

Dimensional Analysis Worksheet

Easy Problems:

1. Levoxyl is a drug used to treat hypothyroidism. If a patient takes one 75 ng tablet per day, how many milligrams of Levoxyl are in their 1 month (30 day) supply?

What information I am given?

What am I asked to find?

What additional information do I know or can get “for free”?

How can I relate the given to the answer?

Solve:

2. A gold bar is 0.84 L of gold and costs \$8,400.00. If the density of gold is 19.7 g/mL, how much does one gold atom cost, to the correct number of sig figs?(1.7×10^{-21} \$/atom)

What information I am given?

What am I asked to find?

What additional information do I know or can get “for free”?

How can I relate the given to the answer?

Solve:

Medium Problems

1. What volume will be occupied by the CO₂ gas at room temperature (use 300K) and 1 atm that has the same number of atoms of carbons as in 17.1 gram of sucrose (C₁₂H₂₂O₁₁). (14.8L)
2. Convert 10.0 g*cm³/s² to kg*m³/hour². (13.0×10^{-6} kg*m³/hour²)

Hard Problems:

1. Write an expression for inner diameter (d) in cm of the opening of a very thin cylindrical glass tube in cm, given the following information (hint the formula for volume of a cylinder is $\pi r^2 H$):
 - a. The tube has a height of H cm
 - b. The mass of the empty glass tube is m_{glass} g
 - c. It is filled with mercury and the mass is re-measured and found to be m_{filled} g
 - d. The density of mercury is ρ g/cm³
2. How many grams of Br₂ has the same number of atoms as a number of atoms in 26.00 gams of Zn (M_{Zn}=65g/mol, M_{Br}=80g/mol))
 - a. Now please write an expression for number of atoms using G grams for grams of Zn and M_{Zn}, M_{Br} for molecular weights.
3. You have an explosion in your lube that releases 9.60×10^3 kJ of energy. It takes 1.50×10^{18} atoms of C to release exactly 1 J of energy. How many mL of ethylene glycol, C₂H₄(OH)₂ is needed to coause that explosino. If the density of ethylene glycol is 1.50 g/m³(992ml)

Practice problems.

1. What is a better deal, one gallon of gasoline for \$3.00 or one liter of gasoline for \$0.70? Support your answer with calculations.
2. How many seconds are in a year? (3×10^7 sec)
3. The circumference of the earth is 25,000 miles at the equator. What is the circumference in centimeters? (4×10^9)
4. To reach the recommended daily intake of calcium, a person must drink 600 mL of milk a day. If 200 mL of milk contains 300 mg of calcium, how much calcium, in kg, is a person recommended to intake in 30 days? (4×10^4 kg)
5. There are 2600 miles between Boston and Los Angeles (in a straight line). If a plane flies at 600 miles/hour. How long is the flight between Boston and LA? (4.3 hours)
6. If you earned one penny for every 10 seconds of your life then how many dollars would you have after 65 years? (2×10^8)

**** Easy**

1. Your car's gas tank holds 12 gallons of gas and is $\frac{1}{4}$ full. Your car gets 20 miles/gallon. You see a sign saying "Next gas 82 miles". Can you make it to the gas station before running out of gas?
2. A popular web site states that a 200 pound person will burn 400 calories/hour bicycling (moderate effort) and 600 calories/hour rock climbing (ascending). A 150 pound person decides to start a training routine in which she will bicycle for 45 minutes, 3 times a week and rock climb for 1.5 hours every Saturday. How many calories will she have burned after 8 weeks of training? What percentage of those are from bicycling?
3. Light travels at a speed of 3.0×10^{10} cm/s. How far would light travel in a year? (9×10^{17} cm)
4. The human body is 60% water by mass. How many grams of water are there in a person who weights 90 kg? (54 kg)
5. An average man requires about 2.0 mg of riboflavin (Vitamin B12) per day. One slice of cheese contains 5.5 μ g of riboflavin. How many slices of cheese would a man have to eat per day if it were his only source of riboflavin? (360)

***** Medium**

1. A diabetic is recommended to use 1 cm^3 of insulin for every 10 grams of carbohydrates consumed. The recommended daily intake of carbohydrates is 300 grams. A diabetic has eaten a slice of wheat toast and has consumed 5% of their daily value of carbohydrates. How many mL of insulin should the diabetic use to maintain a proper blood sugar level after eating the piece of toast? (1.5 cm^3 of insulin)
2. Diamonds are measured in carats and 1 carat = 0.200 grams. The density of diamond is 3.5 g/cm^3 . A diamond is dropped into a graduated cylinder filled with 30 mL of water and the final volume is measured to be 35 mL. How many carats is the diamond? (88 carat)
3. Every 3 hours a fast food employee wraps 350 hamburgers. He works 8 hours per day, 5 days a week. He gets paid every 2 weeks with a salary of \$700. Approximately how many hamburgers will he have to wrap to make his first one million dollars? (1.3×10^7 burgers)
4. The roof of a building is 0.2 km^2 . During the rainstorm one evening, 5.5 cm of rain was measured to be sitting on the roof. What is the mass of the water on the roof after the rainstorm? (1.1×10^{10} g)
5. The ideal gas constant was experimentally found to be $8 \text{ J/K} \cdot \text{mol}$. At a temperature of 300 K, how much energy (in Joules) would a sample of 48×10^{30} atoms of water contain? (2×10^{11} J)

