

Physics Department/Astronomy 201 NAME: _____

ASSIGNMENT1 : DISTANCE in the Universe

USE SCIENTIFIC NOTATION – problems are from your book.

1.

p.9 problem 1

hint: $1\text{km}=1,000\text{m}$ $1\text{m}=100\text{cm}$. (you can use google to find the conversions factor).

2.

p.9 problem 2

hint: solve the proportion

3.

p.9 problem 3

4.

p.9 problem 4

hint: $1\text{ AU} = 150\text{ million km} = 1.5\text{ E}8\text{km}$

5.

p.9 problem 5

hint: Find the distance Sun-Mars in AU (google). The distance Earth-Sun is 1AU. Then solve the proportion: $1\text{AU} = 8\text{ minutes}$ so ... is minutes.

6.

p.9 problem 6

hint: Use previous problems. so time is less by a factor of 400. convert minutes to second.

7.

p.9 problem 7

hint: $1\text{ year} = 3\text{ }10^7\text{ seconds}$. Find the distance covered by light in 1 year. Solve the proportion $E5$ is 1 second so is $3\text{ }10^7\text{ seconds}$.

8.

p.9 problem 8

9.

p.9 problem 9

hint: See INDEX CARD conversions

10.

How long it take a signal to reach Neptune from the Earth ?

Hint: Find in km the distance Earth-Neptune (google). Then you can use light takes 1 year to travel 10^{13} km . Convert to hours. (1 year = 365 days about = $365 \times 24\text{ hours}$)

11.

Kepler found a relationship between the mass of the Sun, the orbital period of a planet p (time for the planet to go around the Sun) and the average distance between the Sun and the planet noted a .

This is called Kepler third's law. $1 = a^3 / p^2$ or $a^3 = p^2$ or $a = p^{2/3}$ or $p = a^{3/2}$

p is the orbital period in Earth years, a the average distance in AU (astronomical unit)

Mars orbits the Sun every 1.88 years (p) . How far is Mars from the Sun in AU (hint; solve for a)?

12.

An asteroid's semi-major axis (average distance a from the Sun) is 3.5AU (a) . What is its period p ?
hint: see 11.

13.

Interestingly the mass of the Moon was found using an artificial satellite during mission Apollo. Kepler third's law was used * and the mass of the moon was found to be $M = 7.36 \cdot 10^{22} \text{ kg} = 7.36 \cdot 10^{25} \text{ g}$. The linear dimension of the moon was also known to be radius = $R = 1737.4 \text{ km} = 173,740,000 \text{ cm}$. Find the density of the moon. in g/cm^3 How it it compared to the density or rock on Earth ? (google density of basalt and granite)

hint: density = mass / volume = M/V and volume of a sphere = $4/3 \Pi R^3$. R in cm and M in grams.

*Kepler's third law can also be written as $GM/4\Pi^2 = a^3 / p^2$ where G is a constant, M the mass of the Moon, a the distance Moon - artificial satellite and p the time for the satellite to orbit)

14.extra credit

In Astronomy, we can find the mass of object if another object orbits it. It turns out that there is a relationship between the total mass of the 2 objects, the orbital period p (how long it takes for the object to orbit each other) and the average distance a between the objects. If one object is really massive, the relationship becomes:

Mass of object being orbited = (distance)³ / (period)² (Kepler third law)

or M (in solar mass) = a^3 / p^2

The mass is in solar mass unit. (so if the object orbited is the Sun, the mass=1). The distance a is in AU

The period p is in Earth years. $1 \text{ AU} = 1.5 \cdot 10^8 \text{ km}$ $1 \text{ year} = 365 \text{ days}$ $M_{\text{sun}} = 2 \cdot 10^{30} \text{ kg}$

Phobos, a moon of Mars, orbit Mars every 0.32 days at a distance of 9,400km.

What is the mass of Mars?

Hint: first convert days to years. (value of p). Then convert km to AU (value of a) and solve for M (in solar mass) . To find the mass of Phobos multiply my the mass of the Sun.