PHYSICS 232 – TEST # 3

NAME:

STUDENT ID #:

USEFUL CONSTANTS

$$\epsilon_0 = 8.85 \times 10^{-12} C^2/(N \cdot m^2)$$
$$c = 3 \times 10^8 m/s$$
$$h = 6.6 \times 10^{-34} J \cdot s$$
$$k = 1.38 \times 10^{-23} J/K$$
$$e = 1.6 \times 10^{-19} C$$
$$m_e = 9.1 \times 10^{-31} kg$$

USEFUL FORMULAS

Time dilation:

$$\Delta t = \frac{\Delta t_o}{\sqrt{1 - u^2/c^2}} = \gamma \Delta t_o \ , \quad \gamma = \frac{1}{\sqrt{1 - u^2/c^2}}$$

Length contraction: $l = \frac{l_o}{\gamma}$

Lorentz transformation

$$x' = \gamma(x - ut) \ , \qquad t' = \gamma(t - ux/c^2) \ .$$

Addition of velocities:

$$v' = \frac{v - u}{1 - uv/c^2} \ , \qquad v = \frac{v' + u}{1 + uv'/c^2}$$

Doppler effect:

$$f = \sqrt{\frac{c + u}{c - u}} f_o$$

Momentum and energy:

$$\vec{p} = \gamma m \vec{v} \ , \qquad E = \sqrt{m^2 c^4 + p^2 c^2} = \gamma m c^2$$

Energy of a photon:

$$E = hf = \frac{hc}{\lambda}$$

Photoelectric effect: $eV_0 = hf - \phi$

Bohr model of the H atom:

$$L = m_e v r = n \frac{h}{2\pi} \qquad r = n^2 a_0$$

where $a_0 = \frac{\epsilon_0 h^2}{\pi m_e e^2} = 5.29 \times 10^{-11} m$,

$$E_n = -\frac{m_e e^4}{8 h^2 \epsilon_0^2 n^2} = -\frac{13.6 \ eV}{n^2}$$

X-rays from electron impact on a target:

$$eV_{AC} = h f_{max} = \frac{hc}{\lambda_{min}}$$

Compton scattering:

$$\lambda' - \lambda = \frac{h}{mc}(1 - \cos\phi)$$

Stefan-Boltzmann law:

$$I = \sigma T^4 \quad \sigma = 5.67 \times 10^{-8} W/m^2 \cdot K^4$$

Wien displacement law:

$$\lambda T = 2.9 \times 10^{-3} m \cdot K$$

Planck radiation law:

$$I(\lambda) = \frac{2\pi h c^2}{\lambda^5 (e^{hc/\lambda k T} - 1)}$$

de Broglie wavelength

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

Heisenberg uncertainty principle:

$$\Delta p_x \Delta x \geq \hbar \quad , \qquad \Delta E \Delta t \geq \hbar \quad , \qquad \hbar = \frac{h}{2\pi}$$

Schrödinger equation:

$$-\frac{\hbar^2}{2m} \frac{d^2 \psi(x)}{dx^2} + U(x)\psi(x) = E\psi(x)$$

Infinitely deep square potential well:

$$E_n = \frac{n^2 h^2}{8 m L^2} = \frac{n^2 \pi^2 \hbar^2}{2 m L^2} \quad , \qquad \psi_n = \sqrt{\frac{2}{L}} \sin \frac{n \pi x}{L}$$

Harmonic oscillator:

$$E_n = \left(n + \frac{1}{2}\right) \hbar \omega \qquad (n = 0, 1, 2, \dots)$$