Chem 3322 test #1 formula sheet

indefinite integral : \[ \int \sin^2(ax) \, dx = \frac{x}{2} - \frac{\sin(2ax)}{4a} \] (1)

The Schrödinger time dependent equation is, for \( \psi(x, t) \)
\[ i\hbar \frac{\partial \psi(x, t)}{\partial t} = -\frac{\hbar^2}{2m} \frac{\partial^2 \psi(x, t)}{\partial x^2} + V(x) \psi(x, t) \] (2)

The Schrödinger time independent equation is, for \( \psi(x) \)
\[ -\frac{\hbar^2}{2m} \frac{d^2 \psi(x)}{dx^2} + V(x) \psi(x) = E \psi(x) \] (3)

The particle in a one dimensional box (of size \( L \)) energy levels are
\[ E_n = \frac{n^2 \pi^2 \hbar^2}{2mL^2} \quad n = 1, 2, 3, ... \] (4)

The particle in a two-dimensional box (of side lengths \( a \) and \( b \)) energy levels are
\[ E = \frac{\pi^2 \hbar^2}{2m} \left( \frac{n_x^2}{a^2} + \frac{n_y^2}{b^2} \right) \quad n_x, n_y = 1, 2, 3, ... \] (5)

ground state wavefunction of the harmonic oscillator:
\[ \psi(x) = \left( \frac{2\alpha}{\pi} \right)^{1/4} e^{-\alpha x^2} \] (6)

with
\[ \alpha = \frac{m \omega}{2\hbar} \quad \text{and} \quad \omega = (k/m)^{1/2} \] (7)

where \( k \) is the force constant and \( m \) is the mass. energy levels of the harmonic oscillator:
\[ E_n = (n + 1/2) \hbar \omega, \quad n = 0, 1, 2, ... \]

energy levels of the particle on a ring:
\[ E_n = \frac{n^2 \hbar^2}{2mR^2} \quad n = 0, 1, 2, ... \] (8)

Speed of light = \( c = 3.0 \times 10^8 \) m/s
electron mass = \( 9.11 \times 10^{-31} \) kg. proton mass = \( 1.67 \times 10^{-27} \) kg.
Avogadro’s constant = \( N_A = 6.022 \times 10^{23} \) mol\(^{-1}\)
Planck constants: $h = 6.6262 \times 10^{-34}$ Js and $\hbar = 1.05459 \times 10^{-34}$ Js

$\pi = 3.14159$

$1 \text{ eV} = 1.6022 \times 10^{-19}$ J (electron volt to joule conversion)

Mass conversion from amu to kg: $1.66 \times 10^{-27}$ kg/amu

Relationship between the wavelength of a photon and its energy $\lambda = \frac{hc}{E}$