Midterm 2 Practice Problems

Midterm 2 on November 11 from 10:45am-12:05 pm, in class

Exam Instructions:
Please show all work, writing solutions/explanations clearly, or no credit will be given. If you get stuck or don't know how to solve a problem, write down what you do know about the topic. Reference to an $8.5\times11''$ equation sheet (both sides usable) and a calculator is allowed. Use of the textbook, notes, homeworks, internet, or other online sources is **not** allowed. The exam represents your individual work; do not copy from others.

1. While doing a planetary transit survey, you find an exoplanet around a nearby solar twin (i.e., $M_* = 1\ M_\odot$, $R_* = 1\ R_\odot$). The depth of this exoplanet's transits is $\delta F/F = 0.01$, and the time between successive transits is $P = 32.0$ days. The host star also has a known peak radial velocity of $v = 65$ m s^{-1}.

   (a) What is the semi-major axis of the planet's orbit?

   (b) What is the radius of the planet?

2. You take a spectrum of a star and determine its spectral type to be G2. You notice the widths of its Balmer absorption lines are narrower than the widths of the same lines in the Sun.

   (a) What can you conclude about the luminosity class of the star? Justify your answer.

   (b) If both the mass and the radius of the star are $10\times$ larger than the mass and radius of the Sun, what is the star's surface gravity?

   (c) If the star's composition is comparable to that of the Sun (i.e., $\mu \approx \mu_\odot$), how should its central temperature T_c compare to the Sun's?

3. In high mass stars, silicon-28 (^{28}Si, mass of 27.9769 $m_{\rm u}$) is fused into ^{40}Ca (39.9626 $m_{\rm u}$) through a chain of reactions involving 3 alpha particles (^{4}He, 4.0026 $m_{\rm u}$) and intermediate products ^{32}S (31.9721 $m_{\rm u}$) and ^{36}Ar (35.9675 $m_{\rm u}$).

   (a) How much energy is produced by each reaction?

   (b) If 0.05 $M_\odot$ of silicon is completely burned into calcium over 1000 years, what should the star's luminosity be (in units of $L_\odot$) assuming all photons coming from the star are produced in these reactions?

4. Imagine you observe a star through a gas cloud, and you measure its V-band magnitude to be $m_V = 15.0$ and its color to be $B - V = 1.3$.

   (a) If the cloud's optical depth is $\tau_V \approx 5$, what would the star's apparent magnitude be in the absence of the cloud?

   (b) Assuming that the local reddening law holds in the cloud (i.e., $R_V \approx 3.1$), what would the star's apparent B magnitude be in the absence of the cloud?