

ASTR430 Midterm  
75 minutes in class  
160 Points

These are three questions from ASTR430 midterms that I have given in the past. This year there will be three problems with about this level of difficulty. As here, I will often ask you to apply what you have learned in ASTR430 to problems that we haven't considered in class yet. There will not be a descriptive question this year.

Draw nice pictures and show your work! If you run out of time, explain where you are stuck, and/or what you would have done. Good luck!

1. **[30 pts]** Two-Body Motion. Find the place along an elliptical orbit where  $v_r = dr/dt$ , the radial velocity, is maximum.
  
2. a) **[25 pts]** Reading from The New Solar System. In a short paragraph, describe Plate Tectonics. What drives it? On which object(s) does it appear to be operating?  
b) **[25 pts]** In a short paragraph or two, describe how the solar wind and cosmic rays cause the aurora and the Van Allen radiation belts on Earth.
  
3. a) **[20 pts]** Dimensional Analysis. Find an approximate expression for the central pressure of the Earth using Dimensional Analysis and assuming that the answer depends only on the Earth's mass  $M_E \approx 6 \times 10^{24}\text{kg}$ , its radius  $R_E \approx 6 \times 10^6\text{m}$ , and the gravitational constant  $G \approx 7 \times 10^{-11}\text{m}^3\text{s}^{-2}\text{kg}^{-1}$ . Assume that the arbitrary dimensionless constant is one, and evaluate your expression in bars –  $10^5\text{pascals (mks unit)} = 1\text{bar}$ . The atmospheric pressure at sea level is 1bar.  
b) **[10 pts]** Repeat part a) to get the form for the pressure a distance  $r$  from the center of the Earth.