



| Half-reaction | E°(volts) |
|---|-----------|
| $F_2(g) + 2 e^- \rightleftharpoons 2 F^-(aq)$ | + 2.89 |
| $H_2O_2(aq) + 2 H^+(aq) + 2 e^- \rightleftharpoons 2 H_2O(l)$ | + 1.76 |
| $PbO_2(s) + SO_4^{2-}(aq) + 4 H^+(aq) + 2 e^- \rightleftharpoons PbSO_4(s) + 2 H_2O(l)$ | + 1.69 |
| $2 HClO(aq) + 2 H^+(aq) + 2 e^- \rightleftharpoons Cl_2(g) + 2 H_2O(l)$ | + 1.63 |
| $MnO_4^-(aq) + 8 H^+(aq) + 5 e^- \rightleftharpoons Mn^{2+}(aq) + 4 H_2O(l)$ | + 1.51 |
| $Au^{3+}(aq) + 3 e^- \rightleftharpoons Au(s)$ | + 1.50 |
| $HClO(aq) + H^+(aq) + 2 e^- \rightleftharpoons Cl^-(aq) + H_2O(l)$ | + 1.49 |
| $PbO_2(s) + 4 H^+(aq) + 2 e^- \rightleftharpoons Pb^{2+}(aq) + 2 H_2O(l)$ | + 1.46 |
| $Cl_2(g) + 2 e^- \rightleftharpoons 2 Cl^-(aq)$ | + 1.36 |
| $Cr_2O_7^{2-}(aq) + 14 H^+(aq) + 6 e^- \rightleftharpoons 2 Cr^{3+}(aq) + 7 H_2O(l)$ | + 1.36 |
| $O_2(g) + 4 H^+(aq) + 4 e^- \rightleftharpoons 2 H_2O(l)$ | + 1.23 |
| $Br_2(l) + 2 e^- \rightleftharpoons 2 Br^-(aq)$ | + 1.08 |
| $Ag^+(aq) + e^- \rightleftharpoons Ag(s)$ | + 0.80 |
| $Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$ | + 0.77 |
| $O_2(g) + 2 H^+(aq) + 2 e^- \rightleftharpoons H_2O_2(aq)$ | + 0.70 |
| $I_2(s) + 2 e^- \rightleftharpoons 2 I^-(aq)$ | + 0.54 |
| $O_2(g) + 2 H_2O(l) + 4 e^- \rightleftharpoons 4 OH^-(aq)$ | + 0.40 |
| $Cu^{2+}(aq) + 2 e^- \rightleftharpoons Cu(s)$ | + 0.34 |
| $S(s) + 2 H^+(aq) + 2 e^- \rightleftharpoons H_2S(aq)$ | + 0.17 |
| $2 H^+(aq) + 2 e^- \rightleftharpoons H_2(g)$ | 0 exactly |
| $Pb^{2+}(aq) + 2 e^- \rightleftharpoons Pb(s)$ | - 0.13 |
| $Sn^{2+}(aq) + 2 e^- \rightleftharpoons Sn(s)$ | - 0.14 |
| $Ni^{2+}(aq) + 2 e^- \rightleftharpoons Ni(s)$ | - 0.24 |
| $Co^{2+}(aq) + 2 e^- \rightleftharpoons Co(s)$ | - 0.28 |
| $PbSO_4(s) + 2 e^- \rightleftharpoons Pb(s) + SO_4^{2-}(aq)$ | - 0.36 |
| $Cd^{2+}(aq) + 2 e^- \rightleftharpoons Cd(s)$ | - 0.40 |
| $2 CO_2(g) + 2 H^+(aq) + 2 e^- \rightleftharpoons H_2C_2O_4(aq)$ | - 0.43 |
| $Fe^{2+}(aq) + 2 e^- \rightleftharpoons Fe(s)$ | - 0.44 |
| $Cr^{3+}(aq) + 3 e^- \rightleftharpoons Cr(s)$ | - 0.74 |
| $Zn^{2+}(aq) + 2 e^- \rightleftharpoons Zn(s)$ | - 0.76 |
| $2 H_2O(l) + 2 e^- \rightleftharpoons H_2(g) + 2 OH^-(aq)$ | - 0.83 |
| $Mn^{2+}(aq) + 2 e^- \rightleftharpoons Mn(s)$ | - 1.18 |
| $Al^{3+}(aq) + 3 e^- \rightleftharpoons Al(s)$ | - 1.68 |
| $Mg^{2+}(aq) + 2 e^- \rightleftharpoons Mg(s)$ | - 2.36 |
| $Na^+(aq) + e^- \rightleftharpoons Na(s)$ | - 2.71 |
| $Ca^{2+}(aq) + 2 e^- \rightleftharpoons Ca(s)$ | - 2.87 |
| $Sr^{2+}(aq) + 2 e^- \rightleftharpoons Sr(s)$ | - 2.90 |
| $Ba^{2+}(aq) + 2 e^- \rightleftharpoons Ba(s)$ | - 2.91 |
| $K^+(aq) + e^- \rightleftharpoons K(s)$ | - 2.94 |

CHEMISTRY DATA SHEET

2015

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This document is valid for teaching and examining until 31 December 2015.

