Webreview - Ch 27 Quantum Physics Practice Test

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. Planck's quantum theory is compatible with the experimental data related to which of the following?
a. blackbody radiation
b. the photoelectric effect
c. line spectra emitted by hydrogen gas
d. all of the above

____ 2. As the temperature of a radiation emitting blackbody becomes higher, what happens to the peak wavelength of the radiation?
a. increases
b. decreases
c. remains constant
d. is directly proportional to temperature
e. behaves differently for different temperatures

____ 3. A quantum of radiation has an energy of 2.0 keV. What is its frequency? ($h = 6.63 \times 10^{-34}$ J·s and 1 eV = 1.60×10^{-19} J)
a. 3.2×10^{17} Hz
b. 4.8×10^{17} Hz
c. 6.3×10^{17} Hz
d. 7.3×10^{17} Hz
e. 8.5×10^{17} Hz

____ 4. If a quantum of radiation has an energy of 2.0 keV, what is its wavelength? ($h = 6.63 \times 10^{-34}$ J·s, 1 eV = 1.60×10^{-19} J, $c = 3.00 \times 10^{8}$ m/s, and 1 nm = 10^{-9} m)
a. 0.32 nm
b. 0.41 nm
c. 0.62 nm
d. 1.02 nm
e. 1.24 nm

____ 5. Classical theories predict that most of the energy from a black body should be radiated:
a. as thermal radiation in the infrared region.
b. at the wavelength given by Wien's displacement law.
c. as ultraviolet light.
d. as gamma rays.
e. a black body should not radiate.

____ 6. The ultraviolet catastrophe predicts that:
a. all objects should radiate extreme amounts of ultraviolet light.
b. as an object gets hotter its light will change from dull red to blue white.
c. a black body can absorb an infinite amount of radiation if the radiation is in the ultraviolet region.
d. the radiated energy approaches zero as the wavelength approaches zero.
e. a black body will be radiating energy in the ultraviolet region until its temperature approaches to the absolute zero.

____ 7. Blue light will not eject electrons from a certain metal; however, which one of the following may possibly eject electrons from that metal?
a. infrared
b. ultraviolet
c. red
d. green
e. yellow

____ 8. Light of wavelength 6.5×10^{-7} m has an energy of: ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s)
a. 3.1×10^{-19} J
b. 3.3×10^{-19} J
c. 1.5×10^{-19} J
d. 1.7×10^{-19} J
e. 1.9×10^{-19} J

____ 9. If a monochromatic light beam with quantum energy value of 3.0 eV incident upon a photocell where the work function of the target metal is 1.60 eV, what is the maximum kinetic energy of ejected electrons?
a. 4.6 eV
b. 4.8 eV
c. 1.4 eV
d. 2.4 eV
e. 3.8 eV

____ 10. Which of the following devices represent(s) a practical application of the photoelectric effect?
a. hologram
b. photocell
c. both of the above choices
d. none of the above choices

____ 11. According to Einstein, what is true of the stopping potential for a photoelectric current as the wavelength of incident light becomes shorter?
a. increases
b. decreases
c. remains constant
d. stopping potential is directly proportional to wavelength
e. stopping potential is directly proportional to intensity

____ 12. According to Einstein, as the wavelength of the incident monochromatic light beam becomes shorter, the work function of a target material in a phototube:
a. increases.
b. decreases.
c. remains constant.
d. is directly proportional to wavelength.
e. is inversely proportional to intensity.

