ASTRONOMY 301
PROBLEM SET NUMBER 1
DUE IN CLASS
Friday, September 19, 2003

READ THESE INSTRUCTIONS. Turn in the your answers in class on the due date. In doing these problems it is not necessary to show your arithmetic on the answer sheet, but it is essential to present clearly the reasoning by which you achieved the solution. Problem 0 is a worked example to show how this may be done. You are encouraged to work together to figure out the method of solution, but you must write out the solutions independently in your own words. **Print your legal name on each page of your answer sheets and staple them together.** Do all five problems; each problem counts 1 point.

#0. What is the phase of the Moon when it rises at midnight?

Answer: In order to figure this out, I will make a drawing of the Earth, Moon and Sun. First, I'll draw the Earth and Sun with a horizon for the Sun-Earth when it is SUNRISE In order to tell the East horizon from the West, I've put a mark E at the East horizon:

```
Sun                     E-------- Earth ------
```

Remembering that the Earth rotates counterclockwise in our convention, a 90° rotation of Earth will represent NOON.

```
                           |
                           |
Sun                      Earth
                           |
                           |
                           E
```

Another 90° will represent SUNSET (not shown) and another 90°, midnight:

```
                           E
                           |
                           |
Sun                      Earth
                           |
                           |
```

If the Moon rises at midnight, it must be in the direction of the Eastern horizon then. Here is the configuration for the Moon rising at midnight.

```
                          Moon
                           E
                           |
                           |
Sun                      Earth
                           |
                           |
```

This configuration has the Moon at quarter Moon. Because it is the quarter Moon just before new Moon - one more rotation would bring us back to the beginning configuration, New Moon, it must be the last quarter, *i.e*., third quarter when it rises at midnight.

A shorter and also acceptable answer would be this:
When the Moon rises at Sunset, it is a Full Moon (it's opposite the Sun in the sky). Rising at midnight means it is half way from a Full Moon going to a New Moon. This must be the last quarter, *i.e*., third quarter rising at midnight.

#1. Express the following numbers in scientific notation:

-365.242
0.0314

#2. The speed of light is about 3×10^5 km/sec. What is this speed in meters/sec? What is it in centimeters/sec?

#3. As we will learn later, the closest star to the Earth is Proxima Centauri at a distance of 1.3 parsecs. At 1000 km/hr (the speed of a passenger jet), how long would it take to get there in years? (Remember that speed is distance divided by time. There are 3.15×10^7 seconds in a year.)

#4. If a planet always keeps the same side to the Sun, how many sidereal days are there in its year?

#5. Suppose two identical light sources, L1 and L2, are located L1 at 200 meters distant, L2 at 600 meters distant. What is the ratio of their apparent brightnesses?

ASTRONOMY 301
PROBLEM SET NUMBER 1
SOLUTIONS

#1 -365.242 shift the decimal two digits left, becomes -3.65242×10^2
0.0314 shift the decimal two digits right, becomes 3.14×10^{-2}

#2. The speed of light is 3×10^5 km/sec. To change 3×10^5 km/sec to m/sec we have to multiply by the number of m / km, which is 1000, i.e., 10^3. In multiplying the exponents add, so the speed of light is 3×10^8 m/sec. To convert this to cm / sec, we multiply by the number of cm/m, which is 100. The speed is then 3×10^{10} cm/sec.

#3. In order to do this problem, we must get all the quantities into the same units. Let's choose to convert parsecs into km. From the class notes we know that 1 parsec contains 206265 Astronomical Units. And, one AU contains 1.5×10^8 km. Multiplying 1.3 parsecs time the number of AU per parsec times the number of km per AU, gives 4.02×10^{13} km to Proxima Centauri. The distance is divided by the speed to get the time to traverse it. So we divide by 1000 km/hr. The result is 4.02×10^{10} hours. To convert this to years, we first convert it to seconds by multiplying twice by 60, i.e. 1.45×10^{14} seconds, then divide it by the number of seconds in a year: obtaining 4.60×10^6 years. To get to the nearest star (other than the Sun) at the speed of a jet plane would take almost 5 million years!

#4. If a planet keeps the same side to the Sun at all times, it must rotate once for each revolution. One rotation is a sidereal day and one revolution is a sidereal year. Thus there is one sidereal day in its sidereal year. The two are the same length.

#5. L1 is at 200 meters and L2 is at 600 meters distance. We are told that both emit the same amount of light. Therefore the more distant one will be fainter by the square of the distance. L2 is 3 times farther than L1 (600/200 = 3), so it will be 3 squared times fainter, i.e., L2 is 1/9 as bright as L1.