On the use of italic and roman fonts for symbols in scientific text

Scientific manuscripts frequently fail to follow the accepted conventions concerning the use of italic and roman fonts for symbols. An italic font is generally used for emphasis in running text, but it has a quite specific meaning when used for symbols in scientific text and equations. The following summary is intended to help in the correct use of italic in preparing manuscript material.

1. The general rules concerning the use of an italic (sloping) font or a roman (upright) font are presented in the IUPAC Green Book [1] on p.5 and 6, and also p.83 to 86 in relation to mathematical symbols and operators (see also p.75, 76, and 93). These rules are also presented in the International Standards ISO 31 and ISO 1000 [2], and in the SI Brochure [3].

2. The overall rule is that symbols representing physical quantities (or variables) are italic, but symbols representing units, or labels, are roman. Sometimes there may seem to be doubt as to whether a symbol represents a quantity or has some other meaning (such as a label): a good general rule is that quantities, or variables, can be given a value, but labels cannot. Vectors, tensors and matrices are usually denoted using a bold-face (heavy) font, but they should still be italic since they are still quantities.

   Example: The mass of my pen $m = 24\ \mathrm{g} = 0.024\ \mathrm{kg}$. The electric field strength $\boldsymbol{E}$ has components E_x, E_y, and E_z. The Planck constant $h = 6.626\,068\,76\,(52) \times 10^{-34}$ J s.

3. The above rule applies equally to letter symbols from both the Greek and the Latin alphabet, although authors often appear to resist putting Greek letters into italic.

   Example: when the symbol μ is used to denote a physical quantity (such as mass or reduced mass) it should be italic, but when it is used in a unit such as the microgram, $\mu\mathrm{g}$, or when it is used as the symbol for the muon, μ (see 5 below), it should be roman.

4. Numbers, and labels, are generally roman (upright), since they are not physical quantities.

   Example: The ground and first excited electronic states of the CH_2 molecule are denoted $\ldots(2a_1)^2(1b_2)^2(3a_1)^1(1b_1)^1$, $\tilde{\mathrm{X}}\ ^3\mathrm{B}_1$, and $\ldots(2a_1)^2(1b_2)^2(3a_1)^2$, $\tilde{\mathrm{a}}\ ^1\mathrm{A}_1$, respectively.
   The π-electron configuration and symmetry of the benzene molecule in its ground state are denoted: $(a_{2u})^2(e_{1g})^4$, $\tilde{\mathrm{X}}\ ^1\mathrm{A}_{1g}$. Note that all these symbols are labels and are roman.

5. Symbols for elements in the periodic table should be roman, since they are not physical quantities. Similarly the symbols used to represent elementary particles are always roman. (See, however, paragraph 9 below for the use of italic font in chemical-compound names.)

   Examples: H, He, Li, Be, B, C, N, O, F, Ne, … for atoms; e for the electron, p for the proton, n for the neutron, μ for the muon, α for the alpha particle, etc.

6. Symbols for physical quantities are single letters of the Latin or Greek alphabet. Exceptionally two letters are used for certain dimensionless quantities, such as the Reynolds number, *Re*. However the symbols are frequently supplemented with subscripts or information in brackets to further specify the quantity. Further symbols used in this way are either italic or roman depending on whether they represent physical quantities or labels.

   Examples: H denotes enthalpy, but H_m denotes molar enthalpy (m is a mnemonic label for molar, and is therefore roman). C_p and C_V denote the heat capacity at constant pressure p and volume V, respectively; but $C_{p,\mathrm{m}}$ and $C_{V,\mathrm{m}}$ denote the *molar* heat capacity at constant p and V, respectively (note the roman m but italic p and V). The chemical potential of argon might be denoted μ_Ar or $\mu(\mathrm{Ar})$, but the chemical potential of the ith component in a mixture would be denoted μ_i, where the i is italic because it is a variable index.

7. Symbols for mathematical operators are always roman. This applies to the symbol Δ for a difference, δ for a small difference, d for an infinitesimal difference (in calculus), and to capital Σ and Π for summation and product signs. The symbols π, e (base of natural logarithms), i (square root of minus one), etc. are always roman, as are the symbols for named functions such as log (lg, ln or lb), exp, sin, cos, tan, erf, div,

grad, **curl** or **rot** (the operator curl or rot, and the corresponding symbol $\nabla\times$, may be printed boldface since it represents a vector). Some of these symbols are also sometimes used to represent physical quantities: then of course they should be italic, to distinguish them from the corresponding mathematical operator.

Examples: $\Delta H = H(\text{final}) - H(\text{initial})$; $(\mathrm{d}p/\mathrm{d}t)$ used for the rate of change of pressure; δt used to denote a small time interval. But for a damped linear oscillator the amplitude F as a function of time t might be expressed by the equation $F = F_0 \exp(-\delta t) \sin(\omega t)$

where δ is the decay coefficient (SI unit: Np/s) and ω is the angular frequency (SI unit: rad/s). Note the use of roman δ for the operator in a small time interval δt, but italic δ for the decay coefficient in the product δt. Note that the products δt and ωt are both dimensionless, but are described as having the unit neper (Np = 1) and radian (rad = 1), respectively.

8. Symbols for the fundamental physical constants are always regarded as quantities (even though they are not quite variables!) and they should accordingly always be italic. Sometimes the fundamental physical constants are used as though they were units, but they are still given italic symbols. However the electronvolt, eV, and the unified atomic mass unit, u, have been recognized as units by the Consultative Committee on Units of the BIPM and they are accordingly given roman symbols.

   Examples: c_0 for the speed of light in vacuum, m_e for the electron rest mass, h for the Planck constant, N_A or L for the Avogadro constant, e for the elementary charge, a_0 for the Bohr radius, etc. But for the electronvolt $\text{eV} = e \times \text{V} = 1.602\,176\,462\,(63) \times 10^{-19}$ J, the symbol eV is roman.

9. Greek letters are used in systematic organic, inorganic, macromolecular, and biochemical nomenclature. These should be roman (upright), since they are not symbols for physical quantities. They designate the position of substitution in side chains, ligating-atom attachment and bridging mode in coordination compounds, end groups in structure-based names for macromolecules, and stereochemistry in carbohydrates and natural products. Letter symbols for elements are italic when they are locants in chemical-compound names indicating attachments to heteroatoms, e.g. *O*-, *N*-, *S*-, and *P*-. The italic element symbol *H* denotes indicated or added hydrogen. See references [4] and [5].

   Examples:
   α-ethylcyclopentaneacetic acid
   β-methyl-4-propylcyclohexaneethanol
   [*N*, *N*′-bis(2-amino-κ*N*-ethyl)ethane-1,2-diamine-κ*N*]chloroplatinum(II)
   tetracarbonyl(η^4-2-methylidenepropane-1,3-diyl)chromium
   α-(trichloromethyl)-ω-chloropoly(1,4-phenylenemethylene)
   α-D-glucopyranose
   5α-androstan-3β-ol
   N-methylbenzamide
   O-ethyl hexanethioate
   3*H*-pyrrole
   naphthalen-2(1*H*)-one

I.M. Mills and W.V. Metanomski, Interdivisional Committee on Nomenclature and Symbols, IUPAC, December 1999.

References:

[1] *Quantities, Units and Symbols in Physical Chemistry*, the IUPAC Green Book, prepared for publication by I. Mills, T. Cvitaš, K. Homann, N. Kallay, and K. Kuchitsu, 2nd Edn., Blackwell Science, Oxford 1993.

[2] The ISO Standards Handbook, *Quantities and Units*, ISO, Geneva, 1993.

[3] *Le Système International d'Unités* (the SI Brochure), 7th Edn. (French and English), BIPM, Sèvres, 1998.

[4] *Principles of Chemical Nomenclature*, a guide to IUPAC recommendations, G.J. Leigh, H.A. Favre, and W.V. Metanomski, Blackwell Science, Oxford 1998.

[5] *A Guide to IUPAC Nomenclature of Organic Compounds*, R. Panico, W.H. Powell, and J-C. Richer, Blackwell Scientific Publications, Oxford 1993.