Problems from Zeilik, Gregory and Smith:

Ch. 14: 11.

Exploding the Star? Assume that the gravitational binding energy of a 1 solar mass star is given by the equation \( U = -1.5 \frac{GM^2}{R} \), and that the radius of the star as a red giant is 1000 times the sun's radius. Use Appendix 5 (or the data used in prob. 16.10) in the text to estimate how much mass is converted to energy in one triple alpha reaction. Suppose 10% of the star's mass is in a helium core which is instantly converted into carbon in a helium flash. How much energy is produced in the flash? Is it sufficient to unbind the star?

Ch. 17: 2, 4, 13a) 17 (note: the pulsar number in the prob. does not correspond to the one in the text. Use the one in the text, and show that the numbers given are inconsistent.)

Ch. 18: 9, 10, (14, for extra credit).

Extra Credit More Black Holes As a followup to problem 17.4....

a) Calculate the orbital period for a spaceship orbiting at a distance of 2.0 Schwarzschild radii from a black hole of mass equal to the Earth’s mass. Next calculate the tidal acceleration across a length of 1 m on the ship, compare it to \( g = 9.8 \text{ m/s}^2 \).

b) Repeat part a) for a one solar mass black hole.

c) Repeat part a) for a \( 10^8 \) solar mass black hole.

d) Comment on the feasibility of these expeditions, based on your results in parts a)-c).