****** Hard**

1. The bromine content of the ocean is about 65 grams of bromine per million grams of sea water. How many cubic meters of ocean must be processed to recover 500. mg of bromine if the density of sea water is $1.0 \times 10^3 \text{ kg/m}^3$?

2. If 20.0 g of coal are burned, heating 1.00 L of water, how much hotter will the water get? Assume all of the heat lost by the coal is gained by the water.

Additional information: Density of water, 1.00 g/mL Specific heat of water, 4.18 J/g·°C Density of coal, 1506 kg/m³ Heat of combustion of coal, 27 MJ/kg

3. The density of pure silver is 10.5 g/cm³. If 5.5 g of pure silver pellets are added to a graduated cylinder containing 11 mL of water, to what volume will the water in the cylinder rise?
4. The re-entry speed of the Apollo 10 space capsule was 11.0 km/s. How many hours would it have taken for the capsule to fall through the 25 miles of stratosphere?
5. Diamonds are measured in carats and 1 carat = 0.200 grams. The density of diamond is 3.51 g/cm³. A diamond is dropped into a graduated cylinder filled with 30 mL of water and the final volume is measured to be 35 mL. How many carats is the diamond?

***** Challenge

1. Silver ions (Ag^+) react with chloride ions (Cl^-) to create an insoluble solid, silver chloride (AgCl). How many moles of AgCl would form if 50 mL of a 5 mol/L Ag^+ solution were mixed with 100 mL of a 2.5 mol/L Cl^- solution?
2. All matter has a property called a specific heat capacity. For silver, this specific heat capacity is 0.24 J/g*K. If 48 kJ of energy is required to raise the temperature of the silver from 25 C to 30.4 C, what is the mass of the silver?
3. The local nuclear power plant produces 4.2×10^{16} joules per ton of Uranium-235. Every day you eat a Hershey's chocolate bar containing 200 kcal.
 - a. How many chocolate bars must you eat in order to consume the same amount of energy as 1 ton of Uranium-235? (1 kcal = 4.2 J) () 5×10^{13} chocolate bars)
 - b. The world's global energy consumption is estimated to be 4×10^{20} J/year. How many months of eating 2 candy bars daily would it take to consume the same amount of energy as the world does in 1 year? (8×10^{15} months)
 - c. How fast do you need to eat chocolate bars in order to power a 40-watt light bulb? (1 watt = 1 joule/sec) (0.05 chocolate bars/sec or 1 chocolate bar every 20 seconds.)

Pico	p	0.000000000001	10^{-12}
Nano	n	0.000000001	10^{-9}
Micro	μ	0.000001	10^{-6}
Milli	m	0.001	10^{-3}
Centi	c	0.01	10^{-2}
Deci	d	0.1	10^{-1}
N/A	N/A	1	10^0
Hecto	h	100	10^2
Kilo	k	1,000	10^3
Mega	M	1,000,000	10^6
Giga	G	1,000,000,000	10^9
Tera	T	1,000,000,000,000	10^{12}

Conversion Factors:

1 Yard = 3 Feet

Avogadro number $N_A=6.02214 \text{ mol}^{-1}$

1 Foot = 12 Inches

Gas constant $R=8.314 \text{ J}/(\text{mol}\cdot\text{K})= 8.314 \text{ L}\cdot\text{kPa}/(\text{mol}\cdot\text{K})=0.08206 \text{ (L}\cdot\text{atm})/(\text{mol}\cdot\text{K})=0.08314(\text{L}\cdot\text{bar})/(\text{mol}\cdot\text{K})$

1 Inch = 2.5 cm

Plank Constant $h=6.626 \cdot 10^{-34} \text{ J}\cdot\text{s}$

1 Mile = 5300 feet

Speed of light $c=2.9979 \cdot 10^8 \text{ m/s}$

1 Mile = 1600 meters

1 oz = 30 g

2 liters = 65 fluid ounces

1 gallon = 130 fluid ounces

1 mL = 1 cm³ = 1 cc

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

$$PV=nRT$$