

Reference Tables for Physical Setting/CHEMISTRY

2002 Edition

Table A
Standard Temperature and Pressure

Name	Value	Unit
Standard Pressure	101.3 kPa 1 atm	kilopascal atmosphere
Standard Temperature	273 K 0°C	kelvin degree Celsius

Table B
Physical Constants for Water

Heat of Fusion	334 J/g
Heat of Vaporization	2260 J/g
Specific Heat Capacity of H ₂ O (ℓ)	4.18 J/g•°C

Table C
Selected Prefixes

Factor	Prefix	Symbol
10 ³	kilo-	k
10 ⁻¹	deci-	d
10 ⁻²	centi-	c
10 ⁻³	milli-	m
10 ⁻⁶	micro-	μ
10 ⁻⁹	nano-	n
10 ⁻¹²	pico-	p

Table D
Selected Units

Symbol	Name	Quantity
m	meter	length
g	gram	mass
Pa	pascal	pressure
K	kelvin	temperature
mol	mole	amount of substance
J	joule	energy, work, quantity of heat
s	second	time
L	liter	volume
ppm	part per million	concentration
M	molarity	solution concentration

Table E
Selected Polyatomic Ions

H ₃ O ⁺	hydronium	CrO ₄ ²⁻	chromate
Hg ₂ ²⁺	dimercury (I)	Cr ₂ O ₇ ²⁻	dichromate
NH ₄ ⁺	ammonium	MnO ₄ ⁻	permanganate
C ₂ H ₃ O ₂ ⁻ CH ₃ COO ⁻ }	acetate	NO ₂ ⁻	nitrite
CN ⁻	cyanide	NO ₃ ⁻	nitrate
CO ₃ ²⁻	carbonate	O ₂ ²⁻	peroxide
HCO ₃ ⁻	hydrogen carbonate	OH ⁻	hydroxide
C ₂ O ₄ ²⁻	oxalate	PO ₄ ³⁻	phosphate
ClO ⁻	hypochlorite	SCN ⁻	thiocyanate
ClO ₂ ⁻	chlorite	SO ₃ ²⁻	sulfite
ClO ₃ ⁻	chlorate	SO ₄ ²⁻	sulfate
ClO ₄ ⁻	perchlorate	HSO ₄ ⁻	hydrogen sulfate
		S ₂ O ₃ ²⁻	thiosulfate

Table F
Solubility Guidelines for Aqueous Solutions

Ions That Form Soluble Compounds	Exceptions	Ions That Form Insoluble Compounds	Exceptions
Group 1 ions (Li ⁺ , Na ⁺ , etc.)		carbonate (CO ₃ ²⁻)	when combined with Group 1 ions or ammonium (NH ₄ ⁺)
ammonium (NH ₄ ⁺)		chromate (CrO ₄ ²⁻)	when combined with Group 1 ions, Ca ²⁺ , Mg ²⁺ , or ammonium (NH ₄ ⁺)
nitrate (NO ₃ ⁻)		phosphate (PO ₄ ³⁻)	when combined with Group 1 ions or ammonium (NH ₄ ⁺)
acetate (C ₂ H ₃ O ₂ ⁻ or CH ₃ COO ⁻)		sulfide (S ²⁻)	when combined with Group 1 ions or ammonium (NH ₄ ⁺)
hydrogen carbonate (HCO ₃ ⁻)		hydroxide (OH ⁻)	when combined with Group 1 ions, Ca ²⁺ , Ba ²⁺ , Sr ²⁺ , or ammonium (NH ₄ ⁺)
chlorate (ClO ₃ ⁻)			
perchlorate (ClO ₄ ⁻)			
halides (Cl ⁻ , Br ⁻ , I ⁻)	when combined with Ag ⁺ , Pb ²⁺ , and Hg ₂ ²⁺		
sulfates (SO ₄ ²⁻)	when combined with Ag ⁺ , Ca ²⁺ , Sr ²⁺ , Ba ²⁺ , and Pb ²⁺		

