

Sample Matrix Selection Guide

Solution-based ICP analyses require complete dissolution of the sample. Different chemical methods may need to be utilized to dissolve a sample completely. For instance, nitric acid is widely used as a digesting agent and a solvent in ICP analyses because of its oxidizing capabilities and the solubility of nitrate salts. However, platinum group metals require the addition of hydrochloric acid to promote dissolution.

The following tables provide solubility information for various elements in different matrices.

DI Water Matrices

Hydrogen 1 H 1.0079																	Helium 2 He 4.0026	
Lithium 3 Li 6.941	Beryllium 4 Be 9.0122																	Neon 10 Ne 20.179
Sodium 11 Na 22.990	Magnesium 12 Mg 24.305																	Argon 18 Ar 39.948
Potassium 19 K 39.098	Calcium 20 Ca 40.078	Scandium 21 Sc 44.956	Titanium 22 Ti 47.867	Vanadium 23 V 50.942	Chromium 24 Cr 51.996	Manganese 25 Mn 54.938	Iron 26 Fe 55.845	Cobalt 27 Co 58.933	Nickel 28 Ni 58.693	Copper 29 Cu 63.546	Zinc 30 Zn 65.38	Gallium 31 Ga 69.723	Germanium 32 Ge 72.64	Arsenic 33 As 74.922	Selenium 34 Se 78.96	Bromine 35 Br 79.904	Krypton 36 Kr 83.796	
Rubidium 37 Rb 85.468	Sr 38 Sr 87.62	Yttrium 39 Y 88.906	Zirconium 40 Zr 91.224	Niobium 41 Nb 92.906	Molybdenum 42 Mo 95.94	Technetium 43 Tc [98]	Ruthenium 44 Ru 101.07	Rhodium 45 Rh 102.91	Palladium 46 Pd 106.42	Silver 47 Ag 107.87	Cadmium 48 Cd 112.41	Indium 49 In 114.82	Sn 50 Sn 118.71	Antimony 51 Sb 121.76	Tellurium 52 Te 127.60	Iodine 53 I 126.905	Xenon 54 Xe 131.29	
Cesium 55 Cs 132.91	Ba 56 Ba 137.33																	Rn 86 Rn 222
Francium 87 Fr [223]	Ra 88 Ra [226]																	

Although DI water is not a common matrix for analysis, and can promote undesired biological growth, the elements highlighted are soluble in water.

Lanthanum 57 La 138.91	Cerium 58 Ce 140.12	Praseodymium 59 Pr 140.91	Nd 60 Nd 144.24	Promethium 61 Pm [145]	Samarium 62 Sm 150.36	Europium 63 Eu 151.96	Gadolinium 64 Gd 157.25	Terbium 65 Tb 158.93	Dysprosium 66 Dy 162.50	Ho 67 Ho 164.93	Erbium 68 Er 167.26	Tm 69 Tm 168.93	Ytterbium 70 Yb 173.05	Lutetium 71 Lu 174.97
Actinium 89 Ac [227]	Thorium 90 Th 232.04	Protactinium 91 Pa 231.04	Uranium 92 U 238.03	Np 93 Np [237]	Pu 94 Pu [244]	Am 95 Am [243]	Cm 96 Cm [247]	Bk 97 Bk [247]	Cf 98 Cf [251]	Es 99 Es [252]	Fm 100 Fm [257]	Md 101 Md [261]	No 102 No [259]	Lr 103 Lr [262]

Nitric Acid Matrices

hydrogen 1 H 1.00794																	helium 2 He 4.002602	
lithium 3 Li 6.941	beryllium 4 Be 9.0122																	neon 10 Ne 20.1797
sodium 11 Na 22.98976928	magnesium 12 Mg 24.304																	argon 18 Ar 39.948
potassium 19 K 39.0983	calcium 20 Ca 40.078	scandium 21 Sc 44.955912	titanium 22 Ti 47.88	vanadium 23 V 50.9415	chromium 24 Cr 51.9961	manganese 25 Mn 54.938044	iron 26 Fe 55.845	cobalt 27 Co 58.933195	nickel 28 Ni 58.6934	copper 29 Cu 63.546	zinc 30 Zn 65.38	gallium 31 Ga 69.723	germanium 32 Ge 72.630	arsenic 33 As 74.9216	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.798	
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29	
cesium 55 Cs 132.91	barium 56 Ba 137.33																	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]																	

X

O

Elements that are stable/soluble in aqueous HNO₃

X

O

Elements that can be dissolved if complexed with Cl⁻ (e.g. aqua regia)

lanthanum 57 La 138.905	cerium 58 Ce 140.12	praseodymium 59 Pr 140.907	neodymium 60 Nd 144.242	promethium 61 Pm [145]	samarium 62 Sm 150.36	europlum 63 Eu 151.964	gadolinium 64 Gd 157.25	terbium 65 Tb 158.925	dysprosium 66 Dy 162.50	holmium 67 Ho 164.930	erbium 68 Er 167.259	thulium 69 Tm 168.934	ytterbium 70 Yb 173.054	lutetium 71 Lu 174.967
actinium 89 Ac [227]	thorium 90 Th 232.0377	protactinium 91 Pa 231.03688	uranium 92 U 238.02891	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]	lawrencium 103 Lr [262]

