photons - practice problems

1. A double slit experiment sends one photon at a time toward the slits. Each photon is measured at one spot on the screen, but after many photons the hits form an interference pattern. What does that tell us about using only the particle model for light?

2. A green photon from a laser pointer has frequency 5.60 × 10 14 Hz. The beam looks continuous to your eye, but each photon carries a separate packet of energy. What is the energy of one photon in joules and electron-volts?

3. A violet photon has frequency 700 THz. Convert the frequency to hertz, then find the energy of one photon in joules.

4. A detector records photons with energy 4.80 × 10 -19 J. What frequency do those photons have, and what wavelength would they have in vacuum?

5. A red LED emits photons with energy 3.20 × 10 -19 J. What wavelength does that light have in vacuum?

6. A violet laser used for optical storage has wavelength 405 nm. What is the energy of one photon in joules and electron-volts?

7. Neutral hydrogen in space emits a famous 21 cm photon that radio telescopes can detect from huge clouds of gas. What are the frequency and energy of one 21 cm photon?

8. Why can dim ultraviolet light release electrons from some metals, while very bright red light usually cannot?

9. A small red laser pointer outputs 5.0 mW of optical power at wavelength 635 nm. The pointer uses two AAA batteries, but that does not matter for this calculation. Assume all the optical power is carried by 635 nm photons. About how many photons leave the laser each second?

10. A blue LED flash releases 0.020 J of light at wavelength 450 nm. The plastic lens spreads the light into a wide cone, but assume every photon has the same wavelength. About how many photons are in the flash?

11. An unknown metal surface is hit by 422 nm light from a 3.0 mW laser for 2.0 s. What is the maximum kinetic energy of the released electrons?

12. A clean metal surface has work function 4.2 eV. It is hit by ultraviolet photons with energy 7.0 eV each. What is the maximum kinetic energy of the released electrons in eV and joules?

13. A metal has work function 2.3 eV. It is illuminated by light with frequency 450 THz. Will electrons be released?

14. A photoelectric experiment measures electrons leaving a metal with maximum kinetic energy 1.8 eV when each incoming photon has energy 6.5 eV. What is the work function of the metal?

15. A greenhouse gas molecule absorbs infrared photons strongly, but it lets most visible photons pass through. Why does the photon energy matter for this kind of absorption?

16. A metal has work function 2.0 eV. What is the threshold frequency for releasing electrons from this metal?

17. A different metal has work function 3.0 eV. What is the longest wavelength of light that could release electrons from it?

18. An electron leaves a metal with maximum kinetic energy 2.4 eV. Using electron mass 9.11 × 10 -31 kg, estimate the electron's speed. Assume the electron is slow enough that the usual kinetic energy equation is reasonable.

19. Why is ionizing radiation described using energy per particle instead of only total power?

20. In hydrogen, the n = 3 energy level is -1.51 eV and the n = 2 energy level is -3.40 eV. If an electron drops from n = 3 to n = 2, what photon energy is emitted, and what wavelength does that photon have?

21. A hydrogen atom absorbs ultraviolet light with wavelength 121 nm. Find the photon energy in eV, then decide whether it is above the 10 eV ionizing-radiation guideline on the page.

22. If an electron in an atom drops from a higher energy level to a lower energy level, is a photon emitted or absorbed?

23. A green photon has wavelength 532 nm. What is its momentum?

24. An electron in an electron microscope moves at 2.0 × 10 6 m/s. Using electron mass 9.11 × 10 -31 kg, what is its de Broglie wavelength?

25. A proton in a low-energy beam moves at 1500 m/s. Use proton mass 1.6726 × 10 -27 kg. What is its de Broglie wavelength?