

Physics Formulas

$$\bar{v} = \frac{\bar{d}}{t}$$

$$\bar{a} = \frac{\bar{v}_f - \bar{v}_i}{t}$$

$$\bar{F}_{\text{net}} = m\bar{a}$$

$$W = Fd$$

$$P = \frac{W}{t}$$

$$E_p = mgh$$

$$E_k = \frac{1}{2} mv^2$$

$$F_g = mg$$

\bar{v} = velocity (m/s)

v = speed (m/s)

\bar{d} = displacement (m)

d = distance (m)

t = time elapsed (s)

\bar{a} = acceleration (m/s²)

\bar{F} = force (kg·m/s² or N)

m = mass (kg)

W = work (N·m or J)

P = power (J/s or W)

E_p = gravitational potential energy (J)

g = magnitude of acceleration
due to gravity (9.81 m/s²)

h = height (m)

E_k = kinetic energy (J)

F_g = magnitude of force due to gravity (N)

Copyright 1998, the Crown in Right of Alberta, as represented by the Minister of Education, Alberta Education, Student Evaluation Branch, 11160 Jasper Avenue, Edmonton, Alberta, T5K 0L2. All rights reserved.

Special permission is granted to Alberta educators only to reproduce, for educational purposes and on a non-profit basis, this document or any of its parts.



.....

Data Booklet

SCIENCE 10

SCIENCE

Table of Contents

1	Miscellaneous
2-3	Periodic Chart of the Elements and Ions
4	Thermodynamics and energy
5	Chemistry
6	Physics

Thermodynamics

Heat Capacities of Some Common Compounds

Compound	Specific Heat Capacity (J/g°C) or kJ/kg°C
Water (liquid)	4.19
Methanol	2.55
Ethanol	2.46
Gold	0.129
Water (solid)	2.01
Water (gas)	2.01
Zinc	0.388
Copper	0.385

Heats of Fusion of Various Substances

Substances	Heat of Fusion kJ/mol
Water	6.01
Copper	12.93
Gold	12.72
Ethanol	5.02
Methanol	3.22
Zinc	7.07

Heats Of Vaporization Of Various Substances

Substances	Heat of Vaporization kJ/mol
Water	40.65
Copper	300.4
Gold	324
Ethanol	39.40
Methanol	35.21
Zinc	123.6

Energy Formulas

$$Q = mc\Delta t$$

$$\Delta H_{\text{fus}} = \frac{Q}{n}$$

$$\Delta H_{\text{vap}} = \frac{Q}{n}$$

Q = quantity of heat energy (kJ)

m = mass (kg)

c = specific heat capacity (kJ/kg°C)

Δt = change in temperature (°C)

ΔH_{fus} = heat of fusion (kJ/mol)

ΔH_{vap} = heat of vaporization (kJ/mol)

n = number of moles (mol)

Chemistry

Prefixes for Molecular Compounds

1 = mono-	6 = hexa-
2 = di-	7 = hepta-
3 = tri-	8 = octa-
4 = tetra-	9 = ennea- (nona-)
5 = penta-	10 = deca-

IUPAC Rules for Naming Acids

Ionic Name	Acid Name	Example		
		Formula	Ionic Name	Acid Name
hydrogen --ide	hydro--ic acid	HCl _(aq)	hydrogen chloride	hydrochloric acid
hydrogen --ate	--ic acid	H ₃ PO _{4(aq)}	hydrogen phosphate	phosphoric acid
hydrogen --ite	--ous acid	H ₃ PO _{3(aq)}	hydrogen phosphite	phosphorous acid

Solubility of Some Common Ionic Compounds in Water at 298.15 K (25°C)

Ion	Group 1 NH ₄ ⁺ H ⁺ (H ₃ O ⁺)	ClO ₃ ⁻ NO ₃ ⁻ ClO ₄ ⁻	CH ₃ COO ⁻	Cl ⁻ Br ⁻ I ⁻	SO ₄ ²⁻	S ²⁻	OH ⁻	PO ₄ ³⁻ SO ₃ ²⁻ CO ₃ ²⁻
Solubility greater than or equal to 0.1 mol/L (very soluble)	all	all	most	most	most	Group 1 Group 2 NH ₄ ⁺	Group 1 NH ₄ ⁺ Sr ²⁺ Ba ²⁺ Tl ⁺	Group 1 NH ₄ ⁺
Solubility less than 0.1 mol/L (slightly soluble)	none	none	Ag ⁺	Ag ⁺ Pb ²⁺ Hg ⁺ Cu ⁺ Tl ⁺	Ca ²⁺ Sr ²⁺ Ba ²⁺ Ra ²⁺ Pb ²⁺ Ag ⁺	most	most	most