____ 13. What is the frequency of monochromatic light where the photon energy is 5.5×10^{-19} J? ($h = 6.63 \times 10^{-34}$ J·s)
a. 2.2×10^{14} Hz
b. 4.4×10^{14} Hz
c. 8.3×10^{14} Hz
d. 9.8×10^{14} Hz
e. 1.4×10^{15} Hz

____ 14. What is the wavelength of a monochromatic light beam, where the photon energy is 5.00×10^{-19} J? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, and 1 nm = 10^{-9} m)
a. 354 nm
b. 398 nm
c. 414 nm
d. 787 nm
e. 875 nm

____ 15. A monochromatic light beam is incident on a barium target, which has a work function of 2.50 eV. If a stopping potential of 1.0 V is required, what is the light beam photon energy?
a. 1.0 eV
b. 1.5 eV
c. 2.5 eV
d. 3.5 eV
e. 4.8 eV

____ 16. A light beam is shining on a metal target that has a work function of 2.20 eV. If a stopping potential of 1.30 V is required, what is the wavelength of the incoming monochromatic light? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.60×10^{-19} J and 1 nm = 10^{-9} m)
a. 355 nm
b. 497 nm
c. 744 nm
d. 1 421 nm
e. 1 812 nm

____ 17. Light of wavelength 450 nm is incident on a target metal that has a work function of 1.80 eV. What stopping potential is required for this combination in a phototube? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.60×10^{-19} J and 1 nm = 10^{-9} m)
a. 0.57 V
b. 0.96 V
c. 2.76 V
d. 4.56 V
e. 5.83 V

____ 18. If barium has a work function of 2.60 eV, what is its cutoff wavelength when used as a phototube target? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.60×10^{-19} J and 1 nm = 10^{-9} m)
a. 398 nm
b. 478 nm
c. 497 nm
d. 596 nm
e. 671 nm

____ 19. What is the energy of a photon whose frequency is 6.0×10^{20} Hz? ($h = 6.63 \times 10^{-34}$ J·s and 1 eV = 1.60×10^{-19} J)
a. 1.6 MeV
b. 2.5 MeV
c. 3.3 MeV
d. 4.8 MeV
e. 5.9 MeV

____ 20. An ultraviolet light beam having a wavelength of 130 nm is incident on a molybdenum surface with work function of 4.2 eV. What is the stopping potential? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.6×10^{-19} J, and 1 nm = 10^{-9} m)
a. 1.3 V
b. 3.5 V
c. 5.4 V
d. 11.9 V
e. 13.6 V

____ 21. Blue light ($\lambda = 460$ nm) is incident on a piece of potassium ($\phi = 2.20$ eV). What is the maximum kinetic energy of the ejected photoelectrons? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.60×10^{-19} J, and 1 nm = 10^{-9} m)
a. 1.0 eV
b. 0.50 eV
c. 0.25 eV
d. 4.9 eV
e. 6.2 eV

____ 22. Light of wavelength 480 nm is incident on a metallic surface with a resultant photoelectric stopping potential of 0.55 V. What is the work function of the metal? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.60×10^{-19} J, and 1 nm = 10^{-9} m)
a. 2.04 eV
b. 3.19 eV
c. 2.59 eV
d. 0.55 eV
e. 0.27 eV

____ 23. Which of the following statements best describes the relation between the quantum theory and the photoelectric effect experiment?
a. Quantum theory explains the photoelectric effect.
b. The photoelectric effect contradicts quantum theory.
c. Quantum theory has no bearing on the photoelectric effect.
d. The photoelectric effect explains quantum theory.
e. The photoelectric effect is another name for quantum theory.

____ 24. A sodium vapor lamp has a power output of 300 W. If 590 nm is the average wavelength of the source, about how many photons are emitted per second? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, and 1 nm = 10^{-9} m)
a. 10^{17}
b. 10^{21}
c. 10^{25}
d. 10^{29}
e. 10^{31}

____ 25. Of the following photons, which has the highest energy?
a. infrared
b. microwave
c. visible
d. ultraviolet
e. radio

____ 26. According to Einstein, increasing the brightness of a beam of light without changing its color will increase:
a. the number of photons.
b. the energy of each photon.
c. the speed of the photons.
d. the frequency of the photons.
e. the mass of each photon.

____ 27. A photon absorbed by an electron will give up more energy to the electron if the photon:
a. is not spread out over many electrons.
b. is moving faster.
c. is moving slower.
d. has a higher frequency.
e. An electron cannot absorb a photon.

