Mapping Density of Rock Samples

Goal: Explore the physical properties of rocks of Virginia and determine their point of origin. Investigate volume, mass, and density with rocks found across the 5 regions of Virginia.

Objectives

Knowledge- Students learn the common rocks of Virginia, how to identify them, their locations, and how to locate them on a geologic map.

Skills-Students use scientific equipment (balance, graduated cylinders, calculators) to determine the density of rock samples.

Values- Student appreciate that Virginia has a variety of rocks that have a multitude of uses.

Grade(s): 5th

Special Safety: Glass Vinegar Vials may break.

VA Standards addressed:

Math (2016): 5.2, 5.5b , 5.8a, 5.9b

Science (2018): 5.1 a, b, g; 5.8

Social Science: VS.2, USi.2d

Materials:

- Class region map (Appendix 9) and Post-It notes
- Slightly dyed water (to make reading the graduated cylinders easier)
- Large copy (at least 11" x 17") of simplified geologic map of Virginia (William and Mary Geology)
- Electronic balance or scales (one per table)
- For each student pair:
    - One 250 mL graduated cylinder with water
    - Rock Table Sheets (Appendix A)
    - Student datasheets (Appendix B)
    - Pencils
    - Graduated cylinder instructions (Appendix C)
    - Sample descriptive words sheet (Appendix D)
    - Large Geology Map (Appendix E)
    - Sets of small fragments of rock from different regions of Virginia (one set per table, each set with at least 4 samples; enough samples for each pair to have at least one sample. We obtained samples from our Soil & Water Conservation District Office, Luck Stone in Virginia, and by reaching out to state parks, etc.)
    - Hand lenses
    - Calculators (optional)
    - Nail and vinegar (optional)

Sedimentary sandstone can be composed of various types of rock sediment. Most sandstones are feldspar or quartz but can also be composed of calcite, mica, or hematite, for example. The three sandstones we used for our density lab are composed of different sediments and thus, have different densities!

Setup:

- Place rock sets (4 samples per set, with matching Rock Tables), two 250 mL graduated cylinders, one scale, one datasheet per pair of students, one graduated cylinder instruction sheet, one sample descriptive words sheet, one nail & vinegar, two beakers with slightly tinted water, and two pencils at each table.
- Set up a table with large simplified geologic map of Virginia with Post-It labels.
- Divide students into teams of 2.

Instructional Strategy:

This activity focuses on science process skills. During instruction, allow time for students to use their problem solving skills and process skills. Some examples are provided below:

A. Inquiry: Tell students: We will be observing and identifying rock and mineral types from across Virginia. Why should we learn about rocks of our area (Ask students to brainstorm reasons for learning about rock types and uses as well as connect to careers, if applicable)?
   1. Density is one of the ways that rocks can be compared to one another. *Ask*: Are all rocks the same weight? Are all rocks used for the same purposes? Use examples, as needed, such as granite versus chalk. Which one is harder, can they be use for the same purpose? Sci 5.1, 5.8
   2. *Ask*: What materials are on your tables? What are they used for?
      i. Graduated cylinders- Measure Volume (in mL)
      ii. Scale- Measure Mass (in grams)

B. Investigation: Before beginning the investigation, explain to students that one of the goals of the activity is for them to use scientific reasoning and problem solving skills and that trial and error is an important step in any scientific research. Instructors may need to help troubleshoot: use of the scales, how to determine the difference in water levels, and how the volume can be determined using the differences in the water's volume.
   1. Each pair will read through their datasheet (Appendix B) to examine and investigate the following:
   2. Describe/diagram the physical properties of the rock (can use the Appendix D to generate ideas).
   3. Use balance/scale to find the mass of a rock sample.
   4. Determine how to use the graduated cylinder to find the rock's volume (see Appendix C). This can be done multiple ways! Allow students time to explore various solutions.

      Examples scenarios of volume measurement challenges:

      i. Students may place the rock into the graduated cylinder without the water and read 15 mL at the top of the rock. Remind students that the rock would have to take up every space of the bottom of the cylinder to make the rock 15 mL.

      ii. Students may place the rock into the graduated cylinder then pour all of the water into the cylinder while reading the mL. This reading would be the total amount of volume in the cylinder and not the volume of the rock.

      iii. Students may pour all of the water into the graduated cylinder (above any mL readings) then place the rock into the graduated cylinder and estimate how much the water increased. Math 5.5b

      iv. Remind students that accuracy and precision are part of the science process. How can we be sure we know exactly how much the water level increased? Gently remind them that they do not have to use all of the water.

5. Next, students use their data sheets to calculate the rock's density once the volume and mass have been found. Providing examples of various objects that have different masses, volumes and densities are helpful. Allow students time to work through the process and problem solve! VS.2, USI.2d

C. Mapping: Once student pairs have completed the above investigative tasks, ask them to use the Rock Tables (Appendix 1) to identify their rock.

1. Next, they locate their rock on the BIG geology map and mark and label its distribution on the class map (Appendix E) using Post-It labels.
2. Explore the characteristics of the regions and the rock types (physiogeography). [Physiography or physical geography is the study of the land features and processes that created them.]

D. Conclusion: Ask students to compare their rocks to other rocks.

1. As time allows, each pair can examine at least one more rock.
2. Discuss: What are some of the physical characteristics (e.g., color, shape, texture, etc.) you learned about rocks of Virginia?
3. Connect: Where do we get the rocks we use for different purposes in our lives? (e.g., Roads, countertops, building materials, jewelry, etc.)

