

Section 2. Short Answer

Name and student ID: ANSWER KEY

- (a) (7 points) Draw a Hertzsprung-Russell (H-R) diagram for a *young* star cluster. Be sure to label the x and y axes, and indicate with arrows which directions represent increasing values. Indicate where are the lowest-mass stars and where are the highest-mass stars.
- (b) (5 points) Draw another HR diagram, but for a star cluster that is 10 billion years old. Write down (label) the approximate value of mass associated with the main-sequence turn-off. Indicate where red-giant stars are and where white-dwarf stars are.

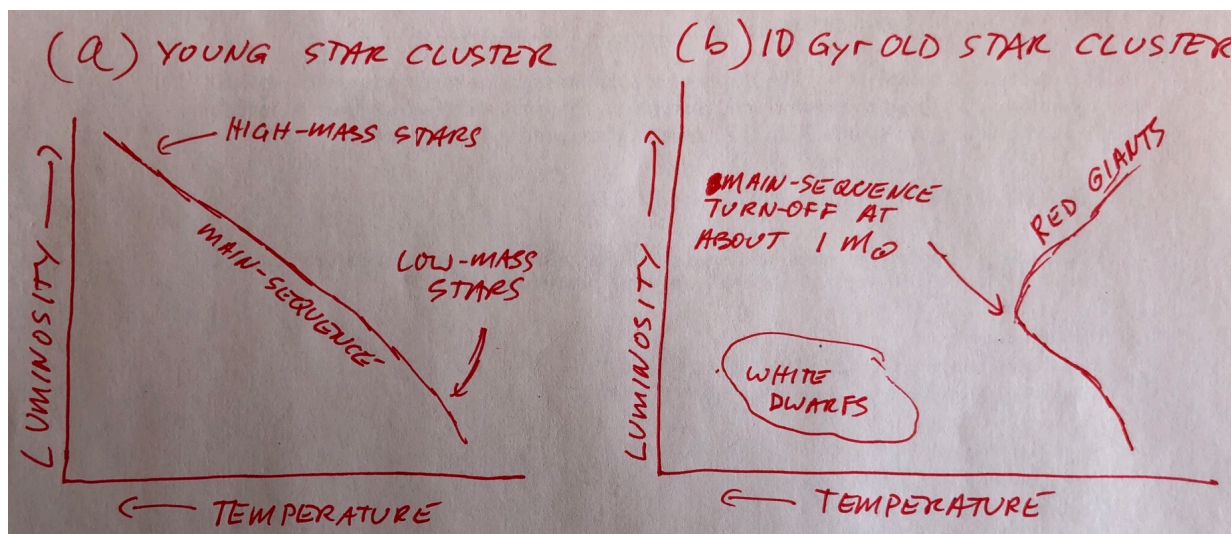


Figure 1: HR diagrams

Answer:

- (3 points) Earth is about 150 million km from the Sun, and the apparent brightness of the Sun in our sky is approximately 1,000 watts per square meter. Determine the apparent brightness that we would measure for the Sun if we were located half Earth's distance from the Sun.

Answer: Apparent brightness (flux) $F = L/(4\pi d^2)$. So, if d is 2 times smaller, the Sun would appear 4 times brighter. So the apparent brightness would be $4 \times 1,000$ watts per square meter = 4,000 watts per square meter.

- (2 points) Do you think it is likely that a 30-solar-mass main-sequence star could harbor an advanced civilization? Explain your reasoning.

Answer: A 30-solar-mass star has a short lifetime on the main-sequence (a few million years). It also produces copious amounts of ultraviolet radiation. Given that it took over 4 billion years for our advanced civilization to arise around the Sun, it is unlikely to happen around such a massive star.

- (3 points) Will our Sun become a white dwarf, a neutron star, a black hole, or none of these? Will it undergo a supernova explosion? Explain your answers.

Answer: The Sun will become a white dwarf, because it is below the minimum mass of $8 M_{\odot}$ for making a neutron star, therefore the only possible end state is a white dwarf. The Sun will not undergo a white-dwarf supernova, because this occurs only in a close binary star system, and our Sun is not part of a close binary.