TRIM 2014/47585

Chemistry Data Sheet updated April 2015

Periodic table

| | | | | | | | | | | | | | | | | | |
|--------------------------------------|---------------------------------------|--------------------------------------|---------------------------------------|--------------------------------------|--|---------------------------------------|---------------------------------------|-------------------------------------|---------------------------------------|------------------------------------|-------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|--------------------------------------|-------------------------------------|
| 1 H hydrogen 1.008 | | | | | | | | | | | | | | | | | 2 He helium 4.003 |
| 3 Li lithium 6.968 | 4 Be beryllium 9.012 | | | | | | | | | | | 5 B boron 10.82 | 6 C carbon 12.01 | 7 N nitrogen 14.01 | 8 O oxygen 16.00 | 9 F fluorine 19.00 | 10 Ne neon 20.18 |
| 11 Na sodium 22.99 | 12 Mg magnesium 24.31 | | | | | | | | | | | 13 Al aluminium 26.98 | 14 Si silicon 28.09 | 15 P phosphorus 30.97 | 16 S sulfur 32.07 | 17 Cl chlorine 35.45 | 18 Ar argon 39.95 |
| 19 K potassium 39.10 | 20 Ca calcium 40.08 | 21 Sc scandium 44.96 | 22 Ti titanium 47.87 | 23 V vanadium 50.94 | 24 Cr chromium 52.00 | 25 Mn manganese 54.94 | 26 Fe iron 55.85 | 27 Co cobalt 58.93 | 28 Ni nickel 58.69 | 29 Cu copper 63.55 | 30 Zn zinc 65.38 | 31 Ga gallium 69.72 | 32 Ge germanium 72.63 | 33 As arsenic 74.92 | 34 Se selenium 78.96 | 35 Br bromine 79.90 | 36 Kr krypton 83.80 |
| 37 Rb rubidium 85.47 | 38 Sr strontium 87.62 | 39 Y yttrium 88.91 | 40 Zr zirconium 91.22 | 41 Nb niobium 92.91 | 42 Mo molybdenum 95.96 | 43 Tc technetium | 44 Ru ruthenium 101.1 | 45 Rh rhodium 102.9 | 46 Pd palladium 106.4 | 47 Ag silver 107.9 | 48 Cd cadmium 112.4 | 49 In indium 114.8 | 50 Sn tin 118.7 | 51 Sb antimony 121.8 | 52 Te tellurium 127.6 | 53 I iodine 126.9 | 54 Xe xenon 131.3 |
| 55 Cs caesium 132.9 | 56 Ba barium 137.3 | 57-71 *La lanthanum | 72 Hf hafnium 178.5 | 73 Ta tantalum 180.9 | 74 W tungsten 183.8 | 75 Re rhenium 186.2 | 76 Os osmium 190.2 | 77 Ir iridium 192.2 | 78 Pt platinum 195.1 | 79 Au gold 197.0 | 80 Hg mercury 200.6 | 81 Tl thallium 204.4 | 82 Pb lead 207.2 | 83 Bi bismuth 209.0 | 84 Po polonium | 85 At astatine | 86 Rn radon |
| 87 Fr francium | 88 Ra radium | 89-103 **Ac actinium | 104 Rf rutherfordium | 105 Db dubnium | 106 Sg seaborgium | 107 Bh bohrium | 108 Hs hassium | 109 Mt meitnerium | 110 Ds darmstadtium | 111 Rg roentgenium | 112 Cn copernicium | | | 114 Fl flerovium | | | 116 Lv livermorium |

Key:

| |
|------------------------|
| Atomic number |
| Symbol |
| Name |
| Standard atomic weight |

| | | | | | | | | | | | | | | |
|---------------------|-------------------------------------|--|---------------------------------------|-------------------------------|--------------------------------------|--------------------------------------|--|-------------------------------------|--|-------------------------------------|------------------------------------|-------------------------------------|---------------------------------------|--------------------------------------|
| * Lanthanide series | 58 Ce cerium 140.1 | 59 Pr praseodymium 140.9 | 60 Nd neodymium 144.2 | 61 Pm promethium | 62 Sm samarium 150.4 | 63 Eu europium 152.0 | 64 Gd gadolinium 157.3 | 65 Tb terbium 158.9 | 66 Dy dysprosium 162.5 | 67 Ho holmium 164.9 | 68 Er erbium 167.3 | 69 Tm thulium 168.9 | 70 Yb ytterbium 173.1 | 71 Lu lutetium 175.0 |
| ** Actinide series | 90 Th thorium 232.0 | 91 Pa protactinium 231.0 | 92 U uranium 238.0 | 93 Np neptunium | 94 Pu plutonium | 95 Am americium | 96 Cm curium | 97 Bk berkelium | 98 Cf californium | 99 Es einsteinium | 100 Fm fermium | 101 Md mendelevium | 102 No nobelium | 103 Lr lawrencium |

[Data source: The International Union of Pure and Applied Chemistry Periodic Table of the Elements (May 2013)]

Solubility rules for ionic solids in water

Soluble in water

| Soluble | Exceptions | |
|----------------|---|---|
| | Insoluble | Slightly soluble |
| Most chlorides | AgCl | PbCl ₂ |
| Most bromides | AgBr | PbBr ₂ |
| Most iodides | AgI, PbI ₂ | |
| All nitrates | No exceptions | |
| All ethanoates | | |
| Most sulfates | SrSO ₄ , BaSO ₄ , PbSO ₄ | CaSO ₄ , Ag ₂ SO ₄ |

Insoluble in water

| Insoluble | Exceptions | |
|-----------------|--|---|
| | Soluble | Slightly soluble |
| Most hydroxides | NaOH, KOH, Ba(OH) ₂ (note: NH ₄ OH and AgOH do not exist) | Ca(OH) ₂ , Sr(OH) ₂ |
| Most carbonates | Na ₂ CO ₃ , K ₂ CO ₃ , (NH ₄) ₂ CO ₃ | |
| Most phosphates | Na ₃ PO ₄ , K ₃ PO ₄ , (NH ₄) ₃ PO ₄ | |
| Most sulfides | Na ₂ S, K ₂ S, (NH ₄) ₂ S | |

Soluble = more than 0.1 mole dissolves per litre
Slightly soluble = between 0.01 and 0.1 mole dissolves per litre
Insoluble = less than 0.01 mole dissolves per litre

Colours of selected ionic substances

In general, ionic solids have the same colour as that of any coloured ion they contain. Two colourless ions in general produce a white solid. Selected exceptions to these two basic rules are noted below.

| Ionic Solid | Colour |
|----------------------|-------------|
| copper(II) carbonate | green |
| copper(II) chloride | green |
| copper(II) oxide | black |
| copper(II) sulfide | black |
| lead(II) iodide | yellow |
| lead(II) sulfide | grey |
| manganese(IV) oxide | black |
| silver carbonate | yellow |
| silver iodide | pale yellow |
| silver oxide | brown |
| silver sulfide | black |

Other coloured substances

Most gases and liquids are colourless, and most metals are silvery or grey. Selected exceptions to these basic rules are noted below.

| Substance | State | Colour |
|------------------|-------|-------------|
| copper | solid | salmon pink |
| gold | solid | yellow |
| nitrogen dioxide | gas | brown |
| sulfur | solid | yellow |

Coloured ions in aqueous solution

| Cation | Colour |
|------------------|------------|
| Cr ³⁺ | deep green |
| Co ²⁺ | pink |
| Cu ²⁺ | blue |
| Fe ²⁺ | pale green |
| Fe ³⁺ | pale brown |
| Mn ²⁺ | pale pink |
| Ni ²⁺ | green |

| Anion | Colour |
|--|--------|
| CrO ₄ ²⁻ | yellow |
| Cr ₂ O ₇ ²⁻ | orange |
| MnO ₄ ⁻ | purple |

Coloured halogens

| Halogen | Colour of free element |
|---------------------|------------------------|
| F ₂ (g) | yellow |
| Cl ₂ (g) | greenish-yellow |
| Br ₂ (l) | red |
| I ₂ (s) | purple |

| Halogen | Colour of halogen in aqueous solution |
|----------------------|---------------------------------------|
| Cl ₂ (aq) | pale yellow |
| Br ₂ (aq) | orange |
| I ₂ (aq) | brown |

| Halogen | Colour of halogen in organic solvent |
|-----------------|--------------------------------------|
| Br ₂ | red |
| I ₂ | purple |

Formulae

$$\text{Number of moles} \quad n = \frac{m}{M} = \frac{\text{mass}}{\text{molar mass}}$$

$$\text{Number of moles of solute} \quad n = cV$$

$$\text{Number of moles of a gas at STP} \quad n = \frac{V}{22.71}$$

$$\text{Ideal gas law} \quad PV = nRT$$

$$\text{Parts per million} \quad \text{ppm} = \frac{\text{mass of solute (mg)}}{\text{mass of solution (kg)}}$$

$$\text{pH of a solution} \quad \text{pH} = -\log [\text{H}^+]$$

Units

Volumes are given in the units of litres (L), or millilitres (mL).

Temperatures are given in the units of degrees Celsius (°C) or kelvin (K).

It may be assumed that 0.0 °C = 273.15 K.

Energy changes are given in kilojoules (kJ).

Pressures are given in kilopascals (kPa).

Solution concentrations are given in the units moles per litre (mol L⁻¹), grams per litre (g L⁻¹) or parts per million (ppm).

Constants

Universal gas constant, R = 8.314 J K⁻¹ mol⁻¹

Avogadro constant, N = 6.022 × 10²³ mol⁻¹

Volume of 1.00 mol of an ideal gas at 0.0 °C and 100.0 kPa is 22.71 L

STP is 0.0 °C and 100.0 kPa

Equilibrium constant for water at 25 °C, K_w = 1.00 × 10⁻¹⁴