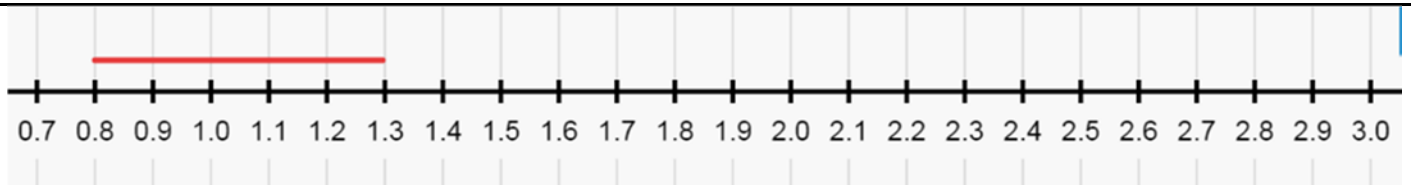
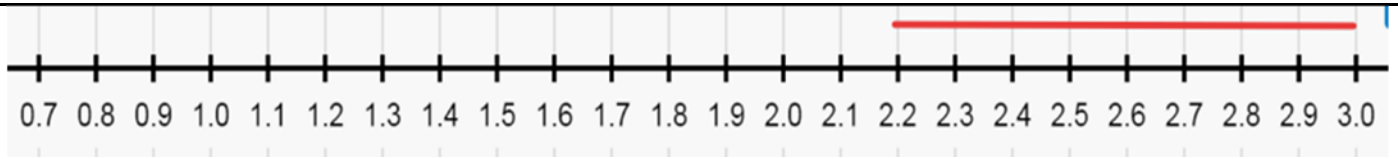
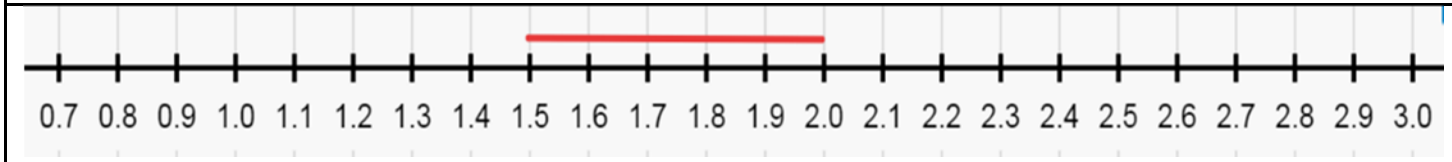
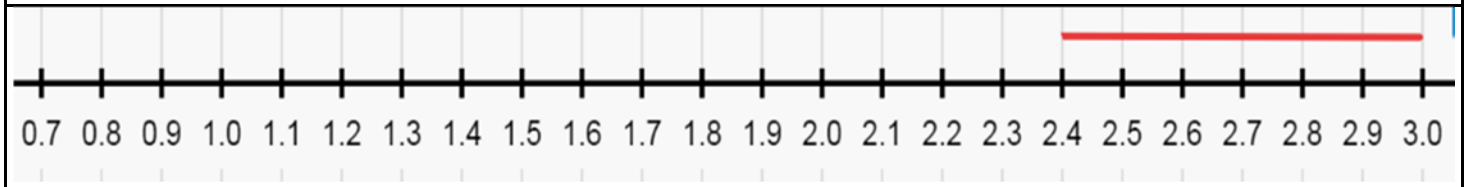
Extension: Place rocks examined in order of lowest to highest density.

APPENDIX A: Rock ID Table Sets

Set A

Rock Table: Identify your rock and record it on your datasheet.				
Density (g/mL)	**Cycle Stage and Physical Property Descriptions**	**Special Characteristic and Use as a Resource**	**Rock Type**	**Region**
0.8-1.3	This sedimentary rock has a **black, shiny**, and bumpy surface. Grains not usually visible	Leaves a black mark on paper. Burned for heat and energy.	coal	Appalachian Plateau
2.3-3	A sedimentary rock that may have parts that are **pinkish, grayish, or greenish**. Looks like small pebbles of different colors glued together with rock.	Gray and red parts fizzes with tiny, tiny bubbles when scraped with a nail dripped with vinegar (use a magnifier to see). Used for building and powdered for use in agriculture.	conglomerate	Piedmont
1.5-2	This sedimentary rock is **yellowish/orangeish/tannish** with very fine sand grains (can be felt but not seen) and an angled surface.	Sand can be scraped off with a nail, but feels like gritty dirt. Sandstone is sometimes used artistically or for building and paving.	sandstone	Ridge and Valley
2.4-3	**Light gray, may have some brownish, tanish, or pinkish parts**. Can see but not really feel individual sand particles, though the surface of this metamorphic rock is rough.	Hard, can't be scratched with a nail. Used decoratively for walls and walkways, sometimes crushed for gravel. Native Americans made it into spear points and other sharp tools.	quartzite	Piedmont

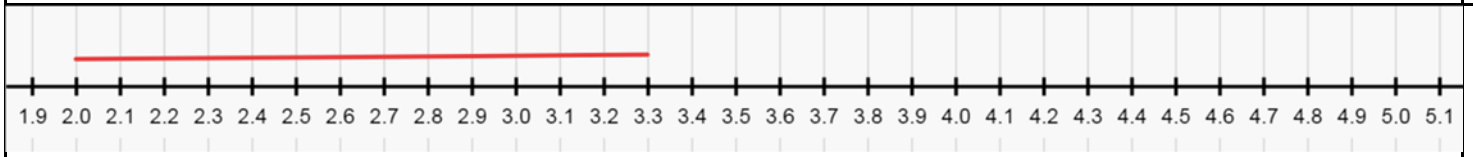
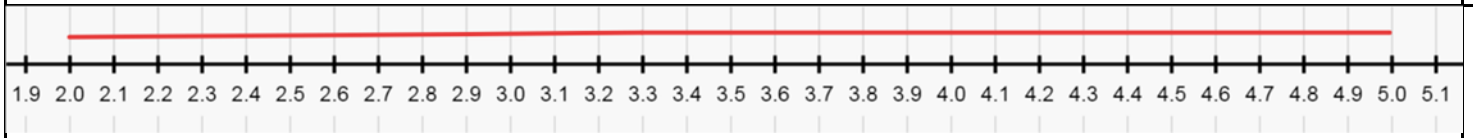
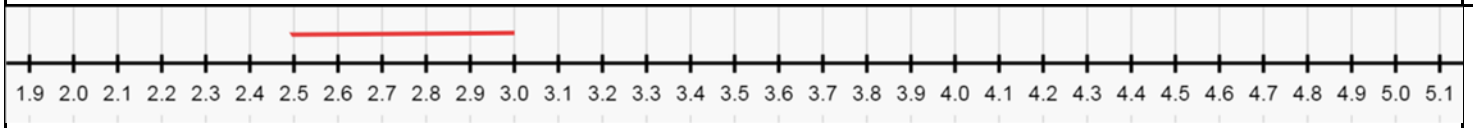
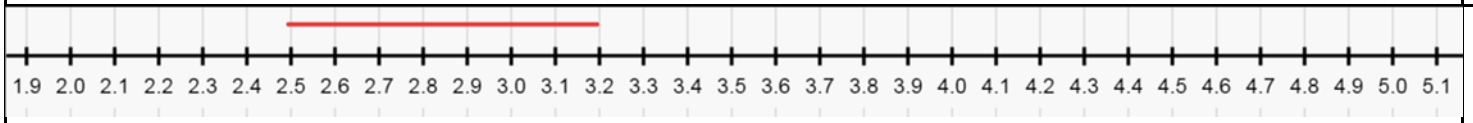
APPENDIX A: Rock ID Table Sets

