



The Density of Particulate Matter The Day of The Big Fire Lesson I



Objective:

Students will understand how to compute volume of a rectangular solid and consider the density of Particulate Matter in the air.

Grade Levels: 6 – 8 (middle school); 9 – 12 (high school)

Subjects:

- 6th grade – Energy in the Earth System (Earth Science), Ecology (Life Science), Resources, Investigation & Experimentation, Number Sense, Algebra, Measurement & Geometry, and Mathematical Reasoning
- 7th grade – Investigation & Experimentation, Algebra, Measurement & Geometry, and Mathematical Reasoning
- 8th grade – (Life Science) Density & Buoyancy, Investigation & Experimentation, and Geometry
- High School – Ecology, Energy in the Earth System (Earth Science), Structure & Composition of the Atmosphere, Investigation & Experimentation, and Geometry

California Science Standards:

6th Grade:

- Energy in the Earth System 4e
- Ecology 5e
- Resources 6b
- Investigation & Experimentation 7a & 7b

7th Grade:

- Investigation & Experimentation 7a & 7c

8th Grade:

- Density & Buoyancy 8a & 8b
- Investigation & Experimentation 9a & 9f

High School:

- Ecology 6b
- Energy in the Earth System 6d
- Structure & Composition of the Atmosphere 8c
- Investigation & Experimentation 1a, 1d, & 1m

California Math Standards:

6th Grade:

- Number Sense 1.2



- Algebra 1.2, 2.1, & 3.1
- Measurement & Geometry 1.3
- Mathematical Reasoning 1.1, 1.2, & 3.3

7th Grade:

- Algebra 1.1
- Measurement & Geometry 1.0, 1.1, 2.1, & 2.3
- Mathematical Reasoning 1.0, 1.1, & 3.3

8th Grade:

- Geometry 8.0 & 11.0

High School:

- Geometry 8.0 & 11.0

Materials:

- Ruler
- Pencil
- Scissors
- Cellophane Tape
- 8" x 10" piece of white paper



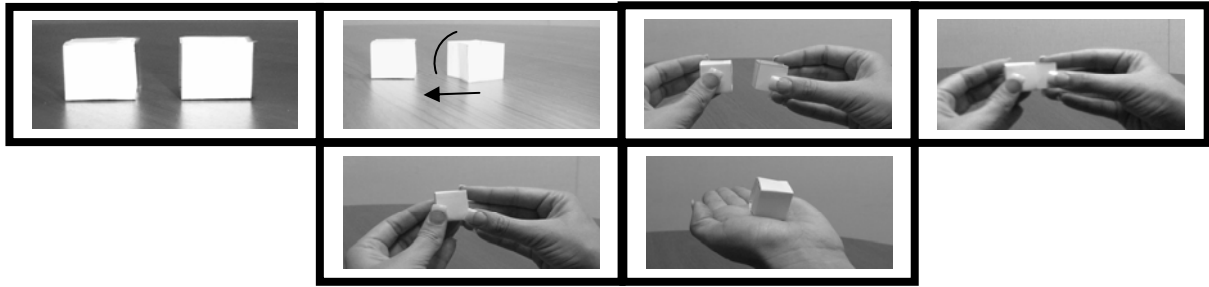
Procedure (Part I):

1. Divided into 12 groups of two, students should use a ruler to draw two rectangles on a white paper. Each rectangle should measure 1" x 4". Students should draw a line at the one inch marks along the long side of the rectangle to show that each rectangle is made up of four one inch squares. If the classroom size is smaller, some groups can work with a second piece of paper to do the same thing.



2. Each student group should cut out their two rectangles and fold them along the one inch lines. Students should use cellophane tape to join the four sides together of one of the rectangles (forming what looks like a square picture frame one inch thick) and cellophane tape to join the other four sides of the second rectangle together with the first rectangle to form a one inch cube. This is done by inserting one of the "picture frames" inside of the other, but turned ninety degrees. Using the tape, students can make the cube quite sturdy.

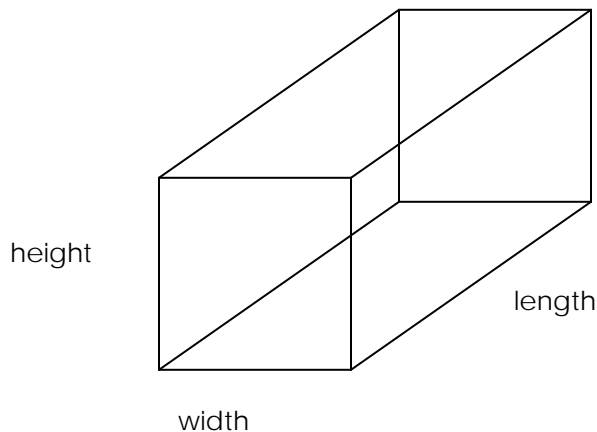




3. Students should be aware that the volume of the cube they have created is found by multiplying the length by the width by the height of the cube. These sides of the cube are all the same length by definition of a cube, or 1 inch. Therefore the volume of the cube is one cubic inch, or $1'' \times 1'' \times 1''$. The class will create 12 cubes this way.
4. Students should create a rectangular solid by putting the cubes together or stacking them up. All 12 cubes should be used. Students should count all 12 cubes before creating the rectangular solid, to remind them of how much volume is in the rectangular solid they are creating. For example, students may wish to place two cubes side by side with a cube above each. If students create three such displays of the cubes and slide them together until their largest surfaces are touching, students will have a rectangular solid with a width of two cubes, a height of two cubes, and a length of three cubes. Students should use the formula for the volume of a rectangular solid to compute the volume. $V = \text{length} \times \text{width} \times \text{height}$. Students should measure the length of the long side of the rectangular solid with a ruler, the width of the rectangular solid and the height of the rectangular solid. The volume of the rectangular solid they created is $V = 3'' \times 2'' \times 2''$. This should yield 12 cubic inches or the same volume of all the cubes inside added together. Any rectangular solid the students create with the 12 cubes will measure such that, using the formula for volume, it will have a volume of 12 cubic inches.



Diagram to aid with instructions:



**Volume of a
Rectangular Solid**

$$V = \text{length} \times \text{width} \times \text{height}$$

Procedure (Part II):

1. Students should be shown a meter stick and one of their cubes side by side. Students should be aware that the cubes they created are one cubic inch and that a cubic meter has the length of the meter stick on each of its sides.
2. Students should be reminded that there are one million micrograms in one gram, so one microgram is one millionth of a gram. A gram is a unit of mass. If there are more than 35 micrograms of particulate matter like Parti, which is PM2.5 or Particulate Matter that is less than 2.5 microns large, in a cubic meter of air then this exceeds the Federal Standards for particulate matter averaged over a twenty-four hour period. Parti is only 2.5 microns large or less. A micron is one millionth of a meter. If the density of Partis or number of micrograms of PM2.5 per cubic meter exceeds 35 micrograms per cubic meter over a 24 hour period, then Parti can be harmful to human health.

Conclusions:

1. How do you compute the volume of a rectangular solid? Is it even easier to compute the volume of a cube? What is the volume of a cube?
2. Does density tell us the amount of mass contained in a certain volume or unit volume? Can students think of ways to determine on their own how much particulate matter is in the air? Can students tell how dusty the air is by looking at the surface of a table that hasn't been dusted in a while?

