Quantum Technologies

Important Values and Definitions

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Explanation and Introduction of this Document

I wrote this document for the students studying Quantum Technologies to have a nice handout set for the important definitions involved in the course. I hope that it is sufficient for this task and it helps all of your studies.
I spent have spent a lot of time developing the template used to make this LaTeX document, I want others to benefit from this work so the source code for this template is available on GitHub [1].

1 Constants & Relevant Definitions

1.1 Constants

Table 1: *Important constants involved in Quantum Mechanics*

Symbol/Definition	*Name/info*	*Value*
$\mathbf{c}$	*Speed of Light in Vacuum* [2]	2.998×10^{8} *metres/second (m/s)*
$\mathbf{e}$	*Elementary unit of charge, charge of an electron/proton* [3]	-1.602×10^{-19} *Coulomb (C)*
$\mathbf{h}$	*Planck's Constant* [4]	6.626×10^{-34} *Joule·second (J·s)* $= 4.136 \times 10^{-15}$ *eV·second (eV·s)*
$\hbar = \frac{\mathbf{h}}{2\pi}$	*The reduced Planck constant, Planck's constant in terms of Radians instead of Hertz.* [5]	1.055×10^{-34} *Joule·second (J·s)* $= 0.658 \times 10^{-15}$ *eV·second (eV·s)*
$\mathbf{k_e} = \frac{1}{4\pi\epsilon_0}$	*Coulomb's Constant, the Electric Force Constant, or the Electrostatic Constant.* [6]	$8.988 \times 10^{9}\ \frac{Newton \cdot metre^2}{Coulomb^2} \left(\frac{N \cdot m^2}{C^2}\right)$
$\mathbf{N_A}$	*Avogadro's Constant* [7]	6.022×10^{23} *mole*$^{-1}$ *or* $\frac{1}{mole}$
$\mathbf{G}$	*Gravitational Constant* [8]	$6.672 \times 10^{-11}\ \frac{metre^3}{Kilogram \cdot second^2} \left(\frac{m^3}{Kg \cdot s^2}\right)$ $= 6.672 \times 10^{-8}\ \frac{centimetre^3}{gram \cdot second^2} \left(\frac{cm^3}{g \cdot s^2}\right)$
$\mathbf{k_B} = \frac{\mathbf{R}}{\mathbf{N_A}}$ $\left(\frac{\text{Molar Gas Constant}}{\text{Number of Molecules}}\right)$	*Boltzmann's Constant, this relates the relative kinetic energy of particles in a gas with the thermodynamic temperature of the gas.* [9]	1.38×10^{-23} *Joule·Kelvin (J·K)* $= 8.617 \times 10^{-5}$ *eV·Kelvin (eV·K)*
$\mathbf{hc}$	*Planck's Constant · Speed of Light in Vacuum*	$19.865 \cdot 10^{-26}$ *Joules·metre (J·m)* $12.41 \cdot 10^{3}$ *electronvolt·Angstrom (eV·Å)* 1241 *Mega-electronvolt·femto-metre (MeV·fm)*

Table 1: *Important constants involved in Quantum Mechanics* (Continued)

$\boldsymbol{\hbar c}$	*Normalised Planck's Constant · Speed of Light in Vacuum*	$3.165 \cdot 10^{-26}$ *Joules·metre (J·m)* 1973 *electronvolt·Angstrom (eV·Å)* 197.3 *Mega-electronvolt·femto-metre (MeV·fm)*
$\mathbf{k_c e^2}$	*Coulomb's Constant·energy*^{2}	1.44 *Mega-electronvolt·femto-metre (MeV·fm)*
$\dfrac{\mathbf{k_c e^2}}{\boldsymbol{\hbar}\,\mathbf{c}}$	*The Fine-Structure Constant* [10]	$\dfrac{1}{137}$
$\mu_B = \dfrac{\mathbf{e}\,\boldsymbol{\hbar}}{\mathbf{2\,m_e}}$	*The Bohr Magneton* [11]	9.27×10^{-24} *Joule/Tesla (J/T)* 5.79×10^{-5} *electronvolt/Tesla (eV/T)*

1.2 Relevant Classical Definitions

TODO

Force Moving on a Charge	Electric Field of a Charge
Magnetic Field of a Current	Induced Electromotive Force
Energy Density in the Field	

Table 2: *Important Definitions Involved in Classical Physics that will be Relevant for Quantum Physics.*

2 Units Involved and Some Important Starting Equations

Table 3: *Important Units Involved in Classical Physics that will be Relevant for Quantum Physics.*

Measurement/Info	***Abbreviation***	***SI Unit (& Other Common/Useful Units)***
Distance	s	*metres (m), Angstrom (Å) [12]*
Mass	m	*kilograms (kg)*
Time	t	*second (s)*
Velocity	v	*metres/Second (m/s)*
Momentum	p	$\frac{\textit{kilogram}\cdot\textit{metres}}{\textit{second}}\left(\frac{kg\cdot m}{s}\right)$
Force	F	*Newtons (N),* $\frac{\textit{kilogram}\cdot\textit{metres}}{\textit{second}^2}\left(\frac{kg\cdot m}{s^2}\right)$
Energy, Work Done	W, E	*Joules (J) [13], electronVolts (eV) [14], Newton metres (Nm)*
Power	P	*Watts (W),* $\frac{\textit{Joules}}{\textit{second}}\left(\frac{J}{s}\right)$
Electric Charge	q	*Coulombs (C), Ampere·seconds (A·s)*
Electric Charge Density	ρ	$\frac{\textit{Coulomb}}{\textit{metre}^3}\left(\frac{C}{m^3}\right)$
Electric Potential	φ	*Volts (V),* $\frac{\textit{Joules}}{\textit{Coulomb}}\left(\frac{J}{C}\right)$
Electric Field	$\vec{E}$	$\frac{\textit{Volts}}{\textit{metre}}\left(\frac{V}{m}\right), \frac{\textit{Newtons}}{\textit{Coulomb}}\left(\frac{N}{C}\right)$
Electric Current	I	*Amperes (A),* $\frac{\textit{Coulomb}}{\textit{second}}\left(\frac{C}{s}\right)$
Electric Current Density	$\vec{J}$	$\frac{\textit{Amperes}}{\textit{metre}^2}\left(\frac{A}{m^2}\right)$

Table 3: *Important Units Involved in Classical Physics that will be Relevant for Quantum Physics.* (Continued)

Resistance	R	*Ohm* (Ω), $\frac{\textit{Volts}}{\textit{Ampere}} \left(\frac{V}{A}\right)$
Resistivity	ρ	*Ohm·metre* (Ω·m)

Magnetic Flux Density	$\vec{B}$	*Tesla (T)* [15], $\frac{\textit{Newtons}}{\textit{Ampere·metre}} \left(\frac{N}{A \cdot m}\right)$
Magnetic Field Strength	$\vec{H}$	$\frac{\textit{Amperes}}{\textit{metre}} \left(\frac{A}{m}\right)$
Magnetic Flux	$\vec{\Phi}$	*Weber (W), Tesla·metre*^{2} ($T \cdot m^2$)

Capacitance	C	*Farads (F)*, $\frac{\textit{seconds}}{\textit{Ohm}} \left(\frac{s}{\Omega}\right)$
Inductance	L	*Henries (H), Ohm·seconds* (Ω·s)

3 Conversions

1 electronvolt (eV)	1.602×10^{-19} Joules (J)
1 Angstrom (Å)	10×10^{-10} metres (m)
1 Ohm (Ω)	1.13×10^{-12} $\frac{\text{seconds}}{\text{centimetre}} \left(\frac{\text{s}}{\text{cm}}\right)$
1 Farad (F)	9×10^{8} metres (m)
1 Henry (H)	1.13×10^{-12} $\frac{\text{seconds}^2}{\text{centimetre}} \left(\frac{\text{s}^2}{\text{cm}}\right)$

Table 4: *Some Conversions for Quantum Mechanics*

4 Properties of Elemental Particles

Electron Properties [3]		
Property	***Abbreviation***	***Value***
Mass at rest	$\mathbf{m_e}$	9.109×10^{-31} *kilogram (kg)* 9.109×10^{-28} *gram (g)*
Charge	$\mathbf{q_e}$, $\mathbf{e^-}$	-1 *elementary charge (e)* -1.602×10^{-19} *Coulombs (C)*
Energy	$\mathbf{E_e = m_e c^2}$	0.511 *Mega electronvolt (MeV)*
Intrinsic Magnetic Moment	$\boldsymbol{\mu}_\mathbf{e}$	-9.285×10^{-24} *Joule/Tesla (J/T)* -1.001 Bohr Magneton (μ_B)
Spin	$\mathbf{S_e}$	$\pm\frac{1}{2}$

Table 5: *Important Properties of the Electron for Quantum Mechanics*

Proton Properties [16]		
Property	***Abbreviation***	***Value***
Mass at rest	$\mathbf{m_p}$	1.673×10^{-27} *kilogram (kg)* 1.673×10^{-24} *gram (g)*
Charge	$\mathbf{q_p}$, $\mathbf{e^+}$	$+1$ *elementary charge (e)* $+1.602 \times 10^{-19}$ *Coulombs (C)*
Energy	$\mathbf{E_p = m_p c^2}$	938.3 *Mega electronvolt (MeV)*
Intrinsic Magnetic Moment	$\boldsymbol{\mu}_\mathbf{p}$	$+1.411 \times 10^{-26}$ *Joule/Tesla (J/T)* $+1.521 \times 10^{-3}$ Bohr Magneton (μ_B)
Spin	$\mathbf{S_p}$	$\pm\frac{1}{2}$

Table 6: *Important Properties of the Proton for Quantum Mechanics*

Properties of Elemental Particles Cont...

Neutron Properties [17]		
Property	*Abbreviation*	*Value*
Mass at rest	$\mathbf{m_n}$	1.675×10^{-27} *kilogram (kg)* 1.675×10^{-24} *gram (g)*
Charge	$\mathbf{q_n}$	≈ 0 *elementary charge (e)* $(-2 \pm 8) \times 10^{-22}$ *e*
Energy	$\mathbf{E_n = m_n c^2}$	939.6 *Mega electronvolt (MeV)*
Intrinsic Magnetic Moment	$\boldsymbol{\mu_n}$	≈ 0 *Joule/Tesla (J/T)*
Spin	$\mathbf{S_n}$	$\pm\frac{1}{2}$

Table 7: *Important Properties of the Neutron for Quantum Mechanics*

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