Elementary Cosmology ... Fall 2012

Final Exam ... December 13, 2012 ... 10:30am-12:30pm

Name:______________________________ NetID:__________

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. Please check your work

1. The meaning of a probabilistic prediction from quantum mechanics is:

   A×) quantum mechanics can never make a precise prediction

   B×) if the measurement is repeated many times the outcomes will never be the same

   C×) the measurement can not be repeated

   D*) if the measurement is repeated many times the outcomes will be distributed according to the predicted probabilities

   E×) all of the above

2. A simplification to the large number of strongly interacting particles was brought about by

   A*) the discovery of quarks

   B×) the distinction between fermions and bosons.

   C×) the discovery of antimatter

   D×) the discovery of the charm quark

   E×) the discovery of helium

3. In quantum chromodynamics the strong charges are given the whimsical name

   A×) charm

   B×) strange

   C×) texture

   D×) flavor

   E*) color

4. In QCD there are 3 charges and 3 anti-charges, How many gluons are there?

   A×) 3

   B×) 6

   C×) 9

   D*) 8

   E×) 1

5. The quark contribution of mesons is

   A×) 3 quarks

   B*) a quark and an anti-quark

C×) 3 anti-quarks

D×) a quark and a gluon

E×) a fermion and a boson

6. Cosmic inflation is introduced to solve

   A×) the flatness problem

   B×) the horizon problem

   C×) the monopole (or monstrosity) problem

   D*) all of the above

   E×) the mass problem

7. Cosmic inflation is driven by

   A*) a phase transition in the Higgs field

   B×) quantum fluctuations

   C×) vacuum polarization

   D×) the gluon field

   E×) extra spatial dimensions

8. The symmetry of the isotropy of space is broken by a ferromagnet since all of the electrons line up in the same direction. The symmetry can be restored if the magnet is

   A×) broken into pieces

   B×) cooled to liquid nitrogen temperatures

   C×) rotated

   D*) heated to above 893 degrees Kelvin

   E×) allowed to pivot like a compass

9. Super symmetry is the name given by particle physicists to the symmetry between

   A*) fermion and boson particles

   B×) the directions of space

   C×) space and time

   D×) matter and antimatter

   E×) right handed and left handed particles

10. Since gravitation is attractive the discovery of an accelerating universe would require

    A×) white holes

B×) more kinds of quarks

C*) a modification to gravitation called dark energy, formerly known as the cosmological constant

D×) black dwarfs

E×) darker dark matter

11. A feature of quantum chromodynamics (QCD) is asymptotic freedom. Asymptotic freedom means

A×) the electromagnetic forces gets stronger at short distances

B×) the proton will split into 3 quarks if struck hard enough

C×) there is an upper limit on the size of an atomic nucleus

D×) protons can decay

E*) the strong force gets weaker at short distances

12. The Messier catalog of galaxies and star clusters was created in 1774 to

A*) avoid mistaking these objects for comets.

B×) look for planets

C×) look for galaxies

D×) understand supernova remnants

E×) determine the age of the universe

13. Star spectral type are indicated by a letter. Ordered according to surface temperature from hottest to coolest, as established by Annie Jump Cannon these types are:

A×) A B C D E F G

B*) O B A F G K M

C×) M K G F A B O

D×) A1 B2 C3 D4 E5 F6

E×) Z Y X W V U T

14. Biblical estimates for the age of the universe yields a value at about

A×) 2012 years

B×) 14 billion years

C*) 5000 years

D×) infinite

E×) 10 billion years since the last recurrence

15. In the mid nineteenth century before nuclear energy generation had been discovered, based on the amount of energy generated by the sun Helmholtz and Kelvin estimated that the age of the sun could be no greater than

   A×) 14 billion years

   B×) 5000 years

   C*) from 40 to 500 million years

   D×) 1000 years

   E×) 14 years

16. The color of a star in our galaxy is most indicative of

   A×) its distance

   B*) its surface temperature

   C×) its surface area

   D×) its elemental composition

   E×) its relative velocity

17. The large scale structure problem of the cosmic microwave background concerns

   A×) the existence of elements heavier than helium

   B×) the absence of magnetic monopoles

   C×) the absence of miniature black holes

   D×) the very long age of the universe

   E*) the emergence of galaxies and galactic clusters from a perfectly smooth universe

18. Cepheid variable stars are a useful distance estimator because

   A*) one can estimate their absolute luminosity from their period of variability

   B×) they have a constant absolute luminosity

   C×) their absolute luminosity depends on their distance

   D×) they are very dim stars

   E×) they live for a very long time

19. Zwicky first encountered the need for dark matter in 1933 when he

   A×) discovered supernovae

   B×) measured the distance to Andromeda

   C*) measured the velocity of galaxies in the Coma Cluster

   D×) invented neutron stars

E×) calibrated the Cepheids

20. Weak gravitation lensing has been used to search for dark matter in the form of

    A×) hot dark matter

    B×) gas and dust

    C*) MACHOs - massive compact halo objects - faint stars and planets

    D×) WIMPs

    E×) a cosmological constant

21. One can estimate the age of a globular cluster of stars by

    A×) measuring the mass of the cluster

    B×) measuring the color of the cluster

    C×) measuring the size of the cluster

    D*) looking for the turn off point of stellar evolution

    E×) measuring the gravitation of the black hole at the center

22. The apparent luminosity of a star is measured by a number, its magnitude. If star A has magnitude 1 and star C has magnitude 6 their brightness differs by

    A×) C is 100 times brighter (2.512^5) than A

    B*) A is 100 times brighter (2.512^5) than C

    C×) C is 6 times brighter than A

    D×) A is 6 times brighter than C

    E×) C is a million times brighter (10^6) than A

23. The reason main sequence stars are found in a band on the color-luminosity diagram, (also known as the H-R or Hertzsprung-Russel diagram) is because

    A×) gas and dust obscures the other stars

    B×) dark matter does not emit light

    C×) black holes are at the centers of galaxies

    D×) stars are constantly being reborn

    E*) their temperature and size are determined almost exclusively by the mass of the star.

