Problem 15

Use the orders of magnitude you found in the previous problem to answer the following questions to within an order of magnitude. (a) How many electrons would it take to equal the mass of a proton? (b) How many Earths would it take to equal the mass of the Sun? (c) How many Earth–Moon distances would it take to cover the distance from Earth to the Sun? (d) How many Moon atmospheres would it take to equal the mass of Earth's atmosphere? (e) How many moons would it take to equal the mass of Earth? (f) How many protons would it take to equal the mass of the Sun?

Solution

<u>Part (a)</u>

Divide the mass of a proton by the mass of an electron to get the number of electrons.

$$\# \text{ of Electrons} = \frac{\text{Mass of Proton}}{\text{Mass of Electron}} \approx \frac{10^{-27} \text{ kg}}{10^{-30} \text{ kg}} = 10^3$$

<u>Part (b)</u>

Divide the mass of the Sun by the mass of the Earth to get the number of Earths.

$$\# \text{ of Earths} = \frac{\text{Mass of Sun}}{\text{Mass of Earth}} \approx \frac{10^{30} \text{ kg}}{10^{25} \text{ kg}} = 10^5$$

<u>Part (c)</u>

Divide the Earth–Sun distance by the Earth–Moon distance to get the number of Earth–Moon distances.

$$\# \text{ of Earth–Moon distances} = \frac{\text{Earth–Sun distance}}{\text{Earth–Moon distance}} \approx \frac{10^{11} \text{ m}}{10^8 \text{ m}} = 10^3$$

<u>Part (d)</u>

Divide the mass of Earth's atmosphere by the mass of the Moon's atmosphere to get the number of Moon atmospheres.

$$\# \text{ of Moon Atmospheres} = \frac{\text{Mass of Earth's atmosphere}}{\text{Mass of Moon's atmosphere}} \approx \frac{10^{19} \text{ kg}}{10^4 \text{ kg}} = 10^{15}$$

<u>Part (e)</u>

Divide the mass of the Earth by the mass of the Moon to get the number of Moons.

$$\# \text{ of Moons} = \frac{\text{Mass of Earth}}{\text{Mass of Moon}} \approx \frac{10^{25} \text{ kg}}{10^{23} \text{ kg}} = 10^2$$

<u>Part (f)</u>

Divide the mass of the Sun by the mass of a proton to get the number of protons.

$$\# \text{ of protons} = \frac{\text{Mass of Sun}}{\text{Mass of proton}} \approx \frac{10^{30} \text{ kg}}{10^{-27} \text{ kg}} = 10^{57}$$