PERIODIC TABLE OF THE ELEMENTS

Table of Selected Radioactive Isotopes

$_0$n	1	(15.3 min) β^-	$_{30}$Zn	67	(61.88 h) β^-	$_{51}$Sb	124	(60.20 d) β^-	$_{74}$W	181	(140 d) EC	$_{91}$Pa	231	(3.28 × 10^4 y) α
$_1$H	3	(12.26 y) β^-		65	(244.1 d) β^+, EC		125	(2.7 y) β^-		185	(75.1 d) β^-	$_{92}$U	233	(1.59 × 10^5 y) α
$_4$Be	7	(53.3 d) EC	$_{31}$Ga	67	(78.2 h) EC	$_{53}$Te	121 m	(154 d) IT		188	(69 d) β^-		234	(2.44 × 10^5 y) α
	10	(1.6 × 10^6 y) β^-		72	(14.10 h) β^-		123 m	(1.197 d) IT	$_{75}$Re	187	(5 × 10^{10} y) β^-		235	(7.04 × 10^8 y) α
$_6$C	11	(20.40 min) β^+	$_{32}$Ge	68	(275 d) EC		127 m	(109 d) IT	$_{76}$Os	194	(6.0 y) β^-		236	(2.34 × 10^7 y) α
	14	(5730 y) β^-	$_{33}$As	73	(80.3 d) EC	$_{53}$I	129	(1.6 × 10^7 y) β^-	$_{77}$Ir	192	(74.2 d) β^-, β^+, EC		238	(4.47 × 10^9 y) α
$_9$F	18	(109.8 min) β^+		74	(17.9 d) β^-, β^+, EC		131	(8.040 d) β^-	$_{79}$Au	195	(183 d) EC	$_{93}$Np	236	(1.1 × 10^5 y) EC, β^-
$_{11}$Na	22	(2.602 y) β^+, EC	$_{34}$Se	75	(118.5 d) β^-	$_{54}$Xe	133	(5.25 d) β^-		196	(6.18 d) β^+, EC, β^-		237	(2.14 × 10^6 y) α
	24	(15.02 h) β^-		79	(6.5 × 10^4 y) β^-		135	(9.10 h) β^-		198	(2.696 d) β^-		239	(2.346 d) β^-
$_{12}$Mg	28	(20.9 h) β^-	$_{35}$Br	82	(35.34 h) β^-	$_{55}$Cs	134	(2.06 y) β^-		199	(3.15 d) β^-	$_{94}$Pu	238	(87.75 y) α
$_{13}$Al	26	(7.2 × 10^5 y) β^+, EC	$_{36}$Kr	81	(2.1 × 10^5 y) EC		135	(2.9 × 10^6 y) β^-	$_{80}$Hg	203	(46.8 d) β^-		239	(2.41 × 10^4 y) α
$_{15}$P	32	(14.26 d) β^-		85	(10.72 y) β^-		137	(30.17 y) β^-	$_{81}$Tl	204	(3.77 y) β^-		240	(6.54 × 10^3 y) α
$_{16}$S	35	(87.2 d) β^-	$_{37}$Rb	86	(18.7 d) β^-	$_{56}$Ba	140	(12.8 d) β^-	$_{82}$Pb	202	(3 × 10^5 y) EC		242	(3.8 × 10^5 y) α
$_{17}$Cl	36	(3.01 × 10^5 y) β^-		87	(4.8 × 10^{11} y) β^-	$_{57}$La	137	(6 × 10^4 y) EC		205	(3 × 10^7 y) EC		244	(8.3 × 10^7 y) α
	38	(37.2 min) β^-	$_{38}$Sr	90	(28.8 y) β^-		140	(40.3 h) β^-		210	(22.3 y) β^-, α	$_{95}$Am	241	(432 y) α
$_{18}$Ar	37	(35.02 d) EC	$_{39}$Y	88	(106.6 d) β^+, EC	$_{58}$Ce	144	(284 d) β^-	$_{83}$Bi	207	(38 y) EC		243	(7.37 × 10^3 y) α
	39	(265 y) β^-	$_{40}$Zr	93	(1.5 × 10^6 y) β^-	$_{59}$Pr	142	(19.1 h) β^-		208	(3.7 × 10^5 y) EC	$_{96}$Cm	242	(163.2 d) α
$_{19}$K	40	(1.28 × 10^9 y) EC		95	(64.0 d) β^-	$_{60}$Nd	147	(11.1 d) β^-		210	(5.01 d) β^-, α		244	(18.12 y) α
	42	(12.36 h) β^-	$_{41}$Nb	94	(2.0 × 10^4 y) β^-	$_{61}$Pm	145	(18 y) EC		210 m	(3 × 10^6) α		247	(1.55 × 10^7 y) α
$_{20}$Ca	45	(165 d) β^-		95	(35.15 d) β^-		147	(2.62 y) β^-	$_{84}$Po	208	(2.90 y) α		248	(3.5 × 10^5 y) α, SF
$_{21}$Sc	46	(83.80 d) β^-	$_{42}$Mo	99	(66.02 h) β^-	$_{62}$Sm	146	(7 × 10^7 y) α		209	(102 y) α	$_{97}$Bk	247	(1.4 × 10^3 y) α
$_{24}$Cr	51	(27.70 d) EC	$_{43}$Tc	97	(2.6 × 10^6 y) EC		151	(93 y) β^-		210	(138.38 d) α	$_{98}$Cf	249	(351 y) α
$_{25}$Mn	53	(2 × 10^6 y) EC		98	(4.2 × 10^6 y) β^-	$_{63}$Eu	152	(13 y) β^+, EC, β^-	$_{85}$At	209	(5.4 h) EC, α		251	(900 y) α
	54	(313.0 d) EC		99	(2.13 × 10^5 y) β^-		154	(8.5 y) β^-		210	(8.1 h) EC	$_{99}$Es	252	(472 d) α
	56	(2.578 h) β^-	$_{44}$Ru	106	(367 d) β^-	$_{64}$Gd	150	(2.1 × 10^6 y) α		211	(7.21 h) EC, α		253	(20.47 d) α
$_{26}$Fe	59	(44.6 d) β^-	$_{45}$Rh	101	(3.3 y) EC	$_{65}$Tb	158	(1.2 × 10^5 y) EC, β^-	$_{86}$Rn	222	(3.824 d) α		254	(276 d) α
$_{27}$Co	56	(78.8d) β^+, EC	$_{46}$Pd	103	(17.0 d) EC		160	(72.3 d) β^-	$_{87}$Fr	212	(19.3 min) EC, α	$_{100}$Fm	255	(20.1 h) α
	57	(270 d) EC		107	(7 × 10^6 y) β^-	$_{67}$Ho	166 m	(1.2 × 10^3 y) β^-		222	(15 min) β^-		257	(100.5 d) α
	58	(71.3 d) β^+, EC	$_{47}$Ag	108	(127 y) EC	$_{69}$Tm	170	(128.6 d) β^-		223	(21.8 min) β^-	$_{101}$Md	258	(55 d) α
	60	(1.77 × 10^6 y) β^-		110	(252 d) β^-		171	(1.92 y) β^-	$_{88}$Ra	226	(1.60 × 10^3 y) α	$_{102}$No	259	(58 min) α
$_{28}$Ni	56	(6.10 d) EC		111	(7.45 d) β^-	$_{70}$Yb	169	(32.0 d) EC	$_{89}$Ac	227	(21.77 y) β^-	$_{103}$Lr	260	(3.0 min) α
	59	(8 × 10^4 y) EC	$_{48}$Cd	109	(453 d) EC		175	(4.19 d) β^-	$_{90}$Th	228	(1.913 y) α	$_{104}$Rf	261	(65 s) α
	63	(92 y) β^-	$_{49}$In	114	(49.51 d) IT	$_{71}$Lu	176	(3.7 × 10^{10} y) β^-		230	(7.7 × 10^4 y) α	$_{105}$Db	262	(40 s) α
$_{29}$Cu	64	(12.70 h) β^-, β^+, EC	$_{50}$Sn	121	(76 y) β^-	$_{72}$Ta	182	(115.0 d) β^-		232	(1.40 × 10^{10} y) α	$_{106}$Sg	263	(0.9 d) α

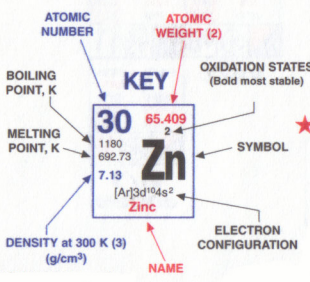
Selected Radioactive Isotopes

Naturally occurring radioactive isotopes are designated by a mass number in blue (although some are also manufactured). Letter indicates an isomer of another isotope of the same mass number. Half-lives follow in parentheses, where s, min, h, d, and y stand respectively for seconds, minutes, hours, days, and years. The table includes mainly the longer-lived radioactive isotopes; many others have been prepared. Isotopes known to be radioactive but with half-lives exceeding 10^{12} y have not been included. Symbols describing the principal mode (or modes) of decay are as follows (these processes are generally accompanied by gamma radiation):

- α alpha particle emission
- β^- beta particle (electron) emission
- β^+ positron emission
- EC orbital electron capture
- IT isomeric transition from upper to lower isomeric state
- SF spontaneous fission

