

Elementary Cosmology ... Fall 2012
Midterm Exam ... October 9, 2012

Name: _____ NetID: _____

Please read all answers. Please choose the correct answer.

1. The principle of equivalence in general relativity states
 - A) any point in the universe is equivalent to any other point
 - B*) gravity is equivalent to an accelerating reference frame
 - C) light can not escape a black hole
 - D) clocks run slowly in a gravitational field
 - E) space and time are equivalent

2. Which of the following is NOT one of the “classic” tests of general relativity, Einstein’s theory of gravitation?
 - A) Bending of light by the sun
 - B*) White dwarf stars with masses above 1.4 solar masses are unstable
 - C) Precession of the orbit (perihelion) of Mercury
 - D) Gravitational red shift
 - E) Gravitational time delays

3. The primary reason there is an upper limit on the mass of a white dwarf star is because:
 - A) thermal gas pressure is insufficient to support the star.
 - B) its radiation pressure blows off most of its mass.
 - C*) the degenerate electron Fermi gas becomes relativistic and can not provide enough pressure.
 - D) mass decreases in strong gravitational fields.
 - E) there is a lower limit on the mass of a neutron star.

4. The first extrasolar astronomical xray source discovered was
 - A*) SCO X1
 - B) 3C273
 - C) Cygnus A
 - D) M31
 - E) Jupiter

5. The first quasar to be identified by Allan Sandage with an optical source in 1960 was
 - A*) 3C48
 - B) SCO X1
 - C) Cygnus A
 - D) Cygnus X1
 - E) the galactic center

6. Karl Jansky discovered radio astronomy in 1932-1935 by finding a strong radio source in the direction of
 - A) M31
 - B) Vega
 - C) New York City
 - D) SCO X1
 - E*) the galactic center
7. Grote Reber helped establish radio astronomy by
 - A) discovering radio emission from the galactic center
 - B) establishing radio telescopes in Australia
 - C) developing radar during World War II
 - D) discovering pulsars
 - E*) mapping out the radio sky from his mother's backyard in Weaton, IL.
8. While originally unexpected, pulsars were quickly realized to be
 - A) messages from advanced civilizations
 - B) very hot white dwarf stars
 - C*) rotating neutron stars
 - D) due to Hawking radiation
 - E) radio galaxies
9. Quasars were thought to be very distant radio sources because
 - A) their x-ray emission is very weak
 - B) they pulse periodically
 - C) their intensity varies on time scales of decades
 - D) they are never found in galaxies near us
 - E*) they have high recessional velocities
10. The "Schwarzschild singularity" was renamed the "horizon" to reflect what important property?
 - A) Schwarzschild had been discredited
 - B) other singularities were discovered
 - C*) no information could flow out from the boundary
 - D) it was dark
 - E) it was chaotic

11. Black holes have no hair means
 - A) two black holes can not coalesce
 - B) they can not radiate
 - C) they can not emit gravitational radiation while being formed
 - D) they are not spherical
 - E*) any non-uniformity in the star is radiated away in the process of black hole formation

12. While Finkelstein coordinates helped “remove” the Schwarzschild singularity at the black hole horizon in the Schwarzschild solution there remained
 - A) pulsar radiation
 - B) supernova explosions
 - C) white dwarf collapse
 - D) Hawking radiation
 - E*) a true singularity at the center

13. A pair of nearly identical quasars only six seconds of arc apart in the sky was the first example of
 - A) a binary quasar
 - B) a binary pulsar
 - C*) gravitational lensing
 - D) a binary x-ray source
 - E) a binary white dwarf

14. The Compton gamma ray observatory observations indicated Gamma ray bursts were of cosmological origin because.
 - A) they had low red shifts.
 - B) they were very dim
 - C) they were not associated with quasars.
 - D) they were very long pulses.
 - E*) they were isotropic and not confined to our galaxy.

15. The Cepheid variable stars period luminosity relationship was calibrated
 - A) using parallax to thousands of them
 - B) using models of stellar collapse
 - C*) using Cepheids in the Large Magellanic Clouds which are all at the same distance
 - D) using their known luminosity to compute their distance
 - E) they have never been calibrated

16. Distance measurement by “standard candle” means
- A) using beacons at known distances
 - B) using the spectrum of known elements to compute distances
 - C) M31, Andromeda is the closest galaxy to the Sun
 - D) Sirius is the brightest star in the sky
 - E*) one can determine distance to an object if its intrinsic luminosity is known
17. A post-diction (a prediction for the past) of the expansion of the universe is
- A) the universe will expand forever
 - B) the universe will eventually collapse
 - C*) a hotter denser early universe
 - D) an inflationary period
 - E) dark matter must exist
18. Big Bang nucleosynthesis ends with Helium because
- A) it gets too cold too quickly
 - B) there is not enough helium present
 - C*) there are no stable nuclei with mass numbers 5 or 8
 - D) all the neutrons are used up
 - E) it doesn't all elements are made
19. More massive stars convert Hydrogen into Helium using the CNO cycle rather than the Proton-Proton fusion process because
- A*) their hotter denser cores allow the proton to overcome the electrical repulsion that prevents this reaction in lighter stars
 - B) they have more magnesium
 - C) they do not use the CNO cycle
 - D) they have more uranium
 - E) they have more nitrogen
20. The observational basis of modern cosmology are
- A) the cosmic microwave background
 - B) primordial element abundance
 - C) the recession of the galaxies
 - D*) all of the above
 - E) the gravitational red shift

