ASTRONOMY 195: OBSERVATIONAL ASTRONOMY

Homework #1: Due August 30, 2016

Problem 1. If the side, $y$, of the right triangle above is 12 cm long, and the angle, $\theta$ is $35^\circ$, what is the length of side $l$?

$$\tan \theta = \frac{y}{l} \rightarrow l = \frac{y}{\tan \theta} = \frac{12 \text{ cm}}{\tan(35^\circ)} = 17.14 \text{ cm}$$

Problem 2. On October 30, 2005 Mars was particularly close to Earth, subtending a (full) angle of 20.2 arcseconds. (To subtend an angle of 20.2 arcseconds, means that Mars is 20.2 arcseconds in angular size on the sky.) The diameter of Mars is 6796 km in diameter.

a) What is the angular extent of Mars in arcminutes?

$$20.2 \text{ arcseconds} \times \frac{1 \text{ arcminute}}{60 \text{ arcseconds}} = 0.337 \text{ arcminutes}$$

b) What is the angular extent of Mars in degrees?

$$20.2 \text{ arcseconds} \times \frac{1^\circ}{3600 \text{ arcseconds}} = 5.61 \times 10^{-3} \text{ degrees}$$

c) What is the angular extent of Mars in radians (recall that 1 radian = 57.3°)?

$$20.2 \text{ arcseconds} \times \frac{1^\circ}{3600 \text{ arcseconds}} \times \frac{\pi \text{ radians}}{180^\circ} = 9.79 \times 10^{-5} \text{ rad}$$

d) What was the distance to Mars on October 30, 2005 in km?

Approximate to a right triangle

$$\sin \theta = \frac{9}{18} \rightarrow d = \frac{l}{\sin \theta} = \frac{6796 \text{ km}}{\sin(5.61 \times 10^{-3} \text{ rad})} = 6.94 \times 10^6 \text{ m}$$

Problem 3. How many seconds are there in a year?

$$1 \text{ yr} \times \frac{365 \text{ days}}{1 \text{ yr}} \times \frac{24 \text{ hr}}{1 \text{ day}} \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{60 \text{ sec}}{1 \text{ min}} = 3.15 \times 10^7 \text{ sec}$$

a) How old are you (approximately) in seconds?

$$18\frac{1}{4} \text{ yrs} \times \frac{3.15 \times 10^7 \text{ sec}}{1 \text{ yr}} = 5.76 \times 10^8 \text{ sec}$$
b) If you live to be 100 years old, how many seconds will you have lived?

\[
100 \text{ yrs} \times \frac{3.15 \times 10^7 \text{ s}}{1 \text{ yr}} = 3.15 \times 10^9 \text{ s}
\]

**Problem 4.** Light travels at \(3 \times 10^5\) meters per second \((3 \times 10^5\) kilometers per second).

How far does light travel in a year? This distance is called a "light-year". (If you could not get problem 3, assume there are "X" seconds in a year, and outline the answer in terms of "X").

\[
\frac{3 \times 10^8 \text{ m}}{1 \text{ s}} \times \frac{3.15 \times 10^7 \text{ s}}{1 \text{ yr}} \times 1 \text{ yr} = 9.46 \times 10^{15} \text{ m}
\]

**Problem 5.** The sun is \(1.5 \times 10^8\) kilometers from the earth. How long does it take light to travel from the sun to the earth?

\[
\frac{1 \text{ yr}}{9.46 \times 10^5 \text{ m}} \times \left(1.5 \times 10^8\right) \text{ km} \times \frac{10^3 \text{ m}}{1 \text{ km}} = 1.58 \times 10^{-5} \text{ yr} \times 3.15 \times 10^7 \text{ s} \times 1 \text{ yr} = 4.97 \text{ years}
\]

**Problem 6.** The Voyager spacecraft travels at 16 kilometers per second. \(\alpha\) Centauri, the nearest star other than the sun, and is 4.3 light years away. How long will it take Voyager to get to \(\alpha\) Centauri? (If you did not get the answer to 4, assume a light year is "X" kilometers, and outline the answer in terms of "X")

\[
\frac{1 \text{ s}}{16 \text{ km}} \times 4.3 \text{ light yr} \times \frac{9.46 \times 10^{15} \text{ m}}{1 \text{ light yr}} \times \frac{1 \text{ km}}{10^3 \text{ m}} \times \frac{1 \text{ yr}}{3.15 \times 10^7 \text{ s}} = 80,710,32 \text{ yrs}
\]

**Problem 7.** *(Don’t use a calculator for either of these questions – you don’t need one!)*

a) The \(\log_{10} 2\) is 0.3. What is the \(\log_{10} 16\) \((=2^4)\)? Show your work.

\[
\log_{10} 16 = \log_{10} (2^4) = 4 \cdot \log_{10} 2 = 4(0.3) = 1.2
\]

b) What is the \(\log_{10} 1024\) \((=2^{10})\)? Again, show your work.

\[
\log_{10} 1024 = \log_{10} (2^{10}) = 10 \cdot \log_{10} 2 = 10(0.3) = 3
\]