PHYS213- FORMULA SHEET
Term202

Relations

$e_{tot} = a\sigma T^4$	$T\lambda_{max} = 2.898 \times 10^{-3}\ \mathrm{m.K}$	$u(\lambda) = \dfrac{8\pi hc\lambda^{-5}}{e^{hc/\lambda KT} - 1}$
$E = nhf$	$K_{max} = \dfrac{1}{2}mv^2 = eV_s$	$K_{max} = hf - \phi$
$2d\sin\theta = n\lambda$	$\lambda' - \lambda_o = \dfrac{h}{m_e c}(1 - \cos\theta)$	$m = ZIT$
$F = k\dfrac{(Z_1 e)(Z_2 e)}{r^2}$	$U = k\dfrac{(Z_1 e)(Z_2 e)}{r}$	$\Delta n = \dfrac{k^2 Z^2 e^4 NnA}{4R^2 K\sin^4(\varphi/2)}$
$\dfrac{1}{\lambda} = R\left(\dfrac{1}{n_f^2} - \dfrac{1}{n_i^2}\right)$	$L = m_e vr = n\hbar$	$\dfrac{e}{m_e} = \dfrac{V\theta}{B^2 ld}$
$r_n = \dfrac{n^2 a_0}{Z}$	$E_n = -\dfrac{13.6Z^2}{n^2}$	$\lambda = \dfrac{h}{p}$
$v_p = \dfrac{\omega}{k}$	$v_g = \dfrac{d\omega}{dk}$	$v_g = v_p + k\dfrac{dv_p}{dk}$
$\Delta x\Delta p_x \geq \dfrac{\hbar}{2}$	$\Delta E\Delta t \geq \dfrac{\hbar}{2}$	$D\sin\theta = D\dfrac{y}{L} = \begin{cases} n\lambda \\ (n+0.5)\lambda \end{cases}$
$T = \dfrac{1}{f} = \dfrac{2\pi r}{v}$	$\lambda_{min} = \dfrac{1.24 \times 10^3}{V}nm$	$qE = qvB$
$\displaystyle\int_{-\infty}^{\infty} \lvert\psi\rvert^2\, dx = 1$	$P(x) = \displaystyle\int_a^b \lvert\psi\rvert^2\, dx$	$\langle Q\rangle = \displaystyle\int_{-\infty}^{\infty} \psi^*\, Q\, \psi\, dx$
$\psi_n(x) = \sqrt{\dfrac{2}{L}}\sin\left(\dfrac{n\pi x}{L}\right)$	$E_n = \dfrac{n^2\pi^2\hbar^2}{2mL^2}$	$\Psi(x,t) = \psi(x)e^{-i\omega t}$
$\psi_n(x,t) = Ae^{i(kx-\omega t)}$	$\Delta Q = \sqrt{\langle Q^2\rangle - \langle Q\rangle^2}$	$[Q]\psi = q\psi$
$[P_x] = \dfrac{\hbar}{i}\dfrac{\partial}{\partial x}$	$[E] = i\hbar\dfrac{\partial}{\partial t}$	$[K] = -\dfrac{\hbar^2}{2m}\dfrac{\partial^2}{\partial x^2}$
$[H] = -\dfrac{\hbar^2}{2m}\dfrac{\partial^2}{\partial x^2} + U(x)$	$P_x = n\dfrac{\pi\hbar}{L}$	$\lvert\vec{L}\rvert = \hbar\sqrt{\ell(\ell+1)}$
$L_z = m_\ell\hbar$	$P(r) = r^2\lvert R_{n,\ell}(r)\rvert^2$	$\langle r\rangle = \displaystyle\int_o^{\infty} rP(r)\, dr$

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

$$T(E) = \left\{1 + \frac{1}{4}\left[\frac{U^2}{E(U-E)}\right]\sinh^2(\alpha L)\right\}^{-1} \qquad \alpha = \frac{\sqrt{2m(U-E)}}{\hbar}$$

$$T(E) = \left\{1 + \frac{1}{4}\left[\frac{E^2}{U(E-u)}\right]\sin^2(\alpha' L)\right\}^{-1} \qquad \alpha' = \frac{\sqrt{2m(E-U)}}{\hbar}$$

$$T(E) = \exp\left\{-4\pi Z\sqrt{\frac{E_0}{E}} + 8\sqrt{\frac{ZR}{r_0}}\right\}$$

$E_0 = 0.0993$ MeV, $\quad r_0 = 7.25$ fm, $\quad \lambda = 10^{21}T(E)$

$$-\frac{\hbar^2}{2m}\frac{\partial^2\Psi(x,t)}{\partial x^2} + U(x)\Psi(x,t) = i\hbar\frac{\partial\Psi(x,t)}{\partial t}$$

$$\int_0^\infty x^n e^{-x}dx = n! \qquad \int_0^\infty z^2 e^{-az^2}\,dz = \frac{1}{4a}\sqrt{\frac{\pi}{a}}\ ,\ a > 0$$

$$E_{n_1,n_2,n_3} = \frac{\pi^2\hbar^2}{2m}\left(\frac{n_1^2}{L_1^2} + \frac{n_2^2}{L_2^2} + \frac{n_3^2}{L_3^2}\right)$$

$$\Psi(r,\theta,\phi,t) = R_{n,\ell}(r)Y_\ell^{m_\ell}(\theta,\phi)e^{-i\omega t}$$

$\mu_L = -\frac{e}{2m_e}L$	$\mu_B = \frac{e\hbar}{2m_e} = 9.27\times10^{-24}$ J/T	$\omega_L = \frac{eB}{2m_e}$
$U = -\vec{\mu}\cdot\vec{B}$	$U = \hbar\omega_L m_l$	$\vec{J} = \vec{L} + \vec{S}$
$\lvert\vec{J}\rvert = \hbar\sqrt{J(J+1)}$	$J_z = \hbar m_j$	$\lvert\vec{S}\rvert = \hbar\sqrt{S(S+1)}$
$S_z = \hbar m_s$	$\mu_s = -\frac{e}{m_e}S$	$r = r_0A^{1/3}$, $r_0 = 1.2$ fm
$\mu_n = \frac{e\hbar}{2m_p} = 5.05\times10^{-27}$ J/T	$N = N_0e^{-\lambda t}$, $\lambda = \frac{ln(2)}{T_{1/2}}$	$R = \lambda N_0 e^{-\lambda t}$
$\frac{R}{R_0} = \frac{\sigma N}{A}$	$N = N_0e^{-n\sigma x}$	$n\tau \geq 10^{14}$ s/cm^3

$$Q_\alpha = (M_X - M_Y - m_\alpha)c^2 \qquad K_\alpha = \frac{M_Y}{M_Y + m_\alpha}Q$$

$$Q_{\beta^-} = [M({}^A_ZX) - M({}_{Z+1}^{\ \ A}Y)]c^2$$

$$Q_{\beta^+} = [M({}^A_ZX) - M({}_{Z-1}^{\ \ A}Y) - 2m_e]c^2$$

$$Q_{\epsilon c} = [M({}^A_ZX) - M({}_{Z-1}^{\ \ A}Y)]c^2$$

$$E_b(\text{MeV}) = [ZM(H) + Nm_n - M_A] \times 931.5\,\frac{\text{MeV}}{\text{u}}$$

$$E_b(MeV) = 15.7A - 17.8A^{2/3} - 0.71\,\frac{Z(Z-1)}{A^{1/3}} - 23.6\,\frac{(N-Z)^2}{A}$$

$$Q = (M_X + M_a - M_Y - M_b)c^2 = K_Y + K_b - K_a$$

$$K_{th} = -Q\left(1 + \frac{M_a}{M_X}\right)$$

Constants:

$e = 1.6 \times 10^{-19}$C	$m_e = 9.11 \times 10^{-31}$kg	$h = 6.626 \times 10^{-34}$ J.s, $\hbar = h/2\pi$
$c = 3 \times 10^{8}$ m/s	$m_p = 1.67 \times 10^{-27}$kg	$k = 9 \times 10^{9}$ N.m^2/C^2
$hc = 1240$ eV.nm	$R = 1.0973 \times 10^{7}$ m^{-1}	$\sigma = 5.67 \times 10^{-8}$ W.m^{-2}.K^{-4}
$\lambda_c = 0.00243$ nm	$a_0 = 0.0529$ nm	$k_B = 1.38 \times 10^{-23}$ J/K
1 Bq = 1 decay/s	1 Ci = 3.7×10^{10} decay/s	$m(H) = 1.007\,825$ u
$m(n) = 1.008664$ u	1 u = 931.5 MeV/c^2	$m_e c^2 = 0.511$ MeV
$N_A = 6.02 \times 10^{23}$ atom/mole	1 MeV = 1.6 x 10^{-13} J	