Name: _____

AS-102, SECTION A1, SPRING 2010
Extra Credit Assignment

Due: No Later than 9:00am Tuesday, May 4
Hand in using Homework Box prior to May 4, or give to Professor Brainerd on May 4

IMPORTANT!
You must hand in a hardcopy with the letters circled to indicate your answers.
If you write your answers on a single piece of paper, you will receive a score of ZERO.

Below are 50 multiple choice questions, each of which is worth 1 point. **CIRCLE THE LETTER** next to the response which you feel best represents the correct answer to the question.

1. Tycho Brahe's observations of _____ discredited the Ancient Greek philosophy about the nature of the heavens.
   a) the retrograde motion of Mars
   b) mountains on the moon
   c) sunspots
   d) a supernova

2. Approximately how many stars exist in galaxies like our own Milky Way galaxy?
   a) 100 thousand
   b) 10 million
   c) 10 billion
   d) 100 billion

3. Imagine you were to take two photographs of a spiral galaxy that is seen edge-on. The first photograph is taken with an ordinary camera which captures optical light. The second photograph is taken with a heat-sensitive camera which captures infrared light. In comparing the two photographs you would notice:
   a) a dark lane running through the disk of the galaxy in the same location on both photographs
   b) a dark lane running through the disk of the galaxy in the second photograph, but not in the first photograph
   c) more individual stars can be seen in the disk of the galaxy in the second photograph than in the first photograph
   d) the second photograph has a shows a bright band of infrared light in the disk that coincides with the location of a dark band in the first photograph

4. Winter in Boston occurs when the earth is traveling at its fastest in its orbit about the sun. Therefore, winter in Boston must also coincide with the time when the earth is at
   a) its minimum distance from the sun
   b) its maximum distance from the sun
   c) its average distance from the sun
   d) a distance of 4 AU from the sun

5. The vast majority of the light in the universe is associated with
   a) active galaxies
   b) normal galaxies
   c) light left over from the big bang
   d) hot material nearby to massive black holes

6. If the Big Bang theory is correct then a star in our galaxy that is 1 million years old should have a far _____ than a star in our galaxy that is 10 billion years old.
   a) higher percentage of magnesium
   b) smaller percentage of silicon
   c) higher percentage of dark matter
   d) smaller percentage of dark energy

7. The reason that the Galilean satellites (i.e., the 4 large moons) orbit about Jupiter is that
   a) Jupiter exerts a greater force of gravity on the satellites than the satellites exert upon Jupiter
   b) the satellites experience a greater acceleration than does Jupiter
   c) the satellites are simply following Jupiter's orbit about the sun
   d) Jupiter has a very large magnetic field

8. If you wanted to detect the remnants of the original explosion with which the universe began, you should look
   a) for a cluster of galaxies
   b) towards any point on the sky with a telescope capable of detecting microwave photons
   c) for a single bright point of visible light that has a large redshift
   d) for a single source of very strong X–ray light

9. The Big Bang theory is falsifiable because
   a) it makes a number of incorrect predications about the observed universe
   b) it makes very specific predictions that can be tested directly with observational data
   c) it does not explain why some large galaxies are spirals and others are ellipticals
   d) it does not account for the existence of dark energy in the universe

10. The mass of the nucleus of a helium atom is slightly less than 4 times the mass of the nucleus of a hydrogen atom. Therefore,
   a) 4 hydrogen nuclei have more mass-energy than does one helium nucleus
   b) the nucleus of a helium atom has 4 more electrons than the nucleus of a hydrogen atom
   c) if you were to apply an identical force to the nucleus of a hydrogen atom and to the nucleus of a helium atom, the helium atom would undergo a greater acceleration
   d) the nucleus of a hydrogen atom will always have less kinetic energy than the nucleus of a helium atom

11. The most common molecule in molecular clouds is
   a) carbon monoxide (CO)
   b) ammonia (NH_3)
   c) alcohol (CH_3CH_2OH)
   d) hydrogen (H_2)

12. Which of the following is a true statement about the ancient Greeks and the phenomenon of stellar parallax?

a) They did not understand that stellar parallax should occur if the earth were to orbit the sun.
b) They observed stellar parallax, but they rejected the observations because they conflicted with their theories of the universe.
c) They did not bother to look for stellar parallax because in their model of the universe stellar parallax would not have occurred.
d) They were unable to observe stellar parallax because the angles were too small for them to measure.

