Elementary Cosmology ... Fall 2013
Midterm Exam ... October 15, 2013

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As a member of the Notre Dame community,
I will not participate in, or tolerate, academic dishonesty.

Please read all answers. Please choose the correct answer.

1. Why wasn't Schwarzchild involved in discussions of the Schwarzchild singularity?

   A) * He died shortly after his solution was published.
   B) He was embarrassed by the singularity.
   C) He didn't understand the singularity.
   D) Einstein did not want him to be involved.
   E) Eddington did not respect Schwarzchild.

2. Sommerfeld apologized to the young student Chandrasekhar because

   A) he was late to the appointment.
   B) * quantum mechanics was developing so rapidly that Sommerfeld's book was already obsolete.
   C) Chandrasekhar had proved Sommerfeld was wrong.
   D) he had forgotten the appointment.
   E) there were many mistakes in the manuscript Sommerfeld had given Chandrasekhar.

3. Eddington rejected Chandrasekhar's upper mass limit to white dwarf stars because

   A) he did not trust quantum mechanics.
   B) he did not understand stellar interiors.
   C) he did not understand general relativity.
   D) * he did not think it physical for a star to close off from the universe.
   E) he did not like Chandrasekhar.

4. Thermodynamic equilibrium is

   A) the balance between gravity and pressure that stabilizes a star
   B) the balance between kinetic and potential energy
   C) the balance between gravity and cosmic inflation
   D) the balance between heat and light
   E) * the balance between energy generation and energy transport

5. Hydrostatic equilibrium is

   A) the balance between energy generation and energy transport
   B) * the balance between gravity and pressure that stabilizes a star
   C) the balance between dark energy and light energy
   D) the balance between positive and negative charges
   E) the balance between air and water pressure at the horizon

6. A white dwarf star is

   A) a quasar
   B) a neutron star
   C) * stabilized by degenerate Fermi gas pressure
   D) a pulsar
   E) a red giant

7. The Chandrasekhar limit is

   A) the speed of light
   B) the minimum size of a neutron core
   C) the event horizon
   D) a singularity
   E) * an upper limit on the mass of a stable white dwarf star

8. A neutron star

   A) can become a quasar
   B) can become a white dwarf star
   C) is just an uncharged normal main sequence star
   D) * has the density of an atomic nucleus
   E) is a red giant

9. Pulsars are

   A) nearby radio galaxies
   B) rapidly rotating white dwarf stars
   C) black holes
   D) * the source of astronomical periodic radio pulses
   E) very distant radio galaxies

10. Landau proposed neutron cores

    A) * as a method of energy generation in normal stars
    B) as a source of cosmic rays
    C) as a source of all elements
    D) the endpoint of stellar evolution
    E) to start the universe

11. In astronomy a nova is

    A) * a star that brightens so as to appear new in the sky

    B) the birth of a star

    C) the death of a star

    D) a binary star

    E) an automobile brand

12. A supernova is

    A) the birth of a star

    B) the event horizon

    C) * the fate of a star that exceeds the Chandrasekhar limit

    D) a big binary star

    E) a white dwarf

13. Serber and Oppenheimer were able to prove that Landau's idea of neutron cores as a source of energy generation in stars did not work because

    A) nuclear reactions did it better

    B) * one could not have a stable neutron core with mass below 0.1 solar masses

    C) neutron stars with mass greater than 3 solar masses are unstable

    D) stars get their energy from gravitational attraction

    E) stars do not generate energy

14. Oppenheimer and Snyder were able to study stellar collapse using the static Schwarzchild solution because

    A) they considered the collapse time scale to be very slow

    B) there is no collapse since all neutron stars are too light

    C) they made a mistake

    D) they were in a hurry to get a result and overlooked this constraint.

    E) * in 1923 George Birkhoff proved the solution was correct for any spherically symmetric mass distribution even if it were imploding.

