

Choose the SINGLE answer which is BEST.

FORM X

1. What is the novel new mirror design that has allowed astronomers to build 10-meter sized optical telescopes for relatively little money?
 - a) refractive optics
 - b) reflective optics
 - c) segmented mirrors
 - d) adaptive optics
 - e) monolithic mirrors

2. Imagine you were born with sensitive radio antennae instead of eyes (lucky you). Assuming you could get out the door to look at the Sun, is it reasonable to expect that you would see it?
 - a) yes, because the Earth's atmosphere is transparent and the Sun emits radio waves
 - b) no, because the Sun is a black-body emitter and only emits in the optical
 - c) no, because the Sun is a black-body emitter and only emits in the optical, UV, and near-infrared
 - d) no, the atmosphere is opaque at radio wavelengths
 - e) yes, because the Earth's atmosphere converts radio waves into optical

3. The wavelength is:
 - a) the amplitude of the radiation.
 - b) the rate at which the atoms are oscillating.
 - c) smaller than 1cm for all types of radiation.
 - d) the distance between the crests of the wave.
 - e) not related to the frequency of light.

4. If we suddenly find out that the Universe is twice as old as we previously thought, which of the following is correct:
 - a) the speed of light is not constant
 - b) we can see only half as far out into space before we reach the event horizon
 - c) the speed of light has changed by a factor of 2
 - d) we can see twice as far out into space before we reach the event horizon
 - e) the concept of using the Universe as a time machine is invalid

5. What was one of Newton's contributions to astronomy?
 - a) He developed a theory of gravity that could explain orbital motion.
 - b) He made extensive and detailed observations of the positions of planets.
 - c) He discovered that the planets move around the Sun in elliptical orbits.
 - d) He said that the Earth is not at the center of the Universe.
 - e) He used a telescope to observe the heavens, thereby reinforcing the notion of heliocentricity.

6. Two particles, one with mass M_1 and the other with mass M_2 , are initially placed at a distance R from each other, but are otherwise isolated in space, with nothing else near them. Over time their mutual gravitational attraction causes them to move towards each other. At some later time, they are one third ($1/3$) the distance apart than they were initially. At this later time, how has their mutual gravitational attraction changed from the initial time?
- different by the inverse of the distance, i.e. $1/3$
 - unknown; it depends on how fast they are moving
 - their mutual gravitational attraction is nine times stronger because they 3 times closer
 - their mutual gravitational attraction is three times stronger because they 3 times closer
 - the same; their masses have not changed
7. To first approximation, you are a perfect thermal emitter (congratulations). Given the Sun is around 6000 degrees K and emits the most radiation at a wavelength $0.5 \mu\text{m}$, and you are about 300 degrees K, at what wavelength do you emit the most radiation?
- $5 \mu\text{m}$, in the ultra-violet
 - 1000 Angstroms
 - $0.5 \mu\text{m}$ – just like the Sun
 - $10 \mu\text{m}$, in the infrared
 - $0.025 \mu\text{m}$, or 250 Angstroms
8. The eccentricity of an orbit of one mass around another mass is small if:
- the ellipse is highly elongated.
 - equal areas are swept out in equal times.
 - the two masses move faster when they are closer together.
 - the two masses move slower when they are closer together.
 - the orbit is fairly close to circular.
9. A perfect thermal emitter is receding from you at high speed. You observe it's electromagnetic radiation through a spectrograph and determine it's temperature via Wein's law. Will it's temperature appear higher or lower than if you observe the object at rest?
- it would appear fainter but the apparent temperature would not change
 - there would be no difference because temperature does not depend on the Doppler shift
 - higher because the peak wavelength will be blueshifted
 - lower because the peak wavelength will be redshifted
 - lower because the peak wavelength will be blueshifted
10. An emission line is produced when:
- radiation passes through the outer layers of a star.
 - an electron passes from a higher to a lower energy level.
 - an electron passes from a lower to a higher energy level.
 - a proton passes from a higher to a lower energy level.
 - a proton passes from a lower to a higher energy level.

11. The Sun's energy is created by

- a) tides from Jupiter
- b) nuclear fusion of Hydrogen to Helium
- c) nuclear fusion of Helium to Carbon
- d) radioactive decay
- e) gravitational contraction

12. We can identify different chemicals in stars by:

- a) parallax.
- b) reflection.
- c) constellations.
- d) spectroscopy.
- e) measuring the brightness of the star.

