PC3246 Astrophysics I

Tutorial 2 (for revision only)

1. Explain how observing an inferior planet at greatest elongation can be used to determine the planet's relative distance (i.e. the distance of the planet from the Sun relative to Earth's distance from the Sun).

2. Consider a superior planet. State the relationship among its synodic period, sidereal period, and Earth's sidereal period. Explain the derivation of the relationship.

3. Problem Set 1, Question 8

4. Problem Set 2, Question 4

   Hint: Let R_1 and R_2 be the radii of curvature of the converging lens and $-R_2$ and R_3 be the radii the curvature of the diverging lens. Consider three wavelengths, λ_r, λ_b, and λ_g. For λ_r and λ_b, find the relationship among R_1, R_2, and R_3 such that $f_{\text{eff},r} = f_{\text{eff},b}$. Show that for the same relationship among R_1, R_2, and R_3, $f_{\text{eff},r} \neq f_{\text{eff},g}$ in general.

5. Plate scale
   a. State the definition of the plate scale.
   b. State the relationship between the plate scale and the focal length. Explain the derivation of the relationship.

6. Illuminance and focal ratio
   a. State the definition of the illuminance.
   b. State the relationship among the illuminance and a lens' parameter(s). Explain the relationship.
   c. State the relationship among the focal ratio and a lens' parameter(s). A lens with a large focal ratio is said to be long or slow. Explain why.

Assignment 2 (for submission)

1. Consider the planet Mars. Calculate its relative distance by using the following observational data. Do not use Kepler's laws of planetary motion and Newton's law of universal gravitation (assume that they have yet to be discovered).

   Hint: Consider the reference frame in which the Sun and Earth are not moving. Find the angle subtended at the Sun by two of the phenomena. Use trigonometry to calculate Mars' relative distance.

Date	Phenomenon
2023-11-18	Conjunction
2024-10-14	Western quadrature
2025-01-16	Opposition
2025-04-21	Eastern quadrature

   Reference: https://eco.mtk.nao.ac.jp/cgi-bin/koyomi/cande/phenomena_en.cgi

2. Consider an observer at the latitude of 40° N and a star at the azimuth $A = 0°$ and altitude $h = 10°$. Find the star's A and h when it transits the upper meridian.

3. Consider an observer at the equator and a star at $A = 90°$ and $h = 0°$ at 8pm. Find the star's A and h at 8pm after 4 months.

4. Consider an observer at the latitude of 20° N and a star at $A = 180°$ and $h = 60°$. If the vernal equinox is at its meridian two hours later, what are the declination and right ascension of the star?

5. Consider an observer at the equator and a star at $A = 70°$ and $h = 0°$. Calculate the star's A and h after 1 hour.

   Hint: Assume that after 1 hour, the star is at point A. Draw a great circle passing through the zenith and point A. Let B be the point where the great circle intersects the horizon. Let the north celestial pole be point C. Consider the spherical triangle ABC. Assume that the radius of the celestial sphere is 1 unit. Hence, the lengths of side c and side a correspond to the altitude and azimuth of the star, respectively.

   a) What is the angle B?
   b) What is the angle C?
   c) What is the length of side b?
   d) By using a law of spherical trigonometry, calculate the length of side c.
   e) By using a law of spherical trigonometry, calculate the length of side a.