exploration and see what additional colors you can create.

Materials:
Red, blue, and yellow water, medicine cups or test tube stand and 6 test tubes, 3 small containers or cups, small graduated cylinder

Procedure:
Continue your investigation and create a color pallet of six colors with combinations of the primary colors. It is your choice to select at least four colors. Record the recipe for each color you select as part of your pallet to share with the class. Also as you work to create your colors remember the process you used and record it below.

Problem—What problem were you working on in this lab?

Materials—What materials did you use?

Hypothesis—How did you decide what colors to combine and how much of each? Think of each color as a variable (manipulated variables) and how they combine to result in another color (responding variable).

Experimental procedure —What did you do to test your colors? Write the recipe for at least three of your colored liquids.

Results - data—What did you see when you were testing your colors?

How did your colors work out? What recipes do you want to remember (at least three).

Conclusions — How could you use or extend what you found?

Activities - Do Different Liquids Have Different Densities?

Concepts
Mass is the amount of matter in an object.
Volume is the amount of space an object occupies.
Density is the relationship between mass and volume.
Reasoning - Problem solving - using measurement or organizing and ordering observable properties to observe a pattern.

Outcomes
Measure mass and volume and use it to determine densities of liquids.
Record data

Background information
Densities of different materials can be found in engineering and machinists manuals. After students calculate their densities find a reference book and let students compare their calculations.
There are many ways to compare the density of the liquids. Layer the liquids in the test tube. Measure the densities with mass/volume. Put objects (potato pieces) into liquids and observe how they float. Put the same volume in beakers and measure only the mass.

1. Measure the mass an empty graduate cylinder.
2. Add 25 ml of the liquid. You could use smaller or larger amounts depending upon the size of your graduated cylinders.
3. Measure the mass again. Subtract. Clean out the graduated cylinders between each liquid.
4. Repeat for all liquids.

Prior knowledge
Properties of matter and how to measure - mass, volume, linear, and problem solving
Second lab (closed) - Density, averaging, experimental and measuring procedures.

Material - There are two choices for the Lab - open or closed
Four or five different liquids with different densities that are different colors (alcohol, water, sugar water, salt water, corn syrup, or oil) If you use alcohol, provide goggles, balance beams, graduated cylinders, small potato chunks, droppers or micro pipettes, mL graduated cylinder, calculators, medicine cups or test tubes and rack, Lab notes

Procedure
Exploration
Show the students two solids that they have already measured and ask if different solids have different densities.
Show four different liquids and ask, if different liquids have different densities.
Ask the students what equipment they need to find the densities.
Ask the students to develop a procedure to determine if different liquids have different densities.
Accept all plans if you can see it heading in a good direction.

Invention
Formative
Students collect data and record the results.

Share data and discuss as a class how they collected data and how they used the data to conclude if densities of liquids vary.
Draw their attention to the idea that there are many ways to get similar results.

Summative

Students summarize how they determined relative densities.

Scoring guide

Check for understanding of the idea of density for liquids. Check for other variables that may have entered into the experiment.

OPEN LAB NOTES - following page
CLOSED LAB NOTES second following page

Name ______________

Lab notes - Do Different Liquids Have Different Densities?

Solids have different densities. Do liquids?
What evidence do you have of this?

How does this evidence either convince you or not?

Write a procedure how you might determine density of a liquid.
Procedure:

Carry out the procedure and continue.

Data
Record your results

Analysis
Did your liquids have different densities?

Why do you believe this is so?

Conclusion:
Write and draw pictures to illustrate the differences

Name _______________

Lab notes - What is the Density of Some Different Liquids?

Purpose: To calculate and compare the density of at least four liquids.

Materials: 5 liquids, graduated cylinder, balance, calculators

Procedure:

1. Measure the mass an empty graduate cylinder.
2. Add 25 ml of the liquid. You could use smaller or larger amounts depending upon the size of your graduated cylinders.
3. Measure the mass again. Subtract. Clean out the graduated cylinders between each liquid.
4. Repeat for all liquids.

