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MATH 100
Fall 2022
HW 4: Due 09/26

"For those who want some proof that physicists are human, the proof is in the idiocy of all the different units which they use for measuring energy."

–Richard Feynman

Problem 1. (10pt) Showing all your work, convert the following indicated units to the units indicated in brackets using the given information:

(a) 1400 m to cm

(b) 4,600 ft to km [1 ft = 0.3048 m]

(c) 55 mph to km per hour [1 mi = 5280 ft, 1 m = 3.28084 ft]

(d) 55 mph to ft per second [5280 ft = 1 mi]

(e) 1000 ft^3 to m^3 [5 m = 16.4042 ft]

Solution.

(a)

$$\frac{1400 \text{ m} \mid 100 \text{ cm}}{\mid\ 1 \text{ m}} = 140{,}000 \text{ cm}$$

(b)

$$\frac{4600 \text{ ft} \mid 0.3048 \text{ m} \mid 1 \text{ km}}{\mid\ 1 \text{ ft} \mid 1000 \text{ m}} = 1.40208 \text{ km}$$

(c)

$$\frac{55 \text{ mi} \mid 5280 \text{ ft} \mid 1 \text{ m} \mid 1 \text{ km}}{1 \text{ hr} \mid 1 \text{ mi} \mid 3.28084 \text{ ft} \mid 1000 \text{ m}} = 88.5139 \text{ km per hr}$$

(d)

$$\frac{55 \text{ mi} \mid 5280 \text{ ft} \mid 1 \text{ hr} \mid 1 \text{ min}}{1 \text{ hr} \mid 1 \text{ mi} \mid 60 \text{ min} \mid 60 \text{ s}} = 80.6667 \text{ ft per second}$$

(e)

$$\frac{1000 \text{ ft}^3 \mid 5 \text{ m} \mid 5 \text{ m} \mid 5 \text{ m}}{\mid\ 16.4042 \text{ ft} \mid 16.4042 \text{ ft} \mid 16.4042 \text{ ft}} = 28.3168 \text{ m}^3$$

Problem 2. (10pt) Tiffany's husband has to order a special paint she wants for their patio. The paint has to be shipped from Europe. He wants to be sure that he orders enough paint to paint the patio, which is 144 ft^2. Each can of paint costs €23 and claims it can cover 4.5 m^2.

(a) How many square feet can the paint cover? [3.28084 ft = 1 m]

(b) How many cans should he order?

(c) What is the cost of the paint in Euros per meter squared?

(d) What is the cost of the paint in USD per square foot? [\$1 = € 0.95]

Solution.

(a) We convert the 4.5 m^2 that the paint covers to square feet:

$$\frac{4.5\ \text{m}^2 \mid 3.28084\ \text{ft} \mid 3.28084\ \text{ft}}{\qquad\quad \mid 1\ \text{m} \mid 1\ \text{m}} = 48.4376\ \text{ft}^2$$

(b) Because each paint can covers 48.4376 ft^2, the minimum number of paint cans required is $144\ \text{ft}^2/48.4376\ \text{ft}^2 \approx 2.97$ cans of paint. However, one can only purchase integer values of paint. The only options are then 2 cans of paint or 3 cans of paint. Because 2 cans will not be enough, Tiffany's husband must purchase 3 cans of paint.

(c) The cost of the paint in Euros per meter squared is € $23/4.5\ \text{m}^2 \approx$ € $5.11/\ \text{m}^2$.

(d) We convert the € $5.11/\ \text{m}^2$ to USD per square foot:

$$\frac{€5.11 \mid \$1 \mid 1\ \text{m} \mid 1\ \text{m}}{1\ \text{m}^2 \mid €0.95 \mid 3.28084\ \text{ft} \mid 3.28084\ \text{ft}} = \$0.50/\text{ft}^2$$

Problem 3. (10pt) Aliens arrive on Earth and try to communicate with humans. Being intelligent beings, they first try to understand our mathematical systems. Aliens measure speed in blips per flarg. They claim to have traveled to Earth at 587 blips per flarg. We discover that in their units, 1 blips is 800 bloop and 465 bloop is 1,000 miles. We discover also 1 flarg is 8.2 s. What speed (in miles per second) did they travel to Earth? If the speed of light is 186,282 miles per second, what percent of the speed of light did they travel?

Solution. This is a traditional conversion problem, albeit with odd units:

$$\frac{587 \text{ blips}}{1 \text{ flarg}} \left| \frac{800 \text{ bloop}}{1 \text{ blips}} \right| \frac{1000 \text{ mi}}{465 \text{ bloop}} \left| \frac{1 \text{ flarg}}{8.2 \text{ s}} \right. = 123{,}158 \text{ miles per second}$$

Therefore, they traveled at...

$$\frac{123,158 \text{ miles per second}}{186,282 \text{ miles per second}} \cdot 100 = 0.661137 \cdot 100 = 66.1137\%$$

of the speed of light.

Problem 4. (10pt) You work at an international real estate company that helps people in the US purchase land in Japan. To help clients compare various options, you quote them the price that they are paying per square foot. Obviously, the prices in Japan are listed in Japanese Yen per square meter. If ¥ 1 is \$0.0069 and 1 m is 3.28084 ft, what number do you multiply the cost in yen per square meter to convert it to USD per square foot for your US clients?

Solution. If we know the cost of ¥ 1 /m^2 of property in USD per square foot, then we can simply multiply any given number of yen per square meter by this factor to find USD per square foot. So we compute this conversion:

$$\frac{¥\ 1}{1\ \text{m}^2} \left| \frac{\$0.0069}{¥\ 1} \right| \frac{1\ \text{m}}{3.28084\ \text{ft}} \left| \frac{1\ \text{m}}{3.28084\ \text{ft}} \right. = 0.000641\ \text{USD/ft}^2$$

Then the conversion factor is 0.000641. For instance, if a property costs ¥ 25840/m^2, then it costs ¥ 25840/$\text{m}^2 \cdot 0.000641 = \$16.57/\text{ft}^2$.

Problem 5. (10pt) One of your coworkers is commenting on how Karen just had her baby. She tells you that the baby was 19.5 in and 420 oz. If there are 16 oz in a pound, does this seem likely? Explain.

Solution. We can convert the weight of the baby from ounces to pounds:

$$\frac{420 \text{ oz} \mid 1 \text{ lb}}{\mid 16 \text{ oz}} = 26.25 \text{ lbs}$$

Considering that most children in the US are born between 5 lbs and 8 lbs and that the world record for birth weight is 22.5 lbs, it is highly unlikely that Karen's baby was 420 oz. It is far more likely that your coworker is misremembering the weight.

Problem 6. (10pt) Children with a certain respiratory issue are prescribed a daily dosage of 28 mg of a certain drug. Parents can refill the prescription up to three times. If each prescription contains 16 tablets and each tablet is 14 mg, how many daily doses can the parents give to their children?

Solution. Because each tablet is 14 mg and a daily dosage is 28 mg, one most take 2 pills to get a daily dose. That is, each pill is half a daily dose. There are 16 tablets per bottle, so that there are 8 daily doses per bottle. The patient has the original prescription plus an additional 3 bottles, for a total of 4 bottles. But then the parents can give their children a maximum of $4 \cdot 8 = 32$ daily doses.

One can also treat this as a conversion problem:

$$\frac{4 \text{ bottles} \mid 16 \text{ tablets} \mid 14 \text{ mg} \mid 1 \text{ daily dose}}{\quad \mid 1 \text{ bottle} \mid 1 \text{ tablet} \mid 28 \text{ mg}} = 32 \text{ daily doses}$$