13. When energy is added to an atom:

- a) a proton will often be knocked out of the nucleus.
- b) an electron will move to a lower energy level.
- c) a neutron will often be knocked out of the nucleus.
- d) an electron will move into the ground state.
- e) an electron may move to an excited level.

14. If the distance between the Earth and the Sun were doubled, how would the gravitational force change?

- a) It would stay the same.
- b) It would be twice as big.
- c) It would be four times as big.
- d) It would be four times smaller.
- e) It would be half as big.

15. Consider the gravitational interaction between the Earth and a baseball thrown into the air. If the force of gravity is acting on both of them, why does the baseball move toward the Earth and not Earth toward the baseball?

- a) The Earth moves an equal distance but we can't detect this.
- b) Because the Sun interferes with gravity.
- c) Because both the Moon and the Sun interfere with gravity.
- d) Because the Moon interferes with gravity.
- e) Because the Earth has a much larger mass than the baseball.

16. The wavelength of visible light is about the size of:

- a) a football player.
- b) a radio wave.
- c) bacteria.
- d) a fingernail.
- e) a mountain.

17. If the same force is applied to a pebble and a boulder:
- a) both will move an equal distance.
 - b) the boulder will move faster.
 - c) neither will move because any object at rest will stay at rest.
 - d) both will move at the same velocity.
 - e) the pebble will move faster.
18. Imagine you are sitting in a giant cloud of tenuous gas in outer space. The gas is so tenuous, you can see stars through it, but you can tell that they are a little bit dimmer than they would be if you weren't in the cloud. Suppose the stars are perfect black-body emitters. If you took a spectrum of any of these stars from inside the cloud, what would you see?
- a) a Planck spectrum
 - b) a blackbody spectrum with emission lines superimposed
 - c) a blackbody spectrum
 - d) a Planck spectrum with absorption lines superimposed
 - e) absorption lines
19. Convection
- a) is one mechanism for energy transport within the sun
 - b) induces fusion within the sun's interior
 - c) carries visible light from the core of the sun into outer space
 - d) occurs inside of a fluid in thermal equilibrium
 - e) causes the sun to rotate
20. How would you best distinguish Kepler's and Newton's 'laws' of orbital motion?
- a) Their laws are mathematically equivalent and therefore indistinguishable
 - b) Kepler's laws were more fundamental because of his greater understanding of quantum mechanics
 - c) Newton's laws were at the level of the Ancient Greeks whereas Kepler was breaking new ground
 - d) Kepler's laws were mathematical whereas Newton had a deeper, more general physical theory (i.e. gravity)
 - e) Newton's laws could not be used to explain orbital motion
21. If a telescope's spatial resolution is not diffraction-limited, which of the following will increase (improve) the spatial resolution?
- a) observing below the atmosphere
 - b) use a CCD with bigger pixels
 - c) building a bigger telescope
 - d) observing at shorter wavelengths
 - e) using adaptive optics

22. A light year
- a) is the distance traveled by light in one Earth year.
 - b) is 10000 seconds.
 - c) refers to the years between the leap-year (1/4 fewer days)
 - d) is 100000 hours.
 - e) is 1000 seconds.
23. Why might we want to observe a galaxy at many different wavelengths?
- a) Observing at one wavelength is adequate.
 - b) Because the Earth's atmosphere blocks some of the wavelengths.
 - c) To see different regions that have different temperatures.
 - d) Because light travels faster at some wavelengths.
 - e) To see how the brightness varies with time.
24. Which of the following is NOT a discovery that Galileo made that confirmed the views of Copernicus?
- a) the moons of Jupiter
 - b) craters on the Moon
 - c) the phases of Venus
 - d) the speed of light
 - e) the rotation of the Sun
25. How much does a Helium atom weigh compared to a Hydrogen atom?
- a) a little less than 4 times as much
 - b) 4 times less
 - c) 2 times less
 - d) the same
 - e) 2 times as much
26. Why are gamma rays generally harmful to life forms but radio waves generally harmless?
- a) Radio waves have a bluer color than gamma rays do.
 - b) Because radio waves cannot pass through mountains.
 - c) Gamma rays carry less energy per photon than radio waves.
 - d) Because gamma rays cannot pass through mountains.
 - e) Gamma rays carry more energy per photon than radio waves.
27. You go through a red light and are stopped by a police officer. To get out of being given a ticket you argue: "As I approached the light, officer, it appeared to be green!" It works. Whom of the following should you thank:
- a) Doppler
 - b) Wien
 - c) Planck
 - d) Kirchhoff
 - e) Stefan

