Assignment 3

Math 1030

Due Friday, September 14th

Name: Solutions

1. **Fundamental vs. Derived Units**

   For the units below make a list of the fundamental units and a list of the derived units:

   { speed, acceleration, energy, length, time, volume }

   Solution

   Fundamental Units

   length
   time

   Derived Units

   speed
   acceleration
   energy
   volume

2. **Unit Conversions**

   Convert the following:

   (a) 1 kilometer into inches.

   Solution

   The appropriate conversion factor here is:

   2.54 cm = 1 in.

   Using this we can compute the solution:

$$1km\left(\frac{1000m}{1km}\right)\left(\frac{100cm}{1m}\right)\left(\frac{1in}{2.54cm}\right) \approx 39,370in$$

   (b) 10 gallons into liters.

   Solution

   If we look up the conversion factor the appropriate one here is:

   1 gallon = 3.785 liters

   So, our calculation is:

$$10gal\left(\frac{3.785L}{1gal}\right) = 37.85L$$

   (c) 65 miles per hour into meters per second.

   Solution

   The appropriate conversion factor here is:

   1.609 km = 1 mile

   And so our calculation is:

$$\left(\frac{65miles}{hour}\right)\left(\frac{1hour}{60min}\right)\left(\frac{1min}{60sec}\right)\left(\frac{1.609km}{1mile}\right)\left(\frac{1000m}{1km}\right) \approx 29.05\frac{m}{s}$$

3. **Mixing Potions**

Professor Snape asks you to create one snarfling of Bulbous Juice. You look up the recipe in your potions book, and you find that one snarblat of Bulbous Juice requires 2 mitgars of mare hair, and 3 goldblats of moondust, mixed in one snarblat of water, and cooked over an open flame for three tocks per snarblat. In muggle units of grams, and seconds, how much mare hair and moondust will you need, and for how long will you need to cook the potion?

You may find the following conversion factors useful:

1 snarfling = 2.3 liters

1 snarblat = .7 liters

1 mitgar = 4 grams

1 goldblat = 17 grams

1 tock = 13 minutes

Solution

Note - The problem initially asked for mare sweat and moonjuice, but those sound like liquid units, and I wanted to use solid units where mass measurements would make the most sense. So, I changed it to mare hair and moondust, which sound like solids.

Well... all the conversions you need are given above, it just might be a little hard to figure out how to use them. So, here's how the calculations would go:

Amount of mare hair required:

$$1 snarfling \left(\frac{2.3L}{snarfling}\right)\left(\frac{1snarblat}{.7L}\right)\left(\frac{2mitgars}{1snarblat}\right)\left(\frac{4g}{mitgar}\right) =$$

$26.3g$ of mare sweat

Amount of moondust required:

$$1 snarfling \left(\frac{2.3L}{snarfling}\right)\left(\frac{1 snarblat}{.7L}\right)\left(\frac{3 goldblats}{snarblat}\right)\left(\frac{17g}{goldblat}\right)$$
$$= 167.57g \text{ of moondust.}$$

Amount of time required to cook:

$$1 snarfling \left(\frac{2.3L}{snarfling}\right)\left(\frac{1 snarblat}{.7L}\right)\left(\frac{3 tocs}{snarblat}\right)\left(\frac{13 min}{tock}\right)\left(\frac{60s}{min}\right)$$
$$\approx 7,688 \text{ seconds to cook.}$$

4. **Compound Units Problem**

An empty water tank is in the shape of a sphere with a radius of 24 meters. Water flows into the tank at a rate of 18 cubic yards per second. How many minutes will it take until the tank is full?

1 meter = 1.094 yards.

Solutions

The total volume of the sphere is given by the formula for the volume of a sphere:

$$V = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi(24m)^3 = 57,905.8m^3.$$

Our rate is in terms of cubic yards, so we have to convert our volume to cubic yards:

$$57,905.8m^3 \left(\frac{1.094yards}{1m}\right)^3 = 75,818.3yards^3$$

Now, to calculate the amount of time it requires, we just divide the total volume we need to fill by the rate:

$$t = \frac{volume}{rate} = \frac{75,818.3yards^3}{\frac{18yards^3}{s}} = 4,212.13 \text{ seconds} \approx 70 \text{ minutes.}$$