Table IV. Compounds for Standard Solutions

Element		Molar Mass (g/mol)	1000 mg/L (g/L)	0.1 M (g/L)	Solvent	Comments
Aluminum	Al metal	26.982	1.0000	2.6982	Hot, dil. HCl	b
Antimony	$KSbOC_4H_4O_6 \bullet \frac{1}{2}H_2O$	33.392	2.7427	33.392	Water	l
Arsenic	As_2O_2	197.84	2.6406	9.892	dil. HCl	a,c,n
Barium	$BaCO_3$	197.35	1.4369	19.735	dil. HCl	
Beryllium	Be metal	9.0122	1.0000	0.9012	HCl	c
Bismuth	Bi_2O_3	465.96	1.1148	23.297	HNO_3	
Boron	H_3BO_3	61.84	5.7200	6.184	Water	b
Bromine	KBr	119.01	1.4894	11.0901	Water	b
Cadmium	CdO	128.40	1.1423	12.840	HNO_3	
Calcium	$CaCO_3$	100.09	2.4972	10.009	dil. HCl	a
Cerium	$(NH_4)_2Ce(NO_3)_6$	548.23	3.9126	54.823	Water	
Cesium	Cs_2SO_4	361.87	1.3614	18.094	Water	
Chromium	$K_2Cr_2O_7$	294.19	2.8290	14.710	Water	a
Cobalt	Co metal	58.933	1.0000	5.8933	HNO_3	b
Copper	Cu metal	63.546	1.0000	6.3546	dil. HNO_3	b
	CuO	79.545	1.2517	7.9545	HCl, hot	b
Dysprosium	Dy_2O_3	373.00	1.1477	18.650	HCl, hot	e
Erbium	Er_2O_2	382.56	1.1435	19.128	HCl, hot	e
Europium	Eu_2O_3	351.92	1.1579	17.596	HCl, hot	e
Fluorine	NaF	41.988	2.2101	4.1988	Water	g
Gadolinium	Gd_2O_3	362.50	1.1526	18.125	HCl, hot	e
Gallium	Ga metal	69.72	1.0000	6.972	HNO_3, hot	f
Germanium	GeO_2	104.60	1.4410	10.460	1 M NaOH, hot	
Gold	Au metal	196.67	1.0000	19.697	Aqua Regia, hot	b
Hafnium	Hf metal	178.49	1.0000	17.849	HF, fusion	i
Holmium	Ho_2O_3	377.86	1.1455	18.893	HCl, hot	e
Indium	In_2O_3	277.64	1.2090	13.882	HCl, hot	
Iodine	KIO_3	214.00	1.6863	21.400	Water	a

Table IV. Compounds for Standard Solutions (cont.)

Element		Molar Mass (g/mol)	1000 mg/L (g/L)	0.1 M (g/L)	Solvent	Comments
Iridium	No Suitable Compound was Found					
Iron	Fe metal	55.47	1.0000	5.5847	HCl, hot	b
Lanthanum	La_2O_3	325.82	1.1728	16.291	HCl, hot	e
Lead	$Pb(NO_3)_2$	331.20	1.5985	33.120	Water	b
Lithium	Li_2CO_3	73.890	5.3243	3.6940	HCl	b
Lutetium	Lu_2O_3	397.94	1.1372	19.987	HCl, hot	
Magnesium	MgO	40.31	1.658	4.031	HCl	
Manganese	$MnSO_4 \bullet H_2O$	169.01	3.0764	16.901	Water	j
Mercury	$HgCl_2$	271.50	1.3535	27.150	Water	c
Molybdenum	MoO_3	143.94	1.5003	14.394	1 M NaOH	
Neodymium	Nd_2O_3	336.48	1.1664	16.824	HCl	c
Nickel	Ni metal	58.71	1.0000	5.871	HNO_3, hot	b
Niobium	Nb_2O_5	265.81	1.4305	13.290	HF, fusion	k
Osmium	Os metal	190.20	1.0000	19.020	H_2SO_4, hot	d
Palladium	Pd metal	106.40	1.0000	10.640	HNO_3, hot	
Phosphorous	KH_2PO_4	136.09	4.3937	13.609	Water	
Platinum	K_2PtCl_4	415.12	2.1278	41.511	Water	
Potassium	KCl	74.55	1.9065	7.455	Water	b
	$KHC_8H_4O_4$	204.22	5.2228	20.422	Water	a,n
	$K_2Cr_2O_7$	294.19	3.7618	36.922	Water	a,n
Praseodymium	Pr_6O_{11}	1021.43	1.2082	17.0247	HCl	e
Rhenium	Re metal	186.2	1.0000	18.62	HNO_3	
	$KReO_4$	289.30	1.5537	28.930	Water	
Rhodium	Rh metal	102.91	1.0000	10.291	H_2SO_4, hot	
Rubidium	Rb_2SO_4	267.00	1.5628	13.357	Water	
Ruthenium	RuO_4	165.07	1.6332	16.507	Water	
Samarium	Sm_2O_3	348.70	2.3193	17.435	HCl, hot	e
Scandium	Sc_2O_3	137.91	1.5339	6.895	HCl, hot	
Selenium	Se metal	78.96	1.0000	7.896	HNO_3, hot	

Table IV. Compounds for Standard Solutions (cont.)

