

DIMENSIONAL ANALYSIS PROBLEMS

1 pound = 454 g (not exact)

1 quart = 0.946 liters (not exact)

1 pound = 16 oz (exact)

1 gallon = 4 quarts (exact)

1 quart = 4 cups (exact)

1 cup = 8 ounces (exact)

1 inch = 2.54 cm (exact)

1 gram = 0.0321507466 troy ounce

1 kilometer = 0.62137 miles

1 ton = 2000 pounds

1 cup = 16 tablespoons

1. Convert 3598 grams into pounds.

Answer: 7.93 pounds 7.925

$$3598 \text{ g} \times \frac{1 \text{ lb}}{454 \text{ g}} = 7.925 \text{ lbs}$$

2. Convert 231 grams into ounces.

Answer: 8.14 ounces

$$231 \text{ g} \times \frac{1 \text{ lb}}{454 \text{ g}} \times \frac{16 \text{ oz}}{1 \text{ lb}} = 8.14 \text{ oz}$$

3. A beaker contains 578 mL of water. What is the volume in quarts?

Answer: 0.611 quarts

$$578 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{1 \text{ qt}}{0.946 \text{ L}} = 0.611 \text{ qt}$$

4. How many ng are there in 5.27×10^{-13} kg?

Answer: 0.527 ng

$$5.27 \times 10^{-13} \text{ kg} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1 \times 10^9 \text{ ng}}{1 \text{ g}} = 5.27 \times 10^{-4} \text{ ng}$$

5. What is 7.86×10^{-2} kL in dL?

Answer: 786 dL

$$7.86 \times 10^{-2} \text{ kL} \times \frac{1000 \text{ L}}{1 \text{ kL}} \times \frac{10 \text{ dL}}{1 \text{ L}} = 786 \text{ dL}$$

6. What is 0.0032 gallons in cL?

Answer: 1.2 cL

$$0.0032 \text{ gal} \times \frac{4 \text{ qt}}{1 \text{ gal}} \times \frac{0.946 \text{ L}}{1 \text{ qt}} \times \frac{100 \text{ cL}}{1 \text{ L}} = 1.2 \text{ cL}$$

7. A box measures 3.12 ft in length, 0.0455 yd in width and 7.87 inches in height. What is its volume in cubic centimeters?

Answer: 7910 cm^3

$$3.12 \text{ ft} \times \frac{12 \text{ in}}{1 \text{ ft}} \times \frac{2.54 \text{ cm}}{1 \text{ in}} = 95.1 \text{ cm}$$

$$7.87 \text{ in} \times \frac{2.54 \text{ cm}}{1 \text{ in}} = 19.9898 \text{ cm}$$

$$0.0455 \text{ yd} \times \frac{3 \text{ ft}}{1 \text{ yd}} \times \frac{12 \text{ in}}{1 \text{ ft}} \times \frac{2.54 \text{ cm}}{1 \text{ in}} = 4.16 \text{ cm}$$

$$V = 7912.32$$

$$7910 \text{ cm}^3$$

8. A block occupies 0.2587 ft^3 . What is its volume in mm^3 ?

Answer: $7.326 \times 10^6 \text{ mm}^3$

$$0.2587 \text{ ft}^3 \times \frac{12 \text{ in}}{1 \text{ ft}} \times \frac{12 \text{ in}}{1 \text{ ft}} \times \frac{12 \text{ in}}{1 \text{ ft}} \times \frac{2.54 \text{ cm}}{1 \text{ in}} \times \frac{2.54 \text{ cm}}{1 \text{ in}} \times \frac{2.54 \text{ cm}}{1 \text{ in}} \times \frac{10 \text{ mm}}{1 \text{ cm}} \times \frac{10 \text{ mm}}{1 \text{ cm}} = 7325568.213 = (7.326 \times 10^6 \text{ mm}^3)$$

9. If you are going 55 mph, what is your speed in nm per second?

Answer: $2.5 \times 10^{10} \text{ nm/s}$

$$\frac{55 \text{ mi}}{\text{hr}} \times \frac{\text{km}}{0.62137 \text{ mi}} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{1 \times 10^9 \text{ nm}}{1 \text{ m}} \times \frac{1 \text{ hr}}{3600 \text{ s}} = 2.5 \times 10^{10} \frac{\text{nm}}{\text{s}}$$

10. If the density of an object is $2.87 \times 10^{-4} \text{ lbs/cubic inch}$, what is its density in g/mL ?

Answer: $7.96 \times 10^{-3} \text{ g/mL}$

$$\frac{2.87 \times 10^{-4} \text{ lb}}{\text{in}^3} \times \frac{454 \text{ g}}{1 \text{ lb}} \times \frac{1 \text{ in}}{2.54 \text{ cm}} \times \frac{1 \text{ in}}{2.54 \text{ cm}} \times \frac{1 \text{ in}}{2.54 \text{ cm}} \times \frac{1 \text{ cm}^3}{1 \text{ mL}} = 0.00795$$

$$7.95 \times 10^{-3} \text{ g/mL}$$

11. A sample of gold has a mass of 1.245 kilograms. The price of gold is currently priced on the New York futures market at \$1790. per troy ounce. What is the value of the gold?