GROUP 1/IA	2/IIA	3/IIIA	4/IVA	5/VA	6/VIA	7/VIIA	8	9 VIIIA	10	11/IB	12/IIB	13/IIIB	14/IVB	15/VB	16/VIB	17/VIIB	18/VIII
1 1.00794 1,-1 20.28 13.81 0.0899 † **H** 1s¹ Hydrogen																	**2** 4.00260 4.216 0.95 at 26 atm 0.1785 † **He** 1s² Helium
3 (6.941) 1 1615 453.7 0.534 **Li** [He]2s¹ Lithium	**4** 9.012182 2 2744 1560 1.85 **Be** [He]2s² Beryllium											**5** 10.811 3 4275 2348 2.37 **B** [He]2s²2p¹ Boron	**6** 12.0107 ±4,2 4675* 3915* 2.26 **C** [He] 2s²2p² Carbon	**7** 14.0067 ±3,5,4,2 77.344 63.15 1.251 † **N** [He] 2s²2p³ Nitrogen	**8** 15.9994 -2,-1 90.2 54.4 1.429 † **O** [He]2s²2p⁴ Oxygen	**9** 18.99840 -1 85.0 53.55 1.696 † **F** [He] 2s²2p⁵ Fluorine	**10** 20.1797 27.07 24.56 0.900 † **Ne** [He] 2s²2p⁶ Neon
11 22.989770 1 1156.1 371.0 0.971 **Na** [Ne]3s¹ Sodium	**12** 24.3050 2 1363 923 1.74 **Mg** [Ne]3s² Magnesium											**13** 26.981538 3 2792 933.5 2.6989 **Al** [Ne]3s²3p¹ Aluminum	**14** 28.0855 4,2 3538 1687 2.33 **Si** [Ne]3s²3p² Silicon	**15** 30.97376 ±3,5,4 553 317.3 1.82 **P** [Ne]3s²3p³ Phosphorus	**16** 32.065 6,±2,4, 717.75 388.36 2.07 **S** [Ne]3s²3p⁴ Sulfur	**17** 35.453 ±1,7,5,3 239.11 171.65 3.214 † **Cl** [Ne]3s²3p⁵ Chlorine	**18** 39.948 87.8 83.8 1.784 † **Ar** [Ne]3s²3p⁶ Argon
19 39.0983 1 1033 336.8 0.862 **K** [Ar]4s¹ Potassium	**20** 40.078 2 1757 1115 1.55 **Ca** [Ar]4s² Calcium	**21** 44.95591 3 3109 1814 2.99 **Sc** [Ar]3d¹4s² Scandium	**22** 47.867 4,3,2 3560 1941 4.54 **Ti** [Ar]3d²4s² Titanium	**23** 50.9415 5,4,3,2 3680 2183 6.11 **V** [Ar]3d³4s² Vanadium	**24** 51.996 3,6,2 2945 2180 7.19 **Cr** [Ar]3d⁵4s¹ Chromium	**25** 54.9380 2,3,4,6,7 2234 1519 7.44 **Mn** [Ar]3d⁵4s² Manganese	**26** 55.845 3,2,6 3134 1811 7.874 **Fe** [Ar]3d⁶4s² Iron	**27** 58.9332 2,3 3200 1768 8.90 **Co** [Ar]3d⁷4s² Cobalt	**28** 58.6934 2,3 3186 1728 8.90 **Ni** [Ar]3d⁸4s² Nickel	**29** 63.546 2,1 2835 1357.8 8.96 **Cu** [Ar]3d¹⁰4s¹ Copper	**30** 65.409 2 1180 692.68 7.13 **Zn** [Ar]3d¹⁰4s² Zinc	**31** 69.723 1,3 2477 302.91 6.095 **Ga** [Ar]3d¹⁰4s²4p¹ Gallium	**32** 72.64 4 3106 1211.4 5.32 **Ge** [Ar]3d¹⁰4s²4p² Germanium	**33** 74.9216 ±3,5 876 (sub.) 1090 (25 atm.) 5.73 **As** [Ar]3d¹⁰4s²4p³ Arsenic	**34** 78.96 4,6,-2 958 494 4.79 **Se** [Ar]3d¹⁰4s²4p⁴ Selenium	**35** 79.904 ±1,7,5,3 331.95 265.95 3.12 **Br** [Ar]3d¹⁰4s²4p⁵ Bromine	**36** 83.80 0,2 119.93 115.8 3.73 † **Kr** [Ar]3d¹⁰4s²4p⁶ Krypton
37 85.4678 1 961 312.46 1.532 **Rb** [Kr]5s¹ Rubidium	**38** 87.62 2 1655 1050 2.54 **Sr** [Kr]5s² Strontium	**39** 88.9059 3 3618 1795 4.47 **Y** [Kr]4d¹5s² Yttrium	**40** 91.224 4 4682 2128 6.51 **Zr** [Kr]4d ²5s² Zirconium	**41** 92.90638 5,3,4 5017 2730 8.57 **Nb** [Kr]4d⁴5s¹ Niobium	**42** 95.94 6,5,4,3,2 4912 2896 10.22 **Mo** [Kr]4d⁵5s¹ Molybdenum	**43** (98) 7,5,4 4538 2430 11.5* **Tc** [Kr]4d⁵5s² Technetium	**44** 101.07 2,3,4,6,8 4423 2607 12.37 **Ru** [Kr]4d⁷5s¹ Ruthenium	**45** 102.90550 2,3,4 3968 2237 12.41 **Rh** [Kr]4d⁸5s¹ Rhodium	**46** 106.42 2,4 3236 1828 12.0 **Pd** [Kr]4d¹⁰ Palladium	**47** 107.8682 1 2435 1234.93 10.50 **Ag** [Kr]4d¹⁰5s¹ Silver	**48** 112.41 2 1040 594.22 8.65 **Cd** [Kr]4d¹⁰5s² Cadmium	**49** 114.82 3 2345 429.75 7.31 **In** [Kr]4d¹⁰5s²5p¹ Indium	**50** 118.710 4,2 2875 505.08 7.31 **Sn** [Kr]4d¹⁰5s²5p² Tin	**51** 121.760 ±3,5 1860 903.78 6.69 **Sb** [Kr]4d¹⁰5s²5p³ Antimony	**52** 127.60 4,6,-2 1261 722.66 6.24 **Te** [Kr]4d¹⁰5s²5p⁴ Tellurium	**53** 126.90447 ±1,5,7 457.51 386.85 4.93 **I** [Kr]4d¹⁰5s²5p⁵ Iodine	**54** 131.29 0,2,4,6,8 165.11 161.4 5.90 † **Xe** [Kr]4d¹⁰5s²5p⁶ Xenon
55 132.90545 1 944 301.54 1.87 **Cs** [Xe]6s¹ Cesium	**56** 137.327 2 2170 1000 3.5 **Ba** [Xe]6s² Barium	**57** 138.9055 3 ★ 3737 1191 6.15 **La** [Xe]5d¹6s² Lanthanum	**72** 178.49 4 4876 2506 13.31 **Hf** [Xe]4f¹⁴5d²6s² Hafnium	**73** 180.9479 5,4 5730 3290 16.65 **Ta** [Xe]4f¹⁴5d³6s² Tantalum	**74** 183.84 6,5,4,3,2 5828 3695 19.3 **W** [Xe]4f¹⁴5d⁴6s² Tungsten	**75** 186.207 7,6,5,4,3,2 5870 3459 21.0 **Re** [Xe]4f¹⁴5d⁵6s² Rhenium	**76** 190.23 4,8,6,3,2 5285 3306 22.57 **Os** [Xe]4f¹⁴5d⁶6s² Osmium	**77** 192.217 4,2,6,3 4700 2720 22.42 **Ir** [Xe]4f¹⁴5d⁷6s² Iridium	**78** 195.08 4,2 4098 2041.55 21.45 **Pt** [Xe]4f¹⁴5d⁹6s¹ Platinum	**79** 196.96655 3,1 3130 1337.33 19.3 **Au** [Xe]4f¹⁴5d¹⁰6s¹ Gold	**80** 200.59 2,1 629.88 234.32 13.55 **Hg** [Xe]4f¹⁴5d¹⁰6s² Mercury	**81** 204.3833 3,1 1746 577 11.85 **Tl** [Xe]4f¹⁴5d¹⁰6s²6p¹ Thallium	**82** 207.2 2,4 2022 600.61 11.35 **Pb** [Xe]4f¹⁴5d¹⁰6s²6p² Lead	**83** 208.9804 3,5 1837 544.55 9.75 **Bi** [Xe]4f¹⁴5d¹⁰6s²6p³ Bismuth	**84** (209) 4,2,6 — 527 9.3 **Po** [Xe]4f¹⁴5d¹⁰6s²6p⁴ Polonium	**85** (210) ±1,7,5,3 610* 575 — **At** [Xe]4f¹⁴5d¹⁰6s²6p⁵ Astatine	**86** (222) 0,2 211.4 202 9.73 † **Rn** [Xe]4f¹⁴5d¹⁰6s²6p⁶ Radon
87 (223) 1 950* 300 — **Fr** [Rn]7s¹ Francium	**88** (226) 2 1413 973 5.0 **Ra** [Rn]7s² Radium	**89** (227) 3 ★★ 3470* 1324 10.07 **Ac** [Rn]6d¹7s² Actinium	**104** (261) — — — **Rf** [Rn]5f¹⁴6d²7s² Rutherfordium	**105** (262) — — — **Db** [Rn]5f¹⁴6d³7s² Dubnium	**106** (266) — — — **Sg** [Rn]5f¹⁴6d⁴7s² Seaborgium	**107** (264) — — — **Bh** [Rn]5f¹⁴6d⁵7s² Bohrium	**108** (277) — — — **Hs** [Rn]5f¹⁴6d⁶7s² Hassium	**109** (268) — — — **Mt** [Rn]5f¹⁴6d⁷7s² Meitnerium	**110** (269) — — — **Ds** [Rn]5f¹⁴6d⁸7s² (Darmstadtium)	**111** (272) — — — **Uuu** [Rn]5f¹⁴6d⁹7s² (Ununium)	**112** (285) — — — **Uub** [Rn]5f¹⁴6d¹⁰7s² (Ununbium)	**113** (284) — — — **Uut** [Rn]5f¹⁴6d¹⁰7s²7p¹* (Ununtrium)	**114** (289) — — — **Uuq** [Rn]5f¹⁴6d¹⁰7s²7p² (Ununquadium)	**115** (288) — — — **Uup** [Rn]5f¹⁴6d¹⁰7s²7p³ (Ununpentium)	**116** — — — **Uuh** [Rn]5f¹⁴6d¹⁰7s²7p⁴ (Ununhexium)	**117** — — — **Uus** (Unseptium)	**118** — — — **Uuo** (Unoctium)

