Physics 25 Practice Problems Chapter 29

1. A 150 mW laser pointer emits photons of 532 nm wavelength. How many photons are emitted each second from this laser?

2. What is the energy (in joules) of photons in light of frequency 3.0×10^{17} Hz?

3. What is the wavelength (in nano-meters, nm) of light that consists of 10 eV photons?

4. What is the energy (in eV) of the photons in light of wavelength 100 nm?

5. The work function of a certain metal is 2.0 eV. Determine the maximum kinetic energies of photo-emitted electrons corresponding to the various light wavelengths in the table below.

Wavelength (nm)	Photon Energy (eV)	Maximum Kinetic Energy (eV)
700	1.78	---
500	2.49	0.49
400		
300		
200		

6. The work function of a metal is 7.0 eV. What is the maximum speed photo-emitted electrons can have when light of wavelength 100 nm is shined on the surface? (The mass of an electron is 9.11×10^{-31} kg.)

7. What is the least frequency of light that will photo-eject electrons from the surface of a substance that has a work function of 7.0 eV?

8. The maximum kinetic energy of photoemitted electrons from a metal is 4.0 eV when light of wavelength 100 nm is incident on the surface of the metal. What is the work function of this metal?

9. What would have to be the speed of a proton in order that its de Broglie wavelength be the same as the wavelength of light containing 6.0 eV photons? (m = 1.67 x 10^{-27} kg)

10. Find the speed of the electron in a hydrogen atom, given that the standing wave associated with the electron in its orbit consists of three matter wavelengths. Assume that the radius of the orbit is 19.04 angstroms. Note: 1 angstrom = 1 x 10^{-10} m, and the mass of an electron is 9.11 x 10^{-31} kg.

11. The de Broglie wavelength of a certain moving proton (m = 1.67 x 10^{-27} kg) is 2 x 10^{-10} m. Determine the kinetic energy of the proton in electron-volts.

12. A glass plate has a mass of 500 g and a specific heat capacity of 0.20 cal/g-C^{o}. How many photons of blue light of 470 nm wavelength must be absorbed by the plate to raise the temperature of the plate by 2.0 C^{o}? (Recall: Q = mcΔT.)

13. What is the de Broglie wavelength of an electron whose kinetic energy is 5.0 eV?

Solutions

1. E = 1243/532 = 2.34 eV/photon 150 mW = 150 x 10^{-3} J/s (150 x 10^{-3} J/s)/1.6 x 10^{-19} J/eV = 9.38 x 10^{17} eV/s (9.38 x 10^{17} eV/s)/ (2.34 eV/photon) = 4.01 x 10^{17} photons/s

2. E = hf = 6.63 x 10^{-34} (3 x 10^{17}) = 1.99 x 10^{-16} J
3. λ = 1243/10 = 124.3 nm (ultraviolet)
4. E = 1243/λ = 1243/100 = 12.43 eV (ultraviolet)

5.

λ (nm)	Photon Energy (eV)	Maximum Kinetic Energy (eV)
700	1.78	---
500	2.49	0.49
400	3.11	1.11
300	4.14	2.14
200	6.22	4.22

6.

$1243/100 - 7.0 = 5.43$ eV

$\frac{1}{2}(9.11 \times 10^{-31})\, v^2 = 5.43 \text{ eV } (1.6 \times 10^{-19} \text{ J/eV})$

$v = 1.38 \times 10^6$ m/s

7.

$1243/7 = 177.57$ nm

$= 177.57 \times 10^{-9}$ m

This is the longest wavelength of light that will cause photoemission, while the least frequency of light that causes photoemission is:

$f = c/\lambda$

$= 3 \times 10^8 / 177.57 \times 10^{-9}$

$= 1.69 \times 10^{15}$ Hz

8.

$4.0 = 1243/100 - W$

$W = 8.43$ eV

9.

$\lambda = 1243/6$

$= 207.17$ nm

$= 207.17 \times 10^{-9}$ m

$h/(mv) = \lambda$

$v = h/(m\lambda)$

$= 6.63 \times 10^{-34} / (1.67 \times 10^{-27} \times 207.17 \times 10^{-9})$

$= 1.92$ m/s

10.

$m = 9.11 \times 10^{-31}$ kg
$3\lambda = 2\pi\,(19.04 \times 10^{-10})$
$\lambda = 3.99 \times 10^{-9}$ m

$6.63 \times 10^{-34}/(9.11 \times 10^{-31}\, v) = 3.99 \times 10^{-9}$

$v = 1.82 \times 10^{5}$ m/s

11.

$6.63 \times 10^{-34}/(1.67 \times 10^{-27}\, v) = 2 \times 10^{-10}$
$v = 1985$ m/s

$K = ½\, mv^2$
$= ½\,(1.67 \times 10^{-27})(1985)^2$
$= 3.29 \times 10^{-21}$ J
$= 3.29 \times 10^{-21}$ J $/1.6 \times 10^{-19}$ J/ev
$= 0.021$ eV

12.

$Q = mc\Delta T$
$= 500(0.20)(2)$
$= 200$ cal
$= (200$ cal$)(4.19$ J/cal$)$
$= 838$ J
$= (838$ J$)/(1.6 \times 10^{-19}$ J/eV$)$
$= 5.24 \times 10^{21}$ eV

$1243/470 = 2.64$ eV
$(5.24 \times 10^{21}$ eV$)/(2.64$ eV/photon$) = 1.98 \times 10^{21}$ photons

13.

$5.0\,(1.6 \times 10^{-19}) = 8 \times 10^{-19}$ J
$½\,(9.11 \times 10^{-31})\, v^2 = 8 \times 10^{-19}$
$v = 1.33 \times 10^{6}$ m/s

$\lambda = h/(mv)$
$= 6.63 \times 10^{-34}/\,[9.11 \times 10^{-31}(1.33 \times 10^{6})]$
$= 5.47 \times 10^{-10}$ m

= 5.47 Å