1. A star has a brightness of 10 units as measured at a distance of 1 light year, its brightness at a distance of 10 light years will be
   A) 1 unit
   B) 0.1 units
   C) 0.01 units
   D) 100 units
   E) 10 units

2. The background radiation is in the form microwaves. In the early universe it was
   A) Not present, it was formed very late by emissions from black holes.
   B) Was originally in the form of X and gamma rays that turned into microwaves due to the gravitational redshift.
   C) Also in the microwave region
   D) Was made of electrons which were transmuted into microwaves
   E) Was made of atoms which were transmuted into microwaves

3. Consider the motion of two bugs doomed to move on a curved surface. Suppose they start from nearby points moving with the same speed in the same direction.
   A) Even though they started moving parallel to each other their paths will necessarily diverge.
   B) Since they started moving parallel to each other they will never meet.
   C) Since they are on a curved surface, the speed of one will necessarily decrease as it goes along and so it will lag behind.
   D) Even though they started moving parallel to each other they will necessarily meet.
   E) Their paths will either meet or diverge according to the shape of the curved surface.

4. A typical size for a galaxy is
   A) 1,000 light years
   B) 100,000 light years
   C) 1 light years
   D) 1,000,000 light years
   E) $10^9$ light-years
5. A Hertzsprung–Russel plot relates
   A) The velocity of a star to its color.
   B) The radius of a star to its color.
   C) The brightness of a star to its color.
   D) The redshift of a star to its distance to Earth.
   E) The brightness of a star to its redshift.

6. The principle of equivalence states that
   A) Space is necessarily flat except near a supernova.
   B) The speed of light is constant.
   C) The gravitational force is completely fictitious.
   D) Pythagoras theorem is correct in all curved surfaces.
   E) The \( m \) in \( F = ma \) and the \( m \) in \( F = mGm/r^2 \) are identical.

7. A pure element
   A) None of the options given
   B) When heated gives of light in a series of characteristic colors
   C) Cannot be isolated
   D) When heated gives of light in a continuum of colors
   E) When heated absorbs all light

8. When a star approaches an observer
   A) No information about this motion can be obtained from the starlight
   B) Its light will be shifted towards the blue.
   C) Its light is unchanged.
   D) It will inevitably burn him/her up.
   E) Its light will be shifted towards the red.

9. Dark matter is
   A) Hypothesized in order to explain the abundance of helium
   B) Another name for the dark side of the moon.
   C) Hypothesized in order to explain the cosmic background radiation
   D) Hypothesized in order to explain how stars are seen to orbit galaxies
   E) A confirmed prediction of the special theory of relativity
10. The Big Bang theory
   A) Predicts the abundances of light elements
   B) Cannot explain the abundances of any element
   C) Assumes that the initial blast was produced by nuclear fusion
   D) Is based on a big nuclear explosion
   E) Does not predict the microwave radiation but explains the abundances of heavy elements such as Uranium

11. The General Theory of Relativity is based on
   A) A multitude of postulates which are difficult to test.
   B) The principle of relativity
   C) Wrong assumptions
   D) The fact that the speed of light is absolute.
   E) A single postulate: the principle of equivalence

12. A Cepheid variable is useful in determining distances because
   A) Their strong X ray emissions are well known
   B) They represent gas clouds and so we can use them to determine the distance to the places where stars are born
   C) They all the same constant brightness
   D) They easily out-shine a galaxy and can be seen from very far
   E) They brighten periodically and their period determines their brightness

13. One of the standard tests of General Relativity is
   A) The constancy of the speed of light.
   B) The Michelson-Morely experiment.
   C) The observation of the bending of light in an eclipse.
   D) The Doppler effect.
   E) The slight difference between gravitational and inertial masses.

14. A massive black hole lies between Earth and a very bright star; both star and black hole are perfectly spherical. Astronomers on Earth see
   A) A quadruple image of the star
   B) A circle of light composed of images of the star
   C) An infinitely bright star
   D) A double image of the star
   E) Nothing: the black hole blocks all light from the star
15. It is found that all galaxy clusters are moving away from our galaxy due to
   A) A particular repulsion generated by our galaxy.
   B) The fact that the universe is expanding and in doing so it carries all matter with it.
   C) An optical illusion produced by the Sun's gravitational force
   D) The fact that all galaxies have negative charge and equal charges repel
   E) The fact that all galaxies have positive charge and equal charges repel

16. Measuring distances to near star using parallax relies on
   A) The fact that light bends around the sun
   B) The 1/(distance)^2 rule
   C) The periodic brightening of all stars (which we know as twinkling)
   D) Geometry, and the knowledge of the size and shape of Earth's orbit
   E) The emission and absorption lines

17. A black hole is an object that
   A) Cannot have object orbiting around it, no matter how far, since they will always be
      pulled into it.
   B) Traps all objects that come too close, including light.
   C) Cannot exist in the center of galaxies since they are very brilliant.
   D) Is the end product of all stellar evolutionary lines.
   E) By virtue of its immense gravitational field cannot rotate.

18. The inertial mass of a body determines
   A) The absolute speed of the body
   B) The acceleration of a body for any given force
   C) The magnetic charge of the body
   D) The electric charge of the body
   E) The strength of the gravitational force generated by the body

19. If the universes is 13.5 billion years old, then any object farther than 13.5 billion light years away from us
   A) Cannot be seen since its light has not reached us
   B) Must have been destroyed during the big bang
   C) Is necessarily too dim to be seen
   D) Will shine in the X-ray region
   E) Is seen to be blue shifted
20. The basic idea for determining distances to luminous objects is to
   A) Use the bending of light to determine the mass of the object and then calculate the orbits using Newton's theory. Then the orbits are observed from Earth and these data determine the distance
   B) Use a very, very long ruler
   C) Use the fact that light, unlike sound, is not Doppler shifted
   D) Wait until space travel is sufficiently advanced to go there
   E) Infer the brightness near by, to measure the brightness on Earth and then use the $1/(\text{distance})^2$ rule

21. A consequence of the equality of the gravitational and inertial masses (that is the mass $m$ appearing in Newton's expression or the gravitational force and the mass $m$ in $F = ma$) is that
   A) Any two sufficiently heavy bodies will follow different trajectories.
   B) There is no absolute velocity.
   C) All bodies are attracted to each other
   D) Gravity produces the same acceleration on all objects.
   E) Light paths are curved

22. A box is being accelerated uniformly while an identical box is placed on top of Mars. Each box comes with its observer. Then when experiments are done in each box both observers will get the same results
   A) Except for the speed of light which is always very small for the observer resting on Mars.
   B) Only for small boxes (provided the acceleration of the first box is chosen appropriately)
   C) For boxes of any size (provided the acceleration of the first box is chosen appropriately).
   D) No matter what the acceleration of the first box is chosen nor what size boxes are used.
   E) Only for boxes as large as the diameter of Mars (provided the acceleration of the first box is chosen appropriately)

23. Gravitational and acceleration effects are equivalent
   A) Only over enormous distances
   B) Only far from black holes
   C) Only over small regions
   D) In all circumstances and over all distances as guaranteed by the principle of equivalence
   E) Only near black holes
24. A clock on the surface of the Earth is compared to a clock far in deep space which is at rest with respect to the Earth. We find that
   A) The Earth and space clocks are perfectly synchronized
   B) The Earth clock is periodically fast and slow with respect to the space clock as the Earth moves around the Sun
   C) The Earth clock is slow with respect to the space clock
   D) The space clock is periodically fast and slow with respect to the Earth clock as the Earth moves around the Sun
   E) The Earth clock is fast with respect to the space clock

25. The orbit of Mercury
   A) Will eventually cross that of Venus and they will collide
   B) Appears to precess, but in fact it does not. The precession is merely an illusion produced by the bending of light near the Sun
   C) Precesses as predicted by General Relativity
   D) Is predicted by Newton's equations to the available accuracy
   E) Is being enlarged continuously by gravity's pull
Answer Key

1. B
2. B
3. E
4. B
5. C
6. E
7. B
8. B
9. D
10. A
11. E
12. E
13. C
14. B
15. B
16. D
17. B
18. B
19. A
20. E
21. D
22. B
23. C
24. C
25. C