Quantum Mechanics Homework

Draw Diagrams, completely explain your answers and show your work.

1. Why is the term ultraviolet catastrophe used to describe the discrepancy between the predictions of classical physics and the experimental data for blackbody radiation?

2. What is meant by the term quantum?

3. What did Planck assume in order to explain the experimental data for blackbody radiation? How did Planck's assumption contradict classical physics?

5. How do observations of the photoelectric effect conflict with the predictions of classical physics?

7. Which has more energy, a photon of ultraviolet radiation or a photon of yellow light?

11. A quantum of electromagnetic radiation has an energy of 2.0 keV. What is its frequency?

12. Calculate the energy in electron volts of a photon having a wavelength in the following ranges:

a. the microwave range, 5.00 cm
b. the visible light range, 5.00×10^{-7} m
c. the X-ray range, 5.00×10^{-8} m

13. Light of frequency 1.5×10^{15} Hz illuminates a piece of tin, and the tin emits photoelectrons of maxi- mum kinetic energy 1.2 eV. What is the threshold frequency of the metal?

14. The threshold frequency of silver is 1.14×10^{15} Hz. What is the work function of silver?

15. What did Rutherford's foil experiment reveal?

23. Electrons in the ground state of hydrogen (energy level E_1) have an energy of –13.6 eV. Use this valueand the energy-level diagram in Sample Problem C to calculate the frequencies of photons emitted when electrons drop to the ground state from the following energy levels:

a. E_2 **b.** E_3 **c.** E_4 **d.** E_5

26. What does Heisenberg's uncertainty principle claim?

33. How fast must an electron move if it is to have a de Broglie wavelength of 5.2×10^{-11} m?

34. Calculate the de Broglie wavelength of a 0.15 kg baseball moving at 45 m/s.

35. A light source of wavelength λ illuminates a metal and ejects photoelectrons with a maximum kinetic energy of 1.00 eV. A second light source of wavelength 1/2 λ ejects photoelectrons with a maximum kinetic energy of 4.00 eV. What is the work function of the metal?

36. A 0.50 kg mass falls from a height of 3.0 m. If all of the energy of this mass could be converted to visible light of wavelength 5.0×10^{-7} m, how many photons would be produced?

37. Red light (λ = 670.0 nm) produces photoelectrons from a certain material. Green light (λ = 520.0 nm) produces photoelectrons from the same material with 1.50 times the previous maximum kinetic energy. What is the material's work function?

38. Find the de Broglie wavelength of a ball with a mass of 0.200 kg just before it strikes the Earth after it has been dropped from a building 50.0 m tall.