You look up at the sky one day and see puffy little cumulus clouds hovering over the beach, a meadow, or over your town. Did you ever wonder just how much a cloud might weigh as it drifts by over your head?

Different clouds carry different amounts of water droplets and so they have different densities. Brilliant white cumulus clouds, for example, have densities of 0.3 grams/meter^3.

From the known cloud densities, we can estimate their masses once we know their volumes because Mass = Density x Volume.

Problem 1 – From the definition of density, what are the other two equations you can create that define mass and volume?

Problem 2 – A puffy cumulus cloud looks almost like a sphere. If its diameter is 3.0 kilometers, what is its volume in cubic meters? (use $\pi = 3.14$)

Problem 3 – What is the total mass of the cumulus cloud in kilograms and metric tons?

Problem 4 – You spot two clouds in the sky. The cumulus cloud is 1/5 the diameter of the cumulonimbus cloud, and the cumulonimbus cloud has 8 times the density of the cumulus cloud. What is the ratio of the mass of the cumulus cloud to the cumulonimbus cloud if both clouds are spherical in shape?

Grade 7 - Working with Density, mass and volume: Examples: 'California Mathematics Standards' - *Students can calculate the mass of a cylinder given its dimensions and density*. - Utah State Science Standards: I.2.c. "*Calculate the density of various solids and liquids."*

Grade 8 - Common Core Math Standards:
CCSS.Math.Content.8.EE.A.4 Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities (e.g., use millimeters per year for seafloor spreading). Interpret scientific notation that has been generated by technology.

Problem 1 – From the definition of density, what are the other two equations you can create that define mass and volume?

Answer: Density = Mass / Volume Volume = Mass/Density

Problem 2 – A puffy cumulus cloud looks almost like a sphere. If its diameter is 3.0 kilometers, what is its volume in cubic meters? (use $\pi = 3.14$)

Answer: $V = 4/3\ \pi\ R^3$ and for D = 3.0 km, we have R = 1500 meters and so $V = 4/3\ \pi$ $(1500\text{meters})^3 =$ **1.4×10^{10} meters^3**

Problem 3 – What is the total mass of the cumulus cloud in kilograms and metric tons?

Answer: Mass = Density x Volume so $M = 0.3\ \text{grams/m}^3 \times 1.4 \times 10^{10}\ \text{m}^3 = 4.2 \times 10^9$ grams. But 1 kg = 1000 grams, so **M = 4,200,000 kg**. This also equals **4200 metric tons**!

Problem 4 – You spot two clouds in the sky. The cumulus cloud is 1/5 the diameter of the cumulonimbus cloud, and the cumulonimbus cloud has 8 times the density of the cumulus cloud. What is the ratio of the mass of the cumulus cloud to the cumulonimbus cloud if both clouds are spherical in shape?

Answer: Mass = Density x Volume.

$V(\text{Cumulus})/V(\text{CN}) = (1/5)^3$ and D(Cumulus) = 1/8D(CN) so

$\text{Mass(Cumulus)} = (1/5)^3 \times (1/8) \times \text{Mass(CN)} = 1/1000\ \text{Mass(CN)}$ and so

Mass(Cumulus)/Mass(CN) = **1/1000**