Prediction: (which is densest?)

Data:

Liquid	*Mass grad.*	*Grad + Liquid*	*Mass Liquid*	*Volume*	*Density*
Salt water					
Corn syrup					
Alcohol					
Water					
Oil					

Analysis:

1. Average of class results.

Salt $H_2 0$ Corn syrup   Alcohol   Oil

2. Why did everyone not get the same densities for the liquids?

3. Which liquid was most dense?
least?

4. If you poured them together in a tube, what order would you predict? (sketch and label)

Conclusion: 2 things you learned.

Activity: Density of Plastics

Outcome:
Use observations to predict the relative density of various solids and liquids.

Description: Students in small groups will determine the density of different plastics using inference.

Materials needed:
4 plastic medicine cups, marker, alcohol, water, salt, three or four different kinds of plastic pieces, tweezers, graduated cylinder

Prior knowledge needed: Mass, volume, density

Name _______________

Lab notes - How is the Density of Plastics Determined?

Purpose: Find density of some plastic pieces through inference.

Materials: 4 plastic medicine cups, marker, alcohol, water, salt, plastic pieces, tweezers, graduated cylinder

Prediction: order plastic pieces by density?

Procedure:
1.Label the medicine cups 1,2,3 and 4.
2. Put 10 ml denatured alcohol into cup 1
3. Put with 5 ml of water and 5 ml of alcohol into cup 2. Stir.
4. Put 10 ml water to cup 3.
5. Add package of salt to cup 4 and 10 ml water. Stir.
3. Use tweezers to add each piece of plastic to each container.
4. Submerge it and let it go between the bottom and the top of the liquid.
5. Record whether it sinks or floats. Dry the plastic on a paper towel in between trials.

Data:

plastic	vial 1	vial 2	vial 3	vial 4
1				
2				
3				
4				

1. Did all the pieces of plastic have the same volume?

2. Did they all have the same mass?

3. Which was the densest? How did you know?

4. Put the plastics in order from least dense to most dense:

5. Which liquid was most dense? How did you know?

Conclusion: (two things you learned)

Activity - Density Field Trip

Description: Students will be taken around to different rooms in the building and analyze the density of the students in that area. Or may want to make it a virtual trip or internet trip.

Materials Needed: Student worksheet after you get back.

Time Needed: 20-40 minutes

Safety issues or specialized background knowledge: You might want to let the administration know that you and your class will be wandering around the building.

Teacher Procedures:
1. Ask the students what the density of elephants in your room is, low or high? Ask several questions like this to get them thinking of density in this way.
2. After a brief introduction of density, mass, and volume I have my students go on a short field trip around the school. We start in the classroom and that will serve as our comparison for the remainder of the trip. The students are the particles of matter or the mass.
3. The places you choose to visit define the volume. Compare the density of each stop to the density in the classroom.
4. One of the stops should be a very small room so they can really understand what happens to density when matter remains constant, but the volume decreases greatly. Also, when you are in the small room, let some of the mass out and ask what happens to the density

Scoring Rubric or answer key:
1. Complete, cooperated and answered questions correctly
2. Complete, some inaccurate
3. Partially complete and accurate
4. Started lab and did not complete and all inaccurate

Name _______________

Lab notes - Density Field Trip

Introduction: You may think of density as a number…Mass divided by Volume. There is another way to look at density by seeing what happens to the density when you change the volume or the mass. Think about you and your classmates as particles in the room. The students are the mass and the room is the volume. Think about it without calculation. Compare one to another.

Prediction If the class were in the parking lot, then how would the density change?

Procedures: List the name of the place or the room we visited and complete the chart comparing all of the rooms to your classroom.

Data

Place	Mass (Higher, Lower or Same)	Volume (Higher, Lower or Same)	Density (Higher, Lower or Same)
Your Science Room as a base to compare			

Analysis

1. Where on the field trip was the density the highest? Why?
2. Where on our field trip was the density the lowest? Why
3. What does volume have to do with density?
4. What does mass have to do with density?
5. As mass (the class) left the small room, what happened to the density? Explain

Conclusion: Describe two things you learned.

