Chapter 1

1. The universe can now be observed in all the regions of the electromagnetic spectrum (radio, IR, visible, UV, x-ray & Gamma-ray) as well as with neutrinos, cosmic rays, meteorites & samples collected by spacecraft.

†2. 3×10^8 m/s; 3×10^{10} cm/s.

3. Because of the finite travel time for light (or other observed signals), astronomers observe objects as they existed in the past, when the light was emitted.

4. A hypothesis still needs to be tested by observations &/or experiments; a theory has been confirmed by substantial experimental & observational data (as well as predictions of new phenomena).

5. Astrology (a pseudoscience) fails to adhere to the scientific method, & lacks any rigorous experimental verification. Astronomy & astrophysics are well established scientific disciplines. (Another example, not discussed in the chapter, is psychology & its pseudoscience, parapsychology.)

†6. (a) 4.642×10^3; 7×10^4; 3.47×10^1.
(b) 2.54×10^{-1}; 4.6×10^{-3}; 1.0243×10^{-1}.
(c) 2,543,000; 200.43; 0.0007673.

†7. (a) The conversion factor between AUs & 15-km-units is 1 AU = 1 unit, so 39.5 AU = 39.5 units = 39.5×15 km = 5.93×10^2 km, about 370 mi.
(b) The conversion factor between kilometers & your units is 1.5×10^8 km = 1 unit, or 1 km = $(2/3) \times 10^{-8}$ units, so 12,800 km = $12{,}800 \times (2/3) \times 10^{-8}$ units = 8.53×10^{-5} units. This numerical value in meters is about at the limit of human naked-eye visibility, comparable to something between the thickness of a fine hair & giant amoeba.
(c) The ratio of the diameters of the Sun & the Earth is about 109, i.e. the Sun is 109 times the size of the Earth.
(d) The conversion factor in part (b) gives 4.2 ly = 1.4×10^{13} km = $1.4 \times 10^{13} \times (2/3) \times 10^{-8}$ units = 9.33×10^4 units.
(e) The numerical values are very roughly of the same order of magnitude ($\approx 10^5$), i.e. the distance to the nearest star relative to the distance between the Earth & the Sun is about the same as the distance from the Earth to the Moon relative to the size of a big city.

†8. (a) For constant speed, the travel time equals the distance divided by the speed, $t = d/v = 4.2$ AU $\times (150 \times 10^6$ km/AU) / (20 km/s) = 3.15×10^7 s = 364.58 d (very

close to a year).
(b) The Earth will be in approximately the same location, but more accurate information about the Earth's location & motion in its orbit, as well as the size of the asteroid, the effect of Earth's gravity, etc. would be necessary to predict an actual impact or near miss.

9. Take care to avoid syndicated astrological newspaper columns.

10. **False.** Light travels at a finite speed, 3×10^5 km/s. Astronomers have observed objects that emitted radiation more than 13 billion years ago.

11. **True.** See answer to Question 1.

12. **True.** Astrology has never been experimentally verified, but if people believe in it, it could affect their behavior.

†13. **False.** In six months Earth would be on the other side of the Sun. A star that had appeared overhead a night would be overhead at noon & thus not visible. (See Star Party 1.1 for a picture & further explanation.)

14. **False.** Constellations are groupings of stars that are in the same direction as seen from Earth.

15. **False.** The first three are correct, but "nano" means one billionth (10^{-9}).

†16. **False.** The ratios 700,000/7,000 = 100, & 25/2.5 = 10 are not the same.

†17. **True.** In one month, Earth moves 30° further around the Sun, which is about 2 h of diurnal rotation ahead of where it was. (See Star Party 1.1)

†18. **False.** If the light took 8 Gy to reach you, you're seeing the galaxy as it was 8 Gy ago. It couldn't be 16 Gy old since the universe isn't even that old.

†19. (a) The ratio $(60 \times 10^{13}$ km) / $(6 \times 10^9$ km) = 10^5, & this equals the ratio of the scaled distance to Aldebaran, D, & one pen-unit, 15 cm. Thus, D = 10^5 pen-units = $10^5 \times 15$ cm = 15 km.

†20. (e) Distance traveled = speed × time = $(4.0 \times 10^3$ m/s) × (120 s) = 4.8×10^5 m.

†21. (c) The fasted signal travels at the speed of light, so time = distance / speed = $(120 \times 10^6$ km) / $(3 \times 10^5$ km/s) = 400 s.

22. (b) See Sec. 1.6.

23. (a) See Sec. 1.2.

†24. See the beginning of Sec. 1.1, or calculate the time = (distance to Sun)/(speed of light) = (150 x 106 km)/(3 x 105 km/s) = (500 s)(1 min/60 s) = 8 ⅓ min, closest to (d).

†25. In a one-quarter scale model, all distances are reduced by (3 ly)/(12 ly) = ¼, so (b) is the best choice for the star's radius.

†26. The time-scale factor in the model is (1 d)/(108 y). Therefore, the scaled age of the Sun would be (4.6 x 109 y)(1 d)/(108 y) = 46 d, or choice (c).

27. The time traveled. Recall: distance = speed × time.

†28. 3.9 = (4.6/14) × 12.

29. Asterisms. (See Sec. 1.3.)

30. Distance. (See FIGURE IT OUT 1.1.)

