Astronomy

HOMEWORK Chapter 1 9th ed

5. In Figure 1-8, what is another name for the "Sun's annual path?"

Ecliptic. A very different word from "elliptic."

10. By about how many degrees does the Sun move along the ecliptic each day?

about 1 degree.

12. Through how many constellations does the Sun move every year?

Thirteen zodiac constellations. The twelve traditional ones, plus the Serpent-Bearer Ophiuchus.

14. What are the vernal and autumnal equinoxes? What are the summer and winter solstices? How are these four events related to the ecliptic and the celestial equator?

The vernal and autumnal equinoxes are the points on the sky where the Ecliptic intersects the Celestial Equator. The summer and winter solstices are the points on the sky on the ecliptic where the sun is farthest north and south of the celestial equator respectively. The Gregorian calendar's rules for leap years are set to keep the calendar aligned to these events. For example, the vernal equinox, when the sun crosses the celestial equator northbound, is the first day of spring. The date on which this occurs stays very close to March 21.

25. How is an annular eclipse of the Sun different from a total eclipse? What causes this difference?

An annular eclipse occurs when the moon is directly in front of the sun, but appears too small to completely cover it, leaving a "ring of fire" around it. A total eclipse is when the moon does completely cover the sun. The most important factor is the 5% variation in the distance to the moon, which leads to an equal variation in its angular size. The 1.7% variation in the earth-sun distance is another factor. Sometimes, even the variation in distance from the moon to different parts of the earth enters, in which case the eclipse is annular-total, or total-annular. The word "annular" is very different from annual.

27. At what phase(s) of the moon does a solar eclipse occur? A lunar eclipse?

A solar eclipse occurs only at new moon, and a lunar eclipse only at full moon.

30. During what phase(s) does the the Moon rise after sunrise but before sunset? After sunset but before sunrise? At sunset? At sunrise?

If the Moon rises during daylight hours, it is as a waxing crescent, first quarter, or waxing gibbous phase. If it rises during night hours, it is as a waning crescent, last quarter, or waning gibbous phase. A full Moon rises at sunset. A new Moon rises at sunrise, but can't be seen except with special instruments.

31. *Why can't a person in Australia use the Big Dipper to find north?*
The North Star is not visible from Australia, or anywhere else south of the Equator. Only some parts of the Big Dipper are visible from Australia; how much depends on where in Australia.

33. At what places on Earth is Polaris seen on the horizon?

Polaris will be on the horizon for observers on the Equator. Remember: which way is up, which way is down, and which ways are horizontal.

34. Where do you have to be on Earth to see the Sun at your zenith? If you stay at one such location for a full year, on how many days will the Sun pass through your zenith?
For the Sun to be at your zenith, you need to be between 23.5° North Latitude (Tropic of Cancer) and 23.5° South Latitude (Tropic of Capricorn). The Sun will be at Zenith two days of the year, except at the extreme limits, when it will be one day per year: June 21 for Tropic of Cancer, Dec 21 for Tropic of Capricorn. For example, at the Equator, the Sun will be at zenith on the equinoxes, Mar 21 and Sep 22.

36. Where on the horizon does the Sun rise at the time of the vernal equinox? [I.e., Northeast, southeast, etc.]

Precisely east. It rises slightly south of east the day before, and slightly north of east the day after.

41. What is the phase of the Moon if it: **a.** rises at 3 AM? **b.** sets at 9 PM? At what time does: **c.** the Full Moon set? **d.** The first quarter Moon rise?

(a) Waning Crescent; (b) Waxing Crescent; (c) sunrise (6 AM); (d) Noon.

42. What is the phase of the Moon if, on the first day of spring, the Moon is located: a. on the vernal equinox; b. on the summer solstice; c. on the autumnal equinox; d. on the winter solstice?

On the first day of spring, the Sun is by definition at the vernal equinox. The Sun moves eastward *relative to the stars* from one day or week to the next. This is right-to-left when you look up at the sky. So:
a) Moon at Vernal Equinox means: it aligns with Sun, so this is a new Moon;
b) The summer solstice is 90° east of the vernal equinox, so the Moon is high in the southern sky at sunset, so first quarter;
c) full Moon
d) last quarter

53. Assuming the Sun makes an angle of 1/2° in the sky, and is at a distance of 1.496×10^{11} m, what is the Sun's diameter? This formula might be easier than the one in the text:

Physical Diameter = (Distance) × (Angle in Degrees)/57.3

Phys. Dia. $= (1.496 \times 10^{11}\text{ m})(0.5)/57.3 = 1.305 \times 10^{9}$ m.

Hence, radius is half of the diameter, or 6.502×10^{8} m. This is off a bit because the "1/2" is only a rough approximation.

62. What if the Earth's axis of rotation were at a different angle? What would the seasons be like if where you are now if the axis of rotation were tilted **a.** 0°; and **b.** 45° to its orbital plane? What would be different about the seasons and the day-night cycle if you lived at one of Earth's poles in these two situations? What would be different about living in San Diego?

With zero tilt, The sun would pass directly overhead every day of the year on the equator, so the tropics would be even hotter. The poles would always have the sun on the horizon, so would be colder. In San Diego, the sun would reach the same maximum elevation every day.
With a tilt of 45°, seasons would be more extreme. The tropics would have the sun directly overhead on the equinoxes (as it is now), but would have it only 45° above the horizon on the solstices (versus 67.5° as it is now), so they would have more variation and be overall cooler. The poles would still have six months of darkness and six of daylight, but the sun would be higher in the sky during the daylight, so the polar regions would be on average warmer. San Diego would have the sun pass directly overhead twice per year (probably in May and August) and would have the sun at astronomical noon be high in the sky *to the north* between these times. Essentially, the latitude of 45° N (e.g., Portland, Oregon) would be the Tropic of Cancer. The Arctic Circle would also move south to 45° N. Seattle, for example, would be inside the new Arctic Circle, and would experience a period of continuous sunlight in June, and a period of complete darkness in December.