AP FaSTudies:
TOPICS IN WAVE-PARTICLE DUALITY
photoelectric effect • bohr atom • de broglie wavelength

Major Players

h = Planck's constant = 6.63×10^{-34} J·s = 4.14×10^{-15} eV·s

E = energy | f or ν = frequency | λ = Wavelength

c = speed of light | KE = kinetic energy | V = potential | q = charge

Φ = work function (defined below) | p = momentum

PHOTOELECTRIC EFFECT

Photon Energy

$E = hf = hc/\lambda$

Photoelectron Energy

f_0 = threshold frequency | λ_0 = threshold or "cut-off" wavelength | $f_0 = c/\lambda_0$

$\Phi = hf_0 = hc/\lambda_0$ = work function

$KE = hf - hf_0$ or $KE = hf - \Phi$ = photoelectron energy (Photoelectric Equation)

Photoelectric Circuits

At retarding potential V, photoelectron energy is $KE = qV$

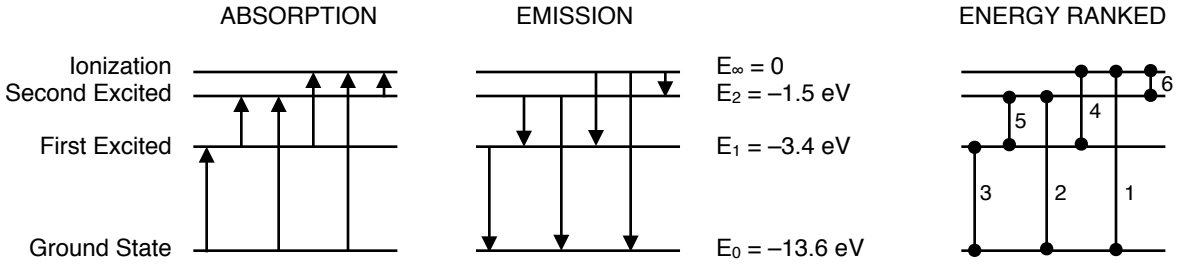
So $KE = {}^1/_2mv^2 = hf - \Phi = qV$

Inverse Photoelectric Effect: Bremsstrahlung

A metal surface bombarded with electrons emits photons (typically X-rays)

THE BOHR ATOM

$\Delta E = hf = hc/\lambda$



THE DE BROGLIE WAVELENGTH

Any particle with momentum p (=mv) has **deBroglie (duh BROE lee) wavelength** λ and any photon with wavelength λ has momentum p given by the relation

$\lambda = h/p$

Since $p = mv$, $\lambda = h/mv$

***Essentials of College Physics* (Serway & Vuille)**

Photoelectric Effect
Read
Chapter 27, Sections 2-3
Answer
Ch. 27 CQ 7, 8, 11
Solve
Ch. 27 P 9-12, 16, 43
AP 1994.3, 1987.6, 1991.6

The Bohr Atom
Read
Chapter 27, Section 1
Chapter 28, Section 3
Solve
Ch. 27 P 7
Ch. 28 P 12-14, 17, 40
AP 1985.6

De Broglie Wavelength (Dual Nature of Light and Matter)
Read
Chapter 27, Section 6
Answer
Ch. 27 CQ 6
Solve
Ch. 27 P 28-30
AP 1995.4

Answers to even-numbered textbook items (odds are in the book)
Ch. 27
CQ 6. Both! Waves: Young's double-slit experiment; Particles: photoelectric effect
CQ 8. UV shorter wavelength = higher frequency = higher energy than visible light
P 10. 5.4 eVP 12. a. only lithium b. 0.81 eV
P 14. a. 8.7E+12 electrons/second
P 16. a. 8.29E-11 m b. 1.24E-11 m
P 28. a. 1.98E-11 m b. 1.98E-14 m
P 30. a. 1.06E-34 m

Ch. 28
P 12. a. II b. I c. II and III
P 14. a. 12.1 eV b. 12.1 eV, 10.2 eV, 1.89 eV
P 40. a. 4.20 mm b. 1.05E+19 photons c. 8.82E+16 photons/cubic millimeter