

# 1 Fundamental Constants, Elements, Units

## 1.1 Fundamental Physical Constants

**Table 1.1.** Fundamental Physical Constants

Electron mass	$m_e = 9.10939 \times 10^{-28} \text{ g}$
Proton mass	$m_p = 1.67262 \times 10^{-24} \text{ g}$
Atomic unit of mass	$m_a = \frac{1}{12}m(^{12}\text{C}) = 1.66054 \times 10^{-24} \text{ g}$
Ratio of proton and electron masses	$m_p/m_e = 1836.15$
Ratio of atomic and electron masses	$m_a/m_e = 1822.89$
Electron charge	$e = 1.602177 \times 10^{-19} \text{ C} = 4.8032 \times 10^{-10} \text{ e.s.u.}$ $e^2 = 2.3071 \times 10^{-19} \text{ erg cm}$
Planck constant	$h = 6.62619 \times 10^{-27} \text{ erg s}$ $\hbar = 1.05457 \times 10^{-27} \text{ erg s}$
Light velocity	$c = 2.99792 \times 10^{10} \text{ cm/s}$
Fine-structure constant	$\alpha = e^2/(\hbar c) = 0.07295$
Inverse fine-structure constant	$1/\alpha = \hbar c/e^2 = 137.03599$
Bohr radius	$a_0 = \hbar^2/(m_e e^2) = 0.529177 \text{ \AA}$
Rydberg constant	$R = m_e e^4/(2\hbar^2) = 13.6057 \text{ eV}$ $= 2.17987 \times 10^{-18} \text{ J}$
Bohr magneton	$\mu_B = e\hbar/(2m_e c) = 9.27402 \times 10^{-24} \text{ J/T}$ $= 9.27402 \times 10^{-21} \text{ erg/Gs}$
Avogadro number	$N_A = 6.02214 \times 10^{23} \text{ mol}^{-1}$
Stephan–Boltzmann constant	$\sigma = \pi^2/(60\hbar^3 c^2) = 5.669 \times 10^{-12} \text{ W/(cm}^2\text{K}^4)$
Molar volume	$R = 22.414 \text{ l/mol}$
Loschmidt number	$L = N_A/R = 2.6867 \times 10^{19} \text{ cm}^{-3}$
Faraday constant	$F = N_A e = 96485.3 \text{ C/mol}$

## 1.2 Elements and Isotopes

There are about 2700 stable and 2000 radioactive isotopes in nature [17]. Stable isotopes relate to elements with a nuclear charge below 83, excluding technetium  $_{43}\text{Tc}$  and promethium  $_{61}\text{Pm}$ , and also to elements with a nuclear charge in the range 90–93 (thorium, protactinium, uranium, neptunium). The diagram Pt1 contains standard atomic masses for elements, taking into account their occurrence in the Earth's crust [2, 18]. If stable isotopes of a given element are absent, the masses are given in square brackets. These masses are given in atomic mass units (amu) where the unit is taken 1/12 mass of the carbon isotope  $_{12}\text{C}$  from 1961 (see Table 1.1).

There is in diagram Pt2 the occurrence of stable isotopes in the Earth's crust, and diagram Pt3 contains the lifetimes of stable isotopes [2, 18–20]. These lifetimes are expressed in days (d) and years (y) and are given for isotopes whose lifetime exceeds 2 hours (0.08 d).

## 1.3 Physical Units and Conversion Factors

### 1.3.1 Systems of Physical Units

The unit system is a set of units through which various physical parameters are expressed. The basis of any mechanical system of units is the fact that the value of any dimensionality may be expressed through three dimensional units—length, mass and time. The CGS system, which is based on the centimeter, gram and second [3], is the oldest system of units and was introduced by British association for the Advancement of Science in 1874. The system of International Units (SI) [4] was adopted in 1960 (the conference des Poids et Mesure, Paris) and is based on the meter (m), kilogram (kg) and second (s). Other bases may be used for specific units.