13. You are standing on a railway platform watching an extremely long, extremely fast train pass by. The train is 600,000 km long and is moving at 100,000 km/s. At the very center of the train is a light bulb (which is switched off) and at either end of the train are doors that will open when they are struck by a light beam. As the train approaches you, a passenger switches on the light bulb. You will notice:

a) both doors on the train open simultaneously
b) the rear door of the train opens first, followed by the front door
c) the front door of the train opens first, followed by the rear door
d) it takes exactly 2 seconds (as measured by your wristwatch) for the light to strike each door

14. Which of the following is a true statement within the context of scientific cosmology?

a) time exists only within the universe but space may exist outside it
b) after the Big Bang, the universe expanded to fill space
c) space exists only within the universe, but time may exist outside it
d) time came into existence with the birth of the universe

15. Which of the following is evidence in support of the idea that elliptical galaxies were formed by the collision and merger of a number of small galaxies?

a) elliptical galaxies are never observed in the distant past, whereas spiral galaxies are often observed in the distant past
b) elliptical galaxies are generally found in isolation, with no nearby neighboring galaxies
c) elliptical galaxies are generally found in large clusters of galaxies, with many nearby neighboring galaxies
d) high-resolution images of elliptical galaxies show that most ellipticals have at least two supermassive black holes at their centers

16. Disks are expected to form during the process of star formation because of the conservation of

a) mass
b) linear momentum
c) total energy
d) angular momentum

17. Which of the following can be considered to be an inertial reference frame?

a) an elevator that is falling freely under gravity
b) a rocket traveling through space at a constant velocity
c) a car traveling along a circular racetrack at constant speed
d) a space probe falling into a black hole

18. Kepler's second law of planetary motion ("equal areas in equal time") could be used to determine how

a) Mars' orbital speed changes throughout the year
b) fast Venus orbits the sun, compared to Jupiter
c) fast the earth rotates on its axis
d) often solar eclipses should occur

19. All galaxies that are located outside the small group of galaxies to which the Milky Way belongs are observed to be redshifted. This is generally interpreted as proof that

a) the universe was smaller in the distant past than it is today
b) the cosmological principle is valid outside of our own small group of galaxies
c) the Milky Way is located at the center of the universe
d) the Milky Way exerts a repulsive force on the galaxies

20. Which of the following is the primary difference between the appearance of the spectra of different stars?

a) the presence or absence of a continuous spectrum
b) the presence or absence of individual emission lines
c) the differing strengths and patterns of absorption lines
d) none of the above - the spectra of all stars have basically the same appearance

21. Suppose you were to attempt to touch the surface of a black hole. Assuming your hand survives the attempt intact, what would the surface of the black hole feel like?

a) the surface is extremely hard
b) the surface is extremely cold
c) the surface is rubbery, like the surface of a balloon
d) nothing – your hand just passes through into the black hole without any resistance

22. Approximately how many galaxies are thought to exist in the observable universe?

a) 100 thousand
b) 500 million
c) 13 billion
d) 100 billion

23. Where on the H-R diagram would you look to find a star that is fusing hydrogen in its core?

a) main sequence
b) upper left
c) red giant region
d) lower left

24. Which of the following observations suggests that the expansion rate of the universe is accelerating at the present day?

a) galaxies inside clusters of galaxies are moving too quickly to be explained by the amount of mass that is contained within the individual galaxies
b) the farther a galaxy is from us, the faster it is receding from us
c) supernovae in very distant galaxies are fainter than would be expected if the expansion rate of the universe decelerated for all time
d) the temperature of the CMBR is about 2.7 K

25. Which of the following is evidence that suggests that spiral galaxies are surrounded by a large amount of dark matter?

a) The rotation speed of the material in the disk decreases with radius in a manner similar to the rotation speeds of the planets in the solar system.
b) Many highly–variable sources of X–ray light, suggestive of the presence of black holes, have been found throughout the luminous parts of their halos.
c) The rotation speed of the material in the disk is approximately constant at large distances from the center of the galaxy.
d) The intensity of light in the disks of spiral galaxies increases with the distance from the center of the galaxy.

26. Consider two elliptical galaxies. Galaxy A has an image that is circular and galaxy B has an image that is noticeably elliptical. Which of the following is most likely to be true?

a) Galaxy A is spherical and galaxy B is shaped like a football.
b) Galaxy B is rotating at a high speed, causing it to flatten out.
c) Both galaxies are shaped like footballs, but are seen from different angles.
d) Galaxy B has been gravitationally lensed.

27. Which of the following does the Big Bang not specifically predict?

a) the evolution of galaxies
b) the CMBR
c) an expanding universe
d) a universe that has changed over time

28. How can an atom change from a high energy state to a low energy state? It must

a) lose energy in the form of light
b) become colder
c) lose kinetic energy
d) gain mass–energy

29. You compare the spectra of two stars, and you discover that the spectrum of star A peaks at a higher frequency than does the spectrum of star B. You also notice that the absorption lines of helium occur at systematically higher frequencies in the spectrum of star A than they do in the spectrum of star B. You therefore conclude

a) star A is hotter than star B, and the spectrum of star A is blueshifted
b) star B is hotter than star A, and star B is stationary with respect to you
c) the distance between you and star A is changing faster than is the distance between you and star B
d) the distance between stars A and B is changing, but it may be either increasing or decreasing

30. Which of the following could never occur if an atom were to absorb a photon?

a) an absorption line is produced
b) the atom is ionized
c) an electron moves to an orbital that corresponds to a higher energy state
d) the atom gains mass–energy

