Physics 111 Exam 3
Spring 2026

Multiple Choice. Choose the one alternative that BEST completes the statement or answers the question, and mark your scan sheet. Only the scan sheet will be graded. Each question is equally weighted.

1) Every second, the Sun converts about 600 million tons of hydrogen into 596 million tons of helium. The remaining 4 million tons of mass is _____.
   A) ejected into space in a solar wind
   B) converted to an amount of energy equal to 4 million tons times the speed of light squared
   C) ejected into space by solar flares
   D) reabsorbed as molecular hydrogen

   Answer: B

2) From hottest to coolest, the order of the spectral types of stars is _____.
   A) OMKGFBA B) OBAFGKM C) OBAGFKM D) ABFGKMO E) ABCDEFG

   Answer: B

3) The fundamental nuclear reaction occurring in the core of the Sun is _____.
   A) radioactive decay B) nuclear fission
   C) nuclear fusion of hydrogen into helium D) nuclear fusion of helium to carbon

   Answer: C

4) Which of the following is the best answer to the question, "Why does the Sun shine?"
   A) As the Sun was forming, nuclear fusion reactions in the shrinking clouds of gas slowly became stronger and stronger, until the Sun reached its current luminosity.
   B) As the Sun was forming, gravitational contraction increased the Sun's temperature until the core become hot enough for nuclear fusion, which ever since has generated the heat that makes the Sun shine.
   C) The Sun initially began making energy through chemical reactions. These heated the interior enough to allow gravitational contraction and nuclear fusion to occur.
   D) The Sun initially began generating energy through nuclear fusion as it formed, but today it generates energy primarily through the sunspot cycle.

   Answer: B

5) Astronomers can measure a star's mass in only certain cases. Which one of the following cases might allow astronomers to measure a star's mass?
   A) The star is of spectral type G. B) We know the star's luminosity and distance.
   C) The star is a member of a binary star system. D) The star is of spectral type A.

   Answer: C

6) According to modern science, approximately how old is the Sun?
   A) 4 1/2 billion years B) 400 million years C) 10,000 years D) 25 million years

   Answer: A

7) Why do sunspots appear dark in pictures of the Sun?
   A) They are extremely hot and emit all their radiation as X rays rather than visible light.
   B) They are too cold to emit any visible light.
   C) They are holes in the solar surface through which we can see through to deeper, darker layers of the Sun.
   D) They actually are fairly bright, but appear dark against the even brighter background of the surrounding photosphere.

   Answer: D

8) Which two theories disagree when it comes to describing the *singularity* thought to be at the center of a black hole?
   A) Quantum physics and Einstein's general theory of relativity
   B) Newton's law of gravity and Einstein's general theory of relativity
   C) Newton's law of gravity and Quantum physics
   D) Quantum physics and Maxwell's theory of electromagnetism
   E) Newton's third law of motion and Einstein's general theory of relativity

   Answer: A

9) Which of the following best explains why nuclear fusion requires bringing nuclei extremely close together?
   A) Nuclei are attracted to each other by the electromagnetic force, but this force is only strong enough to make nuclei stick when they are close together.
   B) Nuclei have to be very hot in order to fuse, and the only way to get them hot is to bring them close together.
   C) Fusion can proceed only by the proton-proton chain, and therefore requires that protons come close enough together to be linked up into a chain.
   D) Nuclei normally repel because they are all positively charged and can be made to stick only when brought close enough for the strong force to take hold.

   Answer: D

10) Sirius is a star with spectral type A star and Rigel is a star with spectral type B star. What can we conclude?
   A) Sirius has a higher surface temperature than Rigel.
   B) Sirius has a higher core temperature than Rigel.
   C) Rigel has a higher surface temperature than Sirius.
   D) Rigel has a higher core temperature than Sirius.

   Answer: C

11) The overall result of the proton-proton chain is _____.
   A) individual protons are joined into long chains of protons
   B) 4 H becomes 1 He + energy
   C) p + p becomes 1 deuterium nucleus (^{2}H) + energy
   D) 6 H becomes 1 He + energy

   Answer: B

12) Star A is <u>identical</u> to Star B, but Star A is twice as far from us as Star B. Therefore _____.
   A) both stars have the same luminosity, but the apparent brightness of Star B is twice that of Star A
   B) both stars have the same apparent brightness, but the luminosity of Star B is four times that of Star A
   C) both stars have the same luminosity, but the apparent brightness of Star B is four times that of Star A
   D) both stars have the same luminosity, but the apparent brightness of Star A is four times that of Star B

   Answer: C

13) From the center outward, which of the following lists the "layers" of the Sun in the correct order?
A) Core, radiation zone, convection zone, photosphere, chromosphere, corona
B) Core, corona, radiation zone, convection zone, photosphere, chromosphere
C) Core, convection zone, radiation zone, corona, chromosphere, photosphere
D) Core, radiation zone, convection zone, corona, chromosphere, photosphere

Answer: A

14) LIGO, the Laser Interferometer Gravitational-Wave Observatory, made the first direct observation of gravitational waves in 2015. These waves came from
A) colliding black holes
B) an asteroid falling into Jupiter
C) a star being torn apart near the event horizon of a black hole
D) a Type Ia (White Dwarf) supernova explosion
E) the supermassive black hole at the center of the galaxy M87

Answer: A

15) Carbon fusion occurs in high-mass stars but not in low-mass stars because _____.
A) only high-mass stars do fusion by the CNO cycle
B) the cores of low-mass stars never contain significant amounts of carbon
C) carbon fusion can occur only in the stars known as *carbon stars*
D) the cores of low-mass stars never get hot enough for carbon fusion

Answer: D

16) Most of the computers at the Harvard Observatory in the the late 19^{th} and early 20^{th} century were
A) women astronomers
B) mathematicians who could perform lengthy calculations very quickly.
C) mechanical computing machines
D) early versions of today's electronic computers
E) either Windows or Mac laptops with just a few Chromebooks.

Answer: A

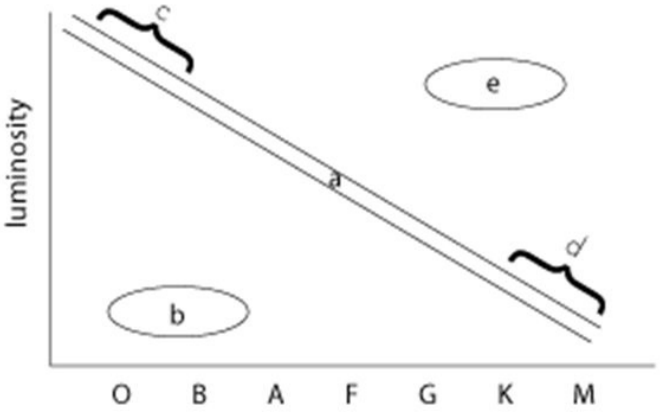
17) Where did Albert Einstein spend the last two decades of his life?
A) Zurich, Switzerland
B) Boston, Massachusetts
C) Berlin, Germany
D) Princeton , New Jersey
E) Los Angeles, California

Answer: D

18) Neil deGrasse Tyson has a word for what happens to someone who falls into a blackhole. The word is
A) macraronization
B) spaghettification
C) tidalization
D) singularization
E) pizzafication

Answer: B

The sketch below shows groups of stars on the H-R diagram, labeled (a) through (e); note that (a) represents the *entire* main sequence, while (c) and (d) represent only small parts of the main sequence.



19) Which group represents stars of the *largest radii*?

A) a B) b C) c D) d E) e

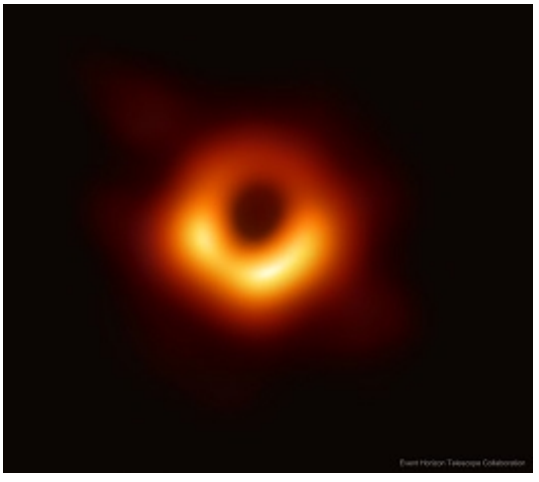
Answer: E

20) Which group represents stars that are *cool* and *dim*?