In transferring from mechanics to other physics branches, additional units or assumptions are required. In particular, along with mechanical units, we deal with electric and magnetic units below. Then the base of SI units along with the above mechanical units contain the unit of an electric current ampere (A). Table 1.2 contains the SI units and their connection with the base units. Note that we express the thermodynamic temperature through energy units below.

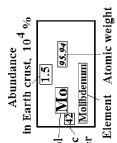
In spreading the CGS system of units to electrostatics, one can use the Coulomb law for the force  $F$  between two charges  $e_1$  and  $e_2$  that are located at a distance  $r$  in a vacuum. This force is given by

$$F = \epsilon_0 \frac{e_1 e_2}{r^2}$$

where  $\epsilon_0$  is the vacuum permittivity. Defining a charge unit from this formula under the assumption  $\epsilon_0 = 1$ , we construct in this manner the CGSE system of units that describes physical parameters of mechanics and electrostatics. In the same way, in constructing of the CGSM system of units on the basis of the mechanical CGS system of units, the assumption is used that the vacuum magnetic conductivity is

### Standard Atomic Weights.

Group Period	I		II		III		IV		V		VI		VII		VIII	
	Element	Atomic weight	Element	Atomic weight	Element	Atomic weight	Element	Atomic weight	Element	Atomic weight	Element	Atomic weight	Element	Atomic weight	Element	Atomic weight
1	H Hydrogen	1.0079	He Helium	4.0026	B Boron	10.81	C Carbon	12.011	N Nitrogen	14.007	O Oxygen	15.999	F Fluorine	18.998	Ne Neon	20.180
	Li Lithium	6.941	Be Beryllium	9.012	B Boron	10.81	C Carbon	12.011	N Nitrogen	14.007	O Oxygen	15.999	F Fluorine	18.998	Ne Neon	20.180
2	Li Lithium	6.941	Be Beryllium	9.012	B Boron	10.81	C Carbon	12.011	N Nitrogen	14.007	O Oxygen	15.999	F Fluorine	18.998	Ne Neon	20.180
	Na Sodium	22.990	Mg Magnesium	24.305	Al Aluminium	26.982	Si Silicon	28.086	P Phosphorus	30.974	S Sulphur	32.06	Cl Chlorine	35.453	Ar Argon	39.948
3	Na Sodium	22.990	Mg Magnesium	24.305	Al Aluminium	26.982	Si Silicon	28.086	P Phosphorus	30.974	S Sulphur	32.06	Cl Chlorine	35.453	Ar Argon	39.948
	K Potassium	39.098	Ca Calcium	40.078	Sc Scandium	44.956	Ti Titanium	47.867	V Vanadium	50.942	Cr Chromium	51.996	Mn Manganese	54.938	Fe Iron	55.845
4	K Potassium	39.098	Ca Calcium	40.078	Sc Scandium	44.956	Ti Titanium	47.867	V Vanadium	50.942	Cr Chromium	51.996	Mn Manganese	54.938	Fe Iron	55.845
	Cu Copper	63.546	Zn Zinc	65.38	Ga Gallium	69.723	Ge Germanium	72.64	As Arsenic	74.922	Se Selenium	78.96	Br Bromine	79.904	Kr Krypton	83.80
5	Cu Copper	63.546	Zn Zinc	65.38	Ga Gallium	69.723	Ge Germanium	72.64	As Arsenic	74.922	Se Selenium	78.96	Br Bromine	79.904	Kr Krypton	83.80
	Rb Rubidium	85.468	Sr Strontium	87.62	Y Yttrium	88.906	Zr Zirconium	91.224	Nb Niobium	92.906	Mo Molybdenum	95.94	Tc Technetium	98.906	Ru Ruthenium	101.07
6	Rb Rubidium	85.468	Sr Strontium	87.62	Y Yttrium	88.906	Zr Zirconium	91.224	Nb Niobium	92.906	Mo Molybdenum	95.94	Tc Technetium	98.906	Ru Ruthenium	101.07
	Ag Silver	107.87	Cd Cadmium	112.41	In Indium	114.82	Sn Tin	118.71	Sb Antimony	121.76	Te Tellurium	127.60	I Iodine	126.90	Xe Xenon	131.29
7	Ag Silver	107.87	Cd Cadmium	112.41	In Indium	114.82	Sn Tin	118.71	Sb Antimony	121.76	Te Tellurium	127.60	I Iodine	126.90	Xe Xenon	131.29
	Cs Cesium	132.91	Ba Barium	137.33	La Lanthanum	138.91	Hf Hafnium	178.49	Ta Tantalum	180.95	W Tungsten	183.84	Re Rhenium	186.21	Os Osmium	190.23
7	Cs Cesium	132.91	Ba Barium	137.33	La Lanthanum	138.91	Hf Hafnium	178.49	Ta Tantalum	180.95	W Tungsten	183.84	Re Rhenium	186.21	Os Osmium	190.23
	Fr Francium	223.02	Ra Radium	226.02	Ac Actinium	227.03	Th Thorium	232.04	Pb Lead	206.98	Bi Bismuth	208.98	Po Polonium	209	At Astatine	210



### Actinides

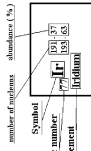
12 Th Thorium	232.04	91 U Uranium	238.03	93 Np Neptunium	237.05	94 Pu Plutonium	244.06	95 Am Americium	243.06
90 Cm Curium	247.07	92 Cf Californium	251.08	94 Pu Plutonium	244.06	95 Am Americium	243.06	96 Cm Curium	247.07
102 No Nobelium	259.10	103 Lr Lawrencium	262.11	104 Rf Rutherfordium	261.10	105 Db Dubnium	262.11	106 Sg Seaborgium	263.10
								107 Bh Bohrium	264.12

### Lantanides

58 Ce Cerium	140.12	59 Pr Praseodymium	140.91	60 Nd Neodymium	144.24	61 Pm Promethium	144.91	62 Sm Samarium	150.36
63 Eu Europium	151.96	64 Gd Gadolinium	157.25	65 Tb Terbium	158.93	66 Dy Dysprosium	162.50	67 Ho Holmium	164.93
68 Er Erbium	167.26	69 Tm Thulium	168.93	70 Yb Ytterbium	173.04	71 Lu Lutetium	174.97	72 Hf Hafnium	178.49
								73 Ta Tantalum	180.95

Pt. Standard atomic weights of elements and their natural occurrence in Earth's crust

Group Period	Abundance of stable isotopes.								VIII								
	I	II	III	IV	V	VI	VII										
1	<sup>1</sup> H Hydrogen 1.008 2.015								<sup>2</sup> He Helium 3.1410 <sup>-4</sup> 4.100								
2	<sup>3</sup> Li Lithium 6.938 7.016	<sup>4</sup> Be Beryllium 9.010	<sup>5</sup> B Boron 10.811 11.009	<sup>6</sup> C Carbon 12.011 13.003	<sup>7</sup> N Nitrogen 14.006 15.003	<sup>8</sup> O Oxygen 15.999 16.999	<sup>9</sup> F Fluorine 18.998	<sup>10</sup> Ne Neon 20.179 21.991									
3	<sup>11</sup> Na Sodium 22.989	<sup>12</sup> Mg Magnesium 24.304 26.010	<sup>13</sup> Al Aluminium 26.981 27.980	<sup>14</sup> Si Silicon 28.085 29.528	<sup>15</sup> P Phosphorus 30.973 31.972	<sup>16</sup> S Sulfur 32.059 33.957	<sup>17</sup> Cl Chlorine 35.453 37.447	<sup>18</sup> Ar Argon 36.966 39.962									
4	<sup>19</sup> K Potassium 39.098 40.961	<sup>20</sup> Ca Calcium 39.962 40.078	<sup>21</sup> Sc Scandium 44.955	<sup>22</sup> Ti Titanium 47.88 48.93	<sup>23</sup> V Vanadium 50.941 51.940	<sup>24</sup> Cr Chromium 51.996 52.004	<sup>25</sup> Mn Manganese 54.938 55.938	<sup>26</sup> Fe Iron 55.845 57.935	<sup>27</sup> Co Cobalt 58.933 58.933	<sup>28</sup> Ni Nickel 58.693 60.000							
5	<sup>37</sup> Rb Rubidium 85.468 87.62	<sup>39</sup> K Potassium 39.098 40.961	<sup>40</sup> Ca Calcium 39.962 40.078	<sup>41</sup> Sc Scandium 44.955	<sup>42</sup> Ti Titanium 47.88 48.93	<sup>43</sup> V Vanadium 50.941 51.940	<sup>44</sup> Cr Chromium 51.996 52.004	<sup>45</sup> Mn Manganese 54.938 55.938	<sup>46</sup> Fe Iron 55.845 57.935	<sup>47</sup> Co Cobalt 58.933 58.933	<sup>48</sup> Ni Nickel 58.693 60.000						
6	<sup>55</sup> Cs Cesium 132.905 132.905	<sup>56</sup> Ba Barium 137.327 137.327	<sup>57</sup> La Lanthanum 138.905 138.905	<sup>58</sup> Ce Cerium 140.12 140.12	<sup>59</sup> Pr Praseodymium 140.907 140.907	<sup>60</sup> Nd Neodymium 144.24 144.24	<sup>61</sup> Pm Promethium 144.912 144.912	<sup>62</sup> Sm Samarium 150.36 150.36	<sup>63</sup> Eu Europium 151.96 151.96	<sup>64</sup> Gd Gadolinium 157.25 157.25	<sup>65</sup> Tb Terbium 158.925 158.925	<sup>66</sup> Dy Dysprosium 162.50 162.50	<sup>67</sup> Ho Holmium 164.93 164.93	<sup>68</sup> Er Erbium 167.26 167.26	<sup>69</sup> Tm Thulium 168.93 168.93	<sup>70</sup> Yb Ytterbium 173.05 173.05	<sup>71</sup> Lu Lutetium 174.96 174.96



Lantanides

<sup>57</sup> La Lanthanum 138.905 138.905	<sup>58</sup> Ce Cerium 140.12 140.12	<sup>59</sup> Pr Praseodymium 140.907 140.907	<sup>60</sup> Nd Neodymium 144.24 144.24	<sup>61</sup> Pm Promethium 144.912 144.912	<sup>62</sup> Sm Samarium 150.36 150.36	<sup>63</sup> Eu Europium 151.96 151.96	<sup>64</sup> Gd Gadolinium 157.25 157.25	<sup>65</sup> Tb Terbium 158.925 158.925	<sup>66</sup> Dy Dysprosium 162.50 162.50	<sup>67</sup> Ho Holmium 164.93 164.93	<sup>68</sup> Er Erbium 167.26 167.26	<sup>69</sup> Tm Thulium 168.93 168.93	<sup>70</sup> Yb Ytterbium 173.05 173.05	<sup>71</sup> Lu Lutetium 174.96 174.96
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Actinides

<sup>88</sup> Ra Radium 226.025 226.025	<sup>89</sup> Ac Actinium 227.028 227.028	<sup>90</sup> Th Thorium 232.037 232.037	<sup>91</sup> Pa Protactinium 231.036 231.036	<sup>92</sup> U Uranium 238.028 238.028
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Pt2. Natural occurrence of stable isotopes