Set A-- Rock Table: Identify your rock and record it on your datasheet.	
Density (g/mL)	**Rock**
 0.8-1.3	coal
 2.2-3.0	conglomerate
 1.5-2.0	sandstone
 2.4-3.0	quartzite

Set B

Rock Table: Identify your rock and record it on your datasheet.				
Density (g/mL)	**Cycle Stage and Physical Property Descriptions**	**Special Characteristic and Use as a Resource**	**Rock Type**	**Region**
2-3.3	**Blue-gray and gold with silver shimmer;** feels soft, almost powdery. This metamorphic rock forms in layers of tiny, flat, and sparkly grains.	Can be scratched with a nail. This rock is used for making cement and mortar, and for making roads and asphalt. Sometimes has dark red (almost black) garnet crystals in it.	phyllite	Piedmont
2-5.0	**Smooth pinkish/orangeish/reddish outside and lighter and rough inside**. Many large sand grains and crystals can be seen and felt in this sedimentary rock.	Sand can be scraped off with a nail. Sandstone is sometimes used artistically or for building and paving.	sandstone	Coastal Plain
2.5-3	**Sparkly milky-white** metamorphic rock with tiny black or small red minerals. Particles are many sizes, sometimes flat, and not all pointing the same direction.	Small particles fall of easily and look like glitter. Used in industrial ceramic manufacturing.	kyanite	Piedmont
2.5-3.2	This igneous rock is made up of pea-sized blobs (some may be bigger or smaller) and sometimes almost layers of **white and black minerals**. Grains of different sizes. The black minerals sparkles.	Similar to granite, this stone can be used for gravestones or countertops and crushed for gravel roads. Sometimes has garnet (a dark pink or dark red mineral that can form crystals) in it.	gabbro	Piedmont

APPENDIX A: Rock ID Table Sets

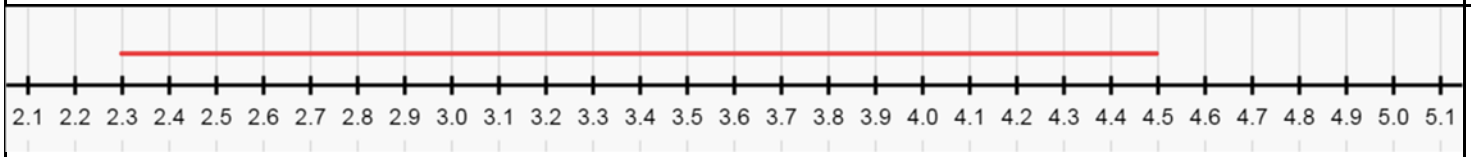
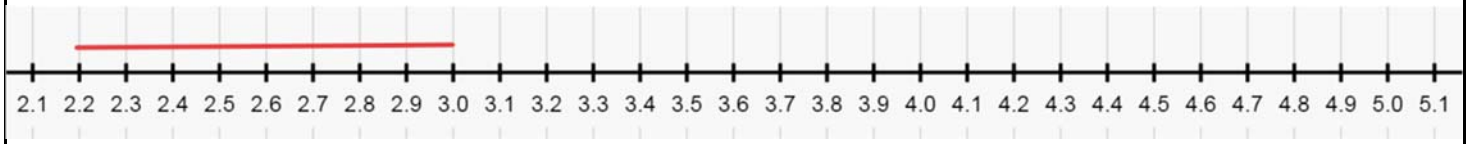
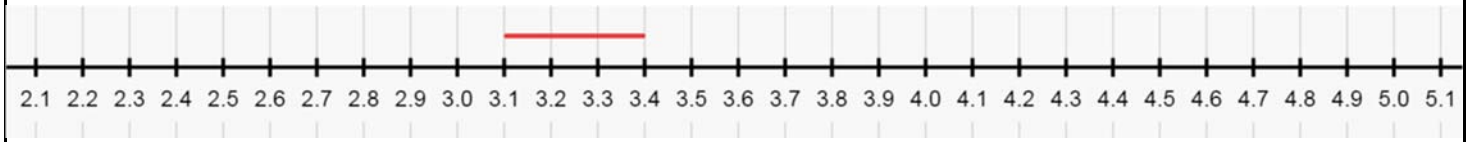
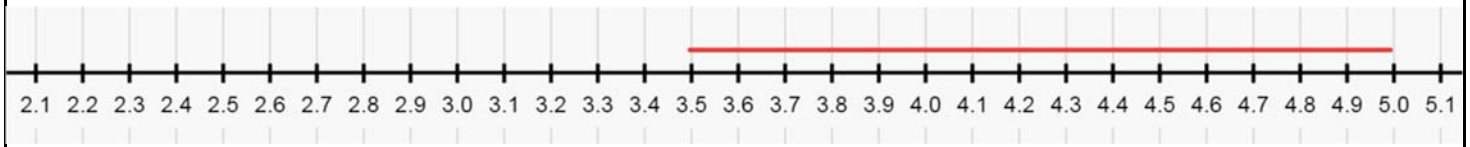
Set B-- Rock Table: Identify your rock and record it on your datasheet.	
Density (g/mL)	**Rock**
 2.0-3.3	phyllite
 2.0-5.0	sandstone
 2.5-3.0	kyanite
 2.5-3.2	gabbro

