

HOMEWORK FOR QUIZ 5 Spring 2008

Possibly useful formulae: $\omega_{final} = \omega_{initial} \times (\frac{R_{initial}}{R_{final}})^2$; where R = radius, ω = spin rate

$$V_{escape} = \sqrt{2GM/R}$$

$$R = 2GM/V_{escape}^2$$

where V_{escape} = escape velocity, M = mass of the object from which you are trying to escape, R = radius from which you are trying to escape and G is the gravitational constant.

$$T = \frac{T_0}{(\sqrt{1-(\frac{v}{c})^2}}$$

1. **We have identified neutron stars in which of the following ways?**

- ___As the secondary in Algol systems
- ___As pulsars
- ___Via x-rays from the hot surface of nearby neutron stars
- ___As the source of energetic cosmic rays

2. **What is the evidence for black holes (the $3 - 10 M_{\odot}$ variety)?**

3. **If the Earth shrank to 1/4 of its current radius, what would the escape velocity be from its new surface? (the current V_{escape} is 25,000 mph)**

4. **Which of the following would be expected to be left behind after a SNII explosion?**

- ___A massive white dwarf
- ___A massive Fe core of a former high-mass star
- ___A neutron star with $M < 1M_{\odot}$
- ___A rapidly-spinning neutron star

5. **Algol is a binary system with a $3.7M_{\odot}$ main-sequence star and a $0.8M_{\odot}$ red giant.**

(a) Explain why this is unexpected if the two stars formed at the same time.

(b) What is the explanation to resolve this paradox?

6. Which of the following do astronomers think might be a path to forming a Black Hole?

- ☐ Pulsar spin down
- ☐ Compressing material in high-pressure diamond vises to produce 'micro' black holes
- ☐ Adding at least $0.6M_{\odot}$ of material to a neutron star
- ☐ Collisions between stars in dense star clusters

7. If an object is compressed to its Schwarzschild Radius, which of the following statements will be true?

- ☐ The object will collapse to zero volume.
- ☐ Photons emitted from the object will be strongly 'bent' forming an 'Einstein ring' gravitational lens.
- ☐ All photons emitted from within the Schwarzschild radius will be trapped and the object will be surrounded by a black hole (with radius=Schwarzschild radius).
- ☐ It is impossible for any object to reach its Schwarzschild Radius

8. Suppose the Sun collapsed from it's current radius of 700,000km to the size of a neutron star (radius = 40km)

(a) would it spin faster, slower or the same as it does now (1/30 revolution per day)?

(b) By what factor?

9. Which of the following are ingredients in the standard explanation of a pulsar?

- ☐ strong magnetic field aligned along the rotation axis of a neutron star
- ☐ rapidly spinning neutron star
- ☐ neutron star with a large magnetic field misaligned with respect to the rotation axis.
- ☐ spinning neutron star with its rotation axis pointed nearly directly at the Earth

10. What is the Schwartzchild radius for an object with a mass of 100,000 grams?
11. Cygnus X-1 is a pretty good candidate for a system containing a black hole. Describe this system and why we can infer the presence of a black hole in it.

REVIEW

12. **For $1M_{\odot}$ stars:**
- (a) What elements are synthesized via fusion reactions?
 - (b) How are these newly minted elements dispersed into the interstellar medium?
13. The Sun will eventually become which of the following?
- ___ SN I
 - ___ SNII
 - ___ Supernova remnant
 - ___ planetary nebula + white dwarf