Astronomy homework sheet ***Practice With Mathematics!***

NAME: ______________________________

Express each of the following using scientific (powers of ten) notation:

1) 10,000,000 = __________________ 2) 24,500,000 = __________________

3) 0.0000001 = __________________ 4) 0.00002408 = __________________

5) Four hundred billion = ____________________________

6) Two million three hundred thousand = ____________________

Express each of the following *<u>without</u>* *scientific (powers of ten) notation*:

7) 10^8 = ________________________ 8) 3.579×10^7 = ________________________

9) 10^{-4} = ________________________ 10) 4.8023×10^{-8} = ______________________

Express each of the following in words (as in Questions 5 & 6 above):

11) 3×10^{10} = ____

12) 4.8×10^8 = _________________________________

As will be discussed in class soon, the energy E of a photon is related to the frequency f of the corresponding light wave by the following relation:

$$E = h \times f \qquad (\textit{ which is usually written } \; E = hf \;)$$

where $h = 6.6 \times 10^{-27}$ *Joule· sec* *is Planck's constant. Use this relation to answer questions 13 & 14.*

13) What is the energy of the photons corresponding to a wave frequency of 10^{15} Hz?

14) What is the frequency of the light wave that corresponds to a photon energy of 10^{-10} Joule?

(*OVER* →)

15) As will be discussed in class soon, the gravitational force F_g (measured in *Newtons, N*) between two objects with masses m_1 and m_2 (measured in *kilograms, kg*) that are a distance *r* apart from each other (measured in *meters, m*), is given by:

$$F_g = G\frac{m_1 m_2}{r^2}$$

where $G = 6.7\times10^{-11}\ N\cdot m^2/kg^2$ is the universal gravitational constant. This relation can be used to find the gravitational force between any two astronomical objects.

EXAMPLE: To find the gravitational force between the Earth and the Moon, all we need is the mass of each object and the distance *r* between them. Here they are:

$$m_{Earth} = 6.0\times10^{24}\ kg \qquad m_{Moon} = 7.3\times10^{22}\ kg \qquad r = 3.8\times10^{8}\ m$$

The gravitational force is then found by simply plugging these into the above equation:

$$F_g = G\frac{m_1 m_2}{r^2} = \left(6.7\times10^{-11}\ N\cdot m^2/kg^2\right)\frac{\left(6.0\times10^{24}\ kg\right)\left(7.3\times10^{22}\ kg\right)}{\left(3.8\times10^{8}\ m\right)^2}$$

$$= \frac{(6.7)(6.0)(7.3)}{(3.8)^2}\times\frac{10^{-11+24+22}}{\left(10^{8}\right)^2}\ \frac{N\cdot m^2\cdot kg\cdot kg}{kg^2\cdot m^2}$$

$$= 20.3\times\frac{10^{35}}{10^{16}}\ N$$

$$= 20.3\times10^{35-16}\ N$$

$$= 20.3\times10^{19}\ N$$

$$= 2.03\times10^{20}\ N$$

Of course, you can also just plug the numbers directly into a calculator if you know how to use your calculator's exponent options.

Now you try one! Find the gravitational force between the Earth and the Sun, given the mass of each and the distance *r* between them:

$$m_{Earth} = 6.0\times10^{24}\ kg \qquad m_{Sun} = 2.0\times10^{30}\ kg \qquad r = 1.5\times10^{11}\ m$$

Show at least some of your calculation here: