Exam

Name_____

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false.

1) Radio waves, visible light, and X-rays are all types of electromagnetic radiation. 1) _____

2) The frequency of a water wave gives us its height. 2) _____

3) If a new wave arrives on shore every two seconds, then its frequency is 2 Hz. 3) _____

4) The greater the disturbance of the medium, the higher the amplitude of the wave. 4) _____

5) While gravity is always attractive, electromagnetic forces are always repulsive. 5) _____

6) Changing the electric field will have no effect on the magnetic fields of a body. 6) _____

7) As they move through space, the vibrating electrical and magnetic fields of a light wave must move perpendicular to each other. 7) _____

8) Wave energy can only be transmitted through a material medium. 8) _____

9) As white light passes through a prism, the red (longer) wavelengths bend less than the blue (shorter) wavelengths, so forming the rainbow of colors. 9) _____

10) Observations in the X-ray portion of the spectrum are routinely done from the surface of the Earth. 10) _____

11) In blackbody radiation, the energy is radiated uniformly in every region of the spectrum, so the radiating body appears black in color. 11) _____

12) According to Wein's law, the larger the blackbody, the shorter its peak wavelength. 12) _____

13) A blue star has a higher surface temperature than a red star. 13) _____

14) According to Wein's law, the higher the surface temperature of a star, the redder its color. 14) _____

15) Doubling the temperature of a blackbody will double the total energy it radiates. 15) _____

16) As a star's temperature increases, the frequency of peak emission also increases. 16) _____

17) The spectral lines of each element are distinctive to that element, whether we are looking at emission or absorption lines. 17) _____

18) An absorption line spectrum, with dark lines crossing the rainbow of the continuum, is produced by a low-density hot gas. 18) _____

19) An emission line results from an electron falling from a higher to lower energy orbital around its atomic nucleus.
19) _____

20) The shorter a wave's wavelength, the greater its energy. 20) _____

21) Spectral lines are produced when an electron makes a transition from one energy state to another. 21) _____

22) In the Bohr model of the atom, an electron can only exist in specific, well-defined energy levels. 22) _____

23) When an electron in a hydrogen atom drops from the second to the first excited energy state it emits a bright red emission line called hydrogen alpha. 23) _____

24) The Zeeman effect reveals the presence of strong magnetic fields by the splitting of spectral lines. 24) _____

25) The broader the spectral line, the higher the pressure of the gas that is creating it. 25) _____

26) In the Doppler effect, a redshift of spectral lines shows us the source is receding from us. 26) _____

27) The larger the redshift, the faster the distant galaxy is rushing toward us. 27) _____

28) If a fire truck's siren is rising in pitch, it must be approaching us. 28) _____

29) You would perceive a change in a visible light wave's amplitude as a change in its color. 29) _____

30) Spectroscopy of a star can reveal its temperature, composition, and line-of-sight motion. 30) _____

31) The Doppler effect can reveal the rotation speed of a star by the splitting of the spectral lines. 31) _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

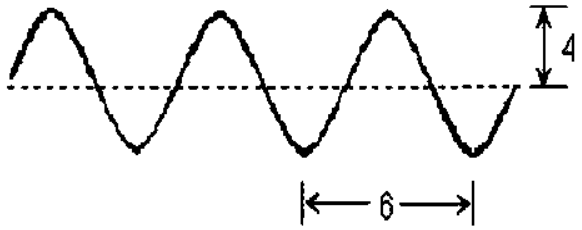
32) Which of these is NOT a form of electromagnetic radiation?
A) ultraviolet causing a suntan
32) _____

B) radio signals
C) DC current from your car battery
D) X-rays in the doctor's office
E) light from your camp fire

33) A wave's velocity is the product of the
A) frequency times the wavelength of the wave.
33) _____

B) amplitude times the wavelength of the wave.
C) frequency times the period of the wave.
D) period times the energy of the wave.
E) amplitude times the frequency of the wave.

34) Consider this diagram. Which statement is true?



34) _____

A) The amplitude is 4 and the wavelength is 6.
B) The amplitude is 4 and the wavelength is 12.
C) The amplitude is 8 and the wavelength is 12.
D) The amplitude is 8 and the wavelength is 6.
E) The amplitude is 6 and the wavelength is 4.

35) If a wave's frequency doubles and its speed stays constant, its wavelength
A) is also doubled.
35) _____

B) is halved.
C) is now 4× longer.
D) becomes 16× longer.
E) is unchanged, as c is constant.

36) The speed of light in a vacuum is
A) 186,000 miles per hour.
36) _____

B) 300,000 km/sec.
C) 768 km/hour.
D) h = E/c.
E) none of the above.

37) Which of these is the same for all forms of electromagnetic (E-M) radiation in a vacuum?
A) frequency
37) _____

B) amplitude
C) speed
D) photon energy
E) wavelength

38) The two forms of electromagnetic (E-M) radiation that experience the least atmospheric opacity are 38) _____

A) visible light and infrared waves.
B) ultraviolet and infrared waves.
C) visible light and radio waves.
D) X and gamma radiation.
E) microwaves and radio waves.

39) The radiation our eyes are most sensitive to is the color
A) violet at 7,000 Angstroms.
39) _____

B) blue at 4,321 nm.
C) black at 227 nm.
D) red at 6563 Angstroms.
E) yellow-green at about 550 nm.

40) Medium A blocks more of a certain wavelength of radiation than medium B. Medium A has a higher 40) _____

A) clarity.
B) albedo.
C) transparency.
D) opacity.
E) seeing.

41) In the Kelvin scale, absolute zero lies at
A) 273 degrees C.
41) _____

B) zero K.
C) -373 degrees C.
D) Both A and B are correct.
E) Both A and C are correct.

42) What is true of a blackbody?
A) If its temperature doubled, the peak in its radiation curve would be doubled in wavelength.
42) _____

B) It has a complete absence of thermal energy.
C) It appears black to us, regardless of its temperature.
D) Its energy is not a continuum.
E) Its energy peaks at the wavelength determined by its temperature.

43) What is the name of the temperature scale that places zero at the point where all atomic and molecular motion ceases? 43) _____

A) Centigrade
B) Fahrenheit
C) Kelvin
D) Ransom
E) Celsius

44) The total energy radiated by a blackbody depends on
A) the fourth root of its temperature.
44) _____

B) the cube of its temperature.
C) the square of its temperature.
D) the fourth power of its temperature.

E) the square root of its temperature.

45) Increasing the temperature of a blackbody by a factor of 3 will increase its energy by a factor of
A) 3. B) 6. C) 9. D) 12. E) 81.
45) _____

46) If a star was the same size as our Sun, but was 81 times more luminous, it must be
A) twice as hot as our Sun.
46) _____

B) three times hotter than the Sun.
C) four times hotter than the Sun.
D) nine times hotter than the Sun.
E) 81 times hotter than the Sun.

47) The Sun's observed spectrum is
A) a continuum with emission lines.
47) _____

B) a continuum with no lines, as shown by the rainbow.
C) only emission lines on a black background.
D) a continuum with absorption lines.
E) only absorption lines on a black background.

48) The element first found in the Sun's spectrum, then on Earth 30 years later, is
A) hydrogen.
48) _____

B) aluminum.
C) technicum.
D) solarium.
E) helium.

49) A jar filled with gas is placed directly in front of a second jar filled with gas. Using a spectroscope to look at one jar through the other you observe dark spectral lines. The jar closest to you contains 49) _____

A) the cooler gas.
B) the hotter gas.
C) the exact same gas as the other jar.
D) gas at very high pressure.
E) gas at the same temperature as the other jar.

50) Which of these is emitted when an electron falls from a higher to lower orbital?
A) a graviton
50) _____

B) another electron
C) a photon
D) a neutrino
E) a positron

51) In Bohr's model of the atom, electrons
A) only make transitions between orbits of specific energies.
51) _____

B) are not confined to specific orbits.
C) move from one orbit to the next orbit in many small steps.
D) are spread uniformly through a large, positive mass.
E) can be halfway between orbits.

52) In general, the spectral lines of molecules are
A) the same as the atoms they contain.
52) _____

B) less complex than those of atoms.
C) more complex than those of atoms.
D) only absorption lines.
E) nonexistent.

53) Electromagnetic radiation
A) can only travel in a dense medium.
53) _____

B) can behave both as a wave and as a particle.
C) is the same as a sound wave.
D) has only the properties of waves.
E) has nothing in common with radio waves.

54) In a hydrogen atom, a transition from the 2nd to the 1st excited state will produce
A) a dark absorption line.
54) _____

B) no emission line.
C) three different emission lines.
D) the bright red Balmer alpha emission line.
E) an ultraviolet spectral line.

55) For hydrogen, the transition from the first to third excited state produces
A) a violet emission line.
55) _____

B) an ultraviolet line.
C) a blue green absorption line.
D) a red emission line.
E) an infrared line.

56) The observed spectral lines of a star are all shifted towards the red end of the spectrum. Which statement is true?
56) _____

A) The star has a radial velocity towards us.
B) This is an example of the photoelectric effect.

C) This is an example of the Doppler effect.
D) The second law of Kirchhoff explains this.
E) The star is not rotating.

57) If a source of light is approaching us at 3,000 km/sec, then all its waves are
A) blueshifted out of the visible spectrum into the ultraviolet.
57) _____

B) redshifted out of the visible into the infrared.
C) blueshifted by 1%.
D) not affected, as c is constant regardless of the direction of motion.
E) redshifted by 1%.

58) If the rest wavelength of a certain line is 600 nm, but we observe it at 594 nm, then
A) the source is getting 1% hotter as we watch.
58) _____

B) the source is approaching us at 0.1% of the speed of light.
C) the source is receding from us at 10% of the speed of light.
D) the source is approaching us at 1% of the speed of light.
E) the source is spinning very rapidly, at 1% of the speed of light.

59) According to the Zeeman effect, the splitting of a sunspot's spectral lines is due to
A) a Doppler shift.
59) _____

B) their rapid rotation.
C) temperature variations.
D) their radial velocity.
E) their magnetic fields.

60) A frequency of one hundred _____ means the wave is vibrating one hundred million times per second; this is a typical carrier frequency for FM (frequency modulation) radio. 60) _____

A) kilohertz
B) millihertz
C) megahertz
D) gigahertz
E) hertz

61) According to Wein's law, the wavelength of the peak energy will be _____ if the temperature of the blackbody is doubled. 61) _____

A) quartered
B) halved
C) doubled
D) quadrupled
E) unchanged

62) The Sun's blackbody curve peaks in the _____ portion of the spectrum.
A) radio

62) _____

B) infrared
C) ultraviolet
D) X-ray
E) visible

63) The common element with bright red, blue-green, and violet emission lines is
A) carbon.
63) _____

B) oxygen.
C) helium.
D) nitrogen.
E) hydrogen.

64) The most energetic photons are
A) X-rays.
64) _____

B) gamma rays.
C) infrared.
D) visible.
E) radio.

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

65) The distance from a wave's crest to its undisturbed position is the _____. 65) _____

66) The product of the wavelength times the frequency of a wave is its _____. 66) _____

67) A wave with a period of .01 seconds has a frequency of _____ Hz. 67) _____

68) A wave with a frequency of 2 Hz will have a period of _____. 68) _____

69) An FM station broadcasts at a frequency of 100 MHz. The wavelength of its carrier wave is _____. 69) _____

70) In electromagnetic waves, the electric and magnetic fields vibrate _____ to each other. 70) _____

71) A featureless spectrum, such as a rainbow, is said to be _____. 71) _____

72) Stars that appear blue or white in color are _____ than our yellow Sun. 72) _____

73) Knowing the peak emission wavelength of a blackbody allows you to determine its _____. 73) _____

74) Stefan's law notes that total energy radiated is proportional to the _____ power of the temperature of the blackbody. 74) _____

75) A dense, hot body will give off a(n) _____ spectrum. 75) _____

76) Fraunhofer was the German astronomer who first noted _____ lines in the Sun's spectrum. 76) _____

77) The common element discovered in the Sun's spectrum before it was found here is _____. 77) _____

78) When an electron moves from a lower to a higher energy state, a photon is _____. 78) _____

79) An electron has a _____ electric charge. 79) _____

80) The energy of the photon depends on its _____. 80) _____

81) Why can't we be certain that the Andromeda Galaxy exists today? 81) _____

82) How do sound and light waves differ? 82) _____

83) An AM station is broadcasting at 980 kHz, while an FM station up the road is assigned 98 MHz. How do their carrier waves compare? 83) _____

84) No one can hear you scream (or fire a weapon) in space, regardless of the Hollywood special effects. Explain why. 84) _____

85) What two regions of the electromagnetic spectrum are best utilized by ground-based astronomers, and why? 85) _____

86) How can you determine the distance to a spacecraft from the time it takes its radio signal to reach Earth? 86) _____

87) Newton found that when light passed through a prism, it was dispersed into the component colors. Which bent the least, and why? 87) _____

88) What do infrared and ultraviolet waves have in common? How do they differ? 88) _____

89) What do gamma rays, X-rays, light, and radio waves all have in common? 89) _____

90) How does human vision's peak in color sensitivity relate to the Sun? 90) _____

91) Give at least two advantages of the Kelvin temperature scale for astronomers. 91) _____

92) The Great Nebula in Orion, M-42, is a low-density cloud of hot gas. Use Kirchhoff's laws to describe its spectrum. 92) _____

93) According to Kirchhoff's first law why do dense, hot bodies create the type of spectrum they do? 93) _____

94) If the magnetic fields are very strong, such as around sunspots, how are spectral lines affected by the Zeeman effect?
94) _____

95) State the relationship between frequency, photon energy, and wavelength. 95) _____

96) Explain how the Zeeman effect allows us to study stellar magnetic fields. 96) _____

97) Explain how Bohr's model creates emission and absorption lines in the spectrum. 97) _____

98) What information about a star can be inferred from its Doppler shift? 98) _____

99) A binary star system is one with two stars orbiting each other. How can the Doppler effect be used to find binary stars whose orbital plane is along our line of sight and determine their periods? 99) _____

100) Explain what types of information can be obtained from a line spectrum. 100) _____

101) If we increased the pressure in a gas, how will its spectral lines be affected? 101) _____

102) Contrast the speeds of sound and light in watching a flash of lightning, then listening for the thunder to follow.
102) _____

103) How can Wein's law be used to determine the temperature of a star? 103) _____

104) Why would a hotter star appear blue-white while a cooler star appear red or not be visible at all? 104) _____

105) How does Stefan's law and a knowledge of Earth's history tell us that the Sun's temperature cannot have varied much in the last 3.5 billion years? 105) _____

106) Explain the appearance of the Sun's spectrum, as noted by Fraunhofer. 106) _____

107) How does the energy of a water wave differ from the energy of a photon? 107) _____

108) Why do we know that the red Balmer emission line in hydrogen represents a smaller quantum leap than the violet line? 108) _____

109) Give an example of the Doppler effect being used in a baseball game. 109) _____

110) Give and explain an example of the use of the Doppler effect on the highway. 110) _____

111) How can the Doppler effect be used to determine if a storm is forming into a tornado? 111) _____

112) Explain how the Doppler effect has been used to detect invisible planets orbiting other Sun-like stars. 112) _____

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

51) A
52) C
53) B
54) D
55) C
56) C
57) C
58) D
59) E
60) C
61) B
62) E
63) E
64) B
65) amplitude
66) velocity
67) 100
68) one-half second (0.5 s)
69) 3 meters
70) perpendicular
71) continuous
72) hotter
73) temperature
74) fourth
75) continuous
76) absorption
77) helium
78) absorbed
79) negative
80) frequency or wavelength.
81) Since it lies 2.5 million light-years distant, the most recent image we have is still 2.5 million years out of date, so we cannot prove it is still there. It probably is, though.
82) Sound waves travel much slower, and need a physical medium, such as air, to be transmitted. Light travels best in the vacuum of space.
83) As the frequency of the FM station is 100 times higher than the AM station, the FM carrier wave must be 100 shorter in wavelength.
84) Sound waves must travel though a material medium, and cannot pass through a vacuum. The blast might be seen, but the boom will not be heard.
85) The atmosphere is opaque to most radiation except visible and radio waves.
86) In a vacuum, all electromagnetic radiation, including radio waves, travel at the same speed: 300,000 km/s. Measuring the time it takes the radio signal to reach us and multiplying by 300,000 km/s gives the distance to the spacecraft.
87) The red waves are bent less by the glass than are the other colors because they have the longest wavelength. Shorter wavelengths bend more than longer wavelengths.
88) Both are forms of electromagnetic radiation, both travel at c in a vacuum, and both are largely absorbed by our atmosphere. They differ greatly in frequency, wavelength, and photon energy, however, with UV much more energetic than IR.
89) While they vary widely in wavelengths and frequencies, they are all forms of electromagnetic radiation and all travel at *c*, the speed of light, in a vacuum.
90) Our eyes are tuned to utilize best the type of radiation our star produces the most of, and yellow lies in the middle of the visible spectrum.
91) It is an absolute scale, so there are never any negative readings. Wein's and Stefan's laws are only mathematically