* Estimated Values



★	**58** 140.116 3 3716 1071 6.77 **Ce** [Xe]4f¹5d¹6s² Cerium	**59** 140.90765 3,4 3785 1204 6.77 **Pr** [Xe]4f³6s² Praseodymium	**60** 144.24 3 3347 1294 7.01 **Nd** [Xe]4f⁴6s² Neodymium	**61** (145) 3 3273 1315 7.26 **Pm** [Xe]4f⁵6s² Promethium	**62** 150.36 3,2 2067 1347 7.52 **Sm** [Xe]4f⁶6s² Samarium	**63** 151.964 3,2 1869 1095 5.24 **Eu** [Xe]4f⁷6s² Europium	**64** 157.25 3 3546 1586 7.90 **Gd** [Xe]4f⁷5d¹6s² Gadolinium	**65** 158.92534 3,4 3503 1629 8.23 **Tb** [Xe]4f⁹6s² Terbium	**66** 162.50 3 2840 1685 8.55 **Dy** [Xe]4f¹⁰6s² Dysprosium	**67** 164.9303 3 2973 1747 8.795 **Ho** [Xe]4f¹¹6s² Holmium	**68** 167.26 3 3140 1802 9.07 **Er** [Xe]4f¹²6s² Erbium	**69** 168.9342 3,2 2223 1818 9.32 **Tm** [Xe]4f¹³6s² Thulium	**70** 173.04 3,2 1469 1092 6.903 **Yb** [Xe]4f¹⁴6s² Ytterbium	**71** 174.967 3 3675 1936 9.841 **Lu** [Xe]4f¹⁴5d¹6s² Lutetium
★★	**90** 232.0381 4 5061 2023 11.72 **Th** [Rn]6d²7s² Thorium	**91** 231.0359 5,4 4300* 1845 15.4* **Pa** [Rn]5f²6d¹7s² Protactinium	**92** 238.0289 6,5,4,3,2 4404 1408 18.95 **U** [Rn]5f³6d¹7s² Uranium	**93** (237) 5,6,4,3 4175* 917 20.2 **Np** [Rn]5f⁴6d¹7s² Neptunium	**94** (244) 4,6,5,3 3505 913 19.84 **Pu** [Rn]5f⁶7s² Plutonium	**95** (243) 3,6,5,4,2 2284 1449 13.7 **Am** [Rn]5f⁷7s² Americium	**96** (247) 3 — 1620 13.5* **Cm** [Rn]5f⁷6d¹7s² Curium	**97** (247) 3,4 — — 14* **Bk** [Rn]5f⁹7s² Berkelium	**98** (251) 3,4 — 1170* — **Cf** [Rn]5f¹⁰7s² Californium	**99** (252) 3 — 1130* — **Es** [Rn]5f¹¹7s² Einsteinium	**100** (257) 3 — 1800* — **Fm** [Rn]5f¹²7s² Fermium	**101** (258) 3 — 1100* — **Md** [Rn]5f¹³7s² Mendelevium	**102** (259) 2,3 — 1100* — **No** [Rn]5f¹⁴7s² Nobelium	**103** (262) 3 — 1900* — **Lr** [Rn]5f¹⁴6d¹7s² Lawrencium

NOTES:

(1) Black — solid. Red — gas. Blue — liquid. Outline — synthetically prepared.

(2) Based upon carbon-12. ( ) indicates most stable or best known isotope.

(3) Entries marked with daggers refer to the gaseous state at 273 K and 1 atm and are given in units of g/l.

The A & B subgroup designations, are those recommended by the International Union of Pure and Applied Chemistry.

IUPAC Periodic Table of the Elements

1																	18
1 **H** hydrogen [1.007, 1.009]	2		Key:									13	14	15	16	17	2 **He** helium 4.003
3 **Li** lithium [6.938, 6.997]	4 **Be** beryllium 9.012		atomic number **Symbol** **name** standard atomic weight									5 **B** boron [10.80, 10.83]	6 **C** carbon [12.00, 12.02]	7 **N** nitrogen [14.00, 14.01]	8 **O** oxygen [15.99, 16.00]	9 **F** fluorine 19.00	10 **Ne** neon 20.18
11 **Na** sodium 22.99	12 **Mg** magnesium [24.30, 24.31]	3	4	5	6	7	8	9	10	11	12	13 **Al** aluminium 26.98	14 **Si** silicon [28.08, 28.09]	15 **P** phosphorus 30.97	16 **S** sulfur [32.05, 32.08]	17 **Cl** chlorine [35.44, 35.46]	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(2)	31 **Ga** gallium 69.72	32 **Ge** germanium 72.63	33 **As** arsenic 74.92	34 **Se** selenium 78.96(3)	35 **Br** bromine [79.90, 79.91]	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(2)	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 lanthanoids	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 [204.3, 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 actinoids	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		

57 **La** lanthanum 138.9	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
89 **Ac** actinium	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

Notes

- IUPAC 2011 Standard atomic weights abridged to four significant digits (Table 4 published in *Pure Appl. Chem.* 85, 1047-1078 (2013); http://dx.doi.org/10.1351/PAC-REP-13-03-02. The uncertainty in the last digit of the standard atomic weight value is listed in parentheses following the value. In the absence of parentheses, the uncertainty is one in that last digit. An interval in square brackets provides the lower and upper bounds of the standard atomic weight for that element. No values are listed for elements which lack isotopes with a characteristic isotopic abundance in natural terrestrial samples. See PAC for more details.
- "Aluminum" and "cesium" are commonly used alternative spellings for "aluminium" and "caesium."
- Claims for the discovery of all the remaining elements in the last row of the Table, namely elements with atomic numbers 113, 115, 117 and 118, and for which no assignments have yet been made, are being considered by a IUPAC and IUPAP Joint Working Party.

For updates to this table, see iupac.org/reports/periodic_table/. This version is dated 1 May 2013.

INTERNATIONAL UNION OF
PURE AND APPLIED CHEMISTRY

MATERIAL SAFETY DATA SHEET

1. Product and Company Identification

Material name	**HYDROCHLORIC ACID**
Version #	11
Revision date	01-17-2012
CAS #	Mixture
Product Codes	**J.T.Baker: 5367, 5537, 5800, 5814, 5821, 5861, 5862, 6900, 9165, 9529, 9530, 9534, 9535, 9536, 9537, 9538, 9539, 9543, 9544, 9548, 9551, 9555, 9625** **Macron: 2062, 20620, 2515, 25496, 2612, 2624, 2626, 37825, 3861, 5587, H611, H613, H616, H987, H999, IM2612, V001, V078, V187, V226**
Synonym(s)	Muriatic acid * hydrogen chloride, aqueous
Manufacturer	Avantor Performance Materials, Inc.
Address	3477 Corporate Parkway Suite #200 Center Valley, PA 18034 US
Customer Service	855-282-6867
24 Hour Emergency	908-859-2151
Chemtrec	800-424-9300

2. Hazards Identification

Emergency overview	DANGER Corrosive. Causes severe skin and eye burns. Causes digestive tract burns. Mist or vapor extremely irritating to eyes and respiratory tract.
OSHA regulatory status	This product is considered hazardous under 29 CFR 1910.1200 (Hazard Communication).
Potential health effects	
Routes of exposure	Ingestion. Inhalation. Skin contact. Eye contact.
Eyes	Corrosive. Causes severe eye burns. Vapor or spray may cause eye damage, impaired sight or blindness.
Skin	Corrosive. Causes severe skin burns.
Inhalation	Corrosive. May cause damage to mucous membranes in nose, throat, lungs and bronchial system.
Ingestion	Corrosive. Ingestion may produce burns to the lips, oral cavity, upper airway, esophagus and possibly the digestive tract.
Target organs	Eyes. Skin. Lungs. Respiratory system.
Chronic effects	Corrosive. Prolonged contact causes serious tissue damage.
Potential environmental effects	The product may affect the acidity (pH-factor) in water with risk of harmful effects to aquatic organisms.

3. Composition / Information on Ingredients

Hazardous components	CAS #	Percent
HYDROCHLORIC ACID	7647-01-0	20 - 40
Non-hazardous components	**CAS #**	**Percent**
WATER	7732-18-5	60 - 80

4. First Aid Measures

First aid procedures

Eye contact	Immediately flush with plenty of water for at least 15 minutes. If easy to do, remove contact lenses. Call a physician or poison control center immediately. In case of irritation from airborne exposure, move to fresh air. Get medical attention immediately.
Skin contact	Immediately flush with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Call a physician or poison control center immediately. Wash clothing separately before reuse. Destroy or thoroughly clean contaminated shoes.
Inhalation	Move to fresh air. If breathing stops, provide artificial respiration. If breathing is difficult, give oxygen. Call a physician or poison control center immediately.
Ingestion	Call a physician or poison control center immediately. Do not induce vomiting. If vomiting occurs, the head should be kept low so that stomach vomit doesn't enter the lungs.
Notes to physician	Keep victim under observation. Treat symptomatically.
General advice	In the case of accident or if you feel unwell, seek medical advice immediately (show the label where possible). Show this safety data sheet to the doctor in attendance. Ensure that medical personnel are aware of the material(s) involved, and take precautions to protect themselves.