APPENDIX A: Rock ID Table Sets

Set C

Rock Table: Identify your rock and record it on your datasheet.				
Density (g/mL)	**Cycle Stage and Physical Property Descriptions**	**Special Characteristic and Use as a Resource**	**Rock Type**	**Region**
2.3-4.5	**Dull, gray, pale yellowish tan, dull pinkish or purplish red** flat sedimentary rock with crumbly layers. Grains mostly too small to see.	Breaks into thin flakes and chips. Because shale forms from compressed mud, it can be crushed and mixed with water to make clay.	shale	Ridge and Valley
2.2-3	**Sparkly and yellowish/orangeish/tannish, maybe white in the center**. Feels gritty like sand. This metamorphic rock forms in layers of tiny, flat, and sparkly grains.	Flat, fragile (easy to break). Some types of schist are used as roofing, in ceramic glazes, in insecticides, and in potting soil mixes.	mica schist	Piedmont
3.1-3.4	**Pale green** metamorphic rock with tiny grains are mostly too small to see, feels slightly rough.	Sometimes has red, sparkly green, or white minerals in it. This rock can be used a gravel or rock fill, or ground up for use in concrete. Native Americans carved it into tools.	greenstone	Blue Ridge
3.5-5	**Dark blue/gray** igneous rock with tiny particles almost too small to see. Feels slightly rough.	Metamorphosis turns this igneous rock into greenstone. Often broken into gravel or rocks for construction, this rock can be cut and used for floor tiles. Very rarely, Native Americans worked it into spear points and other sharp tools.	metabasalt	Blue Ridge

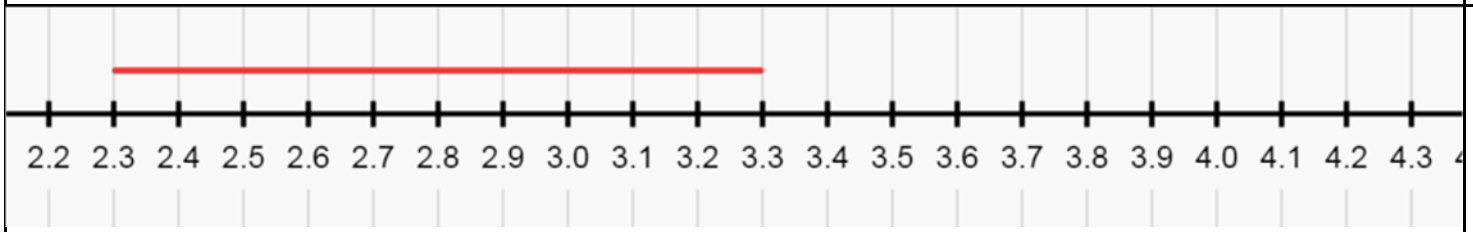
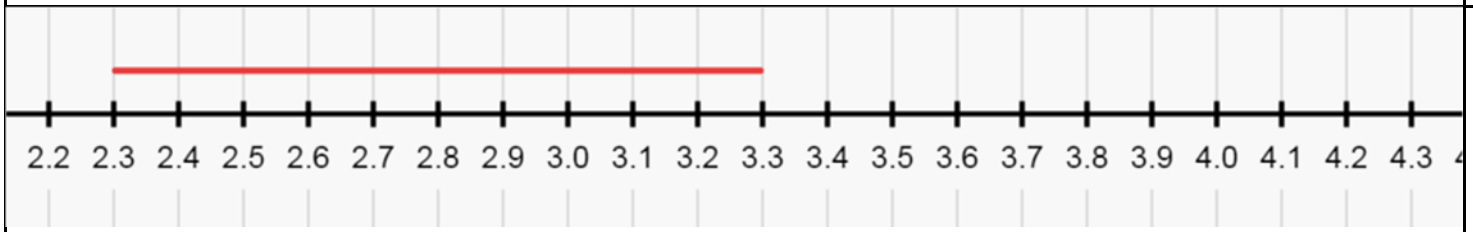
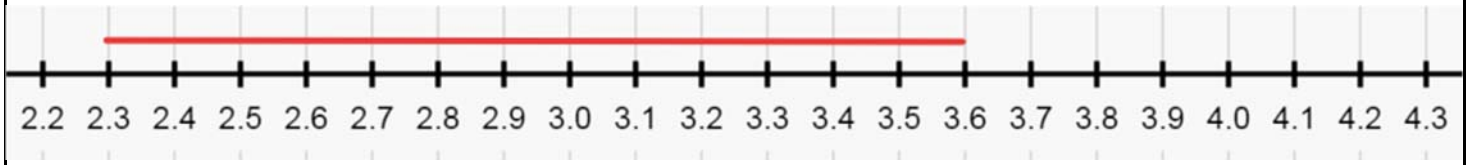
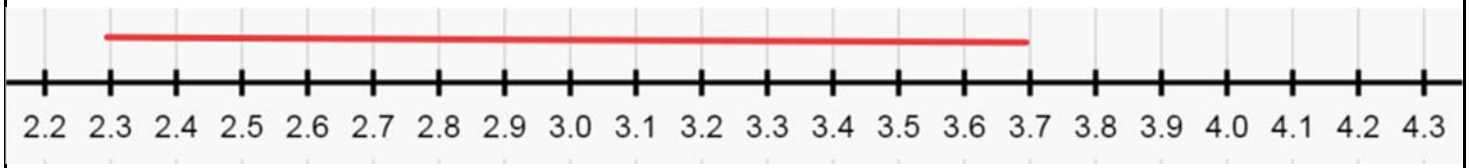
APPENDIX A: Rock ID Table Sets

