MisConceptual Questions

1. Which of the following statements is true regarding how blackbody radiation changes as the temperature of the radiating object increases?
    a. Both the maximum intensity and the peak wavelength increase.
    b. The maximum intensity increases, and the peak wavelength decreases.
    c. Both the maximum intensity and the peak wavelength decrease.
    d. The maximum intensity decreases, and the peak wavelength increases.

2. As red light shines on a piece of metal, no electrons are released. When the red light is slowly changed to shorter-wavelength light (basically progressing through the rainbow), nothing happens until yellow light shines on the metal, at which point electrons are released from the metal. If this metal is replaced with a metal having a higher work function, which light would have the best chance of releasing electrons from the metal?
    a. Blue.
    b. Red.
    c. Yellow would still work fine.
    d. We need to know more about the metals involved.

3. A beam of red light and a beam of blue light have equal intensities. Which statement is true?
    a. There are more photons in the blue beam.
    b. There are more photons in the red beam.
    c. Both beams contain the same number of photons.
    d. The number of photons is not related to intensity.

4. Which of the following is necessarily true?
    a. Red light has more energy than violet light.
    b. Violet light has more energy than red light.
    c. A single photon of red light has more energy than a single photon of violet light.
    d. A single photon of violet light has more energy than a single photon of red light.
    e. None of the above.
    f. A combination of the above (specify).

5. If a photon of energy E ejects electrons from a metal with kinetic energy KE, then a photon with energy $E/2$
    a. will eject electrons with kinetic energy KE/2.
    b. will eject electrons with an energy greater than KE/2.
    c. will eject electrons with an energy less than KE/2.
    d. might not eject any electrons.

6. If the momentum of an electron were doubled, how would its wavelength change?
    a. No change.
    b. It would be halved.
    c. It would double.
    d. It would be quadrupled.
    e. It would be reduced to one-fourth.

p=h/lambda

7. Which of the following can be thought of as either a wave or a particle?
    a. Light.
    b. An electron.
    c. A proton.
    d. All of the above.

8. When you throw a baseball, its de Broglie wavelength is
    a. the same size as the ball.
    b. about the same size as an atom.
    c. about the same size as an atom's nucleus.

d. much smaller than the size of an atom's nucleus.

9. Electrons and photons of light are similar in that
   a. both have momentum given by h/λ.
   b. both exhibit wave–particle duality.
   c. both are used in diffraction experiments to explore structure.
   d. All of the above.
   e. None of the above.

10. In Rutherford's famous set of experiments described in **Section 27–10**, the fact that some alpha particles were deflected at large angles indicated that (choose all that apply)
    a. the nucleus was positive.
    b. charge was quantized.
    c. the nucleus was concentrated in a small region of space.
    d. most of the atom is empty space.
    e. None of the above.

11. Which of the following electron transitions between two energy states (n) in the hydrogen atom corresponds to the emission of a photon with the longest wavelength?
    a. 2 → 5.
    b. 5 → 2.
    c. 5 → 8.
    d. 8 → 5.

12. If we set the potential energy of an electron and a proton to be zero when they are an infinite distance apart, then the lowest energy a bound electron in a hydrogen atom can have is
    a. 0.
    b. –13.6 eV.
    c. any possible value.
    d. any value between –13.6 eV and 0.

13. Which of the following is the currently accepted model of the

27–3 and 27–4 Photons and the Photoelectric Effect

10. (I) What is the energy of photons (joules) emitted by a 91.7-MHz FM radio station? E=hXnu=6.1X10^(-26)
11. (I) What is the energy range (in joules and eV) of photons in the visible spectrum, of wavelength 400 nm to 750 nm? nu=7.5 — 4 X 10^14 E: 5.0 — 2.7 X 10^(-19) J 3.1 — 1.7 eV
12. (I) A typical gamma ray emitted from a nucleus during radioactive decay may have an energy of 320 keV. What is its wavelength? Would we expect significant diffraction of this type of light when it passes through an everyday opening, such as a door?
13. (I) Calculate the momentum of a photon of yellow light of wavelength 5.80×10^{-7} m. 1.14 X 10^(-27) kg m/s
14. (I) What is the momentum of a $\lambda = 0.014$ nm X-ray photon?
15. (I) For the photoelectric effect, make a table that shows expected observations for a particle theory of light and for a wave theory of light. Circle the actual observed effects. (See **Section 27–3** .)
16. (II) About 0.1 eV is required to break a "hydrogen bond" in a protein molecule. Calculate the minimum frequency and maximum wavelength of a photon that can accomplish this.
17. (II) What minimum frequency of light is needed to eject electrons from a metal whose work function is 4.8×10^{-19} J?
18. (II) The human eye can respond to as little as 10^{-18} J of light energy. For a wavelength at the peak of visual sensitivity, 550 nm, how many photons lead to an observable flash?
19. (II) What is the longest wavelength of light that will emit electrons from a metal whose work function is 2.90 eV?
20. (II) The work functions for sodium, cesium, copper, and iron are 2.3, 2.1, 4.7, and 4.5 eV, respectively. Which of these metals will not emit electrons when visible light shines on it?
21. (II) In a photoelectric-effect experiment it is observed that no current flows unless the wavelength is less than 550 nm. (*a*) What is the work function of this material? (*b*) What stopping

27–8 Wave Nature of Matter

38. (I) Calculate the wavelength of a 0.21-kg ball traveling at 0.10 m/s. *h/p=3.2 X 10^(-32) m*
39. (I) What is the wavelength of a neutron ($m = 1.67 \times 10^{-27}$ kg) traveling at 8.5×10^4 m/s? *4.7 X 10^(-12) m*
40. (II) Through how many volts of potential difference must an electron, initially at rest, be accelerated to achieve a wavelength of 0.27 nm?
41. (II) Calculate the ratio of the kinetic energy of an electron to that of a proton if their wavelengths are equal. Assume that the speeds are nonrelativistic.
42. (II) An electron has a de Broglie wavelength $\lambda = 4.5 \times 10^{-10}$ m. (*a*) What is its momentum? (*b*) What is its speed? (*c*) What voltage was needed to accelerate it from rest to this speed?
43. (II) What is the wavelength of an electron of energy (*a*) 10 eV, (*b*) 100 eV, (*c*) 1.0 keV?
44. (II) Show that if an electron and a proton have the same nonrelativistic kinetic energy, the proton has the shorter wavelength.
45. (II) Calculate the de Broglie wavelength of an electron if it is accelerated from rest by 35,000 V as in **Fig. 27–2** . Is it relativistic? How does its wavelength compare to the size of the “neck” of the tube, typically 5 cm? Do we have to worry about diffraction problems blurring the picture on the CRT screen?
46. (III) A Ferrari with a mass of 1400 kg approaches a freeway underpass that is 12 m across. At what speed must the car be moving, in order for it to have a wavelength such that it might somehow “diffract” after passing through this “single slit”? How do these conditions compare to normal freeway speeds of 30 m/s?