**Activity 5.3.5 Problems Using Logarithmic Scales**

**Helpful formulas:**

**pH = -log[H+]**

**M = log(I/I0)**

**, Assume or 10-16 watts/cm2 depending upon the units used in the problem.**

Section I

Numbers 4 – 6 can only be assigned if activity 5.3.3 was completed.

1. A magnitude scale for brightness started with a Greek astronomer Hipparchus and Ptolemy. They started with just 6 star magnitudes. But with the invention of the telescope the star magnitude scale has been extended in both directions. The scale may seem backwards to you for the brightest objects have the smaller numbers and the faintest the larger magnitudes. The Hubble Space Telescope can pick up faint galaxies as faint as magnitude 30. At is brightest, the planet Venus has a magnitude -4.6. The faintest star that can be seen with the eye is about magnitude +7.2 How much brighter is Venus than that faint star?
2. The magnitudes of two stars M1 and M2 are related to the corresponding brightness b1 and b2 by the equation M2 - M1  = 2.5 (log b2 - log b1). Each step by 1 unit in magnitude equals a brightness change of 2.5 times so a star with magnitude 5.0 is 2.5 times fainter than a star with magnitude +4.0. And if they differ by 5 magnitudes then 2.5 2.55 is almost 100 so the brightness is 100 times different. How much fainter than Venus is the faintest star from number 4 above?

Astronomers also must distinguish between apparent and the true brightness. Remember that distance has an impact on observed brightness because the intensity of the light from the source decreases by the inverse square law which you saw in investigation 4.1. You can always research measuring stellar magnitudes further.

1. Geographers are interested in areas ranging from the surface area of the earth down to a few square meters in a backyard. For their scale the 0 is the surface area of the earth Ga = 5.1 X 108 km2. Next they assign a 1 to 5.1 X 107 km2 obtained by Ga/101and a 2 to 5.1 X 106 km2 obtained by Ga/102 and so on to n which is assigned Ga / 10n . The numbers 1, 1, 2 ,n are called G-values. To find a G-value for an area Ra,  the formula G = log (Ga/Ra) is used.
   1. Find the G value for 100 km2.
   2. Suppose you know the G value of a square area is 7.7076. Find the square area.
2. Find the pH of the following substances:
   1. Pineapple juice, [H+] = 1.6 X 10-4
   2. Mouthwash, [H+] = 6.3 X 10-7

* 1. Tomatoes, [H+] = 6.3 X 10-5

1. Find the hydrogen ion concentration of each substance and express the answer in scientific notation
   1. pH of lemon juice is 2.3
   2. pH of stomach acid could be as large as 3.

1. If you make a small batch of lemonade and it needs 8 ounces (1 cup) of lemon juice , how many hydrogen ions will be in the juice? One mole of hydrogen atoms is 6.02 X 1023 hydrogen ions. A liter is 30.3 ounces.

Section II: Some practice.

Solve each equation.

1. 20*e*x-1 = 100
2. 3(6)x = 120
3. 2ln(3x) + ln(4x2) = 6
4. 4 + 2 log x = 10
5. log(log x) = 2
6. log x + log 4 = 20
7. 8 + log 10x = 20
8. log 6x3 – log 2x = 6