Table G Solubility Curves

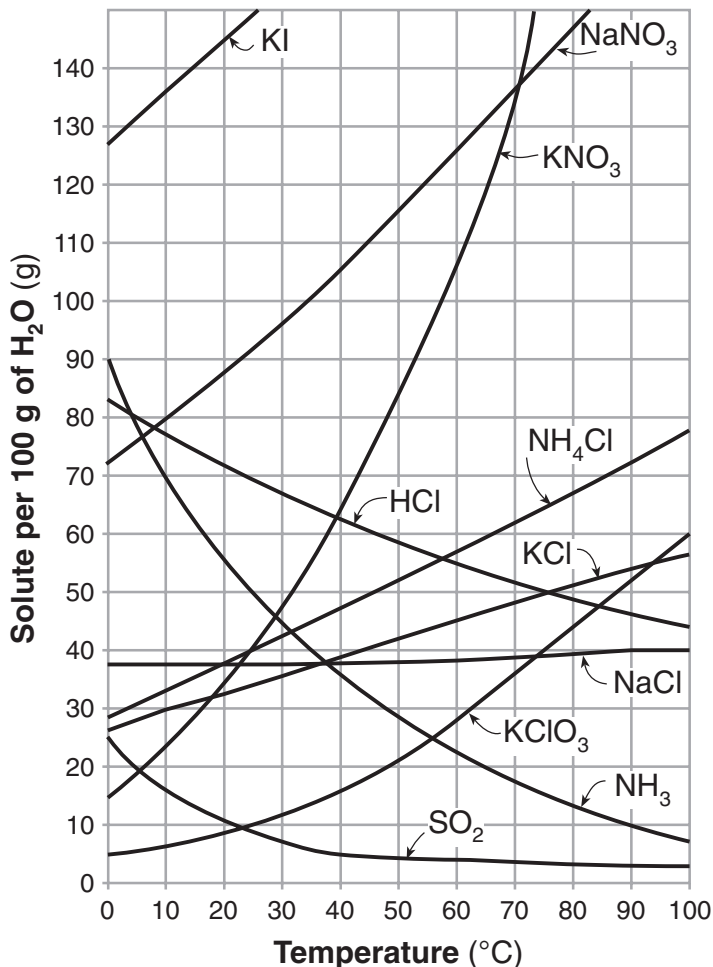


Table H
Vapor Pressure of Four Liquids

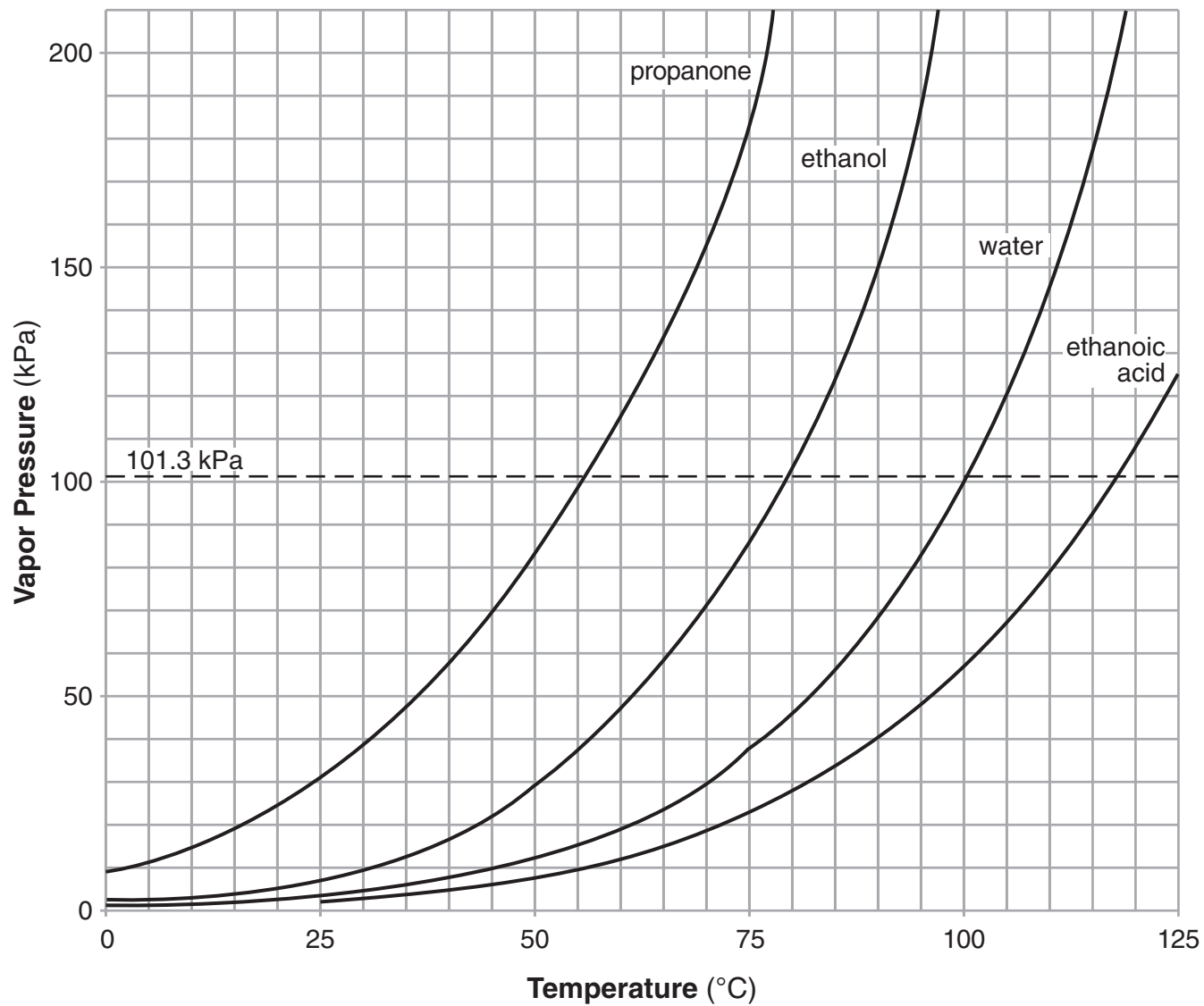


Table I
Heats of Reaction at 101.3 kPa and 298 K

Reaction	ΔH (kJ)*
$\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \longrightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\ell)$	-890.4
$\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \longrightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\ell)$	-2219.2
$2\text{C}_8\text{H}_{18}(\ell) + 25\text{O}_2(\text{g}) \longrightarrow 16\text{CO}_2(\text{g}) + 18\text{H}_2\text{O}(\ell)$	-10943
$2\text{CH}_3\text{OH}(\ell) + 3\text{O}_2(\text{g}) \longrightarrow 2\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\ell)$	-1452
$\text{C}_2\text{H}_5\text{OH}(\ell) + 3\text{O}_2(\text{g}) \longrightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\ell)$	-1367
$\text{C}_6\text{H}_{12}\text{O}_6(\text{s}) + 6\text{O}_2(\text{g}) \longrightarrow 6\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\ell)$	-2804
$2\text{CO}(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{CO}_2(\text{g})$	-566.0
$\text{C}(\text{s}) + \text{O}_2(\text{g}) \longrightarrow \text{CO}_2(\text{g})$	-393.5
$4\text{Al}(\text{s}) + 3\text{O}_2(\text{g}) \longrightarrow 2\text{Al}_2\text{O}_3(\text{s})$	-3351
$\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{NO}(\text{g})$	+182.6
$\text{N}_2(\text{g}) + 2\text{O}_2(\text{g}) \longrightarrow 2\text{NO}_2(\text{g})$	+66.4
$2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{H}_2\text{O}(\text{g})$	-483.6
$2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \longrightarrow 2\text{H}_2\text{O}(\ell)$	-571.6
$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \longrightarrow 2\text{NH}_3(\text{g})$	-91.8
$2\text{C}(\text{s}) + 3\text{H}_2(\text{g}) \longrightarrow \text{C}_2\text{H}_6(\text{g})$	-84.0
$2\text{C}(\text{s}) + 2\text{H}_2(\text{g}) \longrightarrow \text{C}_2\text{H}_4(\text{g})$	+52.4
$2\text{C}(\text{s}) + \text{H}_2(\text{g}) \longrightarrow \text{C}_2\text{H}_2(\text{g})$	+227.4
$\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \longrightarrow 2\text{HI}(\text{g})$	+53.0
$\text{KNO}_3(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{K}^+(\text{aq}) + \text{NO}_3^-(\text{aq})$	+34.89
$\text{NaOH}(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{Na}^+(\text{aq}) + \text{OH}^-(\text{aq})$	-44.51
$\text{NH}_4\text{Cl}(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{NH}_4^+(\text{aq}) + \text{Cl}^-(\text{aq})$	+14.78
$\text{NH}_4\text{NO}_3(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{NH}_4^+(\text{aq}) + \text{NO}_3^-(\text{aq})$	+25.69
$\text{NaCl}(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq})$	+3.88
$\text{LiBr}(\text{s}) \xrightarrow{\text{H}_2\text{O}} \text{Li}^+(\text{aq}) + \text{Br}^-(\text{aq})$	-48.83
$\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \longrightarrow \text{H}_2\text{O}(\ell)$	-55.8

*Minus sign indicates an exothermic reaction.

Table J
Activity Series**

Most	Metals	Nonmetals	Most
↓	Li	F_2	↓
	Rb	Cl_2	
	K	Br_2	
	Cs	I_2	
	Ba		
	Sr		
	Ca		
	Na		
	Mg		
	Al		
	Ti		
	Mn		
	Zn		
	Cr		
	Fe		
	Co		
	Ni		
	Sn		
	Pb		
**H ₂			
Cu			
Ag			
Au			
Least			Least

**Activity Series based on hydrogen standard

Note: H₂ is not a metal

Table K
Common Acids

Formula	Name
HCl(aq)	hydrochloric acid
HNO ₃ (aq)	nitric acid
H ₂ SO ₄ (aq)	sulfuric acid
H ₃ PO ₄ (aq)	phosphoric acid
H ₂ CO ₃ (aq) or CO ₂ (aq)	carbonic acid
CH ₃ COOH(aq) or HC ₂ H ₃ O ₂ (aq)	ethanoic acid (acetic acid)

Table L
Common Bases

Formula	Name
NaOH(aq)	sodium hydroxide
KOH(aq)	potassium hydroxide
Ca(OH) ₂ (aq)	calcium hydroxide
NH ₃ (aq)	aqueous ammonia

Table M
Common Acid–Base Indicators

Indicator	Approximate pH Range for Color Change	Color Change
methyl orange	3.2–4.4	red to yellow
bromthymol blue	6.0–7.6	yellow to blue
phenolphthalein	8.2–10	colorless to pink
litmus	5.5–8.2	red to blue
bromocresol green	3.8–5.4	yellow to blue
thymol blue	8.0–9.6	yellow to blue

Table N
Selected Radioisotopes

Nuclide	Half-Life	Decay Mode	Nuclide Name
¹⁹⁸ Au	2.69 d	β ⁻	gold-198
¹⁴ C	5730 y	β ⁻	carbon-14
³⁷ Ca	175 ms	β ⁺	calcium-37
⁶⁰ Co	5.26 y	β ⁻	cobalt-60
¹³⁷ Cs	30.23 y	β ⁻	cesium-137
⁵³ Fe	8.51 min	β ⁺	iron-53
²²⁰ Fr	27.5 s	α	francium-220
³ H	12.26 y	β ⁻	hydrogen-3
¹³¹ I	8.07 d	β ⁻	iodine-131
³⁷ K	1.23 s	β ⁺	potassium-37
⁴² K	12.4 h	β ⁻	potassium-42
⁸⁵ Kr	10.76 y	β ⁻	krypton-85
¹⁶ N	7.2 s	β ⁻	nitrogen-16
¹⁹ Ne	17.2 s	β ⁺	neon-19
³² P	14.3 d	β ⁻	phosphorus-32
²³⁹ Pu	2.44 × 10 ⁴ y	α	plutonium-239
²²⁶ Ra	1600 y	α	radium-226
²²² Rn	3.82 d	α	radon-222
⁹⁰ Sr	28.1 y	β ⁻	strontium-90
⁹⁹ Tc	2.13 × 10 ⁵ y	β ⁻	technetium-99
²³² Th	1.4 × 10 ¹⁰ y	α	thorium-232
²³³ U	1.62 × 10 ⁵ y	α	uranium-233
²³⁵ U	7.1 × 10 ⁸ y	α	uranium-235
²³⁸ U	4.51 × 10 ⁹ y	α	uranium-238

