Note: All Problems are from *The Cosmic Perspective* (6ed)

**Chapter 1**

**Review Problems**

2. Briefly describe the major levels of structure (such as planet, star, galaxy) in the universe.

Answer:

The largest scale is the universe itself, which is the sum total of all matter and energy. The largest-known organized structures are superclusters of galaxies, then clusters and groups of galaxies, and then the roughly 100 billion individual galaxies, most of which are many thousands of light-years across. Each galaxy contains billions of stars, and many or most stars may be orbited by planets.

4. What did Carl Sagan mean when he said that we are “star stuff”?

Answer:

Nearly every atom from which we are made once (before the solar system formed) was inside of a star.

5. How fast does light travel? What is a light-year?

Answer:

The speed of light is about $3 \times 10^5 \text{ km/s}$. A light-year is the **distance** which light travel in one year.

6. Explain the statement *The farther away we look in distance, the further back we look in time*.

Answer:

Let’s assume that star A is ten light years away from the Earth. Since light can travel a fixed distance in a year, when we observe Star A in the night sky, we see the star as it was ten years ago.

Similarly, the further away a star is, the longer the light has to travel to reach us. Therefore it is said, “the farther away we look in distance, the further back we look in time.”

8. Describe the solar system as it looks on the 1-to-10-billion scale used in the text. How far away are other stars on this same scale?

Answer:

The nearest star, Alpha Centauri, is about 4.4 light years away

$$4.4 \text{ light years} \times \frac{9.5 \times 10^{12} \text{ km}}{1 \text{ light year}} \times \frac{1}{10^{16}} = 4180 \text{ km}$$

11. Define astronomical unit, ecliptic plane, and axis tilt. Explain how each is related to Earth’s rotation and/or orbit.
Answer:

Astronomical unit is the average distance between the Earth and the Sun. Ecliptic plane is a plane on which Earth’s orbit lies. Axis tilt is the angle between an object’s rotational axis and its orbital axis. The axis tilt of the Earth is about 23.5 degree.

Quick Quiz

Choose the best answer to each of the following. Explain your reasoning with one or more complete sentences.

30. If we represented the solar system on a scale that allowed us to walk from the Sun to Pluto in a few minutes, then (a) the planets would be the size of basketballs and the nearest stars would be a few miles away. (b) the planets would all be marble-size or smaller and the nearest stars would be thousands of miles away. (c) the planets would be microscopic and the stars would be light-years away.

Answer:

(b) The average human walking speed is 5.0 km/hr. Pluto’s distance from the Sun is 5.9 billion km. If we can walk from the Sun to Pluto in a few minutes, the scale is about 1 to billion. On this scale, each planet is about the size of a marble or smaller and the nearest stars are about thousands of miles away.

Chapter 2

Review Problems

4. Why does the local sky look like a dome? Define horizon, zenith, and meridian. How do we describe the location of an object in the local sky?

Answer:

Since the view of the bottom half of the sky is blocked from us by the ground, the local sky look like a dome. Horizon is the line at which the Earth’s surface and the sky appears to meet. Zenith is the point directly above an observer. Meridian is the shortest line between two poles that passes through zenith.

5. Explain why we can measure only angular sizes and angular distances for objects in the sky. What are arcminutes and arc-seconds?

Answer:

We can measure only angular size or angular distance on the sky because we lack a simple way to measure distance to objects just by looking at them. It is therefore usually impossible to tell if we are looking at a smaller object that’s near us or a more distant object that’s much larger.

Arcminutes and arcseconds are subdivisions of degrees. There are 60 arcminutes in 1 degree, and there are 60 arcseconds in 1 arcminute.

7. What are latitude and longitude? Does the local sky vary with latitude? Does it vary with longitude? Explain.

Answer:

Latitude measures angular distance north or south of Earth’s equator. Longitude measures angular distance east or west of the Prime Meridian, the meridian in Greenwich, England. The night sky changes with latitude, because it changes the portion of the celestial sphere that can be above your horizon at any time.
The sky does not change with changing longitude, however, because as Earth rotates, all points on the same latitude line will come under the same set of stars, regardless of their longitude.

8. What is the zodiac, and why do we see different parts of it at different times of year?

Answer:

The zodiac is the set of constellations in which the Sun can be found at some point during the year. We see different parts of the zodiac at different times of the year because the Sun is always somewhere in the zodiac and so we cannot see that constellation at night at that time of the year.

15. What do we mean by the apparent retrograde motion of the planets? Why was it difficult for ancient astronomers to explain but is easy for us to explain? How do we explain it today?

Answer:

The apparent retrograde motion of the planets refers to the planets' behaviors when they sometimes stop moving eastward relative to the stars and move westward for a few weeks or months. For ancient people who believed in an Earth-centered universe, apparent retrograde motion was very difficult to explain. The Sun-centered model makes this motion a natural consequence of the fact that the different planets move at different speeds as they go around the Sun. We see the planets appear to move backward because we are overtaking them in our orbit (if they orbit farther from the Sun than Earth) or they are overtaking us (if they orbit closer to the Sun than Earth).

