

Some Facts. Gold, atomic weight 197 and atomic number 79, has a nuclear radius of 7.3×10^{-15} m and an atomic radius of 1.3×10^{-10} m. A proton and neutron are of equal mass and 2000 times more massive than an electron. The Sun has a diameter of 1.4×10^6 km and a mass of 2×10^{30} kg.

1. What is the mass, g, of a gold atom?
2. What is the density, g/cc, of the gold atom nucleus?
3. What is the mass, g, of the Earth?
4. Assuming that it has the same density as a gold nucleus, what is the diameter, cm, of a neutron star that has the same mass as the Earth?
5. If a gold nucleus was expanded to a diameter of 1 m, how far away, m, is the electron cloud?
6. What is the volume fraction of a gold atom occupied by matter?
7. Assuming that it has the same density as a gold nucleus, what is the diameter, cm, of an electron?
8. What is the volume fraction of the Solar System (from the Sun to Earth) occupied by the Sun, and the planets?
9. What is the density, g/cc, of the Sun?
10. If the Sun were to collapse into a neutron star, what would be its diameter, cm?
11. Given the same size reduction as in Problem 10, how far, in cm, is the Earth from the Sun?
12. During the course of a calendar year, how far, km, through space has the moon traveled?
13. How many seconds does it take for light to travel from the Sun to the Earth?
14. How many days would it take a sound wave to travel the same distance at sea level on Earth?
15. A breakfast cereal, similar to Cheerios, is composed of small oat cylinders, 1 cm dia., 4 mm high with a 4 mm diameter hole bored through. Estimate the mass, g, of one cylinder.
16. How many oat cylinders are in a cereal box containing 425 g?
17. Two of the dimensions of the cereal box are 30 and 20 cm. Estimate the width, cm, of the box.
18. The cereal is poured to fill an 8 oz. bowl. Milk is then added to completely fill the bowl. How many cc of milk were added?
19. A lawn has blades of grass that are rectangular in cross-section; 2 mm wide by 0.1 mm thick. There are 10 blades of grass in each 2 by 2 cm area of lawn. The owner mows the grass on his 1 acre lawn to a height of 7cm. For a freshly mowed lawn, estimate the mass, g, of the grass above ground.

20. The grass on the lawn grows 10 cm in height during the week between mowings. Estimate the mass, g, of the grass clippings collected each week.
21. The owner collects and dries the clippings. In the course of a six month growing season, what is the total mass, g, of the dried clippings?

The year is 2030. A limited access highway (cars only) was built from New Jack City to Ballmore.

The road is 250 km long, 12 lanes wide (4 traffic lanes going north and 4 south) with pull-out lanes outside lanes 1 & 4. The road bed is 30 cm thick. A 30 cm concrete barrier separates the north/south roads and 30 m wide grass strips are on the outer portions of the highway. The speed limit is 100 km/hr. E-Z pass toll booths (cars speed through) are situated at the ends and exits of the highway. A driver is expected to maintain a safe distance of 100 m between his/her car and the vehicle in front.

22. What is the volume, m^3 , of the road bed of the highway?
23. On Sunday of Thanksgiving weekend, the highway is at maximum capacity with cars safely going at the speed limit. How many cars are on the highway?
24. For the period when the highway is operating at maximum capacity, how many cars exit from the highway per hour?
25. What is the total area, m^2 , covered by the highway and the grass outer strips?
26. If all of the land that the highway was built upon contained houses with 1 acre lots, how many houses had to be torn down to build the highway?
27. If cars get 20 km/liter gas mileage in 2030, how many liters per hour would be consumed during the period of use at maximum capacity?
28. On the average, during the day the highway is 40% occupied while, at night, it is 10 % full. In a year, how many cars use the highway?
29. What is the total gasoline consumption, gallons, for cars using the highway in a year?
30. On the grass strip going north, a high speed train (250 km/hr) track was built; shortly thereafter, a track was installed on the south grass strip. Assuming that each train was composed of 12 cars with a capacity of 100 people per car. How often, in minutes, would the interval between trains have to be in order to transport the same amount of people that would use the highway in a year?