15. Approximations in the Oppenheimer Snyder calculation of stellar collapse include

    A) ignore rotation

    B) ignore radiation of energy

    C) ignore shock waves

    D) ignore mass loss through ejection of matter

    E) * all of the above

16. At the north pole of the Earth the space is smooth but

A) * the direction of north ceases to exist

B) the direction south ceases to exist

C) the direction up ceases to exist

D) space ceases to exist

E) space becomes two dimensional

17. According to Finkelstein's coordinate transformation space-time at the Schwarzchild "singularity"

A) has a gap in time

B) has a gap in the radial direction

C) ceases to exist

D) has no time component

E) * is perfectly smooth

18. Oppenheimer and Snyder were very troubled by their solution to stellar collapse and black hole formation since

A) black holes would not form

B) black holes would always form

C) * the outcome seemed to depend on where the observer was located

D) it didn't match the Schwarzchild solution in the static limit

E) the upper mass limit for stability was very low being smaller than the mass of the sun.

19. Karl Jansky discovered radio astronomy while

A) * studying noise in trans Atlantic radio telephone communications

B) studying noise in communications satellites

C) looking for the planet Neptune

D) looking for Sco X-1

E) looking for the quasar 3C48

20. Alan Sandage used the 5 meter Palomar telescope to photograph the very strong but very small radio source known as 3C48. What he found was

A) a neutron star

B) a white dwarf star

C) an x-ray source

D) * a single blue dot that looked like a star.

E) a large dim galaxy

21. It was realized that the quasars 3C48 and 3C273 were more than 2 billion light years away when the optical spectrum was

A) diminished by intergalactic dust

B) * red shifted by 37% and 16% respectively

C) the spectrum of iron and nickel

D) the spectrum of a black body

E) periodically time varying

22. Joe Weber used resonant detection to attempt to detect gravitational waves. Resonant detection is a method that allows

A) one to create gravitational waves

B) one to create water waves

C) one to create sound waves

D) * a small signal to gradually accumulate in the detector

E) very low temperatures to be produced

23. The Braginsky quantum limit was

A) a region of space from which no signal would emerge

B) * a fundamental limit to the sensitivity of bar detectors dictated by quantum mechanics.

C) an upper speed limit on gravitational waves

D) a limit on the size (amplitude) of gravitational waves

E) an upper limit on the temperature of a black hole

24. One can defeat the Braginsky quantum limit with

A) lower noise

B) better quantum mechanics

C) better classical mechanics

D) quantum defeatism

E) * quantum nondemolition measurements.

25. Different descriptions of the same physical phenomenon are called by philosophers

A) different views

B) different perspectives

C) * different paradigms

D) disillusion

E) hysteria

26. The difference between an absolute horizon and an apparent horizon is

A) information can be transferred from behind an absolute horizon

B) information can be transferred from behind an apparent horizon

C) an apparent horizon can be time dependent

D) * an absolute horizon can be time dependent

E) they are the same thing

27. Penrose theorem on the formation of singularities states

A) singularities can not occur in the physical world

B) * once a horizon forms the formation of a singularity is inevitable

C) the singularity must be chaotic

D) the singularity must not be chaotic

E) the Schwarzchild singularity is inevitable

28. One can imagine traveling far into the future by

A) traveling to a quasar

B) * hovering for a modest time near but outside the horizon of a black hole

C) falling through a horizon

D) living a very long time

E) looking out to large distances with a telescope

29. In the time travel billiard ball paradox

A) one's grandmother dies before one's parent is born

B) a spinning billiard ball is used as a time machine

C) * a billiard ball emerges from the time machine in time to prevent itself from entering.

D) the color on a blue billiard ball is red shifted to red.

E) a billiard ball quickly falls through the horizon of a black hole

30. Khalatnikov and Lifshitz believed that realistic conditions, of turbulence for example, would prevent the appearance of the singularity inside the horizon predicted by Penrose theorem. Who was right?