5. Fire Fighting Measures

Flammable properties	The product is not flammable. No unusual fire or explosion hazards noted.

Extinguishing media

Suitable extinguishing media	Water. Carbon dioxide (CO2). Dry chemical powder. Foam.
Unsuitable extinguishing media	None known.

Protection of firefighters

Specific hazards arising from the chemical	Fire may produce irritating, corrosive and/or toxic gases.
Protective equipment and precautions for firefighters	Use water spray to cool unopened containers. Self-contained breathing apparatus and full protective clothing must be worn in case of fire. Cool containers exposed to flames with water until well after the fire is out.
Special protective equipment for fire-fighters	Wear full protective clothing, including helmet, self-contained positive pressure or pressure demand breathing apparatus, protective clothing and face mask. Wear self-contained breathing apparatus with a full facepiece operated in the positive pressure demand mode when fighting fires.
Specific methods	In the event of fire and/or explosion do not breathe fumes.

6. Accidental Release Measures

Personal precautions	Wear appropriate protective equipment and clothing during clean-up. Keep upwind. Keep out of low areas. Ventilate closed spaces before entering them. Local authorities should be advised if significant spillages cannot be contained.
Environmental precautions	Prevent further leakage or spillage if safe to do so. Avoid discharge into drains, water courses or onto the ground.
Methods for containment	Stop the flow of material, if this is without risk. Dike the spilled material, where this is possible. Prevent entry into waterways, sewer, basements or confined areas.

Methods for cleaning up

Large Spills: Dike far ahead of spill for later disposal. Use a non-combustible material like vermiculite, sand or earth to soak up the product and place into a container for later disposal.

Small Spills: Wipe up with absorbent material (e.g. cloth, fleece). Clean surface thoroughly to remove residual contamination.

Never return spills in original containers for re-use. Clean up in accordance with all applicable regulations. Neutralize spill area and washings with soda ash or lime. Collect in a non-combustible container for prompt disposal.

J. T. Baker NEUTRASORB® acid neutralizers are recommended for spills of this product.

7. Handling and Storage

Handling

Do not get in eyes, on skin, on clothing. Do not taste or swallow. Wash thoroughly after handling. Do not eat, drink or smoke when using the product. Use caution when combining with water; DO NOT add water to acid, ALWAYS add acid to water while stirring to prevent release of heat, steam and fumes.

Storage

Do not store in metal containers. Keep tightly closed in a dry, cool and well-ventilated place.

8. Exposure Controls / Personal Protection

ACGIH

Components	Type	Value
HYDROCHLORIC ACID (7647-01-0)	Ceiling	2.0000 ppm

Occupational exposure limits

U.S. - OSHA

Components	Type	Value
HYDROCHLORIC ACID (7647-01-0)	Ceiling	5.0000 ppm 7.0000 mg/m3

Engineering controls

Good general ventilation (typically 10 air changes per hour) should be used. Ventilation rates should be matched to conditions. If applicable, use process enclosures, local exhaust ventilation, or other engineering controls to maintain airborne levels below recommended exposure limits. If exposure limits have not been established, maintain airborne levels to an acceptable level.

Personal protective equipment

Eye / face protection

Wear safety glasses with side shields (or goggles) and a face shield.

Skin protection

Wear appropriate chemical resistant clothing. Wear appropriate chemical resistant gloves.

Respiratory protection

If engineering controls do not maintain airborne concentrations below recommended exposure limits (where applicable) or to an acceptable level (in countries where exposure limits have not been established), an approved respirator must be worn. Respirator type: Chemical respirator with acid gas cartridge.

General hygeine considerations

Provide eyewash station and safety shower. Always observe good personal hygiene measures, such as washing after handling the material and before eating, drinking, and/or smoking. Routinely wash work clothing and protective equipment to remove contaminants.

General

Wear chemical protective equipment that is specifically recommended by the manufacturer. Launder contaminated clothing before reuse.

9. Physical & Chemical Properties

Appearance Clear.

Color Colorless.

Odor Pungent.

Odor threshold Not available.

Physical state Liquid.

Form Liquid.

pH	0.1 (1.0 N Solution)
Melting point	-14.8 - -61.6 °F (-26 - -52 °C)
Freezing point	-14.8 - -61.6 °F (-26 - -52 °C)
Boiling point	118.4 - 194 °F (48 - 90 °C)
Flash point	Not available.
Evaporation rate	Not available.
Flammability limits in air, upper, % by volume	Not available.
Flammability limits in air, lower, % by volume	Not available.
Vapor pressure	2.13 - 28.3 kPa
Vapor density	Not available.
Specific gravity	1.149 - 1.189
Relative density	Not available.
Solubility (water)	Not available.
Partition coefficient (n-octanol/water)	Not available
Auto-ignition temperature	Not available.
Decomposition temperature	Not available.
Molecular formula	HCl

10. Chemical Stability & Reactivity Information

Chemical stability	Material is stable under normal conditions.
Conditions to avoid	Reacts violently with strong alkaline substances. This product may react with reducing agents. Do not mix with other chemicals. This product may react with oxidizing agents. Unsuitable containers: metals.
Incompatible materials	Incompatible with bases. Metals. Oxidizing agents. Acids. Amines. Reducing agents.
Hazardous decomposition products	Hydrogen chloride. Chlorine. May decompose upon heating to produce corrosive and/or toxic fumes.
Possibility of hazardous reactions	Hazardous polymerization does not occur.

11. Toxicological Information

Toxicological data

Product	Test Results
HYDROCHLORIC ACID (Mixture)	Acute Inhalation LC50 Rat: 9188 mg/l estimated
	Acute Oral LD50 Rat: 581 mg/kg
Components	**Test Results**
HYDROCHLORIC ACID (7647-01-0)	Acute Inhalation LC50 Rat: 3124 mg/l 1.00 Hours
	Acute Oral LD50 Rat: 238 - 277 mg/kg

Sensitization	Not a skin sensitizer.
Local effects	Causes severe burns.
Chronic effects	Corrosive. Prolonged contact causes serious tissue damage.
Carcinogenicity	This product is not considered to be a carcinogen by IARC, ACGIH, NTP, or OSHA.

ACGIH Carcinogens

HYDROCHLORIC ACID (CAS 7647-01-0)	A4 Not classifiable as a human carcinogen.

IARC Monographs. Overall Evaluation of Carcinogenicity

HYDROCHLORIC ACID (CAS 7647-01-0)	3 Not classifiable as to carcinogenicity to humans.

Skin corrosion/irritation	Corrosive to skin and eyes.
Epidemiology	No epidemiological data is available for this product.
Mutagenicity	No data available to indicate product or any components present at greater than 0.1% are mutagenic or genotoxic.
Neurological effects	No data available for this product.
Reproductive effects	Contains no ingredient listed as toxic to reproduction
Teratogenicity	No data available to indicate product or any components present at greater than 0.1% may cause birth defects.
Symptoms and target organs	Corrosive effects.
Further information	Danger of very serious irreversible effects. Symptoms may be delayed.

12. Ecological Information

Ecotoxicological data

Product	**Test Results**
HYDROCHLORIC ACID (Mixture)	LC50 Fish: 829 mg/l 96.00 hours estimated
Components	**Test Results**
HYDROCHLORIC ACID (7647-01-0)	LC50 Western mosquitofish (Gambusia affinis): 282 mg/l 96.00 hours

Ecotoxicity	The product may affect the acidity (pH-factor) in water with risk of harmful effects to aquatic organisms.
Persistence and degradability	Expected to be readily biodegradable.
Partition coefficient (n-octanol/water)	Not available

13. Disposal Considerations

Waste codes	D002: Waste Corrosive material [pH <=2 or =>12.5, or corrosive to steel]
Disposal instructions	Dispose of this material and its container to hazardous or special waste collection point. Incinerate the material under controlled conditions in an approved incinerator. All wastes must be handled in accordance with local, state and federal regulations.
Contaminated packaging	Since emptied containers retain product residue, follow label warnings even after container is emptied. Offer rinsed packaging material to local recycling facilities.

14. Transport Information

DOT

Basic shipping requirements:

UN number	UN1789
Proper shipping name	Hydrochloric acid
Hazard class	8
Packing group	II

Additional information:

Special provisions	A3, A6, B3, B15, IB2, N41, T8, TP2, TP12

Basic shipping requirements:

Labels required	8

Additional information:

Packaging exceptions	154
Packaging non bulk	202
Packaging bulk	242
ERG number	157

IATA

Basic shipping requirements:

UN number	1789
Proper shipping name	Hydrochloric acid
Hazard class	8
Packing group	II
Additional information:	
ERG code	8L

IMDG

Basic shipping requirements:

UN number	1789
Proper shipping name	HYDROCHLORIC ACID
Hazard class	8
Packing group	II

DOT

IATA

IMDG

15. Regulatory Information

US federal regulations

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.
All components are on the U.S. EPA TSCA Inventory List.

US EPCRA (SARA Title III) Section 302 - Extremely Hazardous Spill: Reportable quantity

HYDROCHLORIC ACID (CAS 7647-01-0)	5000 LBS

US EPCRA (SARA Title III) Section 302 - Extremely Hazardous Substance: Threshold Planning Quantity

HYDROCHLORIC ACID (CAS 7647-01-0)	500 LBS

US EPCRA (SARA Title III) Section 313 - Toxic Chemical: De minimis concentration

HYDROCHLORIC ACID (CAS 7647-01-0)	1.0 %

US EPCRA (SARA Title III) Section 313 - Toxic Chemical: Listed substance

HYDROCHLORIC ACID (CAS 7647-01-0)	Listed.

