

## Physics 7 sample midterm #2

This is intended as an illustration of the types of questions students can expect. The actual examinations also contain short answer questions, no samples of those are provided, but the statements are similar to those of the multiple-choice questions. Though the answer key is at the end of this sample, students are encouraged to attempt questions before looking at the answers

1. The formula  $E = mc^2$  implies that,
  - A) The speed of light is variable depending on the mass of the body.
  - B) Mass has no relation to energy.
  - C) The energy of a body is independent of its mass.
  - D) One cannot convert mass into energy as it requires too much work.
  - E) Mass and energy are equivalent.
  
2. A green comet goes by the Earth, and is observed from both an observatory in England and from a satellite sent by NASA. The satellite's orbit is such that it is at rest with respect to the comet. On December 10 the satellite cameras showed that the tip and the tail of the comet turned from green to red simultaneously, in England they saw
  - A) That these events did not occur simultaneously
  - B) That the tip stayed green but the tail turned red
  - C) That the events occurred simultaneously
  - D) That both tip and tail stayed green
  - E) That the tip turned red but the tail stayed green
  
3. A black hole is an object that
  - A) Traps all objects that come too close, including light.
  - B) Cannot have object orbiting around it, no matter how far, since they will always be pulled into it.
  - C) Cannot exist in the center of galaxies since they are very brilliant.
  - D) By virtue of its immense gravitational field cannot rotate.
  - E) Is the end product of all stellar evolutionary lines.
  
4. One of the standard tests of General Relativity is
  - A) The constancy of the speed of light.
  - B) The Michelson-Morely experiment.
  - C) The Doppler effect.
  - D) The slight difference between gravitational and inertial masses.
  - E) The observation of the bending of light in an eclipse.

5. Measuring distances to near star using parallax relies on
- The emission and absorption lines
  - The  $1/(\text{distance})^2$  rule
  - The fact that light bends around the sun
  - Geometry, and the knowledge of the size and shape of Earth's orbit
  - The periodic brightening of all stars (which we know as twinkling)
6. The Big Bang theory
- Assumes that the initial blast was produced by nuclear fusion
  - Is based on a big nuclear explosion
  - Cannot explain the abundances of any element
  - Does not predict the microwave radiation but explains the abundances of heavy elements such as Uranium
  - Predicts the abundances of light elements
7. 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
- Except for the speed of light which is always very small for the observer resting on Mars.
  - No matter what the acceleration of the first box is chosen nor what size boxes are used.
  - For boxes of any size (provided the acceleration of the first box is chosen appropriately).
  - Only for boxes as large as the diameter of Mars (provided the acceleration of the first box is chosen appropriately)
  - Only for small boxes (provided the acceleration of the first box is chosen appropriately)
8. A star with mass below 1.4 solar masses goes through the following stages from birth to death (BH=black hole, GC=gas cloud, HBS=hydrogen burning star, NS=neutron star, RG=red giant, SN=supernova, WD=white dwarf)
- WD–BH–GC–HBS
  - GC–HBS–BH–GC
  - GC–HBS–RG–WD
  - GC–SN–BH–SN
  - BH–SN–HBS–GC

9. A Hertzsprung–Russel plot relates
- A) The brightness of a star to its redshift.
  - B) The redshift of a star to its distance to Earth.
  - C) The radius of a star to its color.
  - D) The velocity of a star to its color.
  - E) The brightness of a star to its color.
10. 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 brighten periodically and their period determines their brightness
  - D) They all the same constant brightness
  - E) They easily out-shine a galaxy and can be seen from very far
11. In white dwarfs
- A) Thermonuclear reactions rapidly transform all helium into carbon
  - B) There is no force capable of balancing gravity
  - C) The gravitational pull is balanced by the electron degenerate pressure
  - D) The gravitational pull is balanced by the centrifugal force (the star is rapidly rotating)
  - E) The large magnetic forces present produce the emission of X rays
12. Gravitational and acceleration effects are equivalent
- A) Only over enormous distances
  - B) Only near black holes
  - C) Only over small regions
  - D) Only far from black holes
  - E) In all circumstances and over all distances as guaranteed by the principle of equivalence
13. 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 clock is fast with respect to the space clock
  - 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 Earth and space clocks are perfectly synchronized
  - E) The space clock is periodically fast and slow with respect to the Earth clock as the Earth moves around the Sun

