# Used Physics

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| --- | --- | --- |
| Variable | Physical quantity | Physical unit |
|  | Amount of substance | mol |
|  | Molar flow of substance | mol.s‑1 |
|  | Volume | m3 |
|  | Molar concentration of substance A | mol.m‑3 |
|  | Change of heat energy | J.s‑1 |
|  | Molar enthalpy | J.mol‑1 |
|  | Gas constant 8.3144621(75) | J.K‑1.mol‑1 |
|  | Temperature | K |
|  | Forward rate | s‑1 |
|  | Products to reactants ratio at equilibrium | 1 |
|  | Activity coefficients of substance | 1 |
|  | Stoichiometry of i-th reactant, j-th product | 1 |
|  | Partial pressure of substance A | Pa |
|  | Electrical charge of particle | C |
|  | Permeability of membrane for substance | m3.s‑1 |
|  | Ration of specific form S in more general form G | 1 |
|  | Clearance of substance | m3.s‑1 |
|  | Change of volume or volumetric flow | m3.s‑1 |
|  | Osmolarity of solution for membrane m | mol.m‑3 |
|  | Total pressure = hydraulic + osmotic | Pa |
|  | Hydraulic pressure | Pa |
|  | Osmotic permeability of membrane | m3.Pa‑1.s‑1 |
|  | Relative heat energy/relative enthalpy | J |
|  | Mass of compartment | kg |
|  | Change of mass/mass flow | kg.s-1 |
|  | Specific heat of the mass | J.kg‑1.K‑1 |
|  | Heat conductance of heat convection | J.K‑1.s‑1 |
|  | Hydraulic compliance of space with elastic walls | m3.Pa‑1 |
|  | Gravitational acceleration 9.8 | m.s‑1 |
|  | Density of the mass | kg.m‑3 |
|  | Vertical height between two points | m |
|  | Hydraulic conductance | m3.Pa‑1.s‑1 |
|  | Pumping effect | 1 |
|  | Hydraulic inertance of hydraulic inertia | Pa.s2.m‑3 |
|  | Size of population=number of members | 1 |
|  | Change of population | s‑1 |
|  | Change of population per one member | s‑1 |

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| Chemical equations | |
|  | Amount of substance |
|  | Molar concentration |
|  | Heat flow as enthalpy |
|  | Van’t Hoff’s equation |
|  | Chemical reaction |
|  | Ideal gas equation |
|  | Henry’s law |
|  | Electroneutrality |
|  | Gibbs-Donnan equilibrium |
|  | Chemical speciation |
|  | Physiological clearance |
|  | Kirchhoff’s junction rule for molar flows |

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| Osmotic equations | |
|  | Volume accumulation |
|  | Osmolarity |
|  | Osmotic membrane permeability |
|  | Pressure on membrane |
|  | Ideal filtration  (microcirculation) |
|  | Kirchhoff’s junction rule for impermeable solutes |
|  | Kirchhoff’s junction rule for volumetric flows |

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| Thermal equations | |
|  | Heat accumulation |
|  | Temperature |
|  | Heat convection |
|  | Change of heat with change of mass |
|  | Ideal radiator (microcirculation) |
|  | Kirchhoff’s junction rule for heat flows |

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| Hydraulic equations | |
|  | Volume accumulation |
|  | Pressure in container with elastic walls  (blood/lymph vessels) |
|  | Hydraulic conductance/resistance |
|  | Pascal’s law |
|  | Idealized hydraulic valve |
|  | Hydraulic inertia |
|  | Kirchhoff’s junction rule for volumetric flows |

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| Population equations | |
|  | Size of population |
|  | Change of population |
|  | Kirchhoff’s junction rule for population flows |

# Metric Prefixes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| symbol | Name | Decimal logarithm | Decimal value | word |
| Y | yotta | 24 | 1 000 000 000 000 000 000 000 000 | septillion |
| Z | zetta | 21 | 1 000 000 000 000 000 000 000 | sextillion |
| E | exa | 18 | 1 000 000 000 000 000 000 | quintillion |
| P | peta | 15 | 1 000 000 000 000 000 | quadrillion |
| T | **tera** | **12** | **1 000 000 000 000** | **trillion** |
| G | **giga** | **9** | **1 000 000 000** | **billion** |
| M | **mega** | **6** | **1 000 000** | **million** |
| k | **kilo** | **3** | **1 000** | **thousand** |
| h | **hecto** | **2** | **100** | **hundred** |
| da | **deca** | **1** | **10** | **ten** |
|  |  | **0** | **1** | **one** |
| d | **deci** | **-1** | **0.1** | **tenth** |
| c | **centi** | **-2** | **0.01** | **hundredth** |
| m | **milli** | **-3** | **0.001** | **thousandth** |
| µ | **micro** | **-6** | **0.000 001** | **millionth** |
| n | **nano** | **-9** | **0.000 000 001** | **billionth** |
| p | **pico** | **-12** | **0.000 000 000 001** | **trillionth** |
| f | femto | -15 | 0.000 000 000 000 001 | quadrillionth |
| a | atto | -18 | 0.000 000 000 000 000 001 | quintillionth |
| z | zepto | -21 | 0.000 000 000 000 000 000 001 | sextillionth |
| y | yocto | -24 | 0.000 000 000 000 000 000 000 001 | septillionth |

