Chapter 15. Homework answers

41. a. Sirius appears brightest in our sky because it has the smallest (most negative) apparent magnitude.
b. Regulus appears faintest of the stars on the list because it has the largest apparent magnitude.
c. Antares has the greatest luminosity of the stars on the list because it has the smallest (most negative) absolute magnitude.
d. Alpha Centauri A has the smallest luminosity of the stars on the list because it has the largest absolute magnitude.
e. Sirius has the highest surface temperature of the stars on the list because its spectral type, A1, is hotter than any other spectral type on the list.
f. Antares has the lowest surface temperature of the stars on the list because its spectral type, M1, is cooler than any other spectral type on the list.
g. Alpha Centauri A is most similar to the Sun because it has the same spectral type and luminosity class, G2 V.
h. Antares is a red supergiant; its spectral type M means it is red, and its luminosity class I indicates a supergiant.
i. Antares has the largest radius because it is the only supergiant on the list.
j. Aldebaran, Antares, and Canopus have luminosity classes other than V, which means that they have left the main sequence and are no longer burning hydrogen in their cores.
k. Spica is the most massive of the main-sequence stars listed because it has the hottest spectral type of the main-sequence stars; thus, it appears higher on the main sequence of an H-R diagram, where masses are larger.
l. Alpha Centauri A, with spectral type G2, is the coolest and therefore the longest-lived main-sequence star in the table.

42. The list of the brightest stars will include the very luminous hot stars from distances greater than 12 light-years, while the list of the fainter yet closer low-mass stars will not. The list of stars within 12 light-years is “volume-limited,” which means that nearly all of the stars within that distance are listed regardless of luminosity. Such a list is more representative of the total population of stars and is more likely to be dominated by low-mass stars. The list of brightest stars contains only those stars that are above a certain apparent brightness threshold. Therefore, the faintest nearby stars are left out, but the brightest and rarer hot stars are included in higher proportion than they are in a volume-limited list.

43. In Figure 15.10, Proxima Centauri is redder and has a cooler surface temperature than Sirius. Proxima Centauri is at least 10 times smaller in radius than Sirius. Both stars are on the main sequence, but Proxima Centauri is less massive and will have a longer life than Sirius. We can’t tell from this plot how old each star is or how bright they are in our sky compared to each other.

44. The parallax of stars, as viewed from the orbit of Jupiter, would be about five times larger, since Jupiter’s orbit around the Sun is about five times larger than that of Earth’s. Parallactic distances would be easier to measure from Jupiter’s orbit—for the same accuracy experiment, one could measure distances of about five times farther than we can from Earth.

45. If a star doubled in size with no change in luminosity, its surface temperature would go down, because the surface area of the star would increase but its energy output would stay the same, so a lower temperature would be required to maintain its energy output. Mathematically, the surface area would go up by a factor of four, so the temperature would go down by a factor of \(x\), where \((x)^4 = \frac{1}{4}\) or \(x = 1/\sqrt{2} : 0.71\) to maintain a constant luminosity.