Activity - Density of a Gas

Concepts

Outcomes

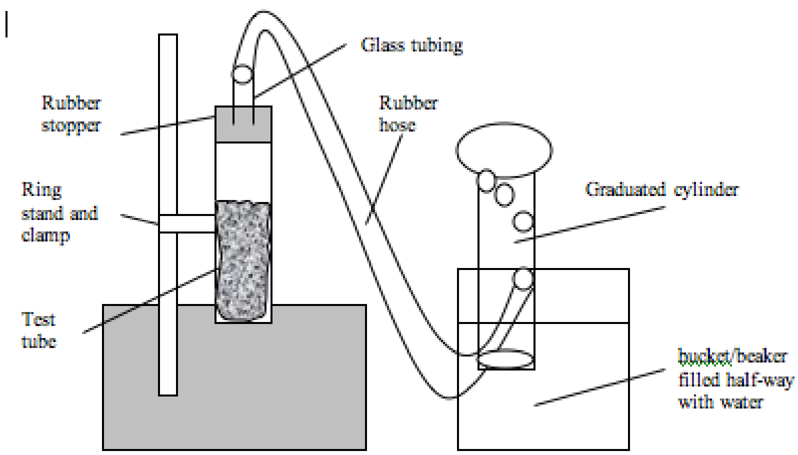
Collect the gas released from a seltzer tablet, measure its volume, mass, and calculate its density.

Background information

Prior knowledge

Materials

plastic bags, plastic tubing, goggles, Alka Seltzer or generic (much cheaper) stomach aid tablets, worksheet, apparatus pictured below



Procedure

Exploration

Ask how the density of gas could be measured. (Find volume and mass.)
Ask how that might be done. Possible answer - fill a bag with a gas (blowing into it) find its mass and volume and calculate the density.

Describe a procedure to generate a gas and collect it. The volume of the bag can be measured by placing it in a large beaker and setting something on top of it to hold it down, level the top and read the volume.
Mass the bag. Because of the very small mass of gases, you may discover it makes no difference whether the bag has air or not, most middle school balances cannot easily detect the difference between masses this small.

Explain there might be another way to measure the density of a gas. (Diagramed above)

Post results on the board or an overhead. (The density of carbon dioxide is about .002) If you can get within a decimal place you have done well.
Discuss sources of error, there are lots of them.

Formative - Collect data, Record data, Share data

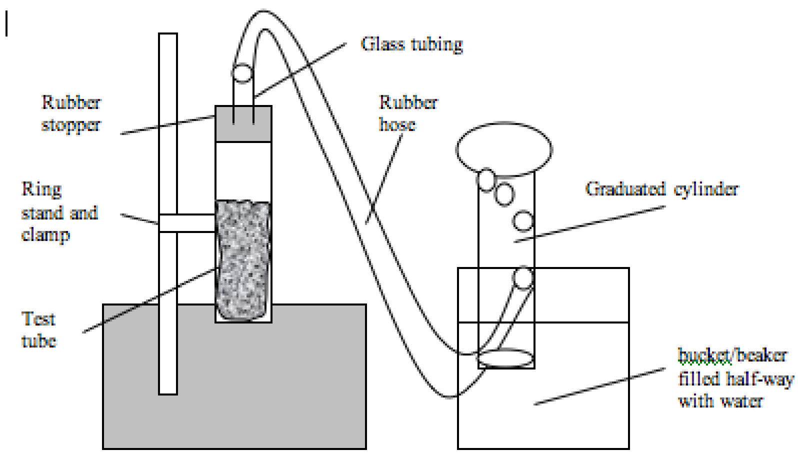
Summative

Scoring guide

Name _______________

Lab notes - How is the Density of Gases Determined?

How is the density of a gas measured? How does it compare to density of solids and liquids?