**Table 1.2.** Basic SI units [1, 2, 4]

Quantity	Name	Symbol	Connection with base units
Frequency	hertz	Hz	1/s
Force	newton	N	m kg/s <sup>2</sup>
Pressure	pascal	Pa	kg/(m s <sup>2</sup> )
Energy	joule	J	m <sup>2</sup> kg/s <sup>2</sup>
Power	watt	W	m <sup>2</sup> kg/s <sup>3</sup>
Charge	coulomb	C	A s
Electric potential	volt	V	W/A
Electric capacitance	farad	F	A <sup>2</sup> s <sup>4</sup> /(m <sup>2</sup> kg)
Electric resistance	ohm	Ω	m <sup>2</sup> kg/(A <sup>2</sup> s <sup>3</sup> )
Conductance	siemens	S	A <sup>2</sup> s <sup>3</sup> /(m <sup>2</sup> kg)
Inductance	henry	H	m <sup>2</sup> kg/(A <sup>2</sup> s <sup>2</sup> )
Magnetic flux	weber	Wb	m <sup>2</sup> kg/(A s <sup>2</sup> )
Magnetic flux density	tesla	T	kg/(A s <sup>2</sup> )

one  $\mu_0 = 1$ . Because of units of electrostatic CGS (CGSE system of units) and electromagnetic CGS (CGSM system of units) are used, we give some conversions between these systems and SI units below.

For atomic systems, the system of atomic units (or Hartree atomic units) is of importance because parameters of atomic systems are expressed through atomic parameters. In construction the system of atomic units, the fact is used that the parameter of any dimensionality may be built on the basis of three parameters of different dimensionality. As a basis for the system of atomic units, the following three parameters are taken: the Planck constant  $\hbar = 1.05457 \times 10^{-27}$  erg s, the electron charge  $e = 1.60218 \times 10^{-19}$  C and the electron mass  $m_e = 9.10939 \times 10^{-28}$  g (we take the vacuum permittivity and the magnetic conductivity of a vacuum to be one). The system of atomic units constructed on these parameters is given below in Table 1.3.

### 1.3.2 Conversion Factors for Units

Tables 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, and 1.10 contain conversion factors between units used. The specific electric field strength  $E/p$  or  $E/N_a$  ( $E$  is the electric field strength,  $p$  is the pressure,  $N_a$  is the number density of atoms) is a spread unit in physics of ionized gases. The unit of  $E/N_a$  is 1 Townsend (Td) [21]. The connection between units of the above quantities is as follows:

$$1 \frac{\text{V}}{\text{cm} \cdot \text{Torr}} = 0.3535 \text{ Td}; \quad 1 \text{ Td} = 2.829 \frac{\text{V}}{\text{cm} \cdot \text{Torr}}; \quad 1 \text{ Td} = 1 \times 10^{-17} \text{ V cm}^2.$$

**Table 1.3.** System of atomic units

Parameter	Symbol, formula	Value
Length	$a_0 = \hbar^2/(me^2)$	$5.2918 \times 10^{-9}$ cm
Velocity	$v_0 = e^2/\hbar$	$2.1877 \times 10^8$ cm/s
Time	$\tau_0 = \hbar^3/(me^4)$	$2.4189 \times 10^{-17}$ s
Frequency	$\nu_0 = me^4/\hbar^3$	$4.1341 \times 10^{16}$ s <sup>-1</sup>
Energy	$\varepsilon_0 = me^4/\hbar^2$	27.2114 eV = $4.3598 \times 10^{-18}$ J
Power	$\varepsilon_0/\tau = m^2e^8/\hbar^5$	0.18024 W
Electric voltage	$\varphi_0 = me^3/\hbar^2$	27.2114 V
Electric field strength	$E_0 = me^5/\hbar^4$	$5.1422 \times 10^9$ V/cm
Momentum	$p_0 = me^2/\hbar$	$1.9929 \times 10^{-19}$ g cm/s
Number density	$N_0 = a_0^{-3}$	$6.7483 \times 10^{24}$ cm <sup>-3</sup>
Volume	$V_0 = a_0^3$	$1.4818 \times 10^{-25}$ cm <sup>3</sup> = 0.089240 cm <sup>3</sup> /mol
Square, cross section	$\sigma_0 = a_0^2$	$2.8003 \times 10^{-17}$ cm <sup>2</sup>
Rate constant	$k_0 = v_0a_0^2 = \hbar^3/(m^2e^2)$	$6.126 \times 10^{-9}$ cm <sup>3</sup> /s
Three body rate constant	$K_0 = v_0a_0^5 = \hbar^9/(m^5e^8)$	$9.078 \times 10^{-34}$ cm <sup>6</sup> /s
Dipole moment	$ea_0 = a_0 = \hbar^2/(me)$	$2.5418 \times 10^{-18}$ esu = 2.5418 D
Magnetic moment	$\hbar^2/(me) = 2\mu_B/\alpha$	$2.5418 \times 10^{-18}$ erg/Gs = $2.5418 \times 10^{-21}$ J/T
Electric current	$I = e/\tau = me^5/\hbar^3$	$6.6236 \times 10^{-3}$ A
Flux	$j_0 = N_0v_0 = m^3e^8/\hbar^7$	$1.476 \times 10^{33}$ cm <sup>-2</sup> s <sup>-1</sup>
Electric current density	$i_0 = eN_0v_0 = m^3e^9/\hbar^7$	$2.3653 \times 10^{14}$ A/cm <sup>2</sup>
Energy flux	$J = \varepsilon_0N_0v_0 = m^4e^{12}/\hbar^9$	$6.436 \times 10^{15}$ W/cm <sup>2</sup>

Table 1.4. Conversion factors for units of energy

1 J	1 erg	1 eV	1 K	1 cm <sup>-1</sup>	1 MHz	1 kcal/mol	1 kJ/mol
1	10 <sup>7</sup>	6.2415 × 10 <sup>18</sup>	7.2429 × 10 <sup>22</sup>	5.0341 × 10 <sup>22</sup>	1.5092 × 10 <sup>27</sup>	1.4393 × 10 <sup>20</sup>	6.0221 × 10 <sup>20</sup>
1 erg	1	6.2415 × 10 <sup>11</sup>	7.2429 × 10 <sup>15</sup>	5.0341 × 10 <sup>15</sup>	1.5092 × 10 <sup>20</sup>	1.4393 × 10 <sup>13</sup>	6.0221 × 10 <sup>13</sup>
1 eV	1.6022 × 10 <sup>-19</sup>	1	11604	8065.5	2.4180 × 10 <sup>8</sup>	23.045	96.485
1 K	1.3807 × 10 <sup>-23</sup>	1.3807 × 10 <sup>-16</sup>	8.6174 × 10 <sup>-5</sup>	1	0.69504	1.9872 × 10 <sup>-3</sup>	8.3145 × 10 <sup>-3</sup>
1 cm <sup>-1</sup>	1.9864 × 10 <sup>-23</sup>	1.9864 × 10 <sup>-16</sup>	1.2398 × 10 <sup>-4</sup>	1.4388	1	2.8591 × 10 <sup>-3</sup>	1.1963 × 10 <sup>-2</sup>
1 MHz	6.6261 × 10 <sup>-28</sup>	6.6261 × 10 <sup>-21</sup>	4.1357 × 10 <sup>-9</sup>	4.7992 × 10 <sup>-5</sup>	1	9.5371 × 10 <sup>-9</sup>	3.9903 × 10 <sup>-7</sup>
1 kcal/mol	6.9477 × 10 <sup>-21</sup>	6.9477 × 10 <sup>-28</sup>	4.3364 × 10 <sup>-2</sup>	503.22	349.76	1	4.184
1 kJ/mol	1.6605 × 10 <sup>-21</sup>	1.6605 × 10 <sup>-28</sup>	1.0364 × 10 <sup>-2</sup>	120.27	83.594	0.23901	1