A) a B) b C) c D) d E) e

Answer: D

21) The image shown below is



A) the supernova remnant from the 1054 A.D. supernova in Taurus
B) the shadow of a black hole event horizon
C) a red supergiant star that will soon explode in a Type II (Massive Star) supernova
D) the shadow of a black hole singularity
E) the eye of Sauron from The Lord of the Rings

Answer: B

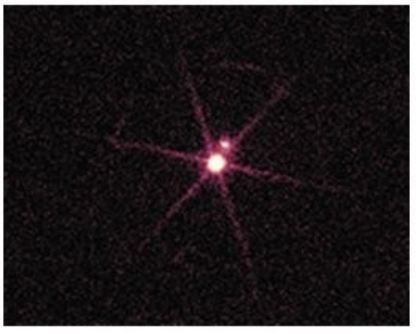
22) A *neutron star* is _____.
A) the remains of a star that died by expelling its outer layers in a planetary nebula
B) the remains of a star that died in a massive star supernova (if no black hole was created)
C) a star made mostly of elements with high atomic mass numbers, so that they have lots of neutrons
D) an object that will ultimately become a black hole

Answer: B

23) What do we mean by the *event horizon* of a black hole?
A) It is the point beyond which neither light nor anything else can escape.
B) It is the center of the black hole.
C) It is the distance from the black hole at which stable orbits are possible.
D) It is the place where x-rays are emitted from black holes.

Answer: A

24) Sirius, the brightest star in the night sky, is actually a binary star system. Sirius A is main-sequence star and Sirius B is a white dwarf. Nearly all the visible light we see from Sirius comes from Sirius A. But when we photograph the system with x-ray light, as shown here, Sirius B is the brighter of the two stars. Why?



A) As a white dwarf, Sirius B is much hotter than Sirius A and thus emits more x-rays.
B) Sirius B is brighter in x-rays because it is a nova.
C) As a white dwarf, Sirius B is too small to emit visible light but not too small to emit x-rays.
D) Sirius B is brighter in x-rays because it is a white dwarf supernova.

Answer: A

25) In which of the following cases can we determine the precise mass and density of an extrasolar planet?
A) We have detected the planet with both the transit and Doppler methods.
B) We have detected the planet with the transit method, but not any other method.
C) We have detected the planet with the Doppler method, but not any other method.
D) We have observed both transits and eclipses of the orbiting planet.

Answer: A

26) Which of the following is a major reason why it so difficult to obtain direct images of extrasolar planets?
A) Telescopes are too busy with other projects.
B) No telescope is powerful enough to detect the faint light from a distant planet.
C) Extrasolar planets give off light at different wavelengths than planets in our solar system.
D) The light of the planets is overwhelmed by the light from their star.

Answer: D

27) The Kepler Satellite was responsible for the discovery of thousands of extrasolar panets. Which detection method did it use?

A) Doppler method
B) Transit method
C) Astrometric method
D) Interferomtry method

Answer: B

28) All the following statements are true. Which one makes it possible to learn of the existence of extrasolar planets without seeing the planets themselves?

A) Planets reflect visible light from their stars.
B) Planets emit infrared light.
C) Planets exert gravitational tugs on their stars that cause stars to orbit around the center of mass of their planetary systems.
D) All the planets in a planetary system tend to orbit their star in the same direction and approximately the same plane.

Answer: C

29) Which of the following stars spends the *longest* time in the protostellar phase of life?

A) A 1 solar-mass star
B) A 2 solar-mass star
C) A 3 solar-mass star
D) A 4 solar-mass star
E) A 5 solar-mass star

Answer: A

30) The most famous equation of all time is $E = mc^2$ from Albert Einstein's Special Theory of Relativity. What does it mean?

A) the speed of light is same for all observers
B) nuclear weapons are possible
C) space and time are relative
D) energy and mass are the same thing
E) space and time are the same thing

Answer: D

31) Below is a photo of the constellation Orion as seen in the east just before sunrise. Of the objects labelled A, B, C, D, and E, which one is Betelgeuse, the star that may explode in a massive star (or Type II) supernova sometime in the (hopefully) near future?

A) A B) B C) C D) D E) E

Answer: A

32) Suppose you drop a clock toward a black hole. As you look at the clock from a high orbit, what will you notice?

