



Lesson Title	Math Mysteries: Solving crimes through sediment analysis
Length of Lesson	2 days
Created By	Shane A. Irvin and Nathan DuFour
Subject	Geometry
Grade Level	10 th -12 th
State Standards	3a
DOK Level	DOK 3
DOK Application	Use inductive reasoning to make conjecture and deductive reasoning to make valid conclusions
National Standards	Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer the
Graduate Research Element	The fellow's research involves filtering soil and different sediment forms to determine the origin of pollutants in the studied surface water.

Student Learning Goal:

The established learning goals for the lesson are to improve the student's ability to understand unit conversion, application of densities, percent analysis, and conversion. The students will work to figure out unknowns through found densities from math conversion. Along with the unknown analysis, the student will be required to figure out the percentages of percents of unknown sediments (rock mixture). The lesson will require the students to use this ability of finding percentages as well as deductive reasoning to learn the exact makeup of the given sediment. Along with establishing a knowledge base in densities and percentages, this lesson will provide a mastery of unit conversion, which is found in most science and mathematics classrooms across the country.

The established goals and practices are seen in many mathematical applications and in standardized test, such as graduate entrance examinations. The students will need a basic prior knowledge of units and percentages prior to the beginning of this lesson. While the students will learn unit conversions, due to the potential complexity of the lessons, the goals of unit conversion will be assisted by calculators and a separate lesson.

Materials Needed (supplies, hand-outs, resources):

One gallon of the sediment mixture [two different sized rocks (pea gravel and normal gravel), sand, crushed shell], four measuring cups, four graduated cylinders, two screen filters [one ¼ inch grade, one 1 millimeter thick], scale, calculators, writing utensil, Worksheet, assessment quiz.



Lesson Performance Task/Assessment:

An assessment with repetitive questioning the day following the lesson will prove understanding of the established goals. The assessment will contain questions of unit conversion (mainly volume measurement), densities measurements, and percentage mathematics. This assessment will occur after a short review to the students to make sure there is no doubt from the teacher that the students grasp the established goal.

Lesson Relevance to Performance Task and Students:

The relevance to this lesson is found in the multitude of mathematics covered in it. While students prepare for college preparatory examinations, the students may not fully grasp what math they are using. Placing the lesson into this real world crime assessment will allow the student to see the relevance to density, unit conversion, and percentages to the STEM community. Along with the anticipatory set, the teacher can establish a list of objects found every day that rely on unit conversion and percentages:

- Sales Tax (percentage)
- Interest (percentage)
- Different containers (unit conversion)
- Meter sticks (unit conversion)

Anticipatory Set/Capture Interest:

The students will be called to be forensic scientist (open the lesson with writing CSI across the board, streaming crime scene tape, and playing The Who, Who Are You). Once the student's attention is captured I will explain the crime. A jeep with used in a crime has been obtained with a sediment all over it. The students must find out through educated deductions and testing where this truck is from. The individual breakdown of the sediment gets the teams closer and closer to their criminal.

Guided Practice:

Day 1:

The teacher will first establish a prior knowledge base for the students in the field of unit analysis and basic conversion. To fully master the subject of density, the student must understand the units of density and where the units come from.

Once this is established, the teacher will begin by taking the student through a crime scene. Explaining what happened (vague to prevent students from taking it too far), at



the same time providing what they must find out as crime scene investigators. Once the students have been given the anticipatory set, the students will sit through a lecture explaining what exactly was found, showing them the soil and explaining where it may have come from (Script Optional) and how they need to do analysis on it. The lecture will give a few examples and also provide the formulas on the board for everyone to see. The lecture will provide a basic refresher on unit conversion and densities. While some of the unit conversions will be tough, the teacher will provide these unit conversions as constants. Once the students have a grasp of unit measurements and densities, independent practice will begin.

Day 2:

The teacher will bring back the anticipatory set to get the students attention again. Citing the fact that it will be day two of the rigorous investigation, the students will pick up from where they left off. While the second day will be substantially shorter than day one with only one topic being covered, the topic could be tougher for the students to grasp, therefore extra time is given. This time will also be used for assessment of the student after the completion of both lessons.

Independent Practice:

Day 1:

The independent practice for the lesson will begin with the student being given the supplies for the lesson. The supplies will consist of one quart (four cups) of the sample. The students will receive a measuring cup, a graduated cylinder; two screen filters [one $\frac{1}{4}$ inch grade, one 1 millimeter thick], calculators, and a writing utensil. The students will then conduct the experiment to worksheet specifications finding densities from mass and volumes (a scale must be provided for mass). The worksheet is attached. Once they find the densities, they will use the worksheet to find the locations of the densities. The worksheet will have some trick answers on it to find out if any students are skipping steps (not filtering the sample twice). As the students finish the lesson, get them to start to clean up their station to move back into regular teaching time.

Day 2:

The students will be asked to take their worksheets from the day before and start conducting percent analysis. The teacher will lecture on percent analysis before the students get a chance to complete the task. The students will then take the volumes from the samples collected the day before and try and find percentage of percent of the original sample. The blanks will be provided on the worksheet.



Remediation and/or Enrichment:

Remediation:

In situations that remediation is needed the student can see the instructor for one on one tutoring. The student can also be paired with a high performing student with full understanding of the lesson.

Enrichment/Extension:

In situations where there is full understanding, the lesson can be extended by incorporating more information percentages, unit conversions, and densities including, determining how the percentages and densities would change again if the students conducted a tertiary filter test on the soil. Individual IEP's will be supported.

Check(s) for Understanding:

The teacher will perform a quiz after day two that covers examples of finding specific densities with given mass and volume, as well as finding volume or mass, with given densities (backwards compatibility). The students will also be asked about finding percentage of percent.

The instructor will then ask the students questions to assess their understanding of the subject:

Why was it important to find the densities of each material?

It was important to emphasize the difference in material type. Densities allow us to see the greatest differences in materials.

What else can densities be applied to?

Any material science that has a classification of more than one material incorporates the importance of density.

Where can we find percentage analysis?

Sales Tax (additional cost percentage)
Interest (loss and gain percentage)
Science (prediction percentage)
Statistics (percentage based statistics)

Where can you apply percent analysis at home?

What percentage of food consumed by members of the family, etc. Get the students to create their own percentages.



Closure:

The students will discuss how they felt that the activity was going to turn out. The students will be asked where else the lesson could be applied. Once the students seem to have full understanding of the lesson, the teacher will move forward.

Possible Alternate Subject Integrations:

Chemistry, Life Science

Teacher Notes:

While this lesson plan uses fine sediment particles, such items like marbles and Lego blocks can be used to gain the same goal. Overall, the lesson will need to be changed to correlate those densities, but percentage of percent will remain the same, based specifically off of volume.