Table 1.5. Conversion factors for units of pressure

1 Pa = 1 N/m <sup>2</sup>	1 dyn/cm <sup>2</sup>	1 Torr	1 atm <sup>a</sup>	1 at <sup>b</sup>	1 bar
1	10	7.5001 × 10 <sup>-3</sup>	9.8693 × 10 <sup>-6</sup>	1.0197 × 10 <sup>-5</sup>	10 <sup>-5</sup>
1 dyn/cm <sup>2</sup>	1	7.5001 × 10 <sup>-4</sup>	9.8693 × 10 <sup>-7</sup>	1.0197 × 10 <sup>-6</sup>	10 <sup>-6</sup>
1 Torr	133.332	1	1.3158 × 10 <sup>-3</sup>	1.3595 × 10 <sup>-3</sup>	1.33332 × 10 <sup>-3</sup>
1 atm <sup>a</sup>	1.01325 × 10 <sup>5</sup>	760	1	1.01332	1.01325
1 at <sup>b</sup>	9.80665 × 10 <sup>4</sup>	735.56	0.96785	1	0.980665
1 bar	10 <sup>5</sup>	750.01	0.98693	1.0197	1

<sup>a</sup> atm—physical atmosphere

<sup>b</sup> at = kg/cm<sup>2</sup>—technical atmosphere

**Table 1.6.** Conversion factors for units of electric voltage

	1 V	1 CGSE	1 CGSM
1 V	1	$3.33564 \times 10^{-3}$	$10^8$
1 CGSE	299.792	1	$2.99792 \times 10^{10}$
1 CGSM	$10^{-8}$	$3.33564 \times 10^{-11}$	1

**Table 1.7.** Conversion factors for units of electric field strength

	1 V/cm	1 CGSE	1 CGSM
1 V/cm	1	$3.33564 \times 10^{-3}$	$10^8$
1 CGSE	299.792	1	$2.99792 \times 10^{10}$
1 CGSM	$10^{-8}$	$3.33564 \times 10^{-11}$	1

**Table 1.8.** Conversion factors for units of electric resistance

	1 $\Omega$	1 CGSE	1 CGSM
1 $\Omega$	1	$1.11265 \times 10^{-12}$	$10^9$
1 CGSE	$8.98755 \times 10^{11}$	1	$8.98755 \times 10^{20}$
1 CGSM	$10^{-9}$	$1.11265 \times 10^{-21}$	1

**Table 1.9.** Conversion factors for units of magnetic field strength

	1 Oe	1 CGSE	1 A/m
1 Oe	1	$2.99792 \times 10^{10}$	79.5775
1 CGSE	$3.33564 \times 10^{-11}$	1	$2.65442 \times 10^{-9}$
1 A/m	0.012566	$1.11265 \times 10^{-21}$	1

**Table 1.10.** Conversion factors for units of magnetic induction

	1 CGSE	1 T = 1 Wb/m <sup>2</sup>	1 Gs
1 CGSE	1	$2.99792 \times 10^6$	$2.99792 \times 10^{10}$
1 T = 1 Wb/m <sup>2</sup>	$3.33564 \times 10^{-7}$	1	$10^4$
1 Gs	$3.33564 \times 10^{-11}$	$10^{-4}$	1

### 1.3.3 Conversion Factors in Formulas of General Physics with Atomic Particles

Explanations to Table 1.11:

1. The particle velocity is  $v = \sqrt{2\varepsilon/m}$ , where  $\varepsilon$  is the energy,  $m$  is the particle mass