Set C-- Rock Table: Identify your rock and record it on your datasheet.	
Density (g/mL)	**Rock**
 2.3-4.5	shale
 2.2-3.0	mica schist
 3.1-3.4	greenstone
 3.5-5.0	metabasalt

Set D

Rock Table: Identify your rock and record it on your datasheet.				
Density (g/mL)	**Cycle Stage and Physical Property Descriptions**	**Special Characteristic and Use as a Resource**	**Rock Type**	**Region**
2.3-3.3	All **gray or layers of light and dark gray**. Grains of this sedimentary rock are too small to see.	Fizzes with tiny, tiny bubbles when scraped with a nail dripped with vinegar (use a magnifier to see). Used for building and powdered for use in agriculture.	Limestone	Ridge and Valley
2.3-3.3	Mostly sand-sized grains of **black, gray, and white** all mixed together. Some light-colored grains sparkle in the light. This igneous rock feels rough.	Used for building and paving, or in houses for countertops.	diabase	Piedmont
2.3-3.6	**Gray, yellow, white, tan, and/or orange** grains of different sizes all blobbed together into one metamorphic rock.	This rock looks very similar to igneous granite rocks, but forms through metamorphosis, not melting and cooling. It can be used like granite, for building, gravel, or countertops.	charnockite	Blue Ridge
2.3-3.7	**Milky whiteish**,**pinkish, blueish, yellowish, or sometimes clear** glassy mineral. May have large crystals.	Sometimes forms clear crystals used for decorative jewelry. Can be melted to make glass.	quartz	Piedmont

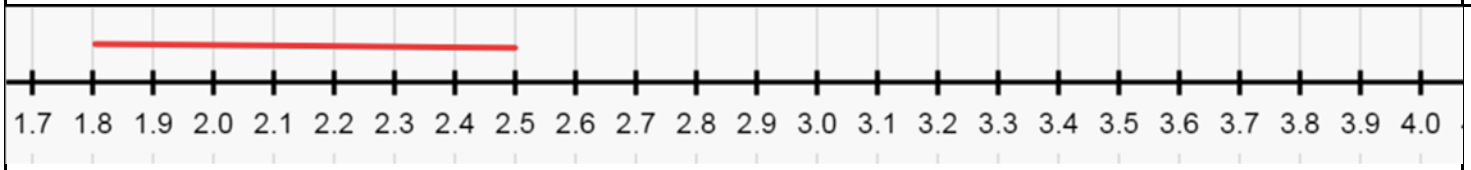
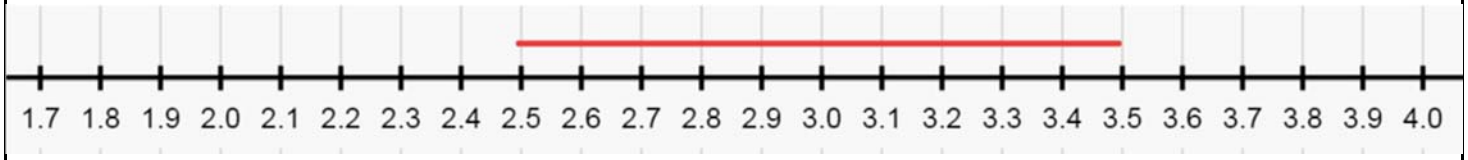
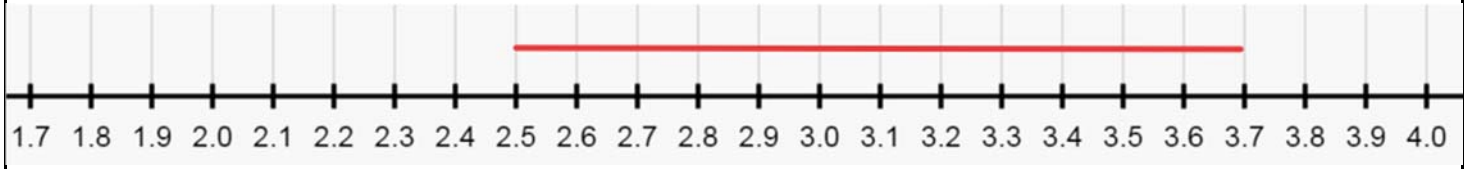
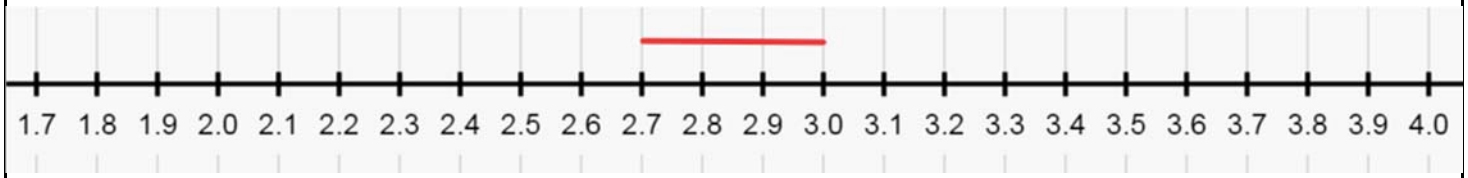
APPENDIX A: Rock ID Table Sets

Set D -- Rock Table: Identify your rock and record it on your datasheet.	
Density (g/mL)	**Rock**
 2.3-3.3	limestone
 2.3-3.3	diabase
 2.3-3.6	charnockite
 2.3-3.7	quartz

Set E

Rock Table: Identify your rock and record it on your datasheet.				
Density (g/mL)	**Cycle Stage and Physical Property Descriptions**	**Special Characteristic and Use as a Resource**	**Rock Type**	**Region**
1.8-2.5	**Dull tan or gray colored sand** cementing together and filling the inside of fossilized shells.	This is a rock in the process of forming from sediment. Pressure and time are fusing the sand, mud, and shells together into a sedimentary rock.	marl (marine fossils in mudrock)	Coastal Plain
2.5-3.5	**Pink-red or orange-red with a lighter inside**. This sedimentary rock looks and feels like it's covered with fine (small grains) sand.	Sand can be scraped off with a nail. Sandstone is sometimes used artistically or for building and paving.	sandstone	Piedmont
2.5-3.7	**Dark gray with some reddish parts**. Grains are mostly very fine but can be seen. Hard and angular.	Shale is a sedimentary rock, but this one has been "baked" or exposed to the heat and pressure that could eventually metamorphose it into slate.	baked shale	Piedmont
2.7-3	**Gray, with some lighter and darker minerals** (may look slightly greenish). This metamorphic rock is made up of sand-size or smaller grains, some of which sparkle in light.	Smooth surfaces feel greasy, like a bar of soap. This rock is used to make outdoor furniture, countertops, pots, sculptures, and woodstoves.	soapstone	Piedmont

APPENDIX A: Rock ID Table Sets

Set E-- Rock Table: Identify your rock and record it on your datasheet.	
Density (g/mL)	**Rock**
 1.8-2.5	marl (marine fossils in mudrock)
 2.5-3.5	sandstone
 2.5-3.7	baked shale
 2.7-3.0	soapstone

APPENDIX B— STUDENT DATA SHEET

DENSITY MAPPING of ROCK SAMPLES

Geologists: _____

1. Describe or diagram the physical properties of your rock sample.

Use the PINK Sample descriptive words for rocks to help!

Density is how tightly packed matter is in a substance.

4. Calculate the density of your rock.
Density = Mass divided by Volume

$$D = \frac{\text{\_\_\_\_\_ g}}{\text{\_\_\_\_\_ mL}} =$$

2.

Mass: _____ g

3. Use the graduated cylinder to find your rock's volume in mL:

Volume _____ mL

TIP: Use the BLUE graduated cylinder guide at your table to help!

5. Compare your data to the GREEN Rock ID Table to identify the rock.

Is it: **igneous** **metamorphic** **sedimentary** **mineral**
(Circle one)

Rock Type: _____

6. Locate your rock type on the BIG Geology map and then mark its location on the class geology map.

Region: _____

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Is it: **igneous** **metamorphic** **sedimentary** **mineral**
(Circle one)

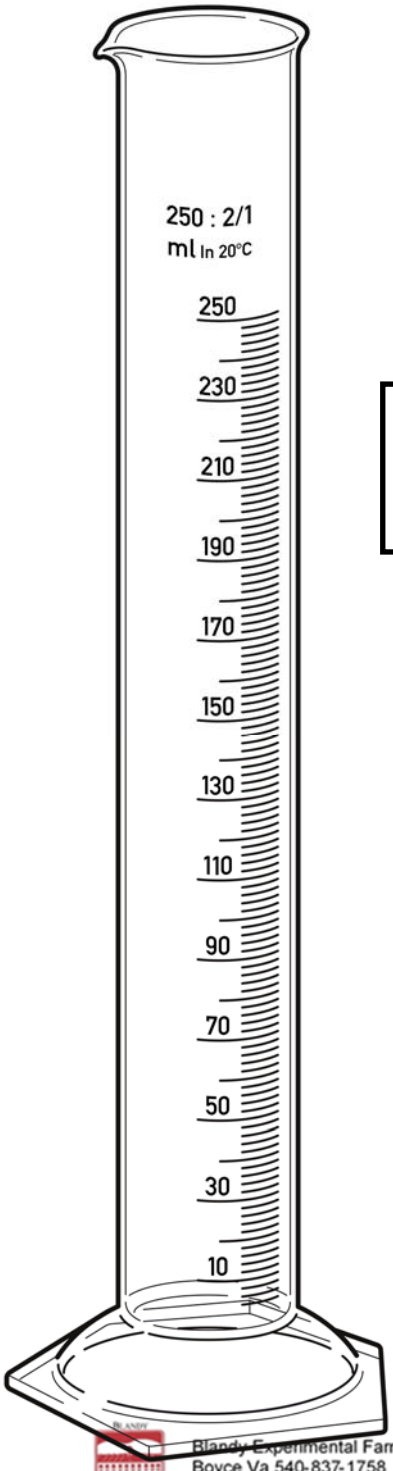
Rock Type: _____

6. Locate your rock type on the BIG Geology map and then mark its location on the class geology map.

Region: _____

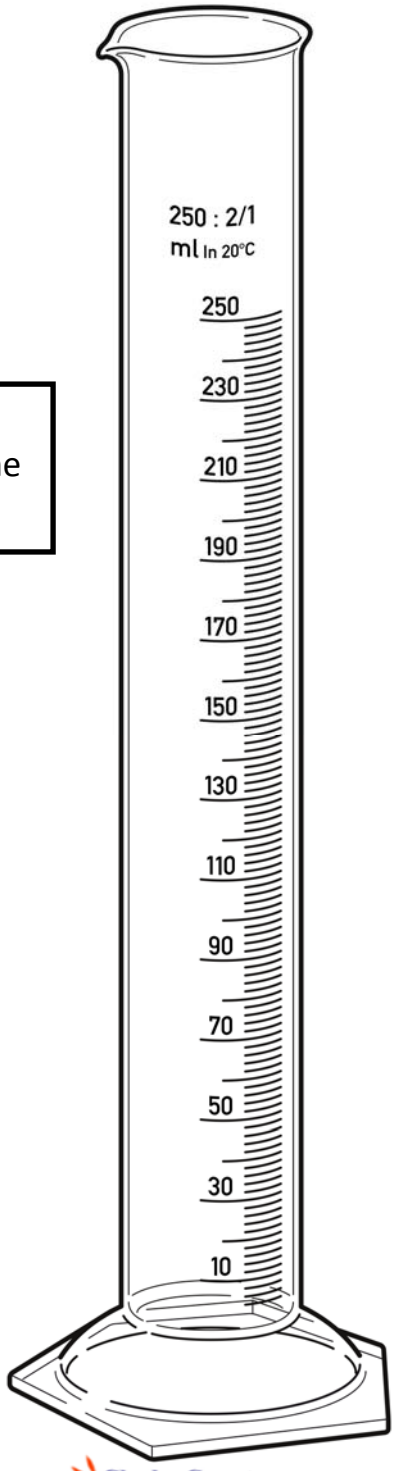
Use the graduated cylinders to find your rock's volume