Procedure:

1. Fill the test tube about ⅓ full with water.
2. Mass the test tube, water, and ½ seltzer tablet.
3. Set up the equipment as pictured below. The graduated cylinder needs to be full of water and upside down. First fill it, then hold your hand over the top and put it in the bucket.
4. Drop the alka seltzer in the test tube and put on stopper. Wait for bubbles to stop.
5. Write down where the water level is in the graduate cylinder and turn right side up.
6. Mass the test tube, beaker, water mixture.

Prediction: (what do you think the density of this gas will be?)

Data:

1. mass of test tube, water, and ½ seltzer tablet before _______g
2. mass of test tube, water, and ½ seltzer tablet after _______g
3. change in mass _______g
4. volume of gas _______ml
5. density _______g/ml

Analysis:

1. What is the class average for the alka seltzer gas?

2. Why did you have to mass the materials before and after the gas escaped?

3. Why was there less mass after the experiment was over?

4. The density of this gas is .002 as determined in a better equipped lab. The density of air is about .0013.If we let this gas out, would it rise or sink?

5. Describe all the characteristics of this gas that you know (color, smell, density) and how is it different from air?

Conclusion:

Title: Density of Liquids

Outcome: Students find the volume and mass of liquids and determine density as a relationship between the two liquids for four liquids.

Materials: 25 mL graduated cylinders, balance, test tube and rack, 4 liquids (water, salt water, alcohol, vegetable oil, corn syrup, glycerin, liquid dishwashing soap etc) food coloring should be used to differentiate the clear liquids into recognizable colors, student work sheet

Student Background Needed: mass, volume, how to use a graduated cylinder to measure volume and a balance to measure mass.

Teacher notes:
Better accuracy can be gained by using more liquid, but increased liquid increases the cost. May want to use different volumes for different substances (10 ml glycerin - 100 ml water or may want to return substances to original containers - not good lab technique, but sometimes necessary when supplies are limited). When students work in groups they can check each others work. Plan ahead for clean-up. May or may not want to provide students with density formula or let them suggest ways to compare the mass and volume of liquids.

Procedure:
1. How did we compare the density of solids? (By floating them in liquids such as water.)
2. What about the density of liquids? How can they be compared? In this activity you will learn about density of liquids.
3. Ask how volume and mass describe the matter (stuff) in the liquids.
4. Ask what differences they would expect between the different liquids.
5. Ask how they could collect data to substantiate their claims.
6. Allow students to work and record their results.
7. Display their results for everyone to view.
4. Discuss results with students and arrive at a way to relate the mass and volume.
5. Ask why it makes more sense that density is described as M / V
6. Ask if the they would want to do class averages for each liquid.
5. Allow students to work on analysis questions.

Scoring Guide:
1 Describes density as a proportional relationship of mass and volume
2 Described density as a relationship of mass and volume (not proportional).
3 Completed worksheet. Says mass and volume relates to density, (not how relates).
4 Parts of the worksheet are not complete. Mentions mass, volume, and density (no mention of them being related).

Title: Density of Liquids - Performance Test

Introduction: The density of solids can be compared by floating them in liquids such as water. But what about the density of liquids? How can they be calculated and compared? In this activity you will learn about density of liquids.

Materials: graduated cylinder, balance, 4 liquids (vegetable oil, alcohol, water, glycerin…).

Prediction: Which liquid do you think will be most dense? Least?

Procedure:

11. Find the mass of your graduated cylinder on the balance. Record it in your data.
12. Pour one liquid into it. Find the mass now and record it.
13. Fill in the volume and mass measurements in the data table and calculate the density of the liquid by dividing mass by volume.
14. Carefully clean out your graduated cylinder and repeat for each liquid.
15. Pour a small amount of each substance into the test tube and draw the results.

Data:

Liquid	Mass of graduate cylinder	Mass of graduated cylinder & liquid	Mass of liquid	Volume of liquid	Density of liquid

Analysis:

1. Which liquid is most dense? What are two ways you know this?

2. A milliliter and a cubic centimeter are the same size. Why use milliliters to measure liquids?

3. When would cubic centimeters be more useful?

4. Does the "thickness" or stickiness of liquid predict its' density? How?

Conclusion: