

Important Units and ConstantsAtomic weight (periodic table): *grams/mole*

$$1 \text{ amu} = 1 \text{ u} = 1 \text{ Da} = 1.6605 \times 10^{-27} \text{ kg} = 931.494893 \text{ MeV}/c^2$$

Avogadro's number: $N_a = 6.022 \times 10^{23}$ (1 mole)

$$\text{Energy: } 1 \text{ eV} = 1.602 \times 10^{-19} \text{ J} \quad K = \frac{1}{2}mv^2$$

$$\text{Planck's constant: } h = 6.626 \times 10^{-34} \text{ J} \cdot \text{s} = 4.1357 \times 10^{-15} \text{ eV} \cdot \text{s}$$

$$\text{Charge unit: } e = 1.602 \times 10^{-19} \text{ C}$$

$$\text{Electron mass } m_e = 9.11 \times 10^{-31} \text{ kg}$$

$$\text{Permittivity: } \epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2/(\text{N} \cdot \text{m}^2)$$

$$\text{Speed of light in vacuum: } v = c = 2.998 \times 10^8 \text{ m/s} \quad (c = 3 \times 10^8 \text{ m/s is good enough})$$

$$\text{Nanometer: } 1 \text{ nm} = 10^{-9} \text{ m}$$

Bohr atom (Z protons, just 1 electron) :

$$r_n = \frac{n^2 h^2 \epsilon_0}{\pi m_e Z e^2} = \frac{n^2}{Z} r_1 \text{ where } r_1 = \frac{h^2 \epsilon_0}{\pi m_e e^2} = 0.0529 \text{ nm (Bohr radius)}$$

$$E_n = -\left(\frac{e^4 m_e}{8 \epsilon_0^2 h^2}\right) \frac{Z^2}{n^2} \quad (\text{in J}) \quad E_n = -13.60569 Z^2 / n^2 \quad (\text{in eV})$$

Photoelectric effect : $E_\gamma = W_o + K$, stopping voltage: $K = (e)(V_s)$ **Photon energy** : $E = hf = hc/\lambda$ if λ in nm and E in eV then $E = (1239.84 \text{ eV} \cdot \text{nm})/\lambda$ **Photon momentum** : $p = E/c = hf/c = h/\lambda$ Particle momentum: $p = mv$ **Radiation Pressure** : $P = F/A$ $P = I/c$ if absorbed; $P = 2I/c$ if 100% reflected**Intensity** in this context refers to power/area.**Radioactive decay** : $N(t) = N_o e^{-\lambda t}$ $t_{1/2} = \ln(2)/\lambda$ **Activity** : $R(t) = |dN/dt| = \lambda N(t) = R_o e^{-\lambda t}$ $R_o = \lambda N_o$

$$1 \text{ Curie} = 1 \text{ Ci} = 3.7 \times 10^{10} \text{ decays/sec}$$

Radioactive attenuation : $I(x) = I_o e^{-\mu x}$ $HVL = x_{1/2} = \ln(2)/\mu$ **Intensity** in this context refers to activity/area.**Matter waves** : de Broglie wavelength of a particle : $\lambda = h/p$ where $p = mv$ **Miscellaneous**

$$1 \text{ hour} = 3600 \text{ sec} \quad 1 \text{ day} = 86400 \text{ s} \quad 1 \text{ year} = 3.156 \times 10^7 \text{ s}$$

Pressure is force per area

Colors: Violet: 400 nm, Blue: 475 nm, Green: 525 nm, Yellow: 580 nm, Red: 700 nm

Ultraviolet: $\lambda < 390 \text{ nm}$ Visible: 390 nm to 750 nm Infrared: $\lambda > 750 \text{ nm}$ Frequency, wavelength and wave speed: $\lambda f = v$.Typical densities: $\rho_{\text{air}} = 1.28 \text{ kg/m}^3$, $\rho_{\text{water}} = 1000 \text{ kg/m}^3$ Circle: circumference : $C = 2\pi r$ area : $A = \pi r^2$ Sphere: surface area : $S = 4\pi r^2$ volume : $V = \frac{4}{3}\pi r^3$ Arc-length: $s = r\theta$ (angle in radians)Quadratic equation: if $ax^2 + bx + c = 0$ then $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Isotope symbol: A_ZX : element **X**, with **Z** protons and **A** nucleons (protons PLUS neutrons).

Masses in Kilograms, Atomic Mass Units, and MeV/c ²			
Object	kg	u (Da)	MeV/c ²
1 u	1.6605×10^{-27}	1.0	931.494893
electron e, β^- , β^+	9.1094×10^{-31}	0.00054857991 .	0.510998950
proton: p^+	1.67262×10^{-27}	1.007276467	938.272088
neutron n	1.67493×10^{-27}	1.008664915	939.565420
alpha α	6.64466×10^{-27}	4.001506179	3727.379378
neutrino ν	~ 0	~ 0 .	~ 0 .
1_1H		1.007825032	938.78307
2_1H		2.014101778	1876.12393
3_1H		3.016049281	2809.43212
3_2He		3.016029322	2809.41353
4_2He		4.002603254	3728.40133
6_3Li		6.015123	
7_3Li		7.016003	
7_4Be		7.016929	
9_4Be		9.012183	
${}^{10}_5B$		10.012937	
${}^{11}_5B$		11.009305	
${}^{11}_6C$		11.011433	
${}^{12}_6C$		12.000000	
${}^{13}_6C$		13.003355	
${}^{14}_6C$		14.003242	
${}^{32}_{15}P$		31.973762	
${}^{39}_{19}K$		38.963706	
${}^{40}_{19}K$		39.963998	
${}^{40}_{20}Ca$		38.962591	