Test Your Understanding

Decide whether the statement makes sense (or is clearly true) or does not make sense (or is clearly false). Explain clearly; not all of these have definitive answers, so your explanation is more important than your chosen answer.

19. Last night the Moon was so big that it stretched for a mile across the sky.

Answer:

The statement doesn’t make sense. The angular diameter of the full moon is only about 31 arcmin.

23. Although all the known stars appear to rise in the east and set in the west, we might someday discover a star that will appear to rise in the west and set in the east.

Answer:

This statement does not make sense. The stars aren’t really moving around us; they only appear to rise in the east and set in the west because Earth rotates.

Quick Quiz

Choose the best answer to each of the following. Explain your reasoning with one or more complete sentences.

30. In winter, Earth’s axis points toward the star Polaris. In spring, (a) the axis also points toward Polaris. (b) the axis points toward Vega. (c) the axis points toward the Sun.

Answer:

(a) Earth’s axis always points toward Polaris.
34. The fact that we always see the same face of the Moon tells us that (a) the Moon does not rotate. (b) the Moon’s rotation period is the same as its orbital period. (c) the Moon looks the same on both sides.

Answer:

(b) Some of the rotational energy of the Earth transfers to the Moon by the gravitational interaction. The outcome is that the rotation of the Moon has been slowed down to match its orbital period.

36. When we see Saturn going through a period of apparent retrograde motion, it means (a) Saturn is temporarily moving backward in its orbit of the Sun. (b) Earth is passing Saturn in its orbit, with both planets on the same side of the Sun. (c) Saturn and Earth must be on opposite sides of the Sun.

Answer:

(b) Please refer to the answer to chapter 2 problem 15.

Chapter S1

Review Problems

3. What do we mean by opposition, conjunction, and greatest elongation for planets? Explain both for planets farther than Earth from the Sun.

Answer:

Opposition is the point at which a planet appears opposite of the Sun. Conjunction is an event in which a planet and the Sun line up in our sky. Only planets closer than the Earth has greatest elongation i.e. only Mercury and Venus. It is the point at which those inner planet appear farthest from the Sun in our sky.

4. Under what circumstances do we see a transit of a planet across the Sun?

Answer:

When Mercury or Venus pass directly across the Sun in the sky, the event is called transit. Because orbits of Mercury or Venus are tilted compared with Earth’s orbit, the planet usually appears above or below the sun. Transit happens only at rare occasion when Earth’s orbit and Mercury or Venus’ orbits align.

5. What is apparent solar time? Why is it different from mean solar time? How are standard time, daylight saving time, and universal time related to mean solar time?

Answer:

Apparent solar time is measured by the actual position of the Sun in your local sky, defined so that noon is when the Sun is on the meridian. On the other hand, mean solar time is measured by the average position of the Sun in your local sky over the course of the year. Because apparent solar time and mean solar time applies only locally, people have developed standard time which is measured according to the internationally recognized time zones. Universal time is the standard time in Greenwich, England.

Daylight saving time is standard time plus 1 hour, so that the Sun appears on the meridian around 1 p.m. rather than around noon.

11. Describe the Sun’s path through the local sky on the equinoxes and on the solstices for latitude 40 °N. Do the same for the North Pole, South Pole, and equator.
5

Answer:

At 40° N latitude, the Sun will rise due east and set due west on the equinoxes. On these days it will cross the meridian at altitude 50° due south. On the summer solstice, the Sun will rise north of due east, cross the meridian at altitude 73.5° due south, and set north of due west. On the winter solstice, the Sun rises south of due east, crosses the meridian at altitude 26.5° due south, and sets south of due west. At the equator on the equinoxes, the Sun will rise due east, pass directly overhead, and set due west. On the summer solstice, the Sun will rise north of due east, cross the meridian at altitude 66.5° to the north and set north of due west. On the winter solstice, the mirror image will occur: The Sun will rise south of due east, cross the meridian at 66.5° altitude to the south, and set south of due west. At the North Pole on the equinoxes, the Sun will skim the horizon, making a circle all around the horizon each day. On the summer solstice the Sun will circle 23.5° above the horizon all day. On the winter solstice, we would not see the Sun at all. At the South Pole on the equinoxes, the Sun will skim the horizon, making a circle all around the horizon each day. On the summer solstice, the Sun would not appear at all. On the winter solstice, the Sun will circle 23.5° above the horizon all day.

13. What is special about the tropics of Cancer and Capricorn? Describe the Sun’s path on the solstices at these latitudes. Do the same for the Arctic and Antarctic Circles?

Answer:

The tropics of Cancer and Capricorn are circles where latitudes are 23.5 degree N and 23.5 S respectively. The region between these two tropics are the part of Earth where the Sun can reach the zenith at noon. At the tropic of Cancer, the Sun reaches the zenith at noon on the summer solstice. Similarly, at the tropic of Capricorn, the Sun reaches the zenith at noon on the winter solstice.