Element		Molar Mass (g/mol)	1000 mg/L (g/L)	0.1 M (g/L)	Solvent	Comments
Silicon	Si metal	28.086	1.0000	2.8066	Conc. NaOH	
	SiO_2	60.08	2.1391	6.008	HF	
Silver	$AgNO_3$	169.87	1.5748	16.987	Water	b,m
Sodium	NaCl	58.422	2.5428	5.8442	Water	a
	$Na_2C_2O_4$	134.01	2.9146	6.700	Water	a,n
Strontium	$SrCO_3$	147.63	1.6849	14.763	HCl	b
Sulfur	K_2SO_4	174.27	5.4351	17.427	Water	
Tantalum	Ta_2O_5	441.89	1.2210	22.094	HF, fusion	k
Tellurium	TeO_2	159.60	1.2507	15.960	HCl	
Terbium	Tb_2O_3	365.85	1.1512	18.292	HCl, hot	e
Thallium	Tl_2CO_3	468.75	1.1468	23.437	Water	b,c
Thulium	Tm_2O_3	385.87	1.1421	19.293	HCl, hot	e
Tin	Sn metal	118.69	1.0000	11.869	HCl	
	SnO	134.69	1.1348	13.469	HCl	
Titanium	Ti metal	47.90	1.0000	4.790	H_2SO_4, 1:1	b
Tungsten	$Na_2WO_4 \bullet 2H_2O$	329.86	1.7942	32.986	Water	h
Uranium	UO_2	270.03	1.1344	27.003	HNO_3	
	U_3O_8	842.09	1.1792	28.068	HNO_3	a,n
Vanadium	V_2O_3	181.88	1.7852	9.0942	HCl, hot	
Ytterbium	Yb_2O_3	394.08	1.1386	19.704	HCl, hot	e
Yttrium	Y_2O_3	225.81	1.2700	11.291	HCl, hot	e
Zinc	ZnO	81.37	1.2448	8.137	HCl	b
Zirconium	Zr metal	91.22	1.0000	9.122	HF, fusion	i

Table IV. Compounds for Standard Solutions (cont.)

[a] Primary standard.

[b] These compounds conform very well to the criteria and approach primary standard quality.

[c] Highly toxic.

[d] Very highly toxic.

[e] The rare earth oxides, because they absorb CO_2 and water vapor from the air, should be freshly ignited prior to weighing.

[f] mp = 29.5°C. The metal may be warmed and weighed as the liquid.

[g] Sodium fluoride solutions will etch glass and should be freshly prepared.

[h] Sodium tungstate loses both water molecules at 110°C. After drying, F.W. = 293.83, 1000 ppm = 1.5982 g/L, 0.1 M = 29.383 g/L. The water is not rapidly regained but the compound should be kept in a desiccator after drying and should be weighed quickly once it is removed.

[i] Zirconium and hafnium compounds were not investigated in the laboratory. The following methods have been recommended for dissolution of zirconium and hafnium (10). 1.000 g of the powdered metal is placed in a platinum dish with 5-10 mL of water and 102 mL of HF (1:5) and covered with a platinum lid or a paraffined watch glass. Once dissolved, the fluorine may be removed by adding 1-2 mL of sulfuric acid (cold) and evaporating to dense fumes or to dryness if required.

A fusion method may also be used. A 5-10 fold excess of $K_2S_2O_7$ is placed in a platinum or quartz crucible along with the sample. After melting to a homogeneous molten mass in a muffle furnace or burner the fusion product is dissolved in 2 N sulfuric acid.

A third method avoids the use of platinum ware. The sample of the metal is finely ground and placed in a small heat-resistant beaker. Two to four grams of ammonium sulfate and 3-6 mL of sulfuric acid are then added. A homogeneous melt is obtained on a hot plate and dissolved in 2 N sulfuric acid.

[j] $MnSO_4 \bullet H_2O$ may be dried at 110°C without losing the water of hydration.

[k] Niobium and tantalum pentoxides are slowly soluble in 40% HF. The addition of H_2SO_4 accelerates the solution process. They may also be dissolved by a fusion techniques. $K_2S_2O_7$ is an often used flux. The pentoxides are fully decomposed at 650-800°C in the presence of an 8-10 fold amount of potassium pyrosulfate. A quartz or porcelain crucible is suitable and the resulting melt may be dissolved in sulfuric acid (11). The authors have used cold HF/H_2SO_4 successfully in plastic beakers with as 10-hr solution time.

[l] Antimony potassium tartrate loses the ½ H_2O with drying at 110°C. After drying, F.W. = 324.92, 1000 ppm = 2.6687 g/L, 0.1 M = 32.492 g/L. The water is not rapidly regained but the compound should be kept in a desiccator after drying and should be weighed quickly once it is removed. The dried compound is water soluble.

[m] When kept dry, silver nitrate crystals are not affected by light. Solutions of silver nitrate should be stored in brown bottles.

[n] These compounds are sold as primary standards by the National Bureau of Standards, Office of Standard Reference Materials, Washington, D.C. 20234.

[o] Boric acid may be weighed accurately directly from the bottle. It will loose 1 H_2O molecule at 100°C and a second H_2O molecule at approximately 130-140°C and is difficult to dry to a constant weight.