28. Infrared radiation can be detected by our senses because:

- a) of the electromagnetic spectrum.
- b) it has a shorter wavelength than blue light.
- c) it causes sunburn.
- d) our eyes are sensitive to this type of radiation.
- e) it is perceived as heat.

29. Which of the following is NOT true about the ground state of an atom?

- a) It is the normal condition of the electron as it orbits the nucleus.
- b) It has a higher energy than an excited state.
- c) It is the state of lowest energy.
- d) It takes energy to excite an atom from the ground state.
- e) It is the state with the electrons closest to the nucleus.

30. What is the key aspect of the proton-proton fusion chain reaction that produces energy to drive the Sun's radiation?

- a) mass and energy are convertible and conserved overall
- b) the mass of the protons are less than the resulting neutrons
- c) proton-proton interactions conserve angular and linear momentum
- d) fusion drives convection in the outer layers of the sun
- e) the neutrino can pass through light-years of lead

31. What is the relationship between wavelength and frequency?

- a) The frequency is always zero.
- b) If the wavelength decreases the frequency increases.
- c) It depends on the amplitude of the light.
- d) If the wavelength increases the frequency increases.
- e) They are not related.

32. How is the observable universe like a time machine?

- a) the universe expands as it ages
- b) there was a beginning of time, and time moves in only one direction
- c) the speed of light is increases in the past
- d) the speed of light is finite, the hence light from more distant objects takes longer to reach us
- e) bigger objects are older

33. According to Wein, the wavelength where a perfect thermal emitter (a 'black-body') emits the most photons decreases with increasing temperature. However, according to Stefan, the total energy emitted by a perfect thermal emitter increases with temperature – proportional to T^4 . Are these two statements consistent?
- a) qualitatively yes, because shorter wavelengths correspond to higher energy
 - b) qualitatively yes, because the total energy is proportional to wavelength
 - c) no, Stefan and Wein were studying different types of systems
 - d) it depends on the range of temperatures considered
 - e) no, Wein's law superseded Stefan's earlier – and erroneous – conclusions
34. A massive interstellar blob of gas collapses under its own weight (gravitational attraction), but for some reason never gets dense and hot enough to start nuclear fusion in its core. However, the final collapsed object is far too dense to see through, and it is somewhat warm (a few hundred degrees K). Were you to analyze the electro-magnetic radiation it emitted using a spectrograph, which of the following best describes the kind of spectrum you would see?
- a) emission lines of ionized Hydrogen
 - b) it would not emit electro-magnetic radiation
 - c) the type of radiation would depend sensitively on the material of the collapsed gas
 - d) a black-body spectrum peaking in the near-infrared
 - e) absorption lines of ionized Hydrogen
35. The sun's surface temperature is around 6000 degrees Kelvin. If it were to suddenly become hotter, where would most of its radiation be emitted?
- a) in the optical, infrared, microwave or radio region, depending on the temperature change
 - b) uniformly at all wavelengths
 - c) in the infrared where it is hottest
 - d) in the optical
 - e) in the optical, ultraviolet, x-ray or gamma ray region, depending on the temperature change
36. The number one million can be expressed in scientific notation as:
- a) 10^5
 - b) 10^{15}
 - c) 10^{10}
 - d) 10^6
 - e) 10^3
37. An absorption spectrum appears as:
- a) dark lines against a bright background.
 - b) a smooth, continuous spectrum.
 - c) bright lines against a dark background.
 - d) an emission spectrum.
 - e) bright lines superimposed over a continuous spectrum.