Answer: \$71,650

$$1.245 \text{ kg} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{0.03215 \text{ troy oz}}{1 \text{ g}} \times \frac{\$1790}{1 \text{ troy oz}} = \$71,650$$

12. The price of gasoline this morning was \$3.55 per gallon. You are planning a trip to visit relatives, and you estimate the total distance roundtrip to be 2480 miles. What will the gasoline cost for the trip? The owner's manual stated that your car gets 15 Km per liter (you bought it in Canada).
Answer: \$250.

$$2480 \text{ mi} \times \frac{1 \text{ km}}{0.62137 \text{ mi}} \times \frac{1 \text{ L}}{15 \text{ km}} \times \frac{1 \text{ qt}}{0.946 \text{ L}} \times \frac{1 \text{ gal}}{4 \text{ qt}} \times \$3.55 = \$250.$$

13. It is known that four hundred pounds of iron metal occupy a volume of 0.02234 cubic meters. Calculate the cubic feet of iron in a statue that has been determined to contain 54.5 kilograms of iron.

Answer: 0.23 ft³ of Fe

$$400 \text{ lbs Fe} = 0.02234 \text{ m}^3$$

$$54.5 \text{ kg Fe} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ lb}}{454 \text{ g}} \times \frac{0.02234 \text{ m}^3}{400 \text{ lbs}} \times \frac{100 \text{ cm}}{1 \text{ m}} \times \frac{100 \text{ cm}}{1 \text{ m}} \times \frac{100 \text{ cm}}{1 \text{ m}} \times \frac{1 \text{ in}}{2.54 \text{ cm}} \times \frac{1 \text{ ft}}{12 \text{ in}} \times \frac{1 \text{ ft}}{12 \text{ in}} \times \frac{1 \text{ ft}}{12 \text{ in}} = 0.237 \text{ ft}^3$$

14. In the fall of 1999, 62 students enrolled in Dr. Fuller's CHEM 151 class at the College of DuPage. Thirty-two percent of the students originally enrolled withdrew from his class before the end of the quarter. Of the remaining students, 26% received A's and 16% received B's. How many students received A's?

Answer: 11 students received A's

$$62 \text{ students} \times \frac{68 \text{ students}}{100 \text{ students}} \times \frac{26 \text{ students}}{100 \text{ students}} = 10.96$$

11 students

15. The density of carbon tetrachloride is 1.60 grams of carbon tetrachloride per cc of carbon tetrachloride. What is its density expressed in tons per cubic yard?

Answer: 1.35 Ton CCl₄ per cubic yard

$$\frac{1.60 \text{ g}}{\text{cm}^3} \times \frac{2.54 \text{ cm}}{1 \text{ in}} \times \frac{2.54 \text{ cm}}{1 \text{ in}} \times \frac{2.54 \text{ cm}}{1 \text{ in}} \times \frac{36 \text{ in}}{1 \text{ yd}} \times \frac{36 \text{ in}}{1 \text{ yd}} \times \frac{36 \text{ in}}{1 \text{ yd}} \times \frac{1 \text{ lb}}{454 \text{ g}} \times \frac{1 \text{ ton}}{2000 \text{ lbs}}$$

1.35 ton/yd³

230000

2.3×10^5

16. Olive oil has a density of 0.89 grams per mL. If a recipe calls for nine ounces of olive oil, how many cups of olive oil are required in the recipe?

Answer: 1.2 cups of olive oil

1 cup

1 cup

$$9 \text{ oz} \times \frac{1 \text{ c}}{8 \text{ oz}} = 1.125$$

17. Suppose someone offered to give you a 2 gallon bucket filled with gold if you carry the bucket of gold up a flight of stairs. But if you fail to carry the bucket up the flight of stairs, you must stay in Honors Chemistry forever. Would you accept the offer? The density of gold is 19.3 g/cc.

Answer: 320 pounds of gold

$$2 \text{ gal} \times \frac{4 \text{ qt}}{1 \text{ gal}} \times \frac{0.946 \text{ L}}{1 \text{ qt}} \times \frac{1000 \text{ mL}}{1 \text{ L}} \times \frac{19.3 \text{ g}}{1 \text{ mL}} \times \frac{1 \text{ lb}}{454 \text{ g}} = 321.7$$

300 lbs

no thanks!