correct if Kelvin temperatures are used.
92) Kirchhoff's second law notes that a hot thin gas will create an emission spectrum of bright lines through the spectroscope.
93) Kirchhoff's first law states that a dense, hot medium emits light of all wavelengths, creating a continuous spectrum.
94) A strong magnetic field will cause the lines to appear split apart.
95) The higher the frequency, the greater the energy the photon carries, but the shorter its wavelength.
96) The Zeeman effect causes spectral lines to appear split into two. This tells us magnetic fields are present. The greater the observed splitting, the stronger the magnetic fields are.
97) Bohr's model has the electron orbitals quantized into discrete energies. Each upward transition to a higher energy state produces an absorption line (energy is absorbed). Each downward transition produces an emission line (energy is emitted). The energy absorbed or emitted is exactly equal to the difference in energy levels.
98) The Doppler shift gives the star's radial velocity, either towards or away from us.
99) As the two stars orbit each other rapidly, one will approach us, creating a blueshift of its spectral lines, while its retreating companion shows a redshift. The time to go through two splits and recombinations of their lines is their orbital period.
100) The element which created it, the line-of-sight velocity of the source, its rotation speed, temperature, the pressure of the gas emitting the radiation, and even its magnetic field may also be found.
101) The lines will broaden (or even disappear if the density becomes too great)
102) Light travels at 300,000 km/sec, so the flash of light is almost instantaneous from a few miles away; sound travels at about a fifth of a mile per second, so if the thunder follows the lightning by five seconds, the bolt hit about a mile away.
103) Careful analysis of the blackbody curve of the star's entire radiation spectrum will reveal a peak that is unique to a given temperature. Basically, the bluer the star's radiation, the hotter its surface will be.
104) Stefan's law notes that the higher the temperature, the more luminous the body is, so such stars produce great amounts of visible light. The hotter the star the shorter the wavelength it peaks at. A star that emits light across the entire visible spectrum would appear white. One that peaked beyond the visible would appear blue-white. A cooler star may peak in the red part of the spectrum, or even in the infrared.
105) Since even a small change in temperature, raised to the fourth power, would result in a large change in the total solar energy radiated, if the Sun had cooled much, our oceans would have frozen and life would have ceased to exist here.
106) The Sun is dense, and gives rise to a continuous spectrum, peaked in the color yellow as dictated by the 5800K temperature of its surface. Then the cooler, less dense gas above the surface absorbs some of the energy in transit, revealing its composition by the particular absorption lines we observe from Earth.
107) Amplitudes of sound (and water) waves can differ greatly and still have the same wavelength and frequency, as they are the result of the motions of large numbers of molecules. For photons, the energy is quantized, so that each photon of a given wavelength must carry the same amount of energy.
108) Red light has a longer wavelength than violet light; therefore a red photon contains less energy than a violet one. Since the photon given off when an electron's energy level changes has an energy equal to the energy difference between the two levels, the less energetic photon represents a smaller difference.
109) The Doppler "gun" can focus on the motion of the baseball, and give us the speed that the pitcher is delivering it to the plate.
110) The radar gun of a highway patrolman sends out a pulsed beam to be reflected back, thus giving the speed of your car and perhaps netting you a ticket.
111) Radar can determine the distance to a storm cloud. Since a tornado rotates very rapidly, Doppler radar can measure the difference in velocity between the two sides of the storm to determine if it is rotating.
112) The planets are massive enough to pull their star slightly off course as they orbit from one side to the other, producing a cycle of redshifts and blueshifts that allow us to deduce that the planet is present, and how long it takes to orbit its star.