First pour some water into a graduated cylinder.



The water level will rise. This difference in water volume is the volume of your rock!

Then place your rock sample into the cylinder.



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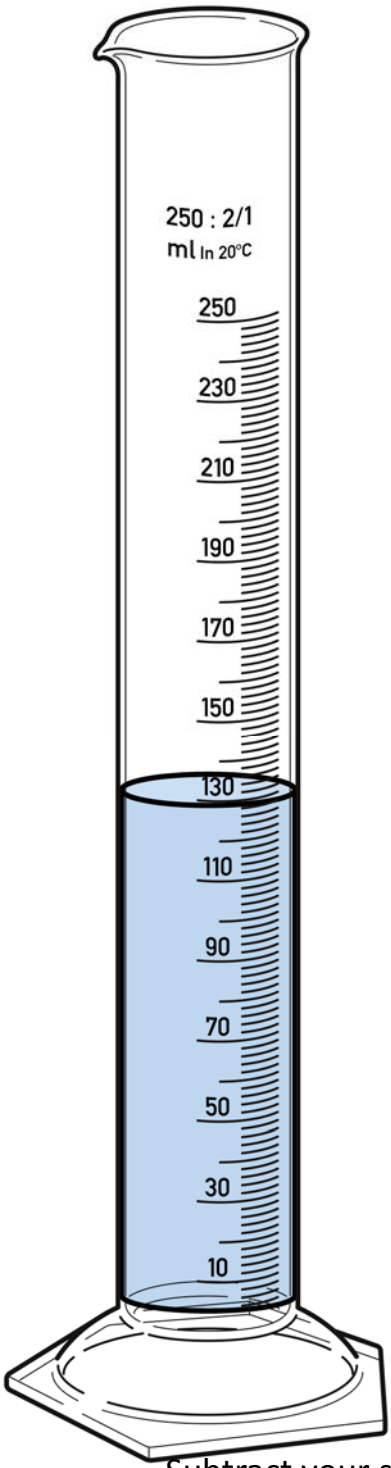
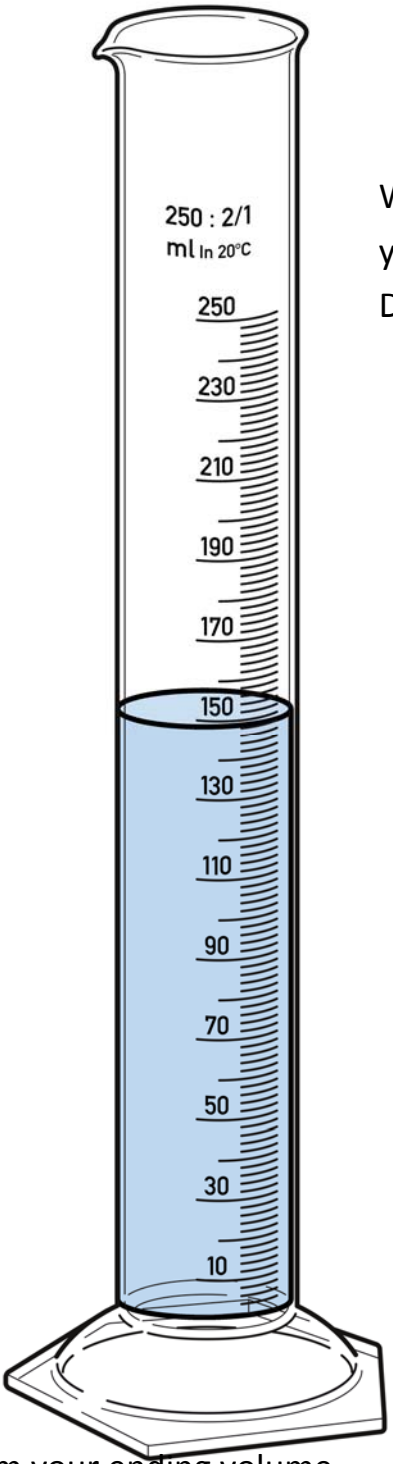
Use the graduated cylinders to find your rock's volume





What happened when you added the rock? Did the water level rise?

Subtract your starting volume from your ending volume.

Starting= 130 mL

Ending= 150 mL

EXAMPLE

150 mL

130 mL

_____

20 mL

Appendix D: Sample descriptive words for rocks

Rough	Sandy	Pale	Pitted (tiny holes all over it)
Smooth	Crumbly	Dark	Transparent (you can see through it)
Sharp	Grainy	Bright	Translucent (light comes through it)
Flat	Muddy	Scratchable	Crystalline (has crystals in it)
Rounded	Dusty	Breakable	Shiny
Oval	Soft	Striped	Sparkly
Square or rectangular	Hard	Spotted	Glittery
Bumpy	Plain	Streaked	Dull
Lumpy	Common	Speckled	Heavy
Broken	Unusual		Light

Color descriptors: Be specific!