A) Time on the clock will run slower as it approaches the black hole, and light from the clock will be increasingly redshifted.
B) The clock will fall faster and faster, reaching the speed of light as it crosses the event horizon.
C) Time on the clock will run faster as it approaches the black hole, and light from the clock will be increasingly blueshifted.
D) The clock will fall toward the black hole at a steady rate, so that you'll see it plunge through the event horizon within just a few minutes.

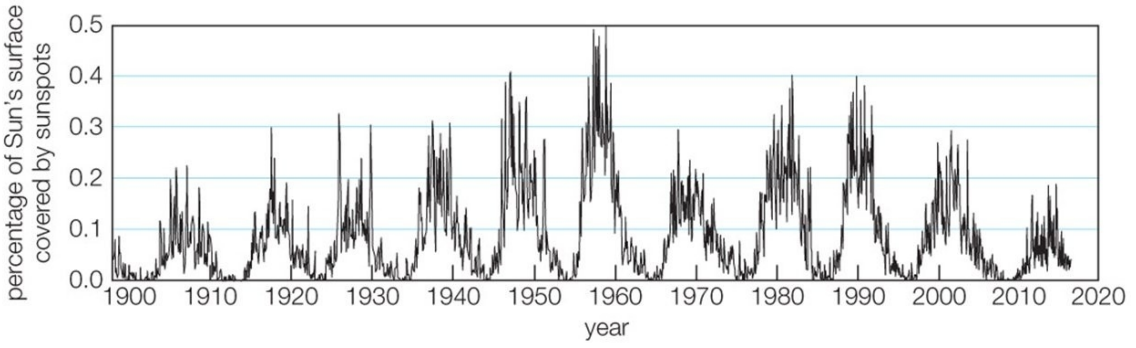
Answer: A

33) In Albert Einstein's General Theory of Relativity, the gravity between the Sun and the Earth is

A) a force of attaction between the Earth and the Sun that is proportional to the product of their masses.
B) caused by the relativity of the speed of light.
C) the Earth moving in the curved spacetime created by the Sun's mass.
D) a force of attraction between the Earth and the Sun that decreases as $1/r^2$.
E) caused by the energy contained in the mass of the Sun according to $E = mc^2$.

Answer: C

34) Study this figure and its axis labels. What is this graph showing us?



A) The latitude at which sunspots appear varies between 0 and 0.5 degrees.
B) The Sun pulsates much like a beating heart, but with each beat taking about a decade.
C) The intensity of Sunlight varies significantly over time, and reached an unusually high peak around 1960.
D) The number of sunspots on the Sun tends to increase and decrease with an approximately 11-year cycle.

Answer: D

35) Below is a photo of the constellation Orion as seen in the east just before sunrise. Of the objects labelled A, B, C, D, and E, which one is M42, an interstellar cloud of gas and dust where stars are forming?

A) A B) B C) C D) D E) E

Answer: E

36) What do we mean by the *singularity* of a black hole?

A) It is the edge of the black hole, where one could leave the observable universe.
B) It is the center of the black hole, a place of infinite density where the known laws of physics cannot describe the conditions.
C) It is the "point of no return" of the black hole; anything closer than this point will not be able to escape the gravitational force of the black hole.
D) The term is intended to emphasize the fact that an object can become a black hole only once, and a black hole cannot evolve into anything else.

Answer: B

37) This photo shows the famous Crab Nebula. What is it?

A) A classic example of a planetary nebula
B) A star that is right now undergoing a supernova explosion
C) An expanding cloud of remains from a star that died in a supernova
D) A star forming cloud that will eventually give birth to hundreds of stars

Answer: C

38) This Hubble Space Telescope photo shows a planetary nebula. What is the white dot in the center (indicated by the arrow)?

A) A white dwarf
B) A neutron star
C) A protostar that will soon become a main-sequence star
D) A red giant star with a strong stellar wind

Answer: A

39) Albert Einstein published his Special Theory of Relativity in 1905. At this time, he was working as

A) a physics teacher in a Swiss high school.
B) a waiter in a German restaurant.
C) a graduate assistant in physics at the ETH in Switzerland.
D) a clerk in the Swiss patent office.
E) a professor of physics in Berlin.

Answer: D

40) Which event marks the beginning of a supernova?

A) The onset of helium fusion after a helium flash
B) The sudden initiation of the CNO cycle
C) The beginning of neon fusion in an extremely massive star
D) The sudden collapse of an iron core into a compact ball of neutrons

Answer: D