Atomic units $\hbar = m = e = 1$ (a.u) (The units in the electron's world.)

Length= a_0= Bohr radius= **0.528 x10^{-8}** cm
Velocity= v_0 =electron velocity in 1st Bohr orbit= **αc =** 2.18x10^{8} cm/s
Energy= twice of ionization potential of H=**27.21 eV** (called Hartree by chemists)
Time= a_0/v_0 = 2.42x10^{-17} sec= **24.2 as** (1fs= 41 a.u)
units of frequency= v_0/a_0= **4.13x10^{16}** sec^{-1}
Electric field = e/a_0^2 = **5.14x10^{9}** V/cm

Other units:

One atomic unit of magnetic field is defined for a Bohr magneton in a B field which has the energy of 13.6 eV. Or $\mu_B B = 13.6eV$ where $\mu_B = e\hbar/2mc = 5.788x10^{-5} eV/Tesla$
Thus 1 a.u. of magnetic field = **2.35x10^{5}** Tesla
Laser intensity=$\frac{1}{2}\varepsilon_0 c E^2$ = **3.51x 10^{16} W/cm^{2}** for **peak** E field at 1 a.u.

Energy conversion factors

1 eV = 8065.54 **cm^{-1}**
1 a.u = 27.211396 eV = 219 474.63 05 **cm^{-1}** =2 Ry
1 Ry = 13.6057 eV
1 degree **kelvin** = 0.0862 meV (energy units for cold atoms)
= 0.695 cm^{-1}

1 **Kcal/mol**= 0.0434 eV = 43.4 meV (energy units used by chemists)

1 **GHz** → 6.6x10^{-7} eV (energy units by laser physicists)
(be careful here-- GHz is the frequency f, to get the energy you need the conversion $\omega = 2\pi f$ to get it right. Thus 2 π x4.13x10^{16} Hz→ 27.21 eV)

Frequently used constants

Speed of light in vacuum c = 2.997 924 580 x10^{8} m/s (exact-by definition)
Planck's constant , h=6.6260755 x 10^{-34} J-s= 4.136 x 10^{-15} eV-s
electron charge q = 1.60217733 x 10^{-19} coulomb
Avogardro number= 6.022x10^{23} /mole
Boltzmann's constant k = 1.380658x 10^{-23} J/K=8.617 x 10^{-5} eV/K

Short-hand notations.

10^9=giga, 10^{12} =tera; 10^{15}= **peta** ; 10^{18} =exa ; 10^{21}=zetta ; 10^{24}=yocto

10^{-9}=nano 10^{-12} =pico; 10^{-15}=femto; 10^{-18}=**atto**; 10^{-21}=zepto; 10^{-24}=yotta

Notable wavelengths, frequencies and energies

photon wavelength to ionize H: 911 ^{o}A

Lymann-α of H: 1216 ^{o}A →10.2 eV or 1 nm → 1.24 keV

photon momentum (a.u.) k= 2.7 x10^{-4} E (eV)

de Broglie wavelength for **electron,** 100 eV is **1.22** angstrom

Lasers

For $\lambda = 1$ ^{o}A, photon energy= 455.71 au for 800 nm -> $\omega = 0.057au$

laser peak intensity (linear polarized) = 3.5 x10^{16} W/cm^2

U_P= $E^2/4\omega^2$ =9.33 I(10^{14} W/cm^2) λ^2 (in μ m)

(6eV for 800 nm at 10^{14} W/cm^2)

Keldysh parameter $\gamma = \sqrt{I/(2U_P)}$

time-frequency width relation for a chirped pulse: $\Delta\omega = \frac{4\ln 2}{\tau_x}\sqrt{1+\xi^2}$

Gaussian pulse

$$I(\omega) = e^{-\tau^2(\omega-\omega_0)^2/(4\ln 2)} \qquad E(t) = e^{-2\ln 2 t^2/\tau^2}$$

(τ is FWHM in time domain)

width in eV for a Gaussian pulse for τ= 1 fs is 1.83 eV.

1.5. Oscillator strength and transition rates

A= $2*(\omega^2/c^3)$ **f** (4.13×10^{16}) 1/sec

where ω is in a.u. , c=137.03604 and f is the oscillator strength for emission