Name: Solutions Physics 1 - Miguel Rocha Date:_____

Homework 1: Conversion of Units

1. GN-z11 is the most distant galaxy we have observed, its distance from us is 9.8 Giga ***parsecs*** (Giga = 10^9). The ***parsec*** (symbol: ***pc***) is a unit of length used to measure large distances to astronomical objects outside the Solar System.

If 1 ***pc*** = 3.26 ***light years*** (***ly***), and 1 ***ly*** = 9.45×10^{15} ***m***.

a) How far is GN-z11 in ***ly***?

$$9.8\ \text{Gpc} = 9.8 \times 10^9\ \cancel{\text{pc}} \left(\frac{3.26\ \text{ly}}{1\ \cancel{\text{pc}}}\right) \simeq 32 \times 10^9\ \text{ly} = \boxed{3.2 \times 10^{10}\ \text{ly}}$$

b) How far is GN-z11 in ***km***?

$$3.2 \times 10^{10}\ \cancel{\text{ly}} \left(\frac{9.45 \times 10^{15}\ \cancel{\text{m}}}{1\ \cancel{\text{ly}}}\right) \left(\frac{1\ \text{km}}{1000\ \cancel{\text{m}}}\right) \simeq 30 \times 10^{22}\ \text{km} = \boxed{3 \times 10^{23}\ \text{km}}$$

2. The size of protons have been measured to be about 1 ***fm***. A ***femtometer*** (symbol: ***fm***) is 10^{-15} ***meters***. Compare the distance to GN-z11 (above) to the size of a proton. HINT: First convert the two measurements to the same units and then take the ratio between the two. I am looking for an answer telling me only the order of magnitude difference (powers of ten).

$$\frac{3 \times 10^{26}\ \cancel{\text{m}}}{10^{-15}\ \cancel{\text{m}}} = 3 \times 10^{26+15} = 3 \times \boxed{10^{41}}$$

3. You use about 3×10^8 ***kg (m/s)²*** of energy every day. How much is that in ***kWh*** (***kilowatt hour***)? HINT: look at the lecture slides for help but show the process to get to the answer.

$1\ \text{J} = 1\ \text{kg}\,(\text{m/s})^2$

$1\ \text{kWh} = 3.6 \times 10^6\ \text{J}$

$$3 \times 10^8\ \cancel{\text{kg}\,(\text{m/s})^2} \left(\frac{1\ \text{J}}{1\ \cancel{\text{kg}\,(\text{m/s})^2}}\right) \left(\frac{1\ \text{kWh}}{3.6 \times 10^6\ \cancel{\text{J}}}\right) = 0.83 \times 10^2\ \text{kWh} = \boxed{83\ \text{kWh}}$$