# Physical Constants

|  |  |  |  |
| --- | --- | --- | --- |
|  | Name | Value | unit |
| *h* | *Planck constant* | *6.62606957(29)×10−34* | *J.s-1* |
| NA | **Avogadro constant** | **6.02214129(27)×1023** | **mol−1** |
| R | **Gas constant** | **8.3144621(75)** | **J.mol-1.K-1** |
| *e* | ***elementary charge*** | ***1.602176565(35)×10−19*** | ***C*** |
| *G* | *gravitation constant* | *6.67384(80)×10−11* | *m3.kg−1.s−2* |
| g | **Earth gravity acceleration** | **≈ 9.8067** | **m.s-2** |
| gMn | Moon gravity acceleration | ≈ 1.625 | m.s-2 |
| gMrs | Mars gravity acceleration | ≈ 3.728 | m.s-2 |
| *c* | *speed of light in vacuum* | *299 792 458* | *m.s-1* |
| *me* | *rest mass of electron* | *9.10938215(45)×10−31* | *kg* |
| mp | rest mass of proton | 1.672621777(74)×10−27 | kg |
| mu | atomic mass unit | 1.660538921(73)×10−27 | kg |
| kB | Boltzmann constant=R/NA | 1.3806488(13)×10−23 | J.K-1 |
| F | Faraday constant = e NA | 9.64853399(24)×104 | C.mol-1 |
| Mu | Molar mass constant = kg/g | 10-3 | kg.g-1 |
| Ɛ0 | Vacuum permittivity | 8.854 187 817… x 10−12 | F.m-1 |
| *µ0* | *Vacuum permeability* | *4π × 10−7* | *N.A-2* |
| µB | Bohr magneton | 9.27400968(20)×10−24 | J.T-1 |
| µN | nuclear magneton | 5.05078353(11)×10−27 | J.T-1 |
| VSTP | molar volume of gas at STP | **2.271 0953(21) × 10−2** | **m3.mol−1** |
| VNIST | molar volume of gas at NIST | 2.437 3845(64) × 10−2 | m3.mol−1 |
| V37 | molar volume of gas at 37°C | 2.578 7304(20) × 10−2 | m3.mol−1 |

# Selected Chemical Substances

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Substance Name | | Molar Mass [kg.mol-1] | |  | Substance Name | | Molar Mass [kg.mol-1] | |
| H­2O | water | | 0.018 |  | Ins | insulin | | 5.808 |
| H+ | proton | | 0.001 |  | Lep | leptin | | 16.03 |
| H­3O+ | hydronium | | 0.019 |  | Glc | glucagon | | 3.485 |
| [H5O2]+ | Zundel cation | | 0.037 |  | PRA | renin | | 48.0 |
| [H9O4]+ | Eigen cation | | 0.073 |  | AGT | angiotensinogen | | 56.8 |
| O­2 | oxygen | | 0.032 |  | AI | angiotensin I | | 1.297 |
| CO­2 | carbon dioxide | | 0.044 |  | AII | angiotensin II | | 1.046 |
| H2CO3 | carbonic acid | | 0.062 |  | Aldo | aldosterone | | 0.360 |
| HCO3- | bicarbonate | | 0.061 |  | ANP | atriopeptin | | 3.060 |
| Na+ | sodium | | 0.023 |  | ADH | vasopressin | | 1.084 |
| K+ | potassium | | 0.039 |  | TSH | thyrotropin | | 28 |
| ­Cl- | chloride | | 0.035 |  | T3-4 | thyroxine | | 0.777 |
| H2PO­4-, HPO­42- | phosphates | | 0.095 |  | EPO | erythropoietin | | 34 |
| SO­42- | sulfates | | 0.096 |  | Epi | epinephrine | | 0.183 |
| NH­4+ | amonium | | 0.018 |  | NE | norepinephrine | | 0.169 |
| Mg2+ | magnesium | | 0.024 |  | D3 | calcitriol | | 0.417 |
| Ca2+ | calcium | | 0.040 |  | PTH | parathormone | | 9.4 |
| Fe2+,  Fe3+ | iron | | 0.056 |  | - | ethanol | | 0.046 |
| Glu | glucose | | 0.181 |  | - | nicotine | | 0.162 |
| FA | fatty acids | | 0.255 |  | - | aspirin | | 0.180 |
| KA | keto acids | | 0.102 |  | - | paracetamol | | 0.151 |
| AA | amino acids | | 0.100 |  | - | nitredipine | | 0.360 |
| Lac- | lactate | | 0.090 |  | - | peridopril | | 0.368 |
| Triglyc | triglyceride | | 0.806 |  | - | metoprolol | | 0.267 |
| urea | urea | | 0.060 |  | - | desglymidodrine | | 0.197 |
| Hb | hemoglobin | | 64.50 |  | - | digoxin | | 0.781 |
| Alb | albumin | | 66.44 |  | - | chlorothiazide | | 0.296 |
| Glb | globulins | | 34.50 |  | - | furosemide | | 0.331 |