Astronomy 1 fall 2009
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Solutions to Assignment 1

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1 Ch. 1 #3

Theories are tested with experiments and observations. Scientists work out the predictions of their theory with previous results and mathematics and then devise experiments to look for predicted effects. A theory that makes predictions in conflict with observations must be thrown away or revised.

Ch. 1 #5

Placing telescopes in space avoids the general deterioration of light as it passes through our atmosphere known as atmospheric distortion or extinction. Thus a telescope in space increases the amount of light collected by a telescope. In addition, telescopes in space avoid the shimmering effects due to atmospheric turbulence that cause stars to twinkle. The earth's atmosphere absorbs certain parts of the electromagnetic spectrum (for example ultraviolet and infrared radiation), so telescopes on the surface of the earth cannot detect such signals effectively. Putting telescopes in space above the atmosphere allows these wavelengths to be observed. Finally, a telescope in space does not need to correct for the rotation of the earth while looking at an object. A space telescope thus has more freedom as to where it can look because it isn't bound by the earth's daily rotation.

Ch. 1 #10

A solar system is a collection of planets in orbit around a star (in our case the Sun). Measurements of distances in solar systems are made in terms of Astronomical Units. A galaxy is a large collection of stars, possibly with their own solar systems, dust, gas, and dark matter. Galaxies are typically measured using kiloparsecs (kpc). Note that 1 pc = 206265 AU

2 Ch. 1 #11

These are all different units for measuring angles. The relationship between these units are as follows:

$$\pi(\text{radians}) = 180°, \qquad 1° = 60', \qquad 1' = 60''$$

Ch. 1 #12

$$1\,\text{deg} \times \frac{60'}{1\,\text{deg}} \times \frac{60''}{1'} = 3600''$$

Ch. 1 #13

See (c) of Box 1-1 in your book.

3 Ch. 1 #16

(a) 10^7
(b) 6×10^4
(c) 4×10^{-3}
(d) 3.8×10^{10}
(e) answers may vary, typical might be a few times 10^2 months

Ch. 1 #17

An AU is defined to be the average earth-Sun distance, where

$$1AU = 1.496 \times 10^{11} m$$

Distances in solar systems are generally measured in terms of AU.

Ch. 1 #19

See figure 1.14 in the book. The parsec is a unit of length, defined to be the distance at which 1 AU perpendicular to the observer's line of sight subtends an angle of 1 arcsecond.

$$1kpc = 10^3 pc$$
$$1Mpc = 10^6 pc$$

4 Ch. 1 #20

(a) kilometer, (b) centimeter, (c) second, (d) kilometers per second, (e) miles per hour, (f) meter, (g) meters per second, (h) hours, (i) years, (j) grams, (k) kilograms. (d), (e) and (g) are units of speed.

Ch. 1 #21

A parsec is a unit of distance, not time. It would be like saying I drove from the university to downtown Santa Barbara in 10 miles—nothing to brag about!

However, this answer could be twisted based on the principles of relativity, in a very nerdy way. Lengths along the direction of motion appear to be contracted to moving observers. You might thus interpret Han Solo's statement to mean that, according to him, the length of the Kessel run appeared to be 12 pc—perhaps assuming that the distance seems longer to a stationary observer. Based on this information, one can actually calculate his speed based on this "length contraction". But, the short answer is most likely that Lucas probably didn't know a parsec from a parsnip!

Ch. 1 #26

If we convert both the radius of a hydrogen atom and the radius of the observable universe into meters, we can set up a ratio to see how many times large the observable universe is as follows:

$$\frac{universe}{hydrogen} = \frac{5.0 \times 10^{-11} m}{1.3 \times 10^{26} m} = 2.6 \times 10^{36}$$

5 Ch. 1 #27

Mass of the Sun: $M_{\odot} = 1.99 \times 10^{30} kg$

Mass of hydrogen atoms in the Sun: $M_{H\odot} = 1.49 \times 10^{30} kg$

Mass of hydrogen atom: $M_H = 1.67 \times 10^{-27} kg$

If we now simply divide the mass of hydrogen atoms in the Sun by the mass of a single hydrogen atom, we will get the number of hydrogen atoms in the Sun:

$$\frac{M_{H/odot}}{M_H} = \frac{1.49 \times 10^{30} kg}{1.67 \times 10^{-27} kg} = 8.94 \times 10^{56} atoms$$

Ch. 1 #29

Knowing the speed of light, c, in meters per second and the distance from the earth of the Sun, 1 AU, in meters, we can solve as follows:

$$distance = veolocity \times time$$

$$time = \frac{distance}{velocity} = \frac{1.5 \times 10^{11} m}{3.0 \times 10^{8} m/s} = 5.0 \times 10^{2} s$$

which turns out to be about just over 8 minutes.

Ch. 1 #36

This can be solved using the small angle formula. First we need to convert the angular size of the moon from degrees into arcseconds as follows:

$$\alpha = 0.5deg \times \frac{60arcmin}{1deg} \times \frac{60arcsec}{1arcmin} = 1.8 \times 10^3 arcsec$$

and the distance from the earth to the moon into meters as follows:

$$d = 3.84 \times 10^5 km \times \frac{10^3 m}{1km} = 3.84 \times 10^8 m$$

And now plug into the small angle formula to find the answer:

$$D = \frac{\alpha d}{206265} = \frac{(1.8 \times 10^3 arcsec)(3.84 \times 10^8 m)}{206265} = 3.4 \times 10^6 m$$