A) Penrose

B) Khalatnikov and Lifshitz

C) Hawking

D) * Both were right. A chaotic (BKL) singularity occurs.

E) Thorne

31. The LIGO project to detect gravitational waves

A) uses bar detectors

B) discovered gravitational waves in 2007

C) discovered gravitational waves from the binary pulsar in 1974

D) discovered gamma ray bursts in 1967

E) * uses laser interferometry

32. The dark lines in the solar spectrum first noticed by von Fraunhoffer are due to

A) emission of light by elements in the sun

B) interference between light and dark matter

C) emission via dark matter

D) * absorption of light from the sun in the solar atmosphere

E) absorption of light in the Earth's atmosphere

33. Kepler who studied planetary motion as Tycho Brahe's assistant is known for three laws. One of these is

A) Time machines are impossible

B) Entropy always increases

C) Black holes have no hair

D) One can never go faster than the speed of light

E) * The square of the orbital period (T^2) is proportional to the cube of the semi-major axis (a^3) of the planets orbit around the Sun

34. First evidence for the gaseous, chemically inert element helium was found in 1868

A) in Holland

B) in New Jersey

C) * in the Sun

D) in the Moon

E) in the Earth

35. Cepheid variable stars are a valuable tool in cosmology since

A) they are powerful radio emitters

B) they are powerful xray emitters

C) * their absolute luminosity is related to their period of variability

D) their variability depends on their distance

E) they are found in the Magellanic clouds

36. In astronomy and cosmology the concept of "standard candle" is

A) * Any luminous object for which its luminosity can be calculated independently of its distance

B) Cepheid variable stars

C) a solar eclipse

D) eclipsing binary stars

E) the solar luminosity

37. Hubble discovered our galaxy by

A) measuring the expansion of the universe

B) measuring the cosmic microwave background radiation

C) measuring the distance to the star Sirius

D) measuring the distance to the sun

E) * measuring the distance to the Andromeda galaxy

38. The Cosmological Principle differs from the *Perfect* Cosmological Principle in that the Cosmological Principle assumes

A) * no special location in the universe

B) no special time in the universe

C) we are at the center of the universe

D) the universe started in New Jersey

E) the universe will end

39. The 3 degree cosmic microwave background radiation is interpreted as observational evidence of

A) ancient starlight

B) distant quasars

C) expansion of the universe

D) * a hot early universe

E) a cold early universe

40. Big bang nucleosynthesis can

A) explain all of the observed elements

B) * explain why the elements in the universe are 24% helium and 75% hydrogen

C) explain the formation of organic elements needed for life

D) explain the source of elements heavier than iron.

E) explain the source of elements with 5 or 8 protons plus neutrons

41. Schrödinger's cat is

A) dead

B) alive

C) sleeping

D) * a macroscopic example of the difference in predictions between quantum and classical physics

E) a radioactive decay

42. The class of identical particles for which destructive interference occurs in symmetrical situations is called

A) * fermions

B) pions

C) photinos

D) gravitons

E) bosons

43. The wave phenomenon in which a wave can bend around objects is known as

A) interference

B) oscillation

C) * diffraction

D) radiation

E) decoherence

44. One sees bright colors reflected from an oil film floating on water due to

A) the color of the oil

B) the color of the water

C) * interference of light reflected from the top and bottom of the film

D) bright illumination

E) the color of the pavement

45. In stars both the CNO cycle and the proton-proton process

A) make most of the elements beyond helium

B) make hydrogen

C) include the triple alpha reaction

D) make deuterium

E) * lead to the conversion of hydrogen into helium to power the star

The Following Three Questions Are Optional

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

    A)
    B)
    C)
    D)
    E)

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

    A)
    B)
    C)
    D)
    E)

48. Suggestions to improve my Physics 10240 Elementary Cosmology Course

    A)
    B)
    C)
    D)
    E)