Formulas

$$n = \frac{m}{M}$$

$$n_r = n_g \times \frac{\text{coefficient}_r}{\text{coefficient}_g}$$

m = mass (g)

M = molar mass (g/mol)

n = number of moles (mol)

r = required substance

g = given substance

Miscellaneous

Data and Formulas

solar constant = 1360 watts/m²

% efficiency = $\frac{\text{output}}{\text{input}} \times 100$

$$\text{slope} = \frac{\text{rise}}{\text{run}} = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$$

% error = $\frac{\text{experimental value} - \text{theoretical value}}{\text{theoretical value}} \times 100$

magnification = $\frac{\text{power of ocular lens}}{\text{power of objective lens}}$

Some Non-SI Units Used with SI

Quantity	Unit Name	Symbol	Definition
Time	minute	min	1 min = 60 s
	hour	h	1 h = 3 600 s
	day	d	1 d = 86 400 s
	year	a	1 a = 31 557 600 s
Area	hectare	ha	1 ha = 1 hm ² = 10 000 m ²
Volume	litre	L	1 L = 1000 cm ³
Mass	metric ton or tonne	t	1 t = 1 000 kg
			= 1 Mg
Pressure	standard atmosphere	atm	1 atm = 101.325 kPa

A System of Prefixes

Prefix	Symbol	Factor by Which Base Unit is Multiplied
exa	E	1 000 000 000 000 000 000 = 10 ¹⁸
peta	P	1 000 000 000 000 000 = 10 ¹⁵
tera	T	1 000 000 000 000 = 10 ¹²
giga	G	1 000 000 000 = 10 ⁹
*mega	M	1 000 000 = 10 ⁶
*kilo	k	1000 = 10 ³
hecto	h	100 = 10 ²
deca	da	10 = 10 ¹
deci	d	0.1 = 10 ⁻¹
centi	c	0.01 = 10 ⁻²
*milli	m	0.001 = 10 ⁻³
*micro	μ	0.000 001 = 10 ⁻⁶
nano	n	0.000 000 001 = 10 ⁻⁹
pico	p	0.000 000 000 001 = 10 ⁻¹²
femto	f	0.000 000 000 000 001 = 10 ⁻¹⁵
atto	a	0.000 000 000 000 000 001 = 10 ⁻¹⁸

