Observational Astronomy - Spring 2014
Midterm Exam

1. Assume New York has latitude 40°N.

   (a) (5 pts) What is the highest altitude that the Sun ever achieves in New York?

   (b) (5 pts) On what date does this occur?

2. (10 pts) Will the year 2100 be a leap year? Explain why or why not.

3. As you have seen in the labs, Jupiter is currently a prominent object in the night sky. According to the JPL Horizons ephemeris for today, March 10, 2014, Jupiter is currently at the following equatorial coordinates: RA = $6^{\mathrm{h}}44^{\mathrm{m}}43.4^{\mathrm{s}}$, Dec = $+23°17'19.0''$.

   (a) (5 pts) Convert these sexagesimal coordinates into decimal degrees for both RA and Dec.

(b) (5 pts) At about what time will Jupiter transit tonight? ± 5 minutes is close enough.

(c) (5 pts) What will be Jupiter's altitude and azimuth at the time of transit? $\pm 1^\circ$ is close enough.

(d) (5 pts) What will be Jupiter's Hour Angle at the time of transit?

4. While looking through your telescope, you discover a new comet. Observations show that this comet has an elliptical orbit with a perihelion distance of 0.1AU and an aphelion distance of 9.9 AU.

   (a) (5pts) What is the semi-major axis a of the orbit in AU?

   (b) (5 pts) What is the eccentricity of the orbit e?

(c) (5 pts) What is the comet's orbital period T in years?

5. A Type 1A supernova (a type of exploding star) was recently discovered in the nearby galaxy Messier 82. This galaxy is at a distance of 3.5 Mpc (3.5 million parsecs). This supernova is the closest such object to be discovered since 1972, so it has caused a lot of excitement among astronomers. It has reached a peak apparent magnitude m = +10.5.

   (a) (5 pts) Calculate its absolute magnitude M.

   (b) (5 pts) The Sun has an absolute magnitude of +4.83. How much brighter is this object than the Sun?

6. The James Webb space telescope will be the successor to the Hubble space telescope, and is expected to launch in 2018. It will have an aperture D = 6.5 meters, so it is several times bigger than the Hubble.

   (a) (5 pts) At a wavelength $\lambda = 1.0\,\mu$m (1 millionth of a meter), what will be its angular resolution in seconds of arc?

(b) (5 pts) Jupiter has a large storm called the Great Red Spot, which is about 10,000 km across. Suppose Jupiter is at a distance of 5.0 AU. What is the angular size of Jupiter's Great Red Spot in seconds of arc?

(c) (5 pts) Will the James Webb telescope be able to resolve the Great Red Spot?

7. (5 pts) During the course of a year, the Sun follows a specific path relative to the fixed stars. What do we call this path?

8. (5 pts) What part of the sky is not within any constellation?

9. (10 pts) There are two "windows" in the electromagnetic spectrum, where the atmosphere is transparent so we can observe the universe with ground-based telescopes. What are these two windows?

1 Important Formulae

- Angular size of an object of size R at distance d (small-angle approximation): $\theta = \frac{\mathrm{R}}{\mathrm{d}}$
- Angular resolution of a telescope of aperture D in wavelength λ: $\theta = 1.22\frac{\lambda}{\mathrm{D}}$
- Relation between apparent magnitude m and absolute magnitude M of an object at distance D in parsecs: $\mathrm{M} = \mathrm{m} + 5 - 5\log_{10}(\mathrm{D})$
- Relation between absolute magnitude M and Luminosity L of two objects: $\frac{\mathrm{L_{obj}}}{\mathrm{L_{ref}}} = 10^{0.4(\mathrm{M_{ref}} - \mathrm{M_{obj}})}$
- Relation between Hour Angle-HA, Right Ascension-RA and Local Sidereal Time-LST: HA = LST - RA
- $360^\circ = 2\pi$ radians
- $1^\circ = 60' = 3600''$
- Kepler's third law: $\mathrm{a}^3 \propto \mathrm{T}^2$
- Perihelion distance: $\mathrm{R_P} = \mathrm{a}(1 - \mathrm{e})$.
- Aphelion distance: $\mathrm{R_A} = \mathrm{a}(1 + \mathrm{e})$.
- 1 AU $= 1.50 \times 10^{11}$ m.
- 1 pc $= 3.08 \times 10^{16}$ m.