38. Which is more massive: A ton of bricks on the Earth or a ton of feathers on the Moon?
- a) the same
 - b) the feathers
 - c) the bricks
 - d) it depends on the phase of the Moon
 - e) it depends on the kind of feathers
39. Compared to visible light, radio waves have:
- a) higher amplitudes.
 - b) longer wavelengths.
 - c) slower speeds.
 - d) higher frequencies.
 - e) faster speeds.
40. Given what you have learned about physics and astronomy in this course to date, which of the following statements best describes our current understanding of the physical universe?
- a) The Ancient Greeks basically figured it all out, and we are filling in the details
 - b) The advance of knowledge stopped with the discoveries of Einstein and Hubble
 - c) We have a comprehensive, working theory of physics and the universe, but it is incomplete
 - d) We are currently in a 'Dark Age' in terms of our understanding of physics and the universe
 - e) We have a complete theory of all physics and the universe which explains everything
41. What is the most likely explanation for why our eyeballs are sensitive to visible light?
- a) at shorter wavelengths our retinas would get sub-burned
 - b) at longer wavelengths we would have to have smaller eyes to see
 - c) it is not possible for organic matter to sense anything but visible light
 - d) it is only possible to form images in visible light
 - e) at visible wavelengths the sun is the brightest and the Earth's atmosphere is transparent
42. Which of the following does not occur – at least in part – in the Sun's photosphere:
- a) fusion
 - b) spicules
 - c) sunspots
 - d) flares
 - e) radiation
43. As compared to a cool star, a hotter star emits:
- a) shorter wavelength, higher frequency, bluer color.
 - b) shorter wavelength, lower frequency, redder color.
 - c) shorter wavelength, lower frequency, bluer color.
 - d) shorter wavelength, higher frequency, redder color.
 - e) longer wavelength, higher frequency, bluer color.

44. Red light has a wavelength of 7×10^{-5} cm. This is the same as:
- a) 0.00007 cm
 - b) 50000 cm
 - c) 70000 cm
 - d) 0.0005 cm
 - e) 0.00005 cm
45. The cost of the Hobby-Eberly Telescope (the world's most inexpensive and cost-effective large telescope) is a mere $\$1.5 \times 10^7$ – peanuts by today's standards of 'big science.' There are roughly 5×10^6 people in Wisconsin. Suppose the Astronomy Department at UW decided to build such a telescope and lobbied the State Government to levy a special new tax to pay for it. Assuming each person in the State of Wisconsin paid the same amount, how much money would each person have to 'contribute' to build such a telescope (expressed in scientific notation):
- a) $\$3 \times 10^0$
 - b) $\$3 \times 10^1$
 - c) $\$5 \times 10^1$
 - d) $\$1.5 \times 10^2$
 - e) $\$3 \times 10^6$
46. Suppose you are experimenting with the spectrum produced by heated hydrogen gas. If you double your quantity of hydrogen and examine the resulting spectral lines, what would you expect to have changed?
- a) the intensity of the lines
 - b) the wavelengths of the lines
 - c) the pattern made by the lines
 - d) the color of the lines
 - e) the number of lines seen
47. The Sun is 1.5×10^8 km from the Earth. How much further away is this than the diameter of the Sun of 1.5×10^5 km?
- a) 3 times
 - b) 1000 times
 - c) 100 times
 - d) 30 times
 - e) 3000 times
48. NASA has built a multi-billion dollar satellite to house a telescope that will observe the distant Universe in x-rays (it's called AXAF, and it will be launched some time late this year). Why is NASA building and launching this telescope?
- a) x-rays do not penetrate the Earth's atmosphere – an x-ray telescope must be in space
 - b) the government wants to use AXAF to detect clandestine nuclear testing on Earth
 - c) rockets are required to compensate for the doppler shift of x-rays due to Earth's motion
 - d) only NASA could afford such an incredibly expensive instrument
 - e) x-ray satellites are the only type of space-based telescope that NASA builds

49. The speed of light in a vacuum is:

- a) 100 miles/hr.
- b) constant.
- c) 1 mile/hr.
- d) 1000 miles/hr.
- e) 10 miles/hr.

50. Why do astronomers put telescopes in orbit around the Earth?

- a) to get above Earth's atmosphere
- b) so gamma rays do not destroy them.
- c) so they are closer to the stars
- d) In case of nuclear war they would not be destroyed.
- e) Because the telescopes must be so large.