21. One of the first noticed indications that *atoms* had structure was
- A) the photoelectric effect
 - B) the Doppler shift
 - C) the black body spectrum of the sun
 - D) the cosmic microwave background
 - E*) unique line spectra for each element
22. The particles that appear as a consequence of radioactive alpha decay are
- A*) Helium nuclei
 - B) gravitons
 - C) Carbon nuclei
 - D) neutrinos
 - E) positrons
23. The proton-proton process that fuses hydrogen in the sun produces neutrinos because
- A*) a proton must turn into a neutron in the process
 - B) a neutron must turn into a proton in the process
 - C) a tritium nucleus disintegrates
 - C) helium is formed in this step of the process
 - D) anti-neutrinos are absorbed
24. Helium was so named because
- A) it is a very rare gas
 - B) it was discovered in the constellation Helios
 - C) It was named for its discoverer Robert A. Helium
 - D*) it was discovered in the Sun's spectrum
 - E) it is used to reach very low temperatures
25. The hypothetical neutrino was proposed
- A) to balance proton charge
 - B) because it had recently been observed
 - C) to explain energy production in black holes
 - D*) to avoid the non-conservation of energy and momentum in beta decays
 - E) to facilitate the beta decay process

26. A quantum measurement is a bit strange in that
- A) only one unique observer can make a quantum measurement
 - B) the answer does not depend on the reference frame
 - C) the quantity may not exist prior to the measurement
 - D) the measurement removes all possible outcomes except the one measured
 - E*) both C and D
27. Probability in quantum mechanics may be interpreted as
- A) experiments are unique and can never be repeated
 - B) when an experiment is repeated one will never get the same result
 - C*) when an experiment is repeated the frequency of the outcomes is well described by the probability prediction
 - D) when an experiment is repeated one will always get the same result
 - E) when any experiment is repeated it is unlikely that one will get the same results
28. In 1888 more than a quarter century after Maxwell's prediction Hertz was the first to produce
- A*) radio waves
 - B) water waves
 - C) celestial mechanics
 - D) auto mechanics
 - E) quantum mechanics
29. Penrose used topological arguments to prove that during stellar collapse once a horizon formed
- A) the star would vanish from our universe
 - B) the star would appear in our universe
 - C) the star would stop collapsing
 - D) the star would stop spinning
 - E*) a singularity was inevitable
30. The reason why Landau's "neutron cores" could not power the sun is:
- A) they could not make enough energy
 - B*) cores small enough to be hidden in the sun would be too small to be stable and would explode
 - C) an alternate explanation was found for the sun's power
 - D) at the time there was no evidence for neutron stars
 - E) the fusion of hydrogen into helium powers the sun

31. Gravitational radiation has been observed
- A) with the Ligo detector
 - B) with x-rays
 - C) with fluctuations in the size of the sun
 - D*) via energy loss from binary pulsars
 - E) it has never been observed
32. A quantum non-demolition experiment can avoid the Braginsky quantum limit because
- A*) no net energy is exchanged with the detector
 - B) the detector is unchanged by the detection
 - C) the detector is demolished by the measurement
 - D) there is no such thing as a quantum limit
 - E) non-demolition experiments can not avoid the limit
33. Hawking radiation from a black hole
- A) has never been observed
 - B) is a quantum mechanical effect in curved space-time
 - C) draws an equivalence between surface gravity and temperature
 - D) draws an equivalence between black hole area and entropy
 - E*) all of the above
34. Energy can be extracted from a rotating black hole because
- A) nothing can fall into a spinning black hole
 - B) 3% of mass falling into the hole is radiated as gravitational waves
 - C) spinning black holes have no mass
 - D) energy can not be extracted from a spinning black hole
 - E*) substantial amounts of energy are stored outside the horizon
35. The difference between an absolute horizon and an apparent horizon is
- A) they are the same thing
 - B) information can be transferred from behind an absolute horizon
 - C) information can be transferred from behind an apparent horizon
 - D*) an absolute horizon can be time dependent
 - E) an apparent horizon can be time dependent

36. The most significant physical consequence of a binary pulsar was
- A) it indicated how common neutron stars are.
 - B) gravitational lensing
 - C) supernova do not disrupt binary star systems
 - D) neutron stars can form binaries
 - E*) it provided for a test of gravitational radiation.
37. The three classic test of general relativity do not include
- A) there are four classic tests of general relativity
 - B) the precession of Mercury's orbit
 - C) bending of light by the sun
 - D*) Hawking radiation
 - E) gravitational time dilation
38. The gaps in stable atomic nuclei with masses of 5 and 8 can be overcome in the cores of hot dense stars with
- A) the fusion of two helium nuclei
 - B) a helium tritium reaction
 - C) the rapid addition of neutrons to a helium core nucleus
 - D) the splitting of Magnesium 24 to make Carbon
 - E*) the triple alpha reaction producing Carbon 12
39. Einstein introduced the concept of photon, a lump of light energy to explain
- A) the stability of the universe
 - B) the bending of light by the sun
 - C) the slowing of clocks by gravity
 - D*) the emission of electrons from certain metals when illuminated by light (the photoelectric effect)
 - E) the cosmological constant
40. Identical particles for which constructive interference occurs in symmetrical situations are called
- A) fermions
 - B) ions
 - C) neutrons
 - D) neutrinos
 - E*) bosons

————— The Following Three Questions Are Optional —————
No Credit is Awarded for these Questions. There is no Wrong Answer

41. Things I like about my Physics 10240 Elementary Cosmology Course

- A)
- B)
- C)
- D)
- E)

42. Things I do not like about my Physics 10240 Elementary Cosmology Course

- A)
- B)
- C)
- D)
- E)

43. Suggestions to improve my Physics 10240 Elementary Cosmology Course

- A)
- B)
- C)
- D)
- E)