PHYSICS 4E makeup QUIZ 1 SPRING QUARTER 2010
PROF. HIRSCH APRIL 16

Formulas and constants:

$hc = 12{,}400\ eV\,A$; $k_B = 1/11{,}600\ eV/K$; $ke^2 = 14.4 eVA$; $m_e c^2 = 0.511\times 10^6 eV$; $m_p/m_e = 1836$

Relativistic energy - momentum relation $E = \sqrt{m^2c^4 + p^2c^2}$; $c = 3\times 10^8 m/s$

Photons: $E = hf$; $p = E/c$; $f = c/\lambda$ Lorentz force: $\vec{F} = q\vec{E} + q\vec{v}\times\vec{B}$

Photoelectric effect: $eV_0 = (\frac{1}{2}mv^2)_{\max} = hf - \phi$, $\phi \equiv$ work function

Integrals: $I_n \equiv \int_0^\infty x^n e^{-\lambda x^2} dx$; $\frac{dI_n}{d\lambda} = -I_{n+2}$; $I_0 = \frac{1}{2}\sqrt{\frac{\pi}{\lambda}}$; $I_1 = \frac{1}{2\lambda}$; $\int_0^\infty \frac{x^3}{e^x - 1}dx = \frac{\pi^4}{15}$

Planck's law: $u(\lambda) = n(\lambda)\bar{E}(\lambda)$; $n(\lambda) = \frac{8\pi}{\lambda^4}$; $\bar{E}(\lambda) = \frac{hc}{\lambda}\frac{1}{e^{hc/\lambda k_B T} - 1}$

Energy in a mode/oscillator: $E_f = nhf$; probability $P(E) \propto e^{-E/k_B T}$

Stefan's law: $R = \sigma T^4$; $\sigma = 5.67\times 10^{-8} W/m^2K^4$; $R = cU/4$, $U = \int_0^\infty u(\lambda)d\lambda$

Wien's displacement law: $\lambda_m T = hc/4.96k_B$

Compton scattering: $\lambda' - \lambda = \frac{h}{m_e c}(1-\cos\theta)$; $\lambda_c \equiv \frac{h}{m_e c} = 0.0243A$

Hydrogen spectrum: $\frac{1}{\lambda} = R(\frac{1}{m^2} - \frac{1}{n^2})$; $R = 1.097\times 10^7\ m^{-1} = \frac{1}{911.3A}$

Rutherford scattering: $b = \frac{kq_\alpha Q}{m_\alpha v^2}\cot(\theta/2)$; $\Delta N \propto \frac{1}{\sin^4(\theta/2)}$

Electrostatics: $F = \frac{kq_1q_2}{r^2}$ (force) ; $U = q_0 V$ (potential energy) ; $V = \frac{kq}{r}$ (potential)

If you copy any part of your work from anybody you are in violation of UCSD's policies and subject to severe sanctions.

Show your work, write clearly.
There are 9 problems in this quiz

Write your answer (a,b,c,d or e) at the end of your work on each question, circle it and write next to it: "this is my answer".

Problems 1,2,3

A filament at temperature T=5000K emits 8W of power in a wavelength range of 1A around 4000A. Assume it is a black body.

Problem 1: How much power does it emit in a wavelength range of 1A around 4000A when its temperature is raised to 10,000K?

(a) 128 W (b) 16W (c) can't tell with given information (d) 300W (e) 160W

Problem 2: At which wavelength does it emit maximum power when it's at temperature 5000K?

(a) 4000A (b) 5200A (c) 5800A (d) 6400A (e) 7200A

Problem 3: At temperature 5000K, how much power does this filament emit in a wavelength range of 1A around the wavelength of maximum power emission?

(a) 12W (b) 15W (c) 30W (d) 45W (e) 8W

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Problems 4, 5, 6

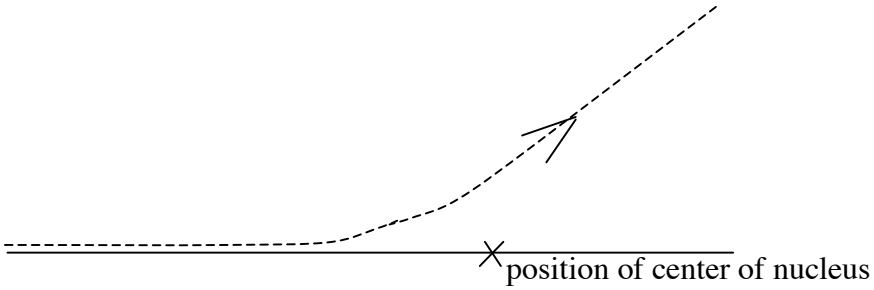
X rays of wavelength 2A are incident on a material, and the scattered X-rays have wavelength 2.014A.

Problem 4: give the kinetic energy of the scattered electron
(a) 43eV (b) 68eV (c) 126eV (d) 220eV (e) 340eV

Problem 5: find the angle at which the photon is scattered relative to the incidence direction.
(a) 25° (b) 35° (c) 45° (d) 55° (e) 65°

Problem 6: Give approximately the momentum component of the electron in the x-direction (direction of photon incidence)
(a) 36 eV/c (b) 360 eV/c (c) 3600 eV/c (d) 4300 eV/c (e) 8600 eV/c

Problems 7,8,9



An α particle with kinetic energy E_k = 9MeV is incident on a nucleus of Z=70. It does not penetrate the nucleus, and at the point where it is closest to the nucleus its kinetic energy is 4.5MeV.

Problem 7: find the ratio of impact parameter to distance of closest approach.
(a) 0.3 (b) 0.5 (c) 0.7 (d) 0.9 (e) 1

Problem 8: find the distance of closest approach.
(a) 2.5×10^{-4} A (b) 3×10^{-4} A (a) 3.5×10^{-4} A (a) 4×10^{-4}A (a) 4.5×10^{-4} A

Problem 9: the radius of this nucleus is
(a) 2.5×10^{-4}A (b) can't tell with given information (c) 3×10^{-4}A (d) 1×10^{-4}A (e) 0.8×10^{-4}A

Show your work, write clearly.

Write your answer (a,b,c,d or e) at the end of your work on each question, circle it and write next to it: "this is my answer".

Don't guess. If the work shown does not support the answer given, something is wrong.