31. Suppose you lived on Mercury. Which of the following would you find to be true?
    a) you would observe all of the other planets to move from west to east with respect to the stars at all times
    b) you would occasionally notice Venus and Earth undergoing retrograde motion, but not Mars or Jupiter
    c) you would notice that all of the other planets undergo retrograde motion simultaneously
    d) you would notice that, over the course of a "year" on Mercury, each one of the other planets would undergo retrograde motion at some time

32. Einstein concluded that mass
    a) causes a curvature of spacetime
    b) causes the speed of light to increase
    c) has no relationship with energy
    d) decreases as one travels faster

33. The smaller is the Schwarzschild radius of a black hole,
    a) the larger is the mass of the black hole
    b) the greater is the curvature at the event horizon
    c) the greater is the escape speed just outside the even horizon
    d) the less will be the tidal stresses encountered by a space probe as it approaches the event horizon

34. You measure the average speeds of the molecules in two gasses, A and B, and you find that the average speed of the molecules in gas A is considerably larger than the average speed of the molecules in gas B. You can therefore conclude
    a) gas B is cooler than gas A
    b) gas A is undergoing a contraction due to the pull of gravity
    c) gas B is more likely than gas A to be emitting black body radiation
    d) gas A contains more helium than gas B

35. The most common morphology of galaxies in the local universe is
    a) irregular
    b) spiral
    c) elliptical
    d) lobed

36. The emission lines of neon gas _____ the absorption lines of neon gas.
    a) occur at very slightly higher frequencies than
    b) may be systematically redshifted compared to
    c) are caused by energy changes that are identical to those that cause
    d) are more likely to be observed in the lab than are

37. Suppose you wanted to study the process of star formation in a large number of galaxies in the nearby universe. You would have the greatest success if you restricted your investigation to
    a) galaxies residing in the center of a large cluster of galaxies
    b) quasars
    c) active galaxies with the biggest central black holes
    d) a randomly-chosen selection of spiral and irregular galaxies

38. Which of the following is currently the biggest challenge for the WIMP theory of the nature of dark matter?

a) It does not produce the correct "lacework" structure in the distribution of galaxies.
b) It is unable to produce enough galaxies over the age of the universe.
c) It is a theory which is based on a currently hypothetical material.
d) It is unable to explain the rotation curves of the disks of spiral galaxies.

39. The greater the energy of a photon, the

a) greater is its speed
b) shorter is its wavelength
c) more likely it is to be blueshifted
d) redder is its color

40. According to the theory of General Relativity, the shortest distance between any two points

a) is never curved
b) is the path taken by light
c) is the path that leads through a black hole
d) often cannot be determined

41. In order for any object to emerge from within a black hole,

a) the black hole would have to have a mass less than that of the earth
b) the object would first have to become very hot
c) the object would have to have the capability of traveling faster than the speed of light
d) the black hole would have to first gain an amount of mass equal to the mass of the object

42. Due to the effects of the cosmological redshift,

a) we see galaxies as they appeared in the distant past
b) the photons emitted from distant galaxies lose energy as they travel towards us
c) galaxies appear to be bluer in color than they otherwise would
d) all faint blue galaxies appear to be moving away from us at speeds greater than c

43. According to the equivalence principle,

a) light and mass are equivalent
b) velocity and speed are equivalent
c) mass and energy are equivalent
d) gravitation and acceleration are equivalent

44. The small, circular secondary orbit along a planet's primary orbit that Ptolemy invoked in order to explain retrograde motion was known as an

a) ellipse
b) epicycle
c) eccentric
d) ecliptic

45. According to the Ancient Greek philosophers, which of the following was associated with disturbances in the earth's atmosphere?

a) comets
b) phases of the moon
c) retrograde motion of the planets
d) eclipses of the sun

46. You discover a intermittent source of X-ray light coming from a particular region of space. The light flickers on and off regularly every few seconds. You can conclude that the region of space from which the X-rays are emitted is

a) larger than the distance over which light can travel in a few seconds
b) smaller than the distance over which light can travel in a few seconds
c) larger than the distance over which light can travel in a few minutes
d) smaller than the distance over which light can travel in a tenth of a second

47. Suppose you are traveling in the vicinity of a black hole in a spaceship that has maximum speed of $0.1c$. The closest that you can get to the black hole and not be pulled in is equal to _____ times the Schwarzschild radius of the black hole.

a) 1
b) 10
c) 100
d) 1000

48. Which is a true statement in the context of modern, scientific cosmology?

a) The universe has a center, but it is not possible to say exactly where the center is located.
b) There is no center to the universe.
c) If you had been able to look in all directions throughout the universe 5 billion years ago, you would have seen that the universe looks exactly the same as it does today.
d) If you had been able to travel to all locations in the universe 5 billion years ago, you would have found them to be exactly the same as they are today.

49. The surface of a plain white cylinder is an example of a surface which is

a) homogeneous, but not isotropic
b) isotropic, but not homogeneous
c) both homogeneous and isotropic
d) neither homogeneous nor isotropic

50. In a geocentric model of the solar system, the rising and setting of the stars is caused by:

a) the rotation of the earth from west to east
b) the rotation of the stars from east to west
c) the rotation of the stars from north to south
d) nothing; the stars do not rise or set