

ASTR 105, Hints for Lab 1: Tools for Success

We have to do a little math, but don't freak out! If you don't understand something, just ask and I'll explain it.

1. Speed = Distance / Time

Q 1.1: The distance from LC to Albuquerque is 210 miles. If you drive 100 mph, how long will it take?

A: Re-arrange the above equation to get time = distance / speed:

$$\text{time} = \frac{\text{distance}}{\text{speed}} = \frac{210 \text{ miles}}{100 \text{ miles/hour}} = 2.1 \text{ hours}$$

We should change 0.1 hours to minutes so it sounds more normal.

$$0.1 \text{ hours} \times \frac{60 \text{ min}}{1 \text{ hour}} = 6 \text{ minutes} \rightarrow \text{Final answer : 2 hrs, 6 min}$$

2. Conversions

This is useful for converting one thing (in 'old' units) to another thing (in 'new' units). The first thing we need to do is figure out our conversion factor, or CF. This is a fraction where the top number equals the bottom number, but with different units:

$$\text{CF} = \text{Conversion Factor} = \frac{\text{some number of new units}}{\text{some number of old units}}$$

To convert, just take the number in 'old' units and multiply it by the CF to get the same value in 'new' units.

Q 2.1: The distance from BX to WH is 170 meters. How many km is this?

A: We know that 1km = 1000m. We'll use this to make our CF. 170m is what we want to convert, so we'll multiply 170m by our CF.

$$170\text{m} \times \frac{1\text{km}}{1000\text{m}} = 170 \times 1 / 1000 = 0.17\text{km}$$

(For units, we have $\text{km} \times \text{m} / \text{km}$. The old units (km) cancel out, and we're left with new units (m), which is what we want. If the old units don't cancel out, your CF is upside down!)

Q 2.2: How many gigameters (Gm) is it from BX to WH?

A: Now we want to convert 170m to Gm. 1 Gm = 1,000,000,000m, so we'll use that to make our CF.

$$170\text{m} \times \frac{1\text{Gm}}{1 \times 10^9\text{m}} = 170 \times 1 / 10^9 = 1.7 \times 10^{-7}\text{Gm}$$

Q 2.3: 1 inch is approximately 2.54cm. How many cm are in 1 foot?

A:

$$12 \text{ in} \times \frac{2.54 \text{ cm}}{1 \text{ in}} = 30.48 \text{ cm}$$

3. Scale Conversions

An example of a scale conversion is when you convert a distance on an image (like a map) to the actual distance.

Q 3.1: Look at the map in the lab (Fig 1.1). How many km is it (in a straight line) from Las Cruces to Socorro?

A: To get the CF, use a ruler to measure the length of the legend in the lower left corner. You should get ~3.7 cm. This tells us that 3.7 cm on the map = 140.8 km in actual distance.

Now that we have our CF, we need to figure out what we're converting. Use a ruler to measure the distance on the map between the two cities. You should get ~ 4.9 cm. So we want to convert 4.9 cm to an actual distance.

$$4.9\text{cm} \times \frac{140.8\text{km}}{3.7\text{cm}} = 186.5\text{km}$$

The actual distance between Las Cruces and Socorro is 186.5 km.

Q 3.2: If we scale the solar system to the size of a football field, the Sun would be at one end and Pluto would be at the other end (100 yards away). Pluto is actually 40 AU away. In our scaled solar system, how many yards is the Earth from the Sun?

A: The Earth is actually 1 AU from the Sun. We want to convert that to yards in our scaled solar system. To figure out our CF, we know that 40 AU (Pluto's real distance) = 100 yds (Pluto's scaled distance).

$$1\text{AU} \times \frac{100\text{yds}}{40\text{AU}} = 2.5\text{yds}$$

So Earth would be at the 2.5-yard line in our scale model.

Q 3.3: Let's assume you're 18 yrs old, and you've been in college for 7 days. If we compress your life into a 24-hr clock, at what time did you start college?

A: For this problem, 18 yrs is your real age, and 24 hrs is your scaled age. This will give us our CF. 7 days ago is when you started college. We want to convert 7 days (real time) to scaled time.

We'll get our CF from the fact that 18 (real) yrs = 24 (scaled) hrs. But the number we want to convert is in (real) days, not yrs. So let's re-write our conversion factor using the fact that there are ~ 365 (real) days in 1 (real) yr.

$$18\text{ yrs} \times \frac{365\text{ days}}{1\text{ yr}} = 6570\text{ days}$$

$$\text{old CF : } 18\text{ (real) yrs} = 24\text{ (scale) hrs}$$

$$\text{new CF : } 6570\text{ (real) days} = 24\text{ (scale) hrs}$$

Now that the number we want to convert (7 days) and our CF both have units of (real) days, we can do our conversion:

$$7\text{ (real) days} \times \frac{24\text{ (scale) hrs}}{6570\text{ (real) days}} = 0.00106544901\text{ (scale) hrs}$$

We're almost done. Let's put 0.00106544901 hrs in seconds instead of hours so it sounds more normal. We know that there are 60 seconds in 1 minute and 60 minutes in 1 hr.

$$0.00106544901\text{ hrs} \times \frac{60\text{ min}}{1\text{ hr}} \times \frac{60\text{ sec}}{1\text{ min}} = 3.84\text{ sec}$$

Cool. So what did we just do? We figured out how long ago we started college, assuming we compressed our 18-yr life into 24 hrs and we started college 7 days ago. So our final answer is that we started college 3.84 seconds before midnight (assuming a 24 hr day starts and ends at midnight). What time does that correspond to? 24 hrs is the same as 23 hrs, 59 min, 60 sec (because 60 sec = 1 min, and if we add that 1 min to 59 min, we get 1 hr, and if we add that 1 hr to 23 hrs, we get 24 hrs). So let's take 23 hrs, 59 min, 60 sec and subtract 3.84 sec.

$$23\text{ hrs, } 59\text{ min, } 60\text{ sec} - 0\text{ hrs, } 0\text{ min, } 3.84\text{ sec} = 23\text{ hrs, } 59\text{ min, } 56.16\text{ sec}$$

And now we're finally done! We started college at 23:59:56.16.