24. Elements beyond helium are not made during the big bang because

    A×) elements are made in stars

    B×) elements are made in supernovae

C*) there are no stable nuclei with 5 or 8 protons plus neutrons

D×) elements are made during stellar birth

E×) all elements are made in the big bang

25. One of the motivations in predicting the charm quark was

    A×) the discovery of charm particles

    B×) the discovery of strange particles

    C×) the discovery of antimatter

    D×) the discovery of parity violation

    E*) the absence of a decay that would otherwise have been allowed

26. Distances to nearby stars can be determined with parallax. Parallax is

    A×) the decrease in brightness with the square of the distance

    B×) the increase of red shift with distance

    C×) proper motion of stars through space

    D*) the apparent shift in location of a star when viewed at different points in the Earth's orbit

    E×) the bending of light by gravitation

27. The CNO cycle is found in some main sequence stars but not the sun. Why?

    A×) the sun lacks the C, N and O needed

    B*) more massive stars have higher core temperatures and densities so they can overcome the stronger electrical repulsion of the CNO cycle

    C×) the proton-proton process is so much faster so CNO can not compete in the sun

    D×) smaller stars use the CNO cycle since their proton-proton rate is so slow

    E×) the sun lacks the hydrogen needed for the CNO process

28. White dwarf stars can be useful clocks since

    A*) they have no energy source and cool with time

    B×) they pulsate with a period that depends on their luminosity

    C×) they are supported by degenerate fermi gas pressure

    D×) when found in binary stars their orbital period can be determined

    E×) all white dwarf stars were created in the Big Bang

29. The COBE satellite measured fluctuations of temperature in the CMB of

    A×) 90 degrees

B×) 2.725 degrees

C×) 1 degree

D×) 5 millionths of one degree

E*) 36 millionths of one degree

30. The largest acoustic peak in the point to point spatial fluctuations in the CMB measured with the WMAP satellite occur at an angular size of

A×) 0.33 degrees (l of about 540)

B×) 0.2 degrees (l of about 800)

C×) 36 millionths of one degree

D×) 36 degrees

E*) 0.60 degrees (l of about 220)

31. One argument that cold dark matter can not be made up of ordinary, proton and neutron matter is

A×) there would be too many stars

B×) there would be too many galaxies

C×) the extra matter would fall into black holes

D*) There would have been to many nucleons in the early universe and too many heavy elements would have been formed

E×) the early universe would have been too hot.

32. In cosmology the horizon problem is

A×) Hawking radiation can be emitted from black holes

B×) radiation is emitted from accretion disks near a black hole

C*) regions of the universe, separated by distances which could not have been crossed since the beginning of the universe have the same temperature

D×) the universe should have collapsed by now

E×) dark matter will block our view of the cosmic microwave background

33. The Bullet cluster, two galaxies which collided about 150 million years ago has been studied with gravitational lensing to map its mass and xrays to map its normal atomic matter. The significance of the spatial separation of these two components is it is observational evidence

A*) for collisionless cold dark matter.

B×) of stars older than the universe

C×) for the creation of matter in collisions

D×) evidence for black holes

E×) for star formation

34. Cosmic inflation requires that space be created

  A*) faster than the speed of light

  B×) by dark matter

  C×) by stellar radiation

  D×) by Hawking radiation

  E×) to compensate for space being destroyed

35. Quantum mechanics teaches us that if we want to measure a very long decay lifetime, such as 10^{31} years, (10 trillion times older than the universe) one can

  A×) wait for about 1/2 of 10^{31} years

  B*) measure a few times 10^{31} particles for a year or two

  C×) look for the decay in a parallel universe

  D×) link the decay to a cat and look for dead cats

  E×) accelerate the decay by manipulating the Higgs field

36. Grand unified theories unite

  A×) the electrical and magnetic forces

  B×) the strong and weak nuclear force

  C×) space and time

  D×) the gravitational, weak, electromagnetic and strong forces

  E*) the strong, electromagnetic and weak forces

37. The unification of quarks and leptons in grand unified theories leads to predictions of new forces that mediate

  A×) gravitation

  B×) the Higgs force

  C×) superstrings

  D×) supergravity

  E*) the decay of protons

38. The total luminosity (light energy radiated) by a star is determined by

  A×) its distance

B×) its angular momentum

C*) its surface temperature (T^4) and surface area

D×) its elemental composition

E×) the age of the star

39. The high z supernova team and the supernova cosmology project concluded the expansion of the universe is accelerating based on observations of supernova at large redshift. The supernova appear to be

A×) moving faster than expected

B×) about 25% brighter than expected so closer than expected

C×) more frequent than expected

D×) decaying faster than expected

E*) about 25% dimmer than expected so further than expected

40. The concept that the universe had a beginning was put forward in 1927 in Belgium by

A×) Albert Einstein

B×) Edwin Hubble

C*) Georges Lemaître

D×) George Gamow

E×) Fritz Zwicky

I hope you have enjoyed this Cosmology course.
Have a safe Christmas holiday.