

Phys 401 Exam #1 Formula Sheet

$$A = x + iy = Ae^{i\theta}, \quad e^{i\theta} = \cos(\theta) + i\sin(\theta), \quad \theta = \tan^{-1}(y/x), \quad A = \sqrt{z^*z} = \sqrt{x^2 + y^2},$$

$$x = A\cos(\theta), y = A\sin(\theta)$$

$$\frac{dy(t)}{dt} = A \Rightarrow y(t) = At + C, \quad \frac{dy(t)}{dt} = Ay(t) \Rightarrow y(t) = Ce^{At}$$

$$\frac{d^2y(t)}{dt^2} + Ay(t) = 0 \Rightarrow y(t) = C_1 e^{i\sqrt{A}t} + C_2 e^{-i\sqrt{A}t}$$

$$k = 2\pi/\lambda, \quad v = 1/T, \quad \omega = 2\pi v, \quad E = hv = \hbar\omega, \quad \lambda = h/p, \quad p = \hbar k$$

$$\langle C \rangle = \sum_i P_i c_i = \int c P(c) dc, \quad \sigma^2 = (\Delta C)^2 = \langle C^2 \rangle - \langle C \rangle^2$$

$$\hat{A}\phi = a\phi, \quad \hat{p} = -i\hbar \frac{d}{dx}, \quad \hat{x} = x, \quad \hat{H} = \frac{-\hbar^2}{2m} \frac{d^2}{dx^2} + V(x)$$

$$\hat{p}\phi = p\phi \Rightarrow \phi = Ae^{ikx}, \quad p = \hbar k; \quad \hat{x}\delta(x) = x\delta(x), \quad f(x_0) = \int f(x)\delta(x-x_0)dx$$

$$\langle C \rangle = \int \Psi^* \hat{C} \Psi dx, \quad |\Psi|^2 dx = P(x)dx$$

$$i\hbar \frac{\partial \Psi(x,t)}{\partial t} = \hat{H}\Psi(x,t), \quad \hat{H}\phi_n = E_n \phi_n, \quad \Psi(x,t) = \sum_n a_n \phi_n e^{-i\omega_n t}, \quad \omega_n \equiv E_n / \hbar, \quad |a_n|^2 = P(E_n)$$

$$V(x) = \begin{cases} 0, & 0 < x < L \\ +\infty, & \text{otherwise} \end{cases} \Rightarrow \phi_n(x) = \sqrt{\frac{2}{L}} \sin\left(\frac{n\pi x}{L}\right), \quad E_n = \frac{\hbar^2 \pi^2 n^2}{2mL^2}, \quad \int \phi_m^*(x) \phi_n(x) dx = \delta_{mn}$$

$$a_m = \int \phi_m^*(x) \psi(x) dx$$

$$V(x) = 0 \Rightarrow \phi(x) = Ae^{ikx}, \quad E(k) = \frac{(\hbar k)^2}{2m},$$

$$\psi(x) = \frac{1}{\sqrt{2\pi}} \int \phi(k) e^{ikx} dk \Leftrightarrow \phi(k) = \frac{1}{\sqrt{2\pi}} \int \psi(x) e^{-ikx} dx$$

$$\Psi(x,t) = \frac{1}{\sqrt{2\pi}} \int \phi(k) e^{i(kx - Et/\hbar)} dk$$