CERCLA (Superfund) reportable quantity

HYDROCHLORIC ACID: 5000.0000

Superfund Amendments and Reauthorization Act of 1986 (SARA)

Hazard categories	Immediate Hazard - Yes Delayed Hazard - No Fire Hazard - No Pressure Hazard - No Reactivity Hazard - No
Section 311 hazardous chemical	Yes

Inventory status

Country(s) or region	Inventory name	On inventory (yes/no)*
Australia	Australian Inventory of Chemical Substances (AICS)	Yes
Canada	Domestic Substances List (DSL)	Yes
Canada	Non-Domestic Substances List (NDSL)	No
China	Inventory of Existing Chemical Substances in China (IECSC)	Yes

Country(s) or region	Inventory name	On inventory (yes/no)*
Europe	European Inventory of Existing Commercial Chemical Substances (EINECS)	Yes
Europe	European List of Notified Chemical Substances (ELINCS)	No
Japan	Inventory of Existing and New Chemical Substances (ENCS)	Yes
Korea	Existing Chemicals List (ECL)	Yes
New Zealand	New Zealand Inventory	Yes
Philippines	Philippine Inventory of Chemicals and Chemical Substances (PICCS)	Yes
United States & Puerto Rico	Toxic Substances Control Act (TSCA) Inventory	Yes

*A "Yes" indicates that all components of this product comply with the inventory requirements administered by the governing country(s)

State regulations

This product does not contain a chemical known to the State of California to cause cancer, birth defects or other reproductive harm.

US - New Jersey Community RTK (EHS Survey): Reportable threshold

HYDROCHLORIC ACID (CAS 7647-01-0) 500 LBS

US - Pennsylvania RTK - Hazardous Substances: Listed substance

HYDROCHLORIC ACID (CAS 7647-01-0) Listed.

Saf-T-Data

Health: 3 - Severe (Poison)
Flammability: 0 - None
Reactivity: 1 - Slight
Contact: 4 - Extreme (Corrosive)
Lab Protective Equip: D - GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES
Storage Color Code: W - White (Corrosive)

16. Labeling Info

Label Hazard Warning

DANGER

Corrosive. Causes severe skin and eye burns. Causes digestive tract burns. Mist or vapor extremely irritating to eyes and respiratory tract.

Label Precautions

Do not breathe mist or vapor. Do not get in eyes, on skin, or on clothing. Use only with adequate ventilation. Keep container closed. Wash thoroughly after handling.

Label First Aid

Immediately flush eyes with plenty of water for at least 15 minutes. Immediately flush skin with plenty of water. If gas/fume/vapor/dust/mist from the material is inhaled, remove the affected person immediately to fresh air. Get medical attention immediately. IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician. Do not induce vomiting without advice from poison control center. If vomiting occurs, keep head low so that stomach content doesn't get into the lungs. Do not use mouth-to-mouth method if victim ingested the substance.

17. Other Information

NFPA ratings

Health: 3
Flammability: 0
Instability: 1

Disclaimer

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Issue date

01-17-2012

Material Safety Data Sheet

Version 5.0
Revision Date 04/27/2012
Print Date 10/23/2013

1. PRODUCT AND COMPANY IDENTIFICATION

Product name	:	Benzene
Product Number	:	12540
Brand	:	Fluka
Supplier	:	Sigma-Aldrich 3050 Spruce Street SAINT LOUIS MO 63103 USA
Telephone	:	+1 800-325-5832
Fax	:	+1 800-325-5052
Emergency Phone # (For both supplier and manufacturer)	:	(314) 776-6555
Preparation Information	:	Sigma-Aldrich Corporation Product Safety - Americas Region 1-800-521-8956

2. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards
Flammable liquid, Target Organ Effect, Irritant, Carcinogen, Mutagen

Target Organs

Blood, Eyes, Female reproductive system., Bone marrowBlood, Eyes, Female reproductive system., Bone marrow

GHS Classification
Flammable liquids (Category 2)
Acute toxicity, Oral (Category 5)
Skin irritation (Category 2)
Eye irritation (Category 2A)
Germ cell mutagenicity (Category 1B)
Carcinogenicity (Category 1A)
Aspiration hazard (Category 1)
Acute aquatic toxicity (Category 2)

GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)

H225	Highly flammable liquid and vapour.
H303	May be harmful if swallowed.
H304	May be fatal if swallowed and enters airways.
H315	Causes skin irritation.
H319	Causes serious eye irritation.
H340	May cause genetic defects.
H350	May cause cancer.
H401	Toxic to aquatic life.

Precautionary statement(s)

P201	Obtain special instructions before use.
P210	Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
P301 + P310	IF SWALLOWED: Immediately call a POISON CENTER or doctor/ physician.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P308 + P313	IF exposed or concerned: Get medical advice/ attention.
P331	Do NOT induce vomiting.

HMIS Classification

Health hazard:	2
Chronic Health Hazard:	*
Flammability:	3
Physical hazards:	0

NFPA Rating

Health hazard:	2
Fire:	3
Reactivity Hazard:	0

Potential Health Effects

Inhalation	May be harmful if inhaled. Causes respiratory tract irritation.
Skin	May be harmful if absorbed through skin. Causes skin irritation.
Eyes	Causes eye irritation.
Ingestion	May be harmful if swallowed. Aspiration hazard if swallowed - can enter lungs and cause damage.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Formula : C_6H_6

Molecular Weight : 78.11 g/mol

Component		Concentration
Benzene		
CAS-No.	71-43-2	-
EC-No.	200-753-7	
Index-No.	601-020-00-8	
Registration number	01-2119447106-44-XXXX	

4. FIRST AID MEASURES

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Wash off with soap and plenty of water. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIREFIGHTING MEASURES

Conditions of flammability
Flammable in the presence of a source of ignition when the temperature is above the flash point. Keep away from heat/sparks/open flame/hot surface. No smoking.

Suitable extinguishing media
Use water spray, alcohol-resistant foam, dry chemical or carbon dioxide.

Specific hazards arising from the chemical
Flash back possible over considerable distance. Container explosion may occur under fire conditions.

Special protective equipment for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

Hazardous combustion products
Hazardous decomposition products formed under fire conditions. - Carbon oxides

Further information
Use water spray to cool unopened containers.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Use personal protective equipment. Avoid breathing vapors, mist or gas. Ensure adequate ventilation. Remove all sources of ignition. Evacuate personnel to safe areas. Beware of vapours accumulating to form explosive concentrations. Vapours can accumulate in low areas.

Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains. Discharge into the environment must be avoided.

Methods and materials for containment and cleaning up
Contain spillage, and then collect with an electrically protected vacuum cleaner or by wet-brushing and place in container for disposal according to local regulations (see section 13).

7. HANDLING AND STORAGE

Precautions for safe handling
Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.
Use explosion-proof equipment. Keep away from sources of ignition - No smoking. Take measures to prevent the build up of electrostatic charge.

Conditions for safe storage
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

Components	CAS-No.	Value	Control parameters	Basis
Benzene	71-43-2	TWA	0.5 ppm	USA. ACGIH Threshold Limit Values (TLV)
Remarks	Leukemia Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Confirmed human carcinogen Danger of cutaneous absorption			
		STEL	2.5 ppm	USA. ACGIH Threshold Limit Values (TLV)
	Leukemia Substances for which there is a Biological Exposure Index or Indices (see BEI® section) Confirmed human carcinogen Danger of cutaneous absorption			
		TWA	10 ppm	USA. Occupational Exposure Limits (OSHA) - Table Z2
	Z37.40-1969			
		CEIL	25 ppm	USA. Occupational Exposure Limits (OSHA) - Table Z2
	Z37.40-1969			
		Peak	50 ppm	USA. Occupational Exposure Limits (OSHA) - Table Z2

	Z37.40-1969			
	See 1910.1028. See Table Z-2 for the limits applicable in the operations or sectors excluded in 1910.1028 The final benzene standard in 1910.1028 applies to all occupational exposures to benzene except some subsegments of industry where exposures are consistently under the action level (i.e., distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures); for the excepted subsegments, the benzene limits in Table Z-2 apply.			
		TWA	0.1 ppm	USA. NIOSH Recommended Exposure Limits
	Potential Occupational Carcinogen See Appendix A			
		ST	1 ppm	USA. NIOSH Recommended Exposure Limits
	Potential Occupational Carcinogen See Appendix A			

Personal protective equipment

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Immersion protection
Material: Fluorinated rubber
Minimum layer thickness: 0.7 mm
Break through time: > 480 min
Material tested:Vitoject® (Aldrich Z677698, Size M)

Splash protection
Material: Fluorinated rubber
Minimum layer thickness: 0.7 mm
Break through time: > 30 min
Material tested:Vitoject® (Aldrich Z677698, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 873000, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an Industrial Hygienist familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Eye protection
Face shield and safety glasses Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin and body protection
Complete suit protecting against chemicals, Flame retardant antistatic protective clothing, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Hygiene measures
Handle in accordance with good industrial hygiene and safety practice. Wash hands before breaks and at the end of workday.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance

Form	liquid
Colour	colourless

Safety data

pH	no data available
Melting point/freezing point	Melting point/range: 5.5 °C (41.9 °F)
Boiling point	80 °C (176 °F)
Flash point	-11.0 °C (12.2 °F) - closed cup
Ignition temperature	562 °C (1,044 °F)
Autoignition temperature	562.0 °C (1,043.6 °F)
Lower explosion limit	1.3 %(V)
Upper explosion limit	8 %(V)
Vapour pressure	221.3 hPa (166.0 mmHg) at 37.7 °C (99.9 °F) 99.5 hPa (74.6 mmHg) at 20.0 °C (68.0 °F)
Density	0.874 g/mL at 25 °C (77 °F)
Water solubility	no data available
Partition coefficient: n-octanol/water	no data available
Relative vapour density	no data available
Odour	no data available
Odour Threshold	no data available
Evaporation rate	no data available

10. STABILITY AND REACTIVITY

Chemical stability
Stable under recommended storage conditions.

