Catalog for Spectrochemistry

Chart with Chemical Elements from J. J. Becher; op. chymica, ca. 17 cent.
THE BETTMAN ARCHIVE, INC.

1 PURE MATERIALS

10 QUALITATIVE STANDARDS
for emission and x-ray spectroscopy

11 SEMIQUANTITATIVE STANDARDS
for emission and x-ray spectroscopy

18 QUANTITATIVE STANDARDS
for chemical analysis, emission and x-ray spectroscopy

23 PREWEIGHED DILUENTS, BUFFERS AND FLUXING MATERIALS
for infrared, emission and x-ray spectroscopy

including, for your convenient reference:

SPEX Methods for Semiquantitative Spectrochemical Analysis

SPEX INDUSTRIES, INC. / BOX 798 / METUCHEN, N.J. 08840 / SPECIALISTS IN SPECTROSCOPY

PURE MATERIALS

When we introduced a line of high purity materials a few years ago we pledged to keep an eye out for higher purities and additional physical forms, as they became available. The degree of our diligence is evidenced here. Listings in bold face type are in our current inventory, which we will gleefully enlarge to include any of the others you request although initial delivery may take up to six weeks. If you do not see what you want, by all means speak up; by the time this printing reaches you we may have unearthed any number of previously hidden treasures. Unfortunately, prices too may fluctuate. Our policy remains:

..... to continue our search for materials of highest practicable purity,

..... to provide a certificate of analysis pertinent to each batch of material,

..... to obtain these analyses in accordance with the procedures outlined in this catalog as Spex Methods for Semiquantitative Spectrochemical Analysis (purity is expressed in 9s