18. Vanadium metal is added to steel to impart strength to the metal. Vanadium has a density of 5.96 g/cm³. The metallurgist adds 580 pounds of vanadium of a batch of steel. What volume, expressed in cubic feet, of vanadium was added to the batch of steel?

Answer: 1.56 cubic feet

1.6

$$580 \text{ lbs} \times \frac{1}{1 \text{ lb}} \times \frac{454 \text{ g}}{1 \text{ lb}} \times \frac{1 \text{ cm}^3}{5.96 \text{ g}} \times \frac{1 \text{ in}}{2.54 \text{ cm}} \times \frac{1 \text{ in}}{2.54 \text{ cm}} \times \frac{1 \text{ in}}{2.54 \text{ cm}} \times \frac{1 \text{ ft}}{12 \text{ in}} \times \frac{1 \text{ ft}}{12 \text{ in}} \times \frac{1 \text{ ft}}{12 \text{ in}}$$

1.6 ft³

19. The futures market on May 19, 2003 listed the opening price of unleaded gasoline at \$0.5462 per gallon. What is the value of a storage tank filled with unleaded gasoline? The cylinder storage tank is 35 feet tall and 45 feet in diameter.

Answer: \$ 2.3 x 10⁵

$$V_{\text{cyl}} = \pi r^2 h$$

$$\frac{45}{2} = 22.5 \quad h = 35$$

$$V = \pi (22.5)^2 \cdot 35$$

$$V = 55665.0948 \text{ ft}^3$$

$$55665.0948 \text{ ft}^3 \times \frac{172.8 \text{ in}^3}{1 \text{ ft}^3} \times \frac{16.387 \text{ cm}^3}{1 \text{ in}^3} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{1 \text{ qt}}{0.946 \text{ L}} \times \frac{1 \text{ gal}}{4 \text{ qt}} \times \frac{\$0.5462}{1 \text{ gal}} =$$

\$ 227524

\$ 230000

$$2.54^3 = 16.387 \text{ cm}^3 = 1 \text{ in}^3$$

$$12^3 = 172.8 \text{ in}^3 = 1 \text{ ft}^3$$

20. A sample of milk is found to have arsenic at a concentration of 1.32×10^3 micrograms/mL. What are the concentration in ounces per gallon?

Answer: **0.00076 ounces per gal** 0.176 oz/gal

$$\frac{1.32 \times 10^3 \mu\text{g}}{\text{mL}} \times \frac{1 \text{ g}}{1 \times 10^6 \mu\text{g}} \times \frac{1 \text{ lb}}{454 \text{ g}} \times \frac{16 \text{ oz}}{1 \text{ lb}} \times \frac{1000 \text{ mL}}{1 \text{ L}} \times \frac{0.946 \text{ L}}{1 \text{ qt}} \times \frac{4 \text{ qt}}{1 \text{ gal}} =$$

$$0.176 \text{ oz/gal}$$

21. An average man requires about 200mg of riboflavin (vitamin B2) per day. How many tablespoons of cheese would a man have to eat each day if this was his only source of riboflavin and if mozzarella cheese contained 5.5 mg. of riboflavin per gram? The density of mozzarella cheese is 0.6893 grams per mL.

Answer: **3.5 tablespoons**

$$200 \text{ mg} \times \frac{1 \text{ g cheese}}{5.5 \text{ mg rib.}} \times \frac{1 \text{ mL}}{0.6893 \text{ g cheese}} \times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{1 \text{ qt}}{0.946 \text{ L}} \times \frac{4 \text{ c}}{1 \text{ qt}} \times \frac{16 \text{ Tbs}}{1 \text{ c}}$$

$$3.569 \text{ Tbs}$$

$$(4 \text{ Tbs})$$

22. If one gram of silver can be converted into 400 square feet of mirrors, how thick is the coating? The density of silver is 10.5 grams per cm^3 .

Answer: **$2.56 \times 10^{-7} \text{ cm}$**

$$1 \text{ g Ag} = 400 \text{ ft}^2 \text{ mirrors}$$

$$1 \text{ g Ag} \times \frac{\text{cm}^3}{10.5 \text{ g Ag}} = 0.095238 \text{ cm}^3$$

$$400 \text{ ft}^2 \times \frac{12 \text{ in}}{1 \text{ ft}} \times \frac{12 \text{ in}}{1 \text{ ft}} \times \frac{2.54 \text{ cm}}{1 \text{ in}} \times \frac{2.54 \text{ cm}}{1 \text{ in}} = 371612.16 \text{ cm}^2$$

$$\frac{0.095238 \text{ cm}^3}{371612.16 \text{ cm}^2} = 2.56 \times 10^{-7}$$

$$(3 \times 10^{-7} \text{ cm})$$