Possibility of hazardous reactions

Vapours may form explosive mixture with air.

Conditions to avoid
Heat, flames and sparks. Extremes of temperature and direct sunlight.

Materials to avoid
acids, Bases, Halogens, Strong oxidizing agents, Metallic salts

Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Carbon oxides
Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Oral LD50
LD50 Oral - rat - 2,990 mg/kg

Inhalation LC50
LC50 Inhalation - rat - female - 4 h - 44,700 mg/m3

Dermal LD50
LD50 Dermal - rabbit - 8,263 mg/kg

Other information on acute toxicity
no data available

Skin corrosion/irritation
Skin - rabbit - Skin irritation

Serious eye damage/eye irritation
Eyes - rabbit - Eye irritation

Respiratory or skin sensitization
no data available

Germ cell mutagenicity
Laboratory experiments have shown mutagenic effects.
In vivo tests showed mutagenic effects

Genotoxicity in vitro - Human - lymphocyte
Sister chromatid exchange

Genotoxicity in vitro - mouse - lymphocyte
Mutation in mammalian somatic cells.

Genotoxicity in vivo - mouse - Inhalation
Sister chromatid exchange

Carcinogenicity

Carcinogenicity - Human - male - Inhalation
Tumorigenic:Carcinogenic by RTECS criteria. Leukaemia Blood:Thrombocytopenia.

Carcinogenicity - rat - Oral
Tumorigenic:Carcinogenic by RTECS criteria. Endocrine:Tumors. Leukaemia

This is or contains a component that has been reported to be carcinogenic based on its IARC, OSHA, ACGIH, NTP, or EPA classification.

Human carcinogen.

IARC:	1 - Group 1: Carcinogenic to humans (Benzene)
NTP:	Known to be human carcinogen (Benzene)

Reproductive toxicity
Reproductive toxicity - mouse - Intraperitoneal
Effects on Fertility: Pre-implantation mortality (e.g., reduction in number of implants per female; total number of implants per corpora lutea). Effects on Embryo or Fetus: Fetal death.

Teratogenicity

Developmental Toxicity - rat - Inhalation
Effects on Embryo or Fetus: Extra embryonic structures (e.g., placenta, umbilical cord). Effects on Embryo or Fetus: Fetotoxicity (except death, e.g., stunted fetus).

Developmental Toxicity - mouse - Inhalation
Effects on Embryo or Fetus: Cytological changes (including somatic cell genetic material). Specific Developmental Abnormalities: Blood and lymphatic system (including spleen and marrow).

Specific target organ toxicity - single exposure (Globally Harmonized System)
no data available

Specific target organ toxicity - repeated exposure (Globally Harmonized System)
no data available

Aspiration hazard
May be fatal if swallowed and enters airways.

Potential health effects

Inhalation	May be harmful if inhaled. Causes respiratory tract irritation.
Ingestion	May be harmful if swallowed. Aspiration hazard if swallowed - can enter lungs and cause

damage.

Skin	May be harmful if absorbed through skin. Causes skin irritation.
Eyes	Causes eye irritation.

Signs and Symptoms of Exposure
Nausea, Dizziness, Headache, narcosis, Inhalation of high concentrations of benzene may have an initial stimulatory effect on the central nervous system characterized by exhilaration, nervous excitation and/or giddiness, depression, drowsiness, or fatigue. The victim may experience tightness in the chest, breathlessness, and loss of consciousness. Tremors, convulsions, and death due to respiratory paralysis or circulatory collapse can occur in a few minutes to several hours following severe exposures. Aspiration of small amounts of liquid immediately causes pulmonary edema and hemorrhage of pulmonary tissue. Direct skin contact may cause erythema. Repeated or prolonged skin contact may result in drying, scaling dermatitis, or development of secondary skin infections. The chief target organ is the hematopoietic system. Bleeding from the nose, gums, or mucous membranes and the development of purpuric spots, pancytopenia, leukopenia, thrombocytopenia, aplastic anemia, and leukemia may occur as the condition progresses. The bone marrow may appear normal, aplastic or hyperplastic, and may not correlate with peripheral blood-forming tissues. The onset of effects of prolonged benzene exposure may be delayed for many months or years after the actual exposure has ceased., Blood disorders

Synergistic effects
no data available

Additional Information
RTECS: CY1400000

12. ECOLOGICAL INFORMATION

Toxicity

Toxicity to fish	LC50 - Oncorhynchus mykiss (rainbow trout) - 5.90 mg/l - 96 h
	LC50 - Pimephales promelas (fathead minnow) - 15.00 - 32.00 mg/l - 96 h
	LC50 - Lepomis macrochirus (Bluegill) - 230.00 mg/l - 96 h
	NOEC - Pimephales promelas (fathead minnow) - 10.2 mg/l - 7 d
	LOEC - Pimephales promelas (fathead minnow) - 17.2 mg/l - 7 d
Toxicity to daphnia and other aquatic invertebrates	EC50 - Daphnia magna (Water flea) - 22.00 mg/l - 48 h
	EC50 - Daphnia magna (Water flea) - 9.20 mg/l - 48 h
Toxicity to algae	EC50 - Pseudokirchneriella subcapitata (green algae) - 29.00 mg/l - 72 h

Persistence and degradability

Biodegradability	Result: - Readily biodegradable.

Bioaccumulative potential

Bioaccumulation	Leuciscus idus (Golden orfe) - 3 d Bioconcentration factor (BCF): 10

Mobility in soil
no data available

PBT and vPvB assessment
no data available

Other adverse effects

An environmental hazard cannot be excluded in the event of unprofessional handling or disposal.

Toxic to aquatic life.

13. DISPOSAL CONSIDERATIONS

Product
Burn in a chemical incinerator equipped with an afterburner and scrubber but exert extra care in igniting as this material is highly flammable. Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 1114 Class: 3 Packing group: II
Proper shipping name: Benzene
Reportable Quantity (RQ): 10 lbs
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG
UN number: 1114 Class: 3 Packing group: II EMS-No: F-E, S-D
Proper shipping name: BENZENE
Marine pollutant: No

IATA
UN number: 1114 Class: 3 Packing group: II
Proper shipping name: Benzene

15. REGULATORY INFORMATION

OSHA Hazards
Flammable liquid, Target Organ Effect, Irritant, Carcinogen, Mutagen

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
The following components are subject to reporting levels established by SARA Title III, Section 313:

	CAS-No.	Revision Date
Benzene	71-43-2	2007-07-01

SARA 311/312 Hazards
Fire Hazard, Acute Health Hazard, Chronic Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Benzene	71-43-2	2007-07-01

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Benzene	71-43-2	2007-07-01

New Jersey Right To Know Components

	CAS-No.	Revision Date
Benzene	71-43-2	2007-07-01

California Prop. 65 Components

	CAS-No.	Revision Date
WARNING! This product contains a chemical known to the State of California to cause cancer. Benzene	71-43-2	2009-02-01

California Prop. 65 Components

	CAS-No.	Revision Date
WARNING! This product contains a chemical known to the State of California to cause birth defects or other reproductive harm. Benzene	71-43-2	2009-02-01

16. OTHER INFORMATION

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Material Safety Data Sheet

Version 5.2
Revision Date 02/05/2013
Print Date 10/22/2013

1. PRODUCT AND COMPANY IDENTIFICATION

Product name	:	Hydrochloric acid
Product Number	:	258148
Brand	:	Sigma-Aldrich
Supplier	:	Sigma-Aldrich 3050 Spruce Street SAINT LOUIS MO 63103 USA
Telephone	:	+1 800-325-5832
Fax	:	+1 800-325-5052
Emergency Phone # (For both supplier and manufacturer)	:	(314) 776-6555
Preparation Information	:	Sigma-Aldrich Corporation Product Safety - Americas Region 1-800-521-8956

2. HAZARDS IDENTIFICATION

Emergency Overview

OSHA Hazards
Toxic by inhalation., Harmful by ingestion., Corrosive

GHS Classification
Acute toxicity, Oral (Category 5)
Acute toxicity, Inhalation (Category 3)
Skin corrosion (Category 1B)
Serious eye damage (Category 1)
Specific target organ toxicity - single exposure (Category 3)

GHS Label elements, including precautionary statements

Pictogram

Signal word Danger

Hazard statement(s)

H303	May be harmful if swallowed.
H314	Causes severe skin burns and eye damage.
H331	Toxic if inhaled.
H335	May cause respiratory irritation.

Precautionary statement(s)

P261	Avoid breathing dust/ fume/ gas/ mist/ vapours/ spray.
P280	Wear protective gloves/ protective clothing/ eye protection/ face protection.
P305 + P351 + P338	IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.
P310	Immediately call a POISON CENTER or doctor/ physician.

HMIS Classification

Health hazard:	3
Flammability:	0
Physical hazards:	0

NFPA Rating

Health hazard:	3
Fire:	0
Reactivity Hazard:	0

Potential Health Effects

Inhalation	Toxic if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract.
Skin	Harmful if absorbed through skin. Causes skin burns.
Eyes	Causes eye burns.
Ingestion	Harmful if swallowed.

3. COMPOSITION/INFORMATION ON INGREDIENTS

Formula : HCl
Molecular Weight : 36.46 g/mol

Component		Classification	Concentration
Hydrochloric acid			
CAS-No. EC-No. Index-No.	7647-01-0 231-595-7 017-002-01-X	Skin Corr. 1B; STOT SE 3; H314, H335	30 - 50 %

For the full text of the H-Statements and R-Phrases mentioned in this Section, see Section 16

4. FIRST AID MEASURES

General advice
Consult a physician. Show this safety data sheet to the doctor in attendance.Move out of dangerous area.

