Astr 01 **HW 13: Black Holes** Name_____

Show ALL work for full credit. Each problem 2 pts unless otherwise noted.

1) In a neutron star, the core is
   A) constantly expanding and contracting.
   B) made of compressed neutrons in contact with each other.
   C) electrons and protons packed so tightly they are in contact.
   D) no longer rotating.
   E) primarily iron and silicon.

2) Two important properties of young neutron stars are
   A) extremely rapid rotation and a strong magnetic field.
   B) extremely slow rotation and a strong magnetic field.
   C) extremely rapid rotation and a weak magnetic field.
   D) no rotation and a weak magnetic field.
   E) no rotation and no magnetic field.

3) Neutron stars are the size of _____.

4) The mass range for neutron stars is
   A) 0.08 to 0.4 solar masses.
   B) 0.4 to 3 solar masses.
   C) 1.4 to 3 solar masses.
   D) 3 to 8 solar masses.
   E) 6 to 11 solar masses.

5) Neutron stars are 100,000 times denser than white dwarfs.

6) Stars of less than 8 solar masses will not go supernova.

7) While white dwarfs have a density a million times that of normal matter, neutron stars are a _____ times denser than even white dwarfs.

8) Which of these does NOT exist?
   A) a 0.06 solar mass brown dwarf
   B) a 1.8 solar mass neutron star
   C) a 1.5 solar mass white dwarf
   D) a million solar mass black hole
   E) a 6 solar mass black hole

9) Newly–formed neutron stars start with weak magnetic fields, but they strengthen over time into pulsars.

10) Who discovered the first four pulsars?
   A) Anthony Hewish
   B) Martin Schwartzschild
   C) Carl Sagan
   D) Jocelyn Bell
   E) Stephen Hawking

11) Pulsars are created in a Type I supernova.

12) Pulsars can range in mass from _____ to _____ solar masses.

13) Three terrestrial–sized planets in orbits of a fraction of an AU have been found near
A) Cygnus X–1.
B) a white dwarf.
C) a millisecond pulsar.
D) a magnetar.
E) Supernova 1987A.

14) Two–thirds of all known millisecond pulsars are found in what type of object?
A) extremely distant galaxies
B) globular clusters
C) open clusters
D) emission nebulae
E) giant molecular clouds

15) While most pulsars slow down over time, millisecond pulsars spin faster due to mass transfer from a close companion.

16) In a hypernova, a very energetic supernova creates a
A) set of planets to orbit their neutron star host.
B) black hole.
C) white dwarf and its planetary nebula.
D) very visible supernova remnant.
E) millisecond pulsar.

17) What would happen if more mass was added to a 1.4–solar–mass neutron star?
A) All of its protons and electrons would turn into quarks.
B) It would erupt as a Type I supernova.
C) It could eventually become a black hole, via a hypernova explosion.
D) It would blow off mass as an X–ray burster.
E) It would grow larger, temporarily becoming a red giant again.

18) A(n) _____ is a very energetic collapse forming a black hole and jets of gamma rays.

19) Which statement about black holes is true?
A) They form an event horizon at twice the Schwartzschild radius.
B) They form from 1.4 solar mass stars.
C) Their main–sequence mass was 5–10 solar masses.
D) Their escape velocity is greater than the speed of light.
E) Their event horizon is a physical surface boundary.

20) The final mass of a neutron star cannot exceed about _____ solar masses.
A) 1.4 B) 3 C) 8 D) 25 E) 100

21) Once crossed, not even light can return over the _____ of a black hole.

22) The Schwartzschild radius for a 12 solar mass star is
A) 4 km. B) 15 km. C) 36 km. D) 100 km. E) 3000 km.

23) What three properties describe a black hole?

24) How is the Schwartzschild radius calculated from the mass of a star?

25) Describe the range of sizes and masses of black holes.

26) Nothing in the universe can travel faster than _____.

27) If light from a distant star passes close to a massive body, the light beam will
A) change color to a shorter wavelength.
B) slow down.
C) accelerate due to gravity.
D) continue moving in a straight line.
E) bend towards the star due to gravity.

28) What can we detect from matter that has crossed an event horizon?
A) visible light
B) gamma-ray bursts
C) radio waves if the matter was traveling fast enough
D) X-rays if the matter was dense
E) nothing

29) As a spaceship nears an event horizon, a clock on the spaceship will be observed
A) to run backwards.
B) to run faster.
C) to run slowly.
D) to stop.
E) to run the same as one on Earth.

30) If the Sun were replaced by a one-solar-mass black hole,
A) we would immediately escape into deep space, driven out by its radiation.
B) we would still orbit it in a period of one year.
C) our clocks would all stop.
D) all terrestrial planets would fall in immediately.
E) life here would be unchanged.

31) A black hole may be indirectly detected from radiation emitted by the _____ disk that surrounds it as matter is pulled inward.

32) When light escapes from near a black hole, we see a(n) _____ redshift.