**Table 1.11.** Conversion factors for formulas involving atomic particles

Number	Formula <sup>a</sup>	Factor $C$	Units used
1	$v = C\sqrt{\varepsilon/m}$	$5.931 \times 10^7$ cm/s	$\varepsilon$ in eV, $m$ in e.m.u. <sup>a</sup>
		$1.389 \times 10^6$ cm/s	$\varepsilon$ in eV, $m$ in a.m.u. <sup>a</sup>
		$5.506 \times 10^5$ cm/s	$\varepsilon$ in K, $m$ in e.m.u.
		$1.289 \times 10^4$ cm/s	$\varepsilon$ in K, $m$ in a.m.u.
2	$v = C\sqrt{T/m}$	$1.567 \times 10^6$ cm/s	$T$ in eV, $m$ in a.m.u.
		$1.455 \times 10^4$ cm/s	$\varepsilon$ in K, $m$ in a.m.u.
3	$\varepsilon = Cv^2$	$3.299 \times 10^{-12}$ K	$v$ in cm/s, $m$ in e.m.u.
		$6.014 \times 10^{-9}$ K	$v$ in cm/s, $m$ in a.m.u.
		$2.843 \times 10^{-16}$ eV	$v$ in cm/s, $m$ in e.m.u.
		$5.182 \times 10^{-13}$ eV	$v$ in cm/s, $m$ in a.m.u.
4	$\omega = C\varepsilon$	$1.519 \times 10^{15}$ s <sup>-1</sup>	$\varepsilon$ in eV
		$1.309 \times 10^{11}$ s <sup>-1</sup>	$\varepsilon$ in K
5	$\omega = C/\lambda$	$1.884 \times 10^{15}$ s <sup>-1</sup>	$\lambda$ in $\mu\text{m}$
6	$\varepsilon = C/\lambda$	1.2398 eV	$\lambda$ in $\mu\text{m}$
7	$\omega_H = CH/m$	$1.759 \times 10^7$ s <sup>-1</sup>	$H$ in Gs, $m$ in e.m.u.
		9655 s <sup>-1</sup>	$H$ in Gs, $m$ in a.m.u.
8	$r_H = C\sqrt{\varepsilon m}/H$	3.372 cm	$\varepsilon$ in eV, $m$ in e.m.u., $H$ in Gs
		143.9 cm	$\varepsilon$ in eV, $m$ in a.m.u., $H$ in Gs
		$3.128 \times 10^{-2}$ cm	$\varepsilon$ in K, $m$ in e.m.u., $H$ in Gs
		1.336 cm	$\varepsilon$ in K, $m$ in a.m.u., $H$ in Gs
9	$p = CH^2$	$4.000 \times 10^{-3}$ Pa	$H$ in Gs
		$= 0.04 \text{ erg/cm}^3$	

<sup>a</sup> e.m.u. is the electron mass unit ( $m_e = 9.108 \times 10^{-28}$  g), a.m.u. is the atomic mass unit ( $m_a = 1.6605 \times 10^{-24}$  g)

2. The average particle velocity is  $v = \sqrt{8T/(\pi m)}$  with the Maxwell distribution function of particles on velocities;  $T$  is the temperature expressed in energetic units,  $m$  is the particle mass
3. The particle energy is  $\varepsilon = mv^2/2$ , where  $m$  is the particle mass,  $v$  is the particle velocity
4. The photon frequency is  $\omega = \varepsilon/\hbar$ , where  $\varepsilon$  is the photon energy
5. The photon frequency is  $\omega = 2\pi c/\lambda$ , where  $\lambda$  is the wavelength
6. The photon energy is  $\varepsilon = 2\pi\hbar c/\lambda$
7. The Larmor frequency is  $\omega_H = eH/(mc)$  for a charged particle of a mass  $m$  in a magnetic field of strength  $H$
8. The Larmor radius of a charged particle is  $r_H = \sqrt{2\varepsilon/m}/\omega_H$ , where  $\varepsilon$  is the energy of a charged particle,  $m$  is its mass,  $\omega_H$  is the Larmor frequency
9. The magnetic pressure is  $p_m = H^2/(8\pi)$