____ 28. Which change will not change the kinetic energy of the most energetic electrons emitted in the photoelectric effect?
a. changing the brightness of the light
b. changing the frequency of the light
c. changing the metal the light is hitting
d. all of the above will change the electron's kinetic energy
e. all of the above will not change the electron's kinetic energy

____ 29. A helium-neon laser emits red light having a wavelength of 632.8 nm and a power of 0.50 mW. How many photons are emitted each second? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s and 1 nm = 10^{-9} m)
a. 1.6×10^{15}
b. 3.3×10^{16}
c. 4.8×10^{17}
d. 2.6×10^{18}
e. 6.3×10^{18}

____ 30. How much energy (in eV) does a photon of red light (λ = 700 nm) have? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, 1 eV = 1.60×10^{-19} J, and 1 nm = 10^{-9} m)
a. 3.11 eV
b. 2.26 eV
c. 1.78 eV
d. 1.24 eV
e. 1.04 eV

____ 31. What is the maximum velocity of a photoelectron emitted from a surface with work function 5.00 eV when illuminated by 200 nm ultraviolet light? ($m_{\text{electron}} = 9.11 \times 10^{-31}$ kg, $h = 6.63 \times 10^{-34}$ J·s, 1 eV = 1.60×10^{-19} J, and 1 nm = 10^{-9} m)
a. 800 000 m/s
b. 653 000 m/s
c. 431 000 m/s
d. 212 000 m/s
e. 184 000 m/s

____ 32. Of the following energies for photons, which is the least energy that could result in photoelectron production if the work function is 3.00 eV?
a. 1.50 eV
b. 2.90 eV
c. 3.50 eV
d. 6.01 eV
e. 8.14 eV

____ 33. Who was the first to successfully explain the photoelectric effect?
a. Planck
b. Young
c. Bohr
d. Einstein
e. Heisenberg

____ 34. Sources of red, blue, and yellow light each emit light with a power of 50 mW. Which source emits more photons per second?
a. the red source
b. the blue source
c. the yellow source
d. They all emit the same number per second.
e. Both red and blue sources emit the same number, and the yellow one emits less.

____ 35. What is the minimum x-ray wavelength produced when electrons are accelerated through a potential of 50 000 V? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, and 1 eV = 1.60×10^{-19} J)
a. 12.4×10^{-12} m
b. 16.5×10^{-12} m
c. 19.8×10^{-12} m
d. 24.9×10^{-12} m
e. 58.0×10^{-12} m

____ 36. If the minimum x-ray wavelength produced is 13.5×10^{-12} m, through what potential are the electrons accelerated in order to generate this radiation? ($h = 6.63 \times 10^{-34}$ J·s, $c = 3.00 \times 10^{8}$ m/s, and 1 eV = 1.60×10^{-19} J)
a. 33 300 V
b. 46 200 V
c. 75 000 V
d. 92 100 V
e. 122 100 V

____ 37. X-ray production occurs in which process?
a. photons hitting a metal, emitting electrons
b. electrons hitting a metal, emitting photons
c. photons hitting a metal, emitting x-rays
d. electrons hitting a metal and scattering elastically
e. X-rays hitting electrons, emitting secondary x-rays

____ 38. Changing the accelerating voltage of an x-ray machine without changing the target material must change:
a. the work function of the material.
b. the wavelength of all the x-rays produced.
c. the wavelength of the minimum wavelength x-ray that will be produced.
d. Both b and c are correct.
e. None of the above choices is correct.

____ 39. What is the highest frequency of the photons produced by a 90-kV x-ray machine? ($h = 6.63 \times 10^{-34}$ J·s)
a. 1.2×10^{19} Hz
b. 1.1×10^{19} Hz
c. 2.4×10^{19} Hz
d. 2.2×10^{19} Hz
e. 3.0×10^{19} Hz

____ 40. The spacing between atoms in KCl crystal is 3.1×10^{-10} m. At what angle from the surface will a beam of 3.14×10^{-11} m x-rays be constructively scattered?
a. 57°
b. 2.9°
c. 90°
d. 10°
e. 43°

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Answer Section

MULTIPLE CHOICE

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