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) Nothing; the black hole blocks all light from the star
  - B) An infinitely bright star
  - C) A quadruple image of the star
  - D) A circle of light composed of images of the star
  - E) A double image of the star
15. During nuclear fusion reactions occurring in stars
- A) All elements are created
  - B) The star is in the last stage of its life
  - C) Only hydrogen is created
  - D) Only uranium is created
  - E) Only elements lighter than and including iron are created, after a substantial amount of iron is created fusion reactions stop
16. A fast train goes through a station. Inside the train waiters serve beverages. A passenger sitting in the middle of a wagon sees two waiters; one at the front and one at the rear of the wagon spill the drinks they carry at the same time. An observer on the platform
- A) Sees both waiters spill the drinks simultaneously
  - B) Sees the waiter at the back spill the drinks first
  - C) Sees the waiter at the front spill the drinks first
  - D) Will see both waiters spill the drinks simultaneously, unless the train moves close to the speed of light in which case the drinks are never spilled in the platform's frame of reference
  - E) Cannot see who does what because the train is moving too fast
17. The General Theory of Relativity is based on
- A) Wrong assumptions
  - B) A single postulate: the principle of equivalence
  - C) A multitude of postulates which are difficult to test.
  - D) The fact that the speed of light is absolute.
  - E) The principle of relativity
18. A neutron star
- A) Is a rotating black hole
  - B) Paradoxically, is a star with almost no neutrons
  - C) Is a star supported against collapse by neutron degenerate pressure
  - D) Is a star supported against collapse by nuclear reactions
  - E) Is the predecessor of a red giant

19. The collapse of a star with a core 5 times as massive as the sun's will result in
- A) A red giant
  - B) A black hole
  - C) A white dwarf
  - D) A main sequence star
  - E) A neutron star
20. 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) 0.01 units
  - B) 10 units
  - C) 100 units
  - D) 0.1 units
  - E) 1 unit
21. A pulsar is
- A) A rotating neutron star which emits a strong X-ray beam
  - B) An average star which increases and decreases its size periodically
  - C) An average star which increases and decreases its size randomly
  - D) The signal from an intelligent civilization
  - E) A rotating white dwarf which emits a strong microwave beam
22. Dark matter is
- A) Hypothesized in order to explain how stars are seen to orbit galaxies
  - B) Hypothesized in order to explain the cosmic background radiation
  - C) A confirmed prediction of the special theory of relativity
  - D) Another name for the dark side of the moon.
  - E) Hypothesized in order to explain the abundance of helium
23. When a star approaches an observer
- A) It will inevitably burn him/her up.
  - B) Its light will be shifted towards the red.
  - C) Its light is unchanged.
  - D) No information about this motion can be obtained from the starlight
  - E) Its light will be shifted towards the blue.

24. A red giant is
- A) A glowing black hole
  - B) A star just formed
  - C) A star which burns helium into heavier elements
  - D) A star burning hydrogen into carbon
  - E) A rapidly rotating neutron star
25. Length contraction
- A) Cannot be understood using Special Relativity.
  - B) Is a real effect: lengths of moving objects are measured to be smaller in the direction of motion.
  - C) Is a consequence of the equivalence principle.
  - D) Is an optical illusion.
  - E) Is produced by the pressure of the ether on all materials.
26. A star whose core mass is below 3 solar masses becomes a supernova,
- A) It will then start receding from Earth at increasingly larger speeds.
  - B) Its collapse is eventually stopped by the neutron degenerate pressure.
  - C) It will then become a red giant.
  - D) It will then look exactly like our Sun.
  - E) Its collapse is stopped by nuclear reactions turning Hydrogen into Helium.
27. The principle of equivalence states that
- A) The  $m$  in  $F = ma$  and the  $m$  in  $F = mMG/r^2$  are identical.
  - B) Pythagoras theorem is correct in all curved surfaces.
  - C) Space is necessarily flat except near a supernova.
  - D) The gravitational force is completely fictitious.
  - E) The speed of light is constant.
28. The background radiation is in the form microwaves. In the early universe it was
- A) Was made of atoms which were transmuted into microwaves
  - B) Was made of electrons which were transmuted into microwaves
  - C) Was originally in the form of X and gamma rays that turned into microwaves due to the gravitational redshift.
  - D) Not present, it was formed very late by emissions from black holes.
  - E) Also in the microwave region