*most commonly used

Periodic Chart of the Elements and Ions

1	2	3	4	5	6	7	8	9																																																
1 H hydrogen 1.01 H ⁺ hydrogen	3 Li lithium 6.94 Li ⁺ lithium	4 Be beryllium 9.01 Be ²⁺ beryllium	<p>Note: The legend at the right denotes the physical state of the elements at 101.325 kPa and 298.15 K (25°C).</p> <p>Legend for the Elements</p> <table border="1"> <tr> <td>Solid</td> <td>Liquid</td> <td>Gas</td> <td>Seldom forms ions</td> </tr> </table> <p>Table of Polyatomic Ions</p> <table border="1"> <thead> <tr> <th colspan="2">Polyatomic ions</th> </tr> </thead> <tbody> <tr> <td>acetate CH₃COO⁻</td> <td>hydrogen carbonate HCO₃⁻</td> </tr> <tr> <td>ammonium NH₄⁺</td> <td>chlorate ClO₃⁻</td> </tr> <tr> <td>benzoate C₆H₅COO⁻</td> <td>hypochlorite ClO⁻</td> </tr> <tr> <td>borate BO₃³⁻</td> <td>chromate CrO₄²⁻</td> </tr> <tr> <td>carbonate CO₃²⁻</td> <td>dichromate Cr₂O₇²⁻</td> </tr> <tr> <td>cyanide CN⁻</td> <td>hydroxide OH⁻</td> </tr> <tr> <td>phosphate PO₄³⁻</td> <td>hydrogen phosphate HPO₄²⁻</td> </tr> <tr> <td>sulfite SO₃²⁻</td> <td>hydrogen sulfide HS⁻</td> </tr> <tr> <td></td> <td>hydrogen sulfate HSO₄⁻</td> </tr> <tr> <td></td> <td>hydrogen sulfite HSO₃⁻</td> </tr> <tr> <td></td> <td>nitrate NO₃⁻</td> </tr> <tr> <td></td> <td>dihydrogen phosphate H₂PO₄⁻</td> </tr> <tr> <td></td> <td>silicate SiO₃²⁻</td> </tr> <tr> <td></td> <td>hydrogen sulfate HSO₄⁻</td> </tr> <tr> <td></td> <td>nitrite NO₂⁻</td> </tr> <tr> <td></td> <td>silicate SiO₄²⁻</td> </tr> <tr> <td></td> <td>hydrogen sulfite HSO₃⁻</td> </tr> <tr> <td></td> <td>permanganate MnO₄⁻</td> </tr> <tr> <td></td> <td>sulfate SO₄²⁻</td> </tr> </tbody> </table>						Solid	Liquid	Gas	Seldom forms ions	Polyatomic ions		acetate CH ₃ COO ⁻	hydrogen carbonate HCO ₃ ⁻	ammonium NH ₄ ⁺	chlorate ClO ₃ ⁻	benzoate C ₆ H ₅ COO ⁻	hypochlorite ClO ⁻	borate BO ₃ ³⁻	chromate CrO ₄ ²⁻	carbonate CO ₃ ²⁻	dichromate Cr ₂ O ₇ ²⁻	cyanide CN ⁻	hydroxide OH ⁻	phosphate PO ₄ ³⁻	hydrogen phosphate HPO ₄ ²⁻	sulfite SO ₃ ²⁻	hydrogen sulfide HS ⁻		hydrogen sulfate HSO ₄ ⁻		hydrogen sulfite HSO ₃ ⁻		nitrate NO ₃ ⁻		dihydrogen phosphate H ₂ PO ₄ ⁻		silicate SiO ₃ ²⁻		hydrogen sulfate HSO ₄ ⁻		nitrite NO ₂ ⁻		silicate SiO ₄ ²⁻		hydrogen sulfite HSO ₃ ⁻		permanganate MnO ₄ ⁻		sulfate SO ₄ ²⁻	7 N nitrogen 14.01 N ³⁻ nitride	8 O oxygen 16.00 O ²⁻ oxide	9 F fluorine 19.00 F ⁻ fluoride	10 Ne neon 20.18 Ne neon
Solid	Liquid	Gas	Seldom forms ions																																																					
Polyatomic ions																																																								
acetate CH ₃ COO ⁻	hydrogen carbonate HCO ₃ ⁻																																																							
ammonium NH ₄ ⁺	chlorate ClO ₃ ⁻																																																							
benzoate C ₆ H ₅ COO ⁻	hypochlorite ClO ⁻																																																							
borate BO ₃ ³⁻	chromate CrO ₄ ²⁻																																																							
carbonate CO ₃ ²⁻	dichromate Cr ₂ O ₇ ²⁻																																																							
cyanide CN ⁻	hydroxide OH ⁻																																																							
phosphate PO ₄ ³⁻	hydrogen phosphate HPO ₄ ²⁻																																																							
sulfite SO ₃ ²⁻	hydrogen sulfide HS ⁻																																																							
	hydrogen sulfate HSO ₄ ⁻																																																							
	hydrogen sulfite HSO ₃ ⁻																																																							
	nitrate NO ₃ ⁻																																																							
	dihydrogen phosphate H ₂ PO ₄ ⁻																																																							
	silicate SiO ₃ ²⁻																																																							
	hydrogen sulfate HSO ₄ ⁻																																																							
	nitrite NO ₂ ⁻																																																							
	silicate SiO ₄ ²⁻																																																							
	hydrogen sulfite HSO ₃ ⁻																																																							
	permanganate MnO ₄ ⁻																																																							
	sulfate SO ₄ ²⁻																																																							
11 Na sodium 22.99 Na ⁺ sodium	12 Mg magnesium 24.31 Mg ²⁺ magnesium	19 K potassium 39.10 K ⁺ potassium	20 Ca calcium 40.08 Ca ²⁺ calcium	21 Sc scandium 44.96 Sc ³⁺ scandium	22 Ti titanium 47.87 Ti ⁴⁺ titanium(IV) Ti ³⁺ titanium(III)	23 V vanadium 50.94 V ⁵⁺ vanadium(V) V ⁴⁺ vanadium(IV)	24 Cr chromium 52.00 Cr ³⁺ chromium(III) Cr ²⁺ chromium(II)	25 Mn manganese 54.94 Mn ²⁺ manganese(II) Mn ⁴⁺ manganese(IV)	26 Fe iron 55.85 Fe ³⁺ iron(III) Fe ²⁺ iron(II)	27 Co cobalt 58.93 Co ²⁺ cobalt(II) Co ³⁺ cobalt(III)																																														
37 Rb rubidium 85.47 Rb ⁺ rubidium	38 Sr strontium 87.62 Sr ²⁺ strontium	39 Y yttrium 88.91 Y ³⁺ yttrium	40 Zr zirconium 91.22 Zr ⁴⁺ zirconium	41 Nb niobium 92.91 Nb ⁵⁺ niobium(V) Nb ³⁺ niobium(III)	42 Mo molybdenum 95.94 Mo ⁶⁺ molybdenum	43 Tc technetium (98) Tc ⁷⁺ technetium	44 Ru ruthenium 101.07 Ru ³⁺ ruthenium(III)	45 Rh rhodium 102.91 Rh ³⁺ rhodium	55 Cs cesium 132.91 Cs ⁺ cesium	56 Ba barium 137.33 Ba ²⁺ barium	57 La lanthanum 138.91 La ³⁺ lanthanum	72 Hf hafnium 178.49 Hf ⁴⁺ hafnium	73 Ta tantalum 180.95 Ta ⁵⁺ tantalum	74 W tungsten 183.84 W ⁶⁺ tungsten	75 Re rhenium 186.21 Re ⁷⁺ rhenium	76 Os osmium 190.23 Os ⁴⁺ osmium	77 Ir iridium 192.22 Ir ⁴⁺ iridium																																							
87 Fr francium (223) Fr ⁺ francium	88 Ra radium (226) Ra ²⁺ radium	89 Ac actinium (227) Ac ³⁺ actinium	104 Rf rutherfordium (261)	105 Db dubnium (262)	106 Sg seaborgium (266)	107 Bh bohrium (264)	108 Hs hassium (277)	109 Mt meitnerium (268)																																																

Lanthanide and Actinide Series Begins

Key

Atomic number → 91
Name of the element → Pa
Atomic mass → 231.04

Symbol of the element → Pa

Ion charge → Pa⁵⁺

Stock name (IUPAC) → protactinium(V)

Symbol of ion → Pa⁴⁺

Based on ¹²/₆C

Most stable or common ion is listed above dotted line.
() indicates mass of the most stable isotope.

References
Lide, D.R. 2005. *CRC Handbook of Chemistry and Physics*. 86th ed. Boca Raton: CRC Press

58 Ce cerium 140.12 Ce ³⁺ cerium	59 Pr praseodymium 140.91 Pr ³⁺ praseodymium	60 Nd neodymium 144.24 Nd ³⁺ neodymium	61 Pm promethium (145) Pm ³⁺ promethium	62 Sm samarium 150.36 Sm ³⁺ samarium(III) Sm ²⁺ samarium(II)
90 Th thorium 232.04 Th ⁴⁺ thorium	91 Pa protactinium 231.04 Pa ⁵⁺ protactinium(V) Pa ⁴⁺ protactinium(IV)	92 U uranium 238.03 U ⁶⁺ uranium(VI) U ⁴⁺ uranium(IV)	93 Np neptunium (237) Np ⁵⁺ neptunium	94 Pu plutonium (244) Pu plutonium(IV) Pu ⁶⁺ plutonium(VI)

