ASTR120
Homework 1 −Solutions

Ch. 1, Prob. 20.
The diameter of the Sun is given as 1.4×10^{11} cm, and its distance to Proxima Centauri is 4.2 ly. If we were to model the Sun using a 30 cm ball we can find the scaled distance to Proxima Centauri by cross multiplying. This method works for this case because it's a fixed scale.

$$\frac{1.4 \times 10^{11}\ \text{cm}}{30\ \text{cm}} = \frac{4.2\ \text{ly}}{x}$$

Solving for x:

$$x = \frac{4.2\ \text{ly} * 30\ \text{cm}}{1.4 \times 10^{11}\ \text{cm}} = \frac{126\ \text{ly}}{1.4 \times 10^{11}} = 9.0 \times 10^{-10}\ \text{ly}$$

$$= 9.0 \times 10^{-10}\ \frac{\text{ly}}{1} \times \frac{9.46 \times 10^{12}\ \text{km}}{\text{ly}} = 8.4 \times 10^{3}\ \text{km}$$

Ch. 1, Prob. 25.
For this problem, we want to use the distance = speed x time relation. We know the speed of light and the distance to the Sun, so we can solve for the time it takes light to get from the Sun to the Earth.

$$\text{distance} = \text{speed} \times \text{time}$$

$$\text{time} = \frac{\text{distance}}{\text{speed}} = \frac{1\ \text{AU}}{c}$$

$$= \frac{1.49 \times 10^{11}\ \text{m}}{3.0 \times 10^{8}\ \text{m/s}} = 4.97 \times 10^{2}\ \text{s} = 8.3\ \text{min.}$$

Ch. 2, Prob. 39.
For this problem we want to look at Figure 2 - 18 and see the circle the North Pole traces out over time due to the Earth's precession. In 2600 B.C., the star closest to that circle is Thuban and currently, in 2005 A.D., the star closest to that circle is Polaris.

Ch. 2, Prob. 43.
Since the two stars have declinations of 0°, we don't have to worry about difference in the angle due to the curvature of the celestial sphere. To find the angle between the two stars, we need to first find the hour angle difference. Between these two stars, the hour difference in RA is:

$$11^h\, 20^m\, 0^s - 8^h\, 0^m\, 0^s = 3^h\, 20^m = 3.33^h$$

We know from the rotation of the Earth, 24 hours covers 360°. Therefore, 1 hour in the sky represents 15°. Using this relation, the angle between the two stars is:

$$\frac{360°}{24^h} = \frac{x}{3.33^h}$$

Solving for x, we get:

$$x = \frac{360 \times 3.33}{24} = 50°$$

Ch. 3, Prob. 27. Note that the book's solution to this problem is wrong.
a) The key to this problem are the words "against the background of stars". This implies that the period we want to use to solve this problem is the *sidereal* period of the Moon. The Moon moves one complete circle around the Earth in about 28 days. So to answer this question, we need to find the time it takes the Moon to move 0.5° on its circle at the rate of 360° in 28 days.

$$\frac{360°}{28\ \text{days}} = \frac{0.5°}{x}$$

Solving for x :

$$x = \frac{0.5 \times 28}{360} = 0.039 \text{ days}$$

$$= 0.039 \frac{\text{days}}{1} \times \frac{24 \text{ hr}}{\text{day}} = 0.93 \text{ hr}$$

b) Knowing that it takes the Moon 0.93 hr to move 0.5 °, it is now simple to find how far it moves in 12 hours.

$$\frac{0.5°}{0.93 \text{ hr}} = \frac{x}{12 \text{ hr}}$$

Solving for x :

$$x = \frac{0.5 \times 12}{0.93} = 6.5°$$

Ch. 3, Prob. 32.
Since it takes the Moon 29.5 days (its synodic period) to complete one cycle of phases, any month with less than 30 days cannot have a blue moon. This is because in order to have 2 full moons, you need 29.5 days in the month. Therefore, February cannot have blue moons.

Ch. 4, Prob. 20.
The equation you need for this problem is Newton's Second Law : F = ma.

The amount of force exerted on a 3 - kg brick with an acceleration of 2 m / s / s is :

$$F = m a$$
$$= 3 * 2$$
$$= 6 \text{ N}$$

If we double the amount of force to 12 N, the acceleration of the same brick would be :

$$12 = m a$$
$$a = 12 / m$$
$$a = 12 / 3$$
$$a = 4 \text{ m / s / s}$$

Ch. 4, Prob. 31.
Mercury : Your diagram should look exactly like the one in box 4 - 1. In this case, the inferior planet is Mercury. You can tell from the diagram that because Earth moves much slower than Mercury, the time it takes from conjunction to conjunction requires Mercury to make more than 1 lap around the Sun. Therefore, its synodic period -- time between conjunctions -- is greater than its sidereal period (time it takes to go 360 ° around the Sun).

Jupiter : Your diagram should look something like the one in box 4 - 1. In this case, the Earth's orbit is the inferior planet orbit and Jupiter's oribit replaces that of the Earth. From this diagram, you can tell that from conjunction to conjuction, Jupiter -- the outer planet -- makes less than 1 lap around the Sun. Therefore, its synodic period is less than its sidereal period.

Extra Credit :
Unless your birthday is the same day as the due date, the sunset and sunrise times should not match. This is because the ecliptic is tilted with respect to the Earth's equator. This means that over the year, the altitude of the Sun changes. This causes the length of day to vary over the year. Thus, the sunset and sunrise times do not match.