ms = milliseconds; s = seconds; min = minutes;
h = hours; d = days; y = years

Table O
Symbols Used in Nuclear Chemistry

Name	Notation	Symbol
alpha particle	${}^4_2\text{He}$ or ${}^4_2\alpha$	α
beta particle (electron)	${}^0_{-1}\text{e}$ or ${}^0_{-1}\beta$	β^-
gamma radiation	${}^0_0\gamma$	γ
neutron	${}^1_0\text{n}$	n
proton	${}^1_1\text{H}$ or ${}^1_1\text{p}$	p
positron	${}^0_{+1}\text{e}$ or ${}^0_{+1}\beta$	β^+

Table P
Organic Prefixes

Prefix	Number of Carbon Atoms
meth-	1
eth-	2
prop-	3
but-	4
pent-	5
hex-	6
hept-	7
oct-	8
non-	9
dec-	10

Table Q
Homologous Series of Hydrocarbons

Name	General Formula	Examples	
		Name	Structural Formula
alkanes	$\text{C}_n\text{H}_{2n+2}$	ethane	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{H} \\ \quad \\ \text{H} \quad \text{H} \end{array}$
alkenes	C_nH_{2n}	ethene	$\begin{array}{c} \text{H} \quad \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C}=\text{C} \\ \diagup \quad \diagdown \\ \text{H} \quad \quad \text{H} \end{array}$
alkynes	$\text{C}_n\text{H}_{2n-2}$	ethyne	$\text{H}-\text{C}\equiv\text{C}-\text{H}$

n = number of carbon atoms

Table R
Organic Functional Groups

Class of Compound	Functional Group	General Formula	Example
halide (halocarbon)	-F (fluoro-) -Cl (chloro-) -Br (bromo-) -I (iodo-)	$R-X$ (X represents any halogen)	$\text{CH}_3\text{CHClCH}_3$ 2-chloropropane
alcohol	-OH	$R-OH$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ 1-propanol
ether	-O-	$R-O-R'$	$\text{CH}_3\text{OCH}_2\text{CH}_3$ methyl ethyl ether
aldehyde	$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{H} \end{array}$	$\begin{array}{c} \text{O} \\ \\ R-\text{C}-\text{H} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3\text{CH}_2\text{C}-\text{H} \end{array}$ propanal
ketone	$\begin{array}{c} \text{O} \\ \\ -\text{C}- \end{array}$	$\begin{array}{c} \text{O} \\ \\ R-\text{C}-R' \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3\text{CCH}_2\text{CH}_2\text{CH}_3 \end{array}$ 2-pentanone
organic acid	$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{OH} \end{array}$	$\begin{array}{c} \text{O} \\ \\ R-\text{C}-\text{OH} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3\text{CH}_2\text{C}-\text{OH} \end{array}$ propanoic acid
ester	$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{O}- \end{array}$	$\begin{array}{c} \text{O} \\ \\ R-\text{C}-\text{O}-R' \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3\text{CH}_2\text{COCH}_3 \end{array}$ methyl propanoate
amine	$\begin{array}{c} \\ -\text{N}- \end{array}$	$\begin{array}{c} R' \\ \\ R-\text{N}-R'' \end{array}$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$ 1-propanamine
amide	$\begin{array}{c} \text{O} \\ \\ -\text{C}-\text{NH} \end{array}$	$\begin{array}{c} \text{O} \quad R' \\ \quad \\ R-\text{C}-\text{NH} \end{array}$	$\begin{array}{c} \text{O} \\ \\ \text{CH}_3\text{CH}_2\text{C}-\text{NH}_2 \end{array}$ propanamide

R represents a bonded atom or group of atoms.