10	11	12	13	14	15	16	17	18																	
5 B boron 10.81 B boron	6 C carbon 12.01 C carbon	7 N nitrogen 14.01 N ³⁻ nitride	8 O oxygen 16.00 O ²⁻ oxide	9 F fluorine 19.00 F ⁻ fluoride	10 Ne neon 20.18 Ne neon	13 Al aluminium 26.98 Al ³⁺ aluminium	14 Si silicon 28.09 Si silicon	15 P phosphorus 30.97 P ³⁻ phosphide	16 S sulfur 32.07 S ²⁻ sulfide	17 Cl chlorine 35.45 Cl ⁻ chloride	18 Ar argon 39.95 Ar argon														
28 Ni nickel 58.69 Ni ²⁺ nickel(II) Ni ³⁺ nickel(III)	29 Cu copper 63.55 Cu ²⁺ copper(II) Cu ⁺ copper(I)	30 Zn zinc 65.41 Zn ²⁺ zinc	31 Ga gallium 69.72 Ga ³⁺ gallium	32 Ge germanium 72.64 Ge ⁴⁺ germanium	33 As arsenic 74.92 As ³⁻ arsenide	34 Se selenium 78.96 Se ²⁻ selenide	35 Br bromine 79.90 Br bromide	36 Kr krypton 83.80 Kr krypton	47 Ag silver 107.87 Ag ⁺ silver	48 Cd cadmium 112.41 Cd ²⁺ cadmium	49 In indium 114.82 In ³⁺ indium	50 Sn tin 118.71 Sn ⁴⁺ tin(IV) Sn ²⁺ tin(II)	51 Sb antimony 121.76 Sb ³⁺ antimony(III) Sb ⁵⁺ antimony(V)	52 Te tellurium 127.60 Te ²⁻ telluride	53 I iodine 126.90 I ⁻ iodide	54 Xe xenon 131.29 Xe xenon	78 Pt platinum 195.08 Pt ⁴⁺ platinum(IV) Pt ²⁺ platinum(II)	79 Au gold 196.97 Au ³⁺ gold(III) Au ⁺ gold(I)	80 Hg mercury 200.59 Hg ²⁺ mercury(II) Hg ⁺ mercury(I)	81 Tl thallium 204.38 Tl ⁺ thallium(I) Tl ³⁺ thallium(III)	82 Pb lead 207.2* Pb ²⁺ lead(II) Pb ⁴⁺ lead(IV)	83 Bi bismuth 208.98 Bi ³⁺ bismuth(III) Bi ⁵⁺ bismuth(V)	84 Po polonium (209) Po ²⁺ polonium(II) Po ⁴⁺ polonium(IV)	85 At astatine (210) At astatide	86 Rn radon (222) Rn radon
110 Ds darmstadtium (271)	111 Rg roentgenium (272)																								

* The isotopic mix of naturally occurring lead is more variable than that of other elements, preventing precision to greater than tenths of a gram per mole.

63 Eu europium 151.96 Eu ³⁺ europium(III) Eu ²⁺ europium(II)	64 Gd gadolinium 157.25 Gd ³⁺ gadolinium	65 Tb terbium 158.93 Tb ³⁺ terbium	66 Dy dysprosium 162.50 Dy ³⁺ dysprosium	67 Ho holmium 164.93 Ho ³⁺ holmium	68 Er erbium 167.26 Er ³⁺ erbium	69 Tm thulium 168.93 Tm ³⁺ thulium	70 Yb ytterbium 173.04 Yb ³⁺ ytterbium(III) Yb ²⁺ ytterbium(II)	71 Lu lutetium 174.97 Lu ³⁺ lutetium
95 Am americium 243 Am ³⁺ americium(III) Am ⁴⁺ americium(IV)	96 Cm curium (247) Cm ³⁺ curium	97 Bk berkelium (247) Bk ³⁺ berkelium(III) Bk ⁴⁺ berkelium(IV)	98 Cf californium (251) Cf ³⁺ californium	99 Es einsteinium (252) Es ³⁺ einsteinium	100 Fm fermium (257) Fm ³⁺ fermium	101 Md mendelevium (258) Md ²⁺ mendelevium(II) Md ³⁺ mendelevium(III)	102 No nobelium (259) No ²⁺ nobelium(II) No ³⁺ nobelium(III)	103 Lr lawrencium (262) Lr ³⁺ lawrencium