

Titanium dioxide, TiO_2 , is the ubiquitous white pigment used in items such as photographic paper, paint, and plastics. TiO_2 has a density of 4.2 g/cc and the pigment particles are cubes with sides of $0.25\mu\text{m}$. A paint formulation contains 42% (wt.) of TiO_2 pigment, 12% resin (density 1.2 g/cc) and the remainder is water. A gallon of this paint can coat 400 ft^2 of walls.

1. Estimate the consumption of pigmentary TiO_2 in the United States in 2004.
2. What is the volume, cc, of the TiO_2 in a gallon of the paint formulation (above)?
3. What is the mass, grams, of a gallon of the paint?
4. What is the mass, grams, of a TiO_2 pigment particle?
5. What is the surface area, cm^2 , of a TiO_2 pigment particle?
6. What is the total surface area, m^2 , of the pigment particles in a gallon of the paint?
7. If the paint is used to coat 400 ft^2 of walls, how thick, cm, is the paint film?
8. What is the average distance, m, between pigment particles in a paint film?
9. How many molecules are in a TiO_2 pigment particle?
10. If all of the TiO_2 pigment particles in the gallon of paint were placed side by side as in a chain, how long, km, is the chain?

WaterWorks. The Earth's oceans cover an area of $3.6 \times 10^8\text{ km}^2$ and their average depth is $4 \times 10^3\text{ m}$. The density of salt water is 1.027 g/cc.

11. What is the total mass, kgm, of the oceans?
12. How many water molecules are in the oceans?
13. If all of the oceans were frozen into a single ice cube, how high, km, would it be?
14. What is the volume, cc, of a water molecule?
15. What is the total mass, tons, of the components in the oceans beside water?

16. If the Earth's oceans covered a sphere the diameter of the moon, how deep, m, would the new ocean be?
17. What is the average pressure, atm, at the bottom of the Earth's oceans?
18. If a 6 foot diameter pipe were built to contain all the ocean water, how many miles long would the pipe have to be?
19. What is the ratio of the length of pipe (prob. 18) to the distance from the Earth to the Sun?
20. If the oceans were frozen into 1 inch ice cubes, how many cubes would there be?
21. If the ice cubes in prob. 20 were placed side by side to form a single line, how long, km, would the line be?
22. How many years would it take for light to travel the length of pipe in problem 18?

Rice Grains. A grain of rice is a rectangular prism, 2 mm x 2 mm x 7 mm long. 100 grains mass 1.7g. A cup of uncooked rice masses 100g and, when boiled with 2 cups of water, makes 3 cups of cooked rice. A rice grain contains 15% water and the rest can be written as $\text{C}_6\text{H}_{10}\text{O}_5$.

23. What is the density, g/cc, of an uncooked grain of rice?
24. How many grains of rice are in a 5 lbs bag?
25. For a cup of uncooked rice, what fraction of the cup is air?
26. 5 lbs of rice yields how many cc of cooked rice?
27. By cooking, how many times does rice expand in volume?
28. If 5 lbs of rice are cooked in ocean water (see WaterWorks), how many grams of salts are in the cooked rice?
29. 5 lbs of rice, if completely oxidized, yields how many grams of water?
30. A cup of cooked rice contains how many grams of the element carbon?