If inhaled
If breathed in, move person into fresh air. If not breathing, give artificial respiration. Consult a physician.

In case of skin contact
Take off contaminated clothing and shoes immediately. Wash off with soap and plenty of water. Take victim immediately to hospital. Consult a physician.

In case of eye contact
Rinse thoroughly with plenty of water for at least 15 minutes and consult a physician.Continue rinsing eyes during transport to hospital.

If swallowed
Do NOT induce vomiting. Never give anything by mouth to an unconscious person. Rinse mouth with water. Consult a physician.

5. FIREFIGHTING MEASURES

Conditions of flammability
Not flammable or combustible.

Suitable extinguishing media
Use extinguishing measures that are appropriate to local circumstances and the surrounding environment.

Special protective equipment for firefighters
Wear self contained breathing apparatus for fire fighting if necessary.

Hazardous combustion products
Hazardous decomposition products formed under fire conditions. - Hydrogen chloride gas

Further information
The product itself does not burn.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions
Wear respiratory protection. Avoid breathing vapours, mist or gas. Ensure adequate ventilation. Evacuate personnel to safe areas.

Environmental precautions
Prevent further leakage or spillage if safe to do so. Do not let product enter drains.

Methods and materials for containment and cleaning up
Soak up with inert absorbent material and dispose of as hazardous waste. Keep in suitable, closed containers for disposal.

7. HANDLING AND STORAGE

Precautions for safe handling
Avoid contact with skin and eyes. Avoid inhalation of vapour or mist.

Conditions for safe storage
Keep container tightly closed in a dry and well-ventilated place. Containers which are opened must be carefully resealed and kept upright to prevent leakage.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Components with workplace control parameters

Components	CAS-No.	Value	Control parameters	Basis
Hydrochloric acid	7647-01-0	C	2 ppm	USA. ACGIH Threshold Limit Values (TLV)
Remarks	Upper Respiratory Tract irritation Not classifiable as a human carcinogen			
		C	5 ppm 7 mg/m3	USA. Occupational Exposure Limits (OSHA) - Table Z-1 Limits for Air Contaminants
	The value in mg/m3 is approximate. Ceiling limit is to be determined from breathing-zone air samples.			
		C	5 ppm 7 mg/m3	USA. OSHA - TABLE Z-1 Limits for Air Contaminants - 1910.1000
		C	5 ppm 7 mg/m3	USA. NIOSH Recommended Exposure Limits
	Often used in an aqueous solution.			

Personal protective equipment

Respiratory protection
Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Hand protection
Handle with gloves. Gloves must be inspected prior to use. Use proper glove removal technique (without touching glove's outer surface) to avoid skin contact with this product. Dispose of contaminated gloves after use in accordance with applicable laws and good laboratory practices. Wash and dry hands.

Full contact
Material: Nitrile rubber
Minimum layer thickness: 0.4 mm
Break through time: 480 min
Material tested:Camatril® (KCL 730 / Aldrich Z677442, Size M)

Splash contact
Material: Nitrile rubber
Minimum layer thickness: 0.11 mm
Break through time: 120 min

Material tested:Dermatril® (KCL 740 / Aldrich Z677272, Size M)

data source: KCL GmbH, D-36124 Eichenzell, phone +49 (0)6659 87300, e-mail sales@kcl.de, test method: EN374
If used in solution, or mixed with other substances, and under conditions which differ from EN 374, contact the supplier of the CE approved gloves. This recommendation is advisory only and must be evaluated by an industrial hygienist and safety officer familiar with the specific situation of anticipated use by our customers. It should not be construed as offering an approval for any specific use scenario.

Eye protection
Tightly fitting safety goggles. Faceshield (8-inch minimum). Use equipment for eye protection tested and approved under appropriate government standards such as NIOSH (US) or EN 166(EU).

Skin and body protection
Complete suit protecting against chemicals, The type of protective equipment must be selected according to the concentration and amount of the dangerous substance at the specific workplace.

Hygiene measures
Avoid contact with skin, eyes and clothing. Wash hands before breaks and immediately after handling the product.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance

Form	liquid
Colour	light yellow

Safety data

pH	no data available
Melting point/freezing point	-30 °C (-22 °F)
Boiling point	> 100 °C (> 212 °F) - lit.
Flash point	not applicable
Ignition temperature	no data available
Auto-ignition temperature	no data available
Lower explosion limit	no data available
Upper explosion limit	no data available
Vapour pressure	227 hPa (170 mmHg) at 21.1 °C (70.0 °F) 547 hPa (410 mmHg) at 37.7 °C (99.9 °F)
Density	1.2 g/cm3 at 25 °C (77 °F)
Water solubility	soluble
Partition coefficient: n-octanol/water	no data available
Viscosity, dynamic	2.3 mPa.s at 15 °C (59 °F)
Relative vapour density	no data available
Odour	pungent
Odour Threshold	no data available
Evapouration rate	no data available

10. STABILITY AND REACTIVITY

Chemical stability
Stable under recommended storage conditions.

Possibility of hazardous reactions
no data available

Conditions to avoid
no data available

Materials to avoid
Bases, Amines, Alkali metals, Metals, permanganates, e.g. potassium permanganate, Fluorine, metal acetylides, hexalithium disilicide

Hazardous decomposition products
Hazardous decomposition products formed under fire conditions. - Hydrogen chloride gas
Other decomposition products - no data available

11. TOXICOLOGICAL INFORMATION

Acute toxicity

Oral LD50
no data available (Hydrochloric acid)

Inhalation LC50
no data available

no data available (Hydrochloric acid)

Dermal LD50
no data available (Hydrochloric acid)

Other information on acute toxicity
no data available (Hydrochloric acid)

Skin corrosion/irritation
Skin - rabbit - Causes burns. (Hydrochloric acid)

Serious eye damage/eye irritation
Eyes - rabbit - Corrosive to eyes (Hydrochloric acid)

Respiratory or skin sensitisation
no data available (Hydrochloric acid)

Germ cell mutagenicity
(Hydrochloric acid)
no data available (Hydrochloric acid)
(Hydrochloric acid)

Carcinogenicity

This product is or contains a component that is not classifiable as to its carcinogenicity based on its IARC, ACGIH, NTP, or EPA classification. (Hydrochloric acid)

(Hydrochloric acid)

(Hydrochloric acid)

IARC:	3 - Group 3: Not classifiable as to its carcinogenicity to humans (Hydrochloric acid)
NTP:	No component of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP.
OSHA:	No component of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA.

Reproductive toxicity

(Hydrochloric acid)

no data available (Hydrochloric acid)

(Hydrochloric acid)

Teratogenicity

(Hydrochloric acid)

(Hydrochloric acid)

no data available (Hydrochloric acid)

Specific target organ toxicity - single exposure (Globally Harmonized System)
The substance or mixture is classified as specific target organ toxicant, single exposure, category 3 with respiratory tract irritation. (Hydrochloric acid)

Specific target organ toxicity - repeated exposure (Globally Harmonized System)
no data available

Aspiration hazard
no data available (Hydrochloric acid)

Potential health effects

Inhalation	Toxic if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract.
Ingestion	Harmful if swallowed.
Skin	Harmful if absorbed through skin. Causes skin burns.
Eyes	Causes eye burns.

Signs and Symptoms of Exposure
burning sensation, Cough, wheezing, laryngitis, Shortness of breath, spasm, inflammation and edema of the larynx, spasm, inflammation and edema of the bronchi, pneumonitis, pulmonary edema, Material is extremely destructive to tissue of the mucous membranes and upper respiratory tract, eyes, and skin. (Hydrochloric acid)

Synergistic effects
no data available

Additional Information
RTECS: MW4025000

12. ECOLOGICAL INFORMATION

Toxicity

Toxicity to fish	LC50 - Gambusia affinis (Mosquito fish) - 282 mg/l - 96 h (Hydrochloric acid)

Persistence and degradability
no data available

Bioaccumulative potential
no data available

Mobility in soil
no data available (Hydrochloric acid)

PBT and vPvB assessment
no data available

Other adverse effects

no data available

13. DISPOSAL CONSIDERATIONS

Product
Offer surplus and non-recyclable solutions to a licensed disposal company. Contact a licensed professional waste disposal service to dispose of this material. Dissolve or mix the material with a combustible solvent and burn in a chemical incinerator equipped with an afterburner and scrubber.

Contaminated packaging
Dispose of as unused product.

14. TRANSPORT INFORMATION

DOT (US)
UN number: 1789 Class: 8 Packing group: II
Proper shipping name: Hydrochloric acid

Reportable Quantity (RQ): 13514 lbs
Marine pollutant: No
Poison Inhalation Hazard: No

IMDG
UN number: 1789 Class: 8 Packing group: II EMS-No: F-A, S-B
Proper shipping name: HYDROCHLORIC ACID
Marine pollutant: No

IATA
UN number: 1789 Class: 8 Packing group: II
Proper shipping name: Hydrochloric acid

15. REGULATORY INFORMATION

OSHA Hazards
Toxic by inhalation., Harmful by ingestion., Corrosive

SARA 302 Components
SARA 302: No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

SARA 313 Components
The following components are subject to reporting levels established by SARA Title III, Section 313:

	CAS-No.	Revision Date
Hydrochloric acid	7647-01-0	1993-04-24

SARA 311/312 Hazards
Acute Health Hazard

Massachusetts Right To Know Components

	CAS-No.	Revision Date
Hydrochloric acid	7647-01-0	1993-04-24

Pennsylvania Right To Know Components

	CAS-No.	Revision Date
Water	7732-18-5	
Hydrochloric acid	7647-01-0	1993-04-24

New Jersey Right To Know Components

	CAS-No.	Revision Date
Water	7732-18-5	
Hydrochloric acid	7647-01-0	1993-04-24

California Prop. 65 Components
This product does not contain any chemicals known to State of California to cause cancer, birth defects, or any other reproductive harm.

16. OTHER INFORMATION

Text of H-code(s) and R-phrase(s) mentioned in Section 3

H314	Causes severe skin burns and eye damage.
H335	May cause respiratory irritation.
Skin Corr.	Skin corrosion
STOT SE	Specific target organ toxicity - single exposure

Further information

The above information is believed to be correct but does not purport to be all inclusive and shall be used only as a guide. The information in this document is based on the present state of our knowledge and is applicable to the product with regard to appropriate safety precautions. It does not represent any guarantee of the properties of the product. Sigma-Aldrich Corporation and its Affiliates shall not be held liable for any damage resulting from handling or from contact with the above product. See www.sigma-aldrich.com and/or the reverse side of invoice or packing slip for additional terms and conditions of sale.

Hazard Communication Standard Pictograms and Hazards

Health Hazard	Flame	Exclamation Mark
		
• Carcinogen • Mutagenicity • Reproductive Toxicity • Respiratory Sensitizer • Target Organ Toxicity • Aspiration Toxicity	• Flammables • Pyrophorics • Self-Heating • Emits Flammable Gas • Self-Reactives • Organic Peroxides	• Irritant (skin and eye) • Skin Sensitizer • Acute Toxicity • Narcotic Effects • Respiratory Tract Irritant • Hazardous to Ozone Layer (Non-Mandatory)
Gas Cylinder	**Corrosion**	**Exploding Bomb**
		
• Gases Under Pressure	• Skin Corrosion/Burns • Eye Damage • Corrosive to Metals	• Explosives • Self-Reactives • Organic Peroxides
Flame Over Circle	**Environment** (Non-Mandatory)	**Skull and Crossbones**
		
• Oxidizers	• Aquatic Toxicity	• Acute Toxicity (fatal or toxic)

https://www.osha.gov/Publications/HazComm_QuickCard_Pictogram.html

GHS-Safety Data Sheet requirement:
https://www.osha.gov/dsg/hazcom/hazcom-appendix-d.html

APPENDIX D TO §1910.1200 - SAFETY DATA SHEETS (MANDATORY)

A safety data sheet (SDS) shall include the information specified in Table D.1 under the section number and heading indicated for sections 1-11 and 16. If no relevant information is found for any given subheading within a section, the SDS shall clearly indicate that no applicable information is available. Sections 12-15 may be included in the SDS, but are not mandatory.

Table D.1. Minimum Information for an SDS

	Heading	Subheading
1.	**Identification**	(a) Product identifier used on the label; (b) Other means of identification; (c) Recommended use of the chemical and restrictions on use; (d) Name, address, and telephone number of the chemical manufacturer, importer, or other responsible party; (e) Emergency phone number.
2.	**Hazard(s) identification**	(a) Classification of the chemical in accordance with paragraph (d) of §1910.1200; (b) Signal word, hazard statement(s), symbol(s) and precautionary statement(s) in accordance with paragraph (f) of §1910.1200. (Hazard symbols may be provided as graphical reproductions in black and white or the name of the symbol, e.g., flame, skull and crossbones); (c) Describe any hazards not otherwise classified that have been identified during the classification process; (d) Where an ingredient with unknown acute toxicity is used in a mixture at a concentration = 1% and the mixture is not classified based on testing of the mixture as a whole, a statement that X% of the mixture consists of ingredient(s) of unknown acute toxicity is required.
3.	**Composition/ information on ingredients**	Except as provided for in paragraph (i) of §1910.1200 on trade secrets: **For Substances** (a) Chemical name; (b) Common name and synonyms; (c) CAS number and other unique identifiers; (d) Impurities and stabilizing additives which are themselves classified and which contribute to the classification of the substance. **For Mixtures** In addition to the information required for substances: (a) The chemical name and concentration (exact percentage) or concentration ranges of all ingredients which are classified as health hazards in accordance with paragraph (d) of §1910.1200 and (1) are present above their cut-off/concentration limits; or (2) present a health risk below the cut-off/concentration limits. (b) The concentration (exact percentage) shall be specified unless a trade secret claim is made in accordance with paragraph (i) of §1910.1200, when there is batch-to-batch variability in the production of a mixture, or for a group of substantially similar mixtures (See A.0.5.1.2) with similar chemical composition. In these cases, concentration ranges may be used. **For All Chemicals Where a Trade Secret is Claimed** Where a trade secret is claimed in accordance with paragraph (i) of §1910.1200, a statement that the specific chemical identity and/or exact percentage (concentration) of composition has been withheld as a trade secret is required.
4.	**First-aid measures**	(a) Description of necessary measures, subdivided according to the different routes of exposure, i.e., inhalation, skin and eye contact, and ingestion; (b) Most important symptoms/effects, acute and delayed. (c) Indication of immediate medical attention and special treatment needed, if necessary.
5.	**Fire-fighting measures**	(a) Suitable (and unsuitable) extinguishing media. (b) Specific hazards arising from the chemical (e.g., nature of any hazardous combustion products). (c) Special protective equipment and precautions for fire-fighters.
6.	**Accidental release measures**	(a) Personal precautions, protective equipment, and emergency procedures. (b) Methods and materials for containment and cleaning up.
7.	**Handling and storage**	(a) Precautions for safe handling. (b) Conditions for safe storage, including any incompatibilities.
8.	**Exposure controls/personal protection**	(a) OSHA permissible exposure limit (PEL), American Conference of Governmental Industrial Hygienists (ACGIH) Threshold Limit Value (TLV), and any other exposure limit used or recommended by the chemical manufacturer, importer, or employer preparing the safety data sheet, where available. (b) Appropriate engineering controls. (c) Individual protection measures, such as personal protective equipment.
9.	**Physical and chemical properties**	(a) Appearance (physical state, color, etc.); (b) Odor; (c) Odor threshold; (d) pH; (e) Melting point/freezing point; (f) Initial boiling point and boiling range; (g) Flash point; (h) Evaporation rate; (i) Flammability (solid, gas); (j) Upper/lower flammability or explosive limits; (k) Vapor pressure; (l) Vapor density; (m) Relative density;

		(n) Solubility(ies); (o) Partition coefficient: n-octanol/water; (p) Auto-ignition temperature; (q) Decomposition temperature; (r) Viscosity.
10.	**Stability and reactivity**	(a) Reactivity; (b) Chemical stability; (c) Possibility of hazardous reactions; (d) Conditions to avoid (e.g., static discharge, shock, or vibration); (e) Incompatible materials; (f) Hazardous decomposition products.
11.	**Toxicological information**	Description of the various toxicological (health) effects and the available data used to identify those effects, including: (a) Information on the likely routes of exposure (inhalation, ingestion, skin and eye contact); (b) Symptoms related to the physical, chemical and toxicological characteristics; (c) Delayed and immediate effects and also chronic effects from short- and long-term exposure; (d) Numerical measures of toxicity (such as acute toxicity estimates). (e) Whether the hazardous chemical is listed in the National Toxicology Program (NTP) Report on Carcinogens (latest edition) or has been found to be a potential carcinogen in the International Agency for Research on Cancer (IARC) Monographs (latest edition), or by OSHA.
12.	**Ecological information (Non-mandatory)**	(a) Ecotoxicity (aquatic and terrestrial, where available); (b) Persistence and degradability; (c) Bioaccumulative potential; (d) Mobility in soil; (e) Other adverse effects (such as hazardous to the ozone layer).
13.	**Disposal considerations (Non-mandatory)**	Description of waste residues and information on their safe handling and methods of disposal, including the disposal of any contaminated packaging.
14.	**Transport information (Non-mandatory)**	(a) UN number; (b) UN proper shipping name; (c) Transport hazard class(es); (d) Packing group, if applicable; (e) Environmental hazards (e.g., Marine pollutant (Yes/No)); (f) Transport in bulk (according to Annex II of MARPOL 73/78 and the IBC Code); (g) Special precautions which a user needs to be aware of, or needs to comply with, in connection with transport or conveyance either within or outside their premises.
15.	**Regulatory information (Non-mandatory)**	Safety, health and environmental regulations specific for the product in question.
16.	**Other information, including date of preparation or last revision**	The date of preparation of the SDS or the last change to it.

GREEN CHEMISTRY – 12 Principles

According to USEPA (http://www.epa.gov/sciencematters/june2011/principles.htm),

1) Prevention
It's better to prevent waste than to treat or clean up waste afterwards.

2) Atom Economy
Design synthetic methods to maximize the incorporation of all materials used in the process into the final product.

3) Less Hazardous Chemical Syntheses
Design synthetic methods to use and generate substances that minimize toxicity to human health and the environment.

4) Designing Safer Chemicals
Design chemical products to affect their desired function while minimizing their toxicity.

5) Safer Solvents and Auxiliaries
Minimize the use of auxiliary substances wherever possible make them innocuous when used.

6) Design for Energy Efficiency
Minimize the energy requirements of chemical processes and conduct synthetic methods at ambient temperature and pressure if possible.

7) Use of Renewable Feedstocks
Use renewable raw material or feedstock rather whenever practicable.

8) Reduce Derivatives
Minimize or avoid unnecessary derivatization if possible, which requires additional reagents and generate waste.

9) Catalysis
Catalytic reagents are superior to stoichiometric reagents.

10) Design for Degradation
Design chemical products so they break down into innocuous products that do not persist in the environment.

11) Real-time Analysis for Pollution Prevention
Develop analytical methodologies needed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.

12) Inherently Safer Chemistry for Accident Prevention Choose substances and the form of a substance used in a chemical process to minimize the potential for chemical accidents, including releases, explosions, and fires.