QUIZ 3 – ASTR-2 Fall 2019 YOUR FULL NAME:_____

V_{escape}=SQRT(2MG/R); $M_{Earth}=6 \times 10^{27}$grams; $R_{Earth}= 6.4 \times 10^{8}$cm; $c=3 \times 10^{10}$cm/second

1. **Which of the following are True (T) and which False (F) in describing an event horizon?**

   _T__ It is the distance from a singularity where the escape velocity is the speed of light

   _F_ It is the extent of the gravitational influence of a black hole

   _F__ The event horizon of a million solar mass black hole would be much smaller than that of a ten solar mass black hole.

   _T__ No electromagnetic radiation can travel from inside the event horizon to outside

2. **Which of the following are predictions of Special or General Relativity? (label True or False)**

   _F__ If you are in a spaceship moving at 0.9 the speed of light and shine a flashlight in the direction of travel, you will measure the speed of the light beam to be 0.1c ($3x10^7$ m/sec).

   _T__ Mass warps the space-time fabric of the universe

   _F__ Time reverses as an object approaches the speed of light

   _T__ Electromagnetic radiation traveling near a mass will appear to bend as it follows a straight line through curved space

3. **Which of the following best describes the calculation of the Schwarzchild radius for an object with mass M? (select one)**

   __X_ Set velocity equal to the speed of light in the equation for escape velocity and solve for radius at a given M

   ___ Calculate the maximum radius for a neutron star and adjust by the maximum mass for a neutron star $3M_{Sun}$ divided by M (a factor of $3M_{Sun}/M$)

   ___ Calculate the equivalent energy for an object using $E=Mc^2$ and use this to determine the closest orbit of a photon before it is captured by the object

   ___ Determine the radius from a mass M where time slows to zero based on the time dilation formula from Special and General Relativity

4. **Which of the following statements about the Milky Way Galaxy are (T)rue and which (F)alse?**

   _T__ It is a member of the Local Group of a few hundred galaxies

   _F__ It is one of the largest (in mass and radius) galaxies we know of in the Universe

   _T__ Star formation is still on going in the Milky Way Galaxy

   _F__ It is known to contain ~10^5 (100,000) stars in total and a slightly larger number of planets

5. **The escape velocity from the surface of the Earth is ~25,000 miles/hour. If the mass of the Earth increased by a factor of four but the radius stayed the same, what would be the escape velocity from the more-massive Earth?**

$V_{escape} \propto$ SQRT(M); so if M increases by a factor of 4, V_{escape} increases by a factor of SQRT(4) =2. So, the escape velocity from the more massive Earth is 2 x 25,000 = 50,000mph

6. **Which of the following are processes that produce elements with atomic number larger than Iron? (select any that are)**

__X_ addition of neutrons to existing nuclei followed by "beta" decay (emission of an electron)

___ the fusion of helium to light nuclei resulting in the "even-odd effect"

__X_ non-equilibrium fusion reactions during supernova explosions producing Co and Ni

___ the rapid addition of protons to existing nuclei

7. **Which of the following provide evidence for space-time expansion? (select any that do)**

__X__ The vast majority of galaxies appear to be moving away from the Milky way Galaxy

____ The deflection of starlight seen during a solar eclipse

____ Energetic jets observed near QSOs and active galactic nuclei

____ The blueshift of light from the Andromeda Galaxy

8. **Which of the following are part of the scenario for SNI? (select any that are)**

__X__ Mass transfer from a close companion onto a white dwarf

____ The collapse of a white dwarf whose mass exceeds $8M_{Sun}$ (8 times the mass of the Sun)

____ The formation of a neutron star

__X__ Fusion reactions in a collapsing white dwarf that produce elements including radioactive cobalt and nickel

9. **Which of the following are part of the reasoning chain that leads us to believe that binary system Cygnus X-1 contains a stellar-mass black hole? (select any that are true)**

____ There is an unseen companion in the system that is emitting degenerate electrons

__X__ There is an unseen companion that is at least $5M_{Sun}$ but is not visible at optical wavelengths and is therefore not a red giant or main-sequence star

__X__ There is an unseen companion that is at least $5M_{Sun}$ which excludes the possibility that it could be a white dwarf or neutron star

__X__ The system emits "hard" (short-wavelength) X-rays from material heated to high temperature near the black hole

10. **What is the evidence for a dominant dark matter component of the Galaxy? (select as many as are correct)**

____ Planets in the outer solar system orbit the Sun at larger and larger speeds

____ gravitational lens experiments have demonstrated a population of black holes in the Galactic bulge

__X__ the "rotation curve" of the Galaxy is flat: stars in the outer parts of the Galactic disk orbit faster than expected based on the stars and gas seen inside their orbits

____ Galaxies at increasing distances have larger recessional velocities