Brown: tan, beige, muddy brown, cardboard brown, dark brown, chocolate, Cocoa Puff brown, sandy brown, leaf brown

Gray: dark gray, light gray, elephant gray, storm gray, fog gray, smoky gray, pale gray, silver, steel gray, cement gray, lead gray

Black: shiny black, midnight black, ebony, oily black, dull black, tire black, ink black, sooty black, spider black, patent leather black, licorice

White: milk white, marshmallow white, cloud white, ghost white, paper white, polar bear, ivory, cream, snowflake, moon white, vanilla, eggshell

Questions to investigate:

Can you scratch it with your fingernail?

Can you write or make marks on paper with it?

What does it smell like?

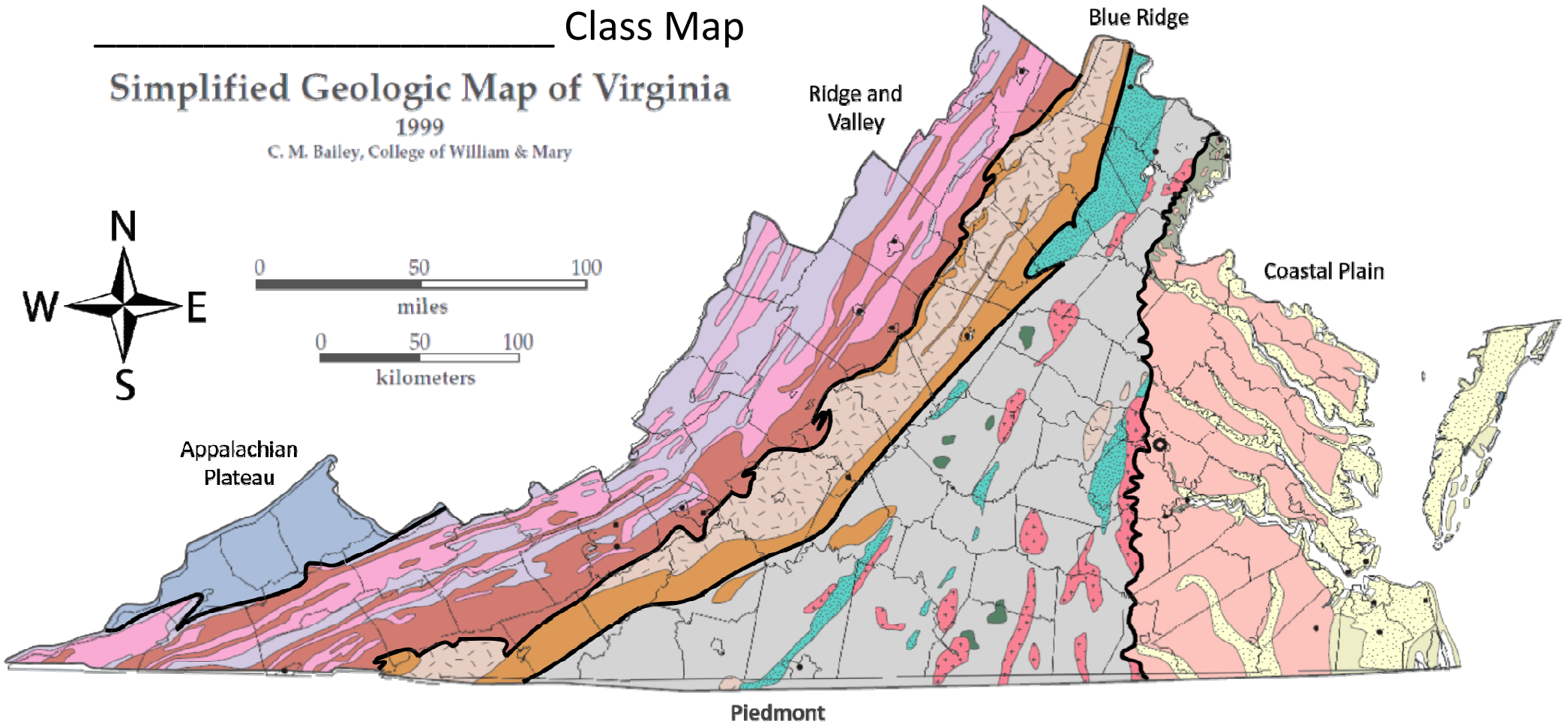
What happens when you rub it?

What could you use it for?

Is it lighter or heavier than other rocks of a similar size?

Does it have _____ (holes? dents? fossils? crystals? bubbles?) in it?

_____ Class Map



Proterozoic

Neoproterozoic (550-750 Ma)
Metasedimentary rocks, metarhyolite, & metabasalt

Mesoproterozoic (980-1400 Ma)
Granite, granitic gneiss, charnockite, & layered gneiss

Proterozoic-Paleozoic (550-750 Ma)
Gneiss, schist, slate, phyllite, quartzite, & marble

Paleozoic (300-500 Ma)
Granite & other felsic igneous rocks

Paleozoic (300-500 Ma)
Gabbro & other mafic igneous rocks

Paleozoic

Cambrian (500-550 Ma)
Dolomite, limestone, shale, & sandstone

Silurian-Ordovician (410-500 Ma)
Limestone, dolomite, shale, & qtz sandstone

Mississippian-Devonian (320-410 Ma)
Sandstone, shale with minor gypsum & coal

Pennsylvanian (290-320 Ma)
Sandstone, shale & coal

Mesozoic

Cretaceous (65-140 Ma)
Partly lithified sand, clay, and sandstone

Triassic-Jurassic (200-225 Ma)
Red & gray shale, sandstone, & conglomerate Intruded by diabase & basalt

Cenozoic

Quaternary (20 ka- 2 Ma)
Sand, mud, & gravel

Tertiary (2-65 Ma)
Sand, mud, limy sand, & marl.

Holocene (present- 20 ka)
Sand, mud, & peat deposited in beaches, marshes, swamps, & estuaries