Hydrochloric Acid Matrices

hydrogen 1 H 1.00794																	helium 2 He 4.002602	
lithium 3 Li 6.941	beryllium 4 Be 9.0122																	neon 10 Ne 20.1797
sodium 11 Na 22.98976928	magnesium 12 Mg 24.304																	argon 18 Ar 39.948
potassium 19 K 39.0983	calcium 20 Ca 40.078	scandium 21 Sc 44.955912	titanium 22 Ti 47.88	vanadium 23 V 50.9415	chromium 24 Cr 51.9961	manganese 25 Mn 54.938044	iron 26 Fe 55.845	cobalt 27 Co 58.933195	nickel 28 Ni 58.6934	copper 29 Cu 63.546	zinc 30 Zn 65.38	gallium 31 Ga 69.723	germanium 32 Ge 72.630	arsenic 33 As 74.9216	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.798	
rubidium 37 Rb 85.468	strontium 38 Sr 87.62	yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29	
cesium 55 Cs 132.91	barium 56 Ba 137.33																	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]																	

X

O

Elements that are stable/soluble in aqueous HCl

lanthanum 57 La 138.905	cerium 58 Ce 140.12	praseodymium 59 Pr 140.907	neodymium 60 Nd 144.242	promethium 61 Pm [145]	samarium 62 Sm 150.36	europlum 63 Eu 151.964	gadolinium 64 Gd 157.25	terbium 65 Tb 158.925	dysprosium 66 Dy 162.50	holmium 67 Ho 164.930	erbium 68 Er 167.259	thulium 69 Tm 168.934	ytterbium 70 Yb 173.054	lutetium 71 Lu 174.967
actinium 89 Ac [227]	thorium 90 Th 232.0377	protactinium 91 Pa 231.03688	uranium 92 U 238.02891	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]	lawrencium 103 Lr [262]

Sulfuric Matrices

Hydrogen 1 H 1.0079																	Helium 2 He 4.0026						
Lithium 3 Li 6.941	Boron 5 B 10.811	Carbon 6 C 12.011	Nitrogen 7 N 14.007	Oxygen 8 O 15.999	Fluorine 9 F 18.998	Neon 10 Ne 20.180																	
Sodium 11 Na 22.990	Magnesium 12 Mg 24.305	Aluminum 13 Al 26.982	Silicon 14 Si 28.086	Phosphorus 15 P 30.974	Sulfur 16 S 32.065	Chlorine 17 Cl 35.453	Argon 18 Ar 39.948																
Potassium 19 K 39.098	Calcium 20 Ca 40.078	Scandium 21 Sc 44.956	Titanium 22 Ti 47.867	Vanadium 23 V 50.942	Chromium 24 Cr 51.996	Manganese 25 Mn 54.938	Iron 26 Fe 55.845	Cobalt 27 Co 58.933	Nickel 28 Ni 58.693	Copper 29 Cu 63.546	Zinc 30 Zn 65.38	Gallium 31 Ga 69.723	Germanium 32 Ge 72.64	Arsenic 33 As 74.922	Selenium 34 Se 78.96	Bromine 35 Br 79.904	Krypton 36 Kr 83.796						
Rubidium 37 Rb 85.468	Sr 38 Sr 87.62	Yttrium 39 Y 88.906	Zirconium 40 Zr 91.224	Niobium 41 Nb 92.906	Molybdenum 42 Mo 95.94	Technetium 43 Tc [98]	Ruthenium 44 Ru 101.07	Rhodium 45 Rh 102.9	Palladium 46 Pd 106.42	Silver 47 Ag 107.87	Cadmium 48 Cd 112.41	Indium 49 In 114.82	Tin 50 Sn 118.7	Antimony 51 Sb 121.76	Te 52 Te 127.60	Iodine 53 I 126.90	Xenon 54 Xe 131.29						
Cesium 55 Cs 132.91	Ba 56 Ba 137.33	Hafnium 72 Hf 178.49	Tantalum 73 Ta 180.95	Tungsten 74 W 183.84	Rhenium 75 Re 186.21	Osmium 76 Os 190.23	Iridium 77 Ir 192.22	Platinum 78 Pt 195.08	Gold 79 Au 196.97	Mercury 80 Hg 200.59	Thallium 81 Tl 204.38	Lead 82 Pb 207.2	Bismuth 83 Bi 208.98	Po 84 Po [209]	Astatine 85 At [210]	Rn 86 Rn [222]							
Francium 87 Fr [223]	Ra 88 Ra [226]	Rutherfordium 104 Rf [261]	Dubnium 105 Db [262]	Seaborgium 106 Sg [263]	Berkelium 107 Bk [264]	Hassium 108 Hs [265]	Mt 109 Mt [266]	Ds 110 Ds [267]	Rg 111 Rg [268]														
Lanthanum 57 La 138.91	Cerium 58 Ce 140.12	Praseodymium 59 Pr 140.91	Nd 60 Nd 144.24	Pm 61 Pm [145]	Samarium 62 Sm 150.36	Europium 63 Eu 151.96	Gadolinium 64 Gd 157.25	Tb 65 Tb 158.93	Dy 66 Dy 162.50	Ho 67 Ho 164.93	Er 68 Er 167.26	Tm 69 Tm 168.93	Yb 70 Yb 173.05	Lu 71 Lu 174.967									
Actinium 89 Ac [227]	Th 90 Th 232.04	Pa 91 Pa 231.04	U 92 U 238.03	Np 93 Np [237]	Pu 94 Pu 244	Am 95 Am [243]	Cm 96 Cm [247]	Bk 97 Bk 247	Cf 98 Cf [251]	Es 99 Es [252]	Fm 100 Fm [257]	Md 101 Md [261]	No 102 No [259]	Lr 103 Lr [262]									

X

Elements that benefit or tolerate H₂SO₄

X

Elements that can be dissolved in H₂SO₄ if complexed with Cl⁻