Observational Astronomy - Spring 2014
Homework 2 - Coordinates, Constellations, Magnitudes, Types of Object
Answer Sheet

1. What is the maximum and minimum declination of the Sun? When does the sun reach these points?

   - The Earth's axis of rotation is tilted by 23.5° with respect to the plane of the Earth's orbit. So the sun reaches a maximum declination of +23.5° and a minimum declination of −23.5°. It reaches the maximum declination on the summer solstice in the northern hemisphere on about June 21, and it reaches the minimum declination on the winter solstice in the northern hemisphere on about Dec. 21.

2. Estimate the transit time of the star Vega on June 1. Show your calculations. (Note: All transit times in this homework can be within ±15 minutes.)

   - Vega - RA = 18^h36^m
   - RA = 18^h transits at midnight on Jun 21.
   - Number of days between Jun 1 and Jun 21 = 20.
   - Transit time shift at 4 min/day = 4 * 20 = 80 min = 1^h20^m.
   - On Jun 1, RA = 18^h transits at $24^h + (1^h20^m)$ = 1:20 AM.
   - RA = 18^h36^m transits at $1^h20^m + 36^m = 1^h56^m$ = 1:56 AM.
   - Add 1 hour for daylight savings time to give 2:56 AM.
   - Stellarium gives 2:51 AM.

3. On February 15, 2014, Jupiter will be at the location RA = 6^h47^m, Dec = $+23°12'$. When will Jupiter transit on that date? What will be the hour angle of Jupiter at 7:00 PM on that date? Show your calculations.

   - Jupiter - RA = 6^h47^m
   - RA = 6^h transits at midnight on Dec 21.
   - Number of days between Feb 15 and Dec 21 = 10 + 31 + 15 = 56.
   - Transit time shift at 4 min/day = 4 * 56 = 224 min = 3^h44^m.
   - On Feb 15, RA = 6^h transits at $24^h - (3^h44^m)$ = 8:16 PM.
   - RA = 6^h47^m transits at $20^h16^m + 47^m = 21^h3^m$ = 9:03 PM.
   - Stellarium gives 9:04 PM.

- At 7:00 PM, 2^h3^m earlier, the hour angle of Jupiter will be -2^h3^m.

4. Comet 2014A4 (also called Comet SONEAR) has been reported to have the following ephemeris (an ephemeris is a list of coordinates vs time).
   Assume that you need the comet to be at least 20° above your southern horizon in order to see it above the trees, buildings, smog, etc. What is the first date in the table when it reaches this altitude? What is it's transit time on that date? Will you likely be able to see it from New York? (In fact this comet is quite faint, only about magnitude +17, so it would take a really big telescope to see it. But let's assume that you have a big enough telescope, and the brightness is not a problem).

Date	RA	Dec
Feb 1	RA = 5^h30^m	Dec = $-37°19'$
Mar 1	RA = 5^h10^m	Dec = $-32°49'$
Apr 1	RA = 5^h2^m	Dec = $-27°34'$
May 1	RA = 5^h5^m	Dec = $-22°50'$
Jun 1	RA = 5^h15^m	Dec = $-20°17'$

   - An object with declination equal to $-90° +$Latitude will just graze your southern horizon as it transits. In order to reach an altitude 20° above your southern horizon, it needs to have a declination 20° greater than this. Since our latitude is about 40°, we need the comet to have a declination greater than $-50° + 20° = -30°$. This first happens on Apr. 1. As to whether it would be visible, on Apr 1, it will transit at around 5:30 PM, which is still in daylight. So it will be nearly set by the time it gets dark, and will be very difficult to see.

5. Rigel has an apparent magnitude of +0.15, and is about 240 parsecs away. What is its absolute magnitude? How much more luminous than the Sun is it? Show your calculations.

   - Remember, apparent and absolute magnitude are related by $M = m + 5 - 5\log_{10}(D)$, so:
   - $M = 1.95 + 5 - 5\log_{10}(132) = -3.65$

   $$M = 0.15 + 5.0 - 5.0 \times \log_{10}(240) = 5.15 - 5.0 \times 2.38 = -6.75$$

   The luminosities are related by:

   $$\frac{L_{Rigel}}{L_{Sun}} = 10^{0.4(4.83-(-6.75))} = 10^{4.63} \approx 42000 \text{ times}$$

6. The Sun has an absolute magnitude of 4.83. If our descendants set up a colony at out nearest stellar neighbor, Alpha Centauri, which is 1.33 parsecs away, what apparent magnitude will they see the Sun to have? Will it be a naked eye object?

   - Remember, apparent and absolute magnitude are related by $m = M - 5 + 5\log_{10}(D)$, so:

   $$m = 4.83 - 5.0 + 5.0 \times \log_{10}(1.33) = 0.45$$

   This is an easy naked eye object, about as bright as the star Betelgeuse appears from Earth.

7. Look up the following objects and fill in the table.

Object	RA	Dec	Constellation	Type
Messier 13	$16^{\mathrm{h}}\ 41^{\mathrm{m}}$	$+36°27'$	Hercules	Globular Cluster
Messier 101	$14^{\mathrm{h}}\ 3^{\mathrm{m}}$	$+54°21'$	Ursa Major	Galaxy
Messier 45	$3^{\mathrm{h}}\ 47^{\mathrm{m}}$	$+20°7'$	Taurus	Open Cluster
Messier 42	$5^{\mathrm{h}}\ 35^{\mathrm{m}}$	$-5°23'$	Orion	Nebula
Messier 31	$0^{\mathrm{h}}\ 43^{\mathrm{m}}$	$+41°16'$	Andromeda	Galaxy