Name ___________________________

Student Page on Background Information

I. Metric Unit Review

This activity will remind you of how to convert metric units. In the table below, you see the basic organization of units. In the center is the base unit which depends on what you are measuring. For example, the base unit for length is the meter. The prefixes above the base unit are used for larger units, while those below are used for smaller units. The factor column tells you how much bigger or smaller a unit is compared to the base unit. For example, a dekameter is ten times as big as a meter, while a decimeter is one-tenth the size of a meter.

Prefix	Symbol	Factor	Exponent Form
Giga	G	1,000,000,000	10^9
Mega	M	1,000,000	10^6
Kilo	k	1,000	10^3
Hecto	h	100	10^2
Deka	da	10	10^1
	Base unit	**1**	
Deci	d	0.1	10^{-1}
Centi	c	0.01	10^{-2}
Milli	m	0.001	10^{-3}
Micro	μ	0.000001	10^{-6}
nano	N	0.000000001	10^{-9}

To convert from a unit to a larger unit, divide by how much bigger that unit is than your existing unit. This is easy for the base unit because the number is listed in the factor column. So, to convert from 1200 meters to kilometers, divide by 1000, and you get 1.2 km. You could also have moved the decimal place three places (once for each zero) to the left because that is the same as dividing by 1000. It is a little more challenging to convert from a prefixed unit to a larger prefixed unit, but it is possible. There are two ways you can accomplish this feat. First, you could convert it to the base unit and then to the desired prefix unit. Or, you can convert directly from one prefix unit to another. The exponent form column will help you determine what number to divide by. Let's use an example to illustrate this point.

Convert 180,000 hectometers (hm) to Megameters (Mm).

If we look at the exponent column, we see that hecto has the exponent form 10^2 while Mega has the exponent form 10^6. If you subtract the exponent for hecto from the exponent for Mega, you will get how much larger this unit is. So Mega is 10^4 larger than hecto. We could divide by 10000 (10^4 in long form) or move the decimal point 4 places to the left. Either way, you end up with 180,000 hm = 18 Mm.

To convert from a unit to a smaller unit, you need to multiply by how much larger the existing unit is than the unit you want to move to. Again, let's use an example to illustrate this point.

Convert 0.0015 decimeters (dm) to nanometers (Nm).

Looking at the exponents, we want to know how much larger a decimeter is compared to a nanometer.

So, you subtract 10^{-1} from 10^{-9}. Which can be written -1 – (-9). When you have two minuses in a row, it turns into a positive, which gives you -1 + 9 = 8. So a decimeter is 10^8 or 100,000,000 larger than a nanometer. This means you can multiply by 100,000,000 or move the decimal point 8 places to the right, which is the same as multiplying. Both methods give you an answer of 150,000 Nm.

Exercises

1. A wave has a wavelength of 0.000125 m. What is that in nanometers?	2. A signal is intercepted with a frequency of 2568 MHz. What is that value in hertz?	3. The textbook tells Danny that a wave has a wavelength of 12 X 10^3 nm. He wants to think about that in meters, a more familiar unit. What is that wavelength in meters? Using the diagram of the electromagnetic spectrum, which category does this wave belong?

4. Shannon records the wavelength for a wave as 2.5 Nm. Juan records the wavelength of a different wave as 2.5 mm. How much bigger is the wavelength for Jua's wave?	5. The wavelength for a wave is measured at 4567 Gigahertz. What is that in Megahertz?	6. Dominique records a wave frequency of 32 Megahertz. Sean records a frequency of 32 hectohertz. How much smaller is the frequency Sean recorded?

2. The Wave Equation

As you saw in the electromagnetic spectrum diagram, the wavelength and frequency of a wave determine the characteristics of a wave. Through the wave equation, we know that the speed of a wave is equal to the wavelength times the frequency.

$$v = \lambda \cdot f$$

Where v is the velocity or speed, measured in meters per second (m/s), λ is wavelength, measured in meters, and f is frequency, measured in inverse time (1/seconds).

Sometimes a scientist can measure some of the values but not the others, which means they must be able to manipulate the equation to find the missing values. Below are some practice problems. Please work with your partner to complete them.

The speed of electromagnetic (EM) radiation, including "light" and "radio" waves, is constant in any given medium. For our purposes, it is precise enough to state that the speed of EM radiation in space and Earth's atmosphere is 3.00×10^8 m/s. This constant value of the speed of light is given the symbol c.

$$c = 3.00 \times 10^8 \text{ m/s}$$

1) Researchers determined an electromagnetic wave had a wavelength (λ) of 4.87×10^{-7} m. What is its frequency?	2) The AM radio band extends from 5.4 X 10^5 to 1.7×10^6 Hz. What are the longest and shortest wavelengths in this frequency range?
3) FM radio stations in the United States broadcast in the "very high frequency" (VHF) portion of the radio spectrum between 88 and 108 MHz. If an FM station is broadcasting at 97.5 MHz, what is the wavelength of the EM radiation?	

4) Most modern microwave ovens operate at a frequency of 2.45 GHz. What is the wavelength of this radiation?
   a) in m? b) in cm?

5) The compound eyes of bees and other insects are highly sensitive to light in the ultraviolet portion of the spectrum, particularly light with frequencies between 7.5×10^{14} Hz and 1.0×10^{15} Hz. To what wavelengths do these frequencies correspond?

6) The brightest light detected from the star Antares has a frequency of about 3×10^{14} Hz. What is the wavelength of this light?

7) Why do astronomers observing distant galaxies talk about looking backward in time?

3. Video Questions

After watching this video (https://www.youtube.com/watch?v=QNY6DPZNZII) answer these questions.

1. How did they get the telescope into space?

2. How were wireless communications used in the deployment of the telescope?

3. What kind of energy does the telescope use for astronomy?