Quantities, Units, Symbols and Nomenclature used in NCEA Chemistry Level 3 and Scholarship Examination Papers

NCEA Chemistry examinations will use the following information, which has been based on International Union of Pure and Applied Chemistry (IUPAC) recommendations. Candidates should be encouraged to use this IUPAC terminology, but those who use other terminology will not be penalised if their answers indicate a clear understanding of the chemistry involved.

General Chemistry

Symbols for the physical quantities, ***M***, ***V***, ***H***, ***s***, ***K***, are written in italics (sloping letters). Any following subscripts will be in upright type.

Symbols / Expressions	**Units in common use**
M, molar mass, is the mass of one mole of a defined substance and will be used for elements and compounds. M_r, relative molecular mass, and A_r, relative atomic mass, will not be used.	g mol^{-1}
V, volume. A looped ℓ is not used in these abbreviations.	L and mL
n, amount of substance, expressed in moles. It is incorrect to use the term 'number of moles'. (See details under 'Amount of Substance' below.)	mol
c, *amount concentration*, is expressed as moles per litre, also denoted by the format [ ].	mol L^{-1}
Concentrations may also be written as *mass concentration*, expressed as grams per litre.	g L^{-1}
Composition of a mixture, commonly expressed as % *w/V*, % *w/w* and % *V/V*, will be used only after giving a clear definition of their meaning (eg grams per 100 mL, grams per 100 g, mL per 100 mL respectively).	
s (*italic s*), solubility, units as for concentration.	mol L^{-1}

Amount of Substance

This is a physical quantity, symbol *n* (*italic n*), measured in a unit called the mole, which has the abbreviation mol.

The term 'number of moles' is to be avoided in favour of the 'amount of substance in moles'. In the same manner, the size of an object can be described in terms of its 'length in metres', rather than its 'number of metres'.

Graph Axes and Table Headings

Labelled as quantity / unit, eg *c* / mol L^{-1}. Only values will then be written on the axes or in a table.

Enthalpy changes, ΔH *Units commonly used kJ mol^{-1}*

$\Delta_r H°$, standard enthalpy of reaction when reactants and products are in their standard state (usually the state at 25°C). For example:

$2H_2(g) + O_2(g) \rightarrow 2H_2O(\ell)$ $\quad\quad$ $\Delta_r H°$ (H_2O, ℓ) = –570 kJ mol^{-1}

The term mol^{-1} means per mole of reaction, which is determined by the chemical equation; ie 2 mol of H_2 reacting with 1 mol of O_2 to give 2 mol of H_2O.

$\Delta_f H°$, standard enthalpy of formation, per mole of product. For example, the standard enthalpy of formation of liquid water:

$H_2(g) + {}^1\!/_2O_2(g) \rightarrow H_2O(\ell)$ $\quad\quad$ $\Delta_f H°$ (H_2O, ℓ) = –285 kJ mol^{-1}

$\Delta_c H°$, standard enthalpy of combustion, per mole of substance burnt. For example, the standard enthalpy of combustion of hydrogen gas to give liquid water:

$H_2(g) + {}^1\!/_2O_2(g) \rightarrow H_2O(\ell)$ $\quad\quad$ $\Delta_c H°$ (H_2, g) = –285 kJ mol^{-1}

Note (i) The superscript ° denotes a defined standard state.

(ii) The alternative superscript $^\theta$ (plimsoll) is acceptable.

(iii) A space is always left between any value and its unit, as well as between units for composite units.

$\Delta_{fus}H$, enthalpy of fusion (melting)

$\Delta_{vap}H$, enthalpy of vaporisation

$\Delta_{sub}H$, enthalpy of sublimation

Standard Electrode Potential

Electrode potentials are defined as standard electrode potentials, $E°$.
Units are volts, symbol V.

eg	**Redox couple**	$E°$ **/ V**
	Zn^{2+} / Zn	–0.76
	Fe^{3+} / Fe^{2+}	+0.77

A half cell is an electrode and the couple it is in contact with. When the oxidant and reductant are in different phases, a vertical line in the cell diagram is used to represent the phase boundary.
For example
Zn (*s*) | Zn^{2+} (*aq*) Oxidant and reductant are in different phases. Metal electrode is part of redox couple.
OR
Fe^{3+} (*aq*), Fe^{2+} (*aq*) | Pt Oxidant and reductant are in the same phase. An inert electrode is used.
The vertical line represents a phase boundary.

Equilibrium Constant, K

Constants will be dimensionless, ie have no units, in keeping with current IUPAC conventions. They will include:

- $\boldsymbol{K_c}$ General equilibrium constant in which the equilibrium composition is expressed in terms of concentration of species
- $\boldsymbol{K_a}$ Acid association constant or acidity constant
- $\boldsymbol{K_w}$ Dissociation constant of water
- $\boldsymbol{K_s}$ Solubility product or solubility constant

– p notation will be restricted to: $\mathbf{pK_a}$ for $-\log_{10}K_a$
and **pH** for $-\log_{10}[H_3O^+]$

Chemical Formulae

These denote entities composed of more than one atom (molecules, simple and complex ions, groups of atoms, etc).

	Formula	**Information conveyed**
	H_2O	one water molecule or one mole of water
#	$\frac{1}{2}O_2$	half a mole of oxygen molecules
	$Zn_3(PO_4)_2$	one mole of zinc phosphate comprising zinc and phosphate ions in a 3:2 ratio
	$2MgSO_4$	two moles of magnesium sulfate
#	$\frac{1}{5}KMnO_4$	one-fifth of a mole of potassium permanganate (manganate VII)

# Indicates examples that are artificial and are used as a convenient way of calculating amounts of substance in moles.

Equations for Chemical Reactions

$H_2(g) + Br_2(g) \rightarrow 2HBr(g)$ forward reaction

$H_2(g) + Br_2(g) \rightleftharpoons 2HBr(g)$ equilibrium

States of Aggregation

These are written in parentheses printed in *italic* type, immediately after the formula or substance and on the same line as chemical formula symbols.

eg ***s*** solid, ***ℓ*** liquid, ***g*** gas or vapour

aq aqueous solution (dissolved in water)

HCl(*g*) hydrogen chloride in the gaseous state

Temperature

Celsius temperature	°C
Thermodynamic (Kelvin) temperature	K

Pressure

Units are pascals (Pa), or more commonly kPa.
Standard pressure is 10^5 Pa or 1 bar

IUPAC Approved Spelling

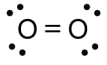
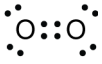
Spelling of the element with atomic number 16 is the IUPAC recommended spelling of **sulfur**. Derived ions have consistent spelling:

eg sulfide sulfate sulfite thiosulfate.

Lewis Structures

These show the arrangement of valence electrons in molecules. Bonding electrons may be represented using : or –

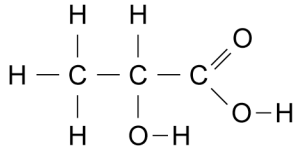
For F_2  or 

For O_2  or 

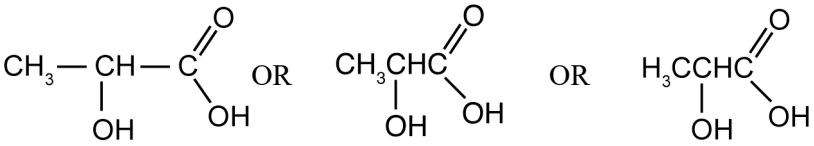
Organic Chemical Formulae

	Information conveyed	**Example: lactic acid**
empirical formula	Stoichiometric proportions of atoms only. Simplest ratio formula.	CH_2O
molecular formula	Formula of the actual molecule.	$C_3H_6O_3$
structural formula	Shows how atoms are connected. It may be drawn in different ways.	

(a) All atoms and bonds are shown.

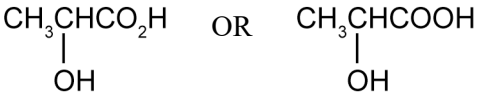


(b) Bonds to hydrogen are not shown

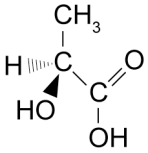


OR

Only bonds to substituents are shown.



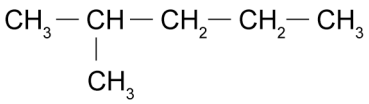
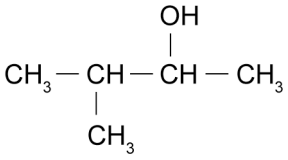
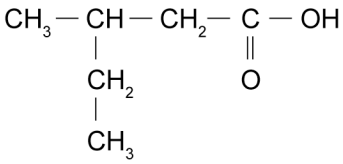
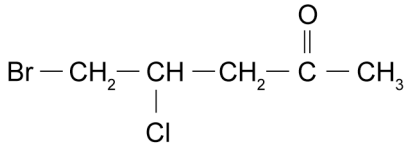
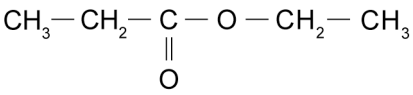
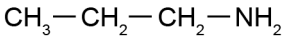
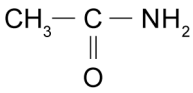
(c) Stereochemistry (3-D arrangement of atoms) is shown.



The structural formulae in (b) are referred to as condensed structural formulae.

Organic Chemical Nomenclature

IUPAC conventions will be followed. There is ongoing discussion on some of the following naming. Candidates will be given full credit for alternative naming if an unambiguous structure is implied. Some examples are:

Structure	IUPAC name
	2-methylpentane
	3-methylbutan-2-ol
	3-methylpentanoic acid
	5-bromo-4-chloropentan-2-one
	ethyl propanoate
	propan-1-amine
	ethanamide

References

P Akins and L Jones, *Chemistry – Molecules, Matter and Change* (3rd edition), WH Freeman, 1997.
Aylward & Findlay, *SI Chemical Data* (6th Edition), John Wiley & Sons, Australia, 2008.