29. It is found that all galaxy clusters are moving away from our galaxy due to
- A) An optical illusion produced by the Sun's gravitational force
  - B) A particular repulsion generated by our galaxy.
  - C) The fact that the universe is expanding and in doing so it carries all matter with it.
  - 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
30. Two events are seen by Peter to occur simultaneously at different places; his grandfather will
- A) See the events not to be simultaneous no matter whether he moves with respect to Peter or not
  - B) Will see the events to be simultaneous only if he is at rest with respect to Peter. If he moves with respect to Peter the events will not be simultaneous.
  - C) See the events to be simultaneous no matter whether he moves with respect to Peter or not
  - D) See the events to be simultaneous provided he moves sufficiently fast with respect to Peter
  - E) See the events to be simultaneous and at the same spot provided he moves very close to the speed of light with respect to Peter or not
31. The statement that the speed of light is absolute means that
- A) That all light came from the Big Bang
  - B) It has the same value for all observers
  - C) That it changes according to the motion of the source
  - D) That it is slowed down by gravity
  - E) That it is accelerated by gravity
32. The orbit of Mercury
- A) Appears to precess, but in fact it does not. The precession is merely an illusion produced by the bending of light near the Sun
  - B) Will eventually cross that of Venus and they will collide
  - C) Precesses as predicted by General Relativity
  - D) Is being enlarged continuously by gravity's pull
  - E) Is predicted by Newton's equations to the available accuracy
33. Light
- A) In outer space travels at different speeds in different directions
  - B) In outer space travels at different speeds in different places
  - C) Needs some transparent material such as air or water in order to propagate
  - D) Does not need any medium to propagate
  - E) Needs the ether to propagate

34. A consequence of the equality of the gravitational and inertial masses (that is the mass  $m$  appearing in Newton's expression of 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
35. If the universe is 13.5 billion years old, then any object farther than 13.5 billion light years away from us
- A) Is necessarily too dim to be seen
  - B) Will shine in the X-ray region
  - C) Must have been destroyed during the big bang
  - D) Is seen to be blue shifted
  - E) Cannot be seen since its light has not reached us
36. When a body is accelerated to speeds close to the speed of light, one observes that
- A) Its mass decreases.
  - B) Its mass increases.
  - C) Its size remains unchanged.
  - D) It slowly turns into light.
  - E) Its mass is unaltered.
37. The basic idea for determining distances to luminous objects is to
- A) Wait until space travel is sufficiently advanced to go there
  - B) 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
  - C) Use a very, very long ruler
  - D) Infer the brightness near by, to measure the brightness on Earth and then use the  $1/(\text{distance})^2$  rule
  - E) Use the fact that light, unlike sound, is not Doppler shifted
38. The inertial mass of a body determines
- A) The strength of the gravitational force generated by the body
  - B) The acceleration of a body for any given force
  - C) The magnetic charge of the body
  - D) The absolute speed of the body
  - E) The electric charge of the body

39. 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) Their paths will either meet or diverge according to the shape of the curved surface.
  - B) Since they are on a curved surface, the speed of one will necessarily decrease as it goes along and so it will lag behind.
  - C) Since they started moving parallel to each other they will never meet.
  - D) Even though they started moving parallel to each other they will necessarily meet.
  - E) Even though they started moving parallel to each other their paths will necessarily diverge.
40. A typical size for a galaxy is
- A) 1 light years
  - B) 1,000,000 light years
  - C) 100,000 light years
  - D)  $10^9$  light-years
  - E) 1,000 light years
41. A pure element
- A) When heated gives off light in a series of characteristic colors
  - B) None of the options given
  - C) Cannot be isolated
  - D) When heated absorbs all light
  - E) When heated gives off light in a continuum of colors
42. During most of a normal star's life the main nuclear reactions
- A) Accelerate the contraction of the star.
  - B) Stop.
  - C) Absorb energy.
  - D) Consist of Hydrogen being converted into Helium.
  - E) Consist of Oxygen being converted into Silicon
43. A correct statement of Einstein's principle of relativity is
- A) Absolute velocity can be determined by observing light phenomena.
  - B) Newton is always wrong.
  - C) The speed of light is relative to the state of motion of the observer.
  - D) The same laws of physics will hold in any two frames for which the laws of mechanics hold.
  - E) Galileo was right except for the case where light is concerned.

## Answer Key

1. E
2. A
3. A
4. E
5. D
6. E
7. E
8. C
9. E
10. C
11. C
12. C
13. C
14. D
15. E
16. B
17. B
18. C
19. B
20. D
21. A
22. A
23. E
24. C
25. B
26. B
27. A
28. C
29. C
30. B
31. B
32. C
33. D
34. D
35. E
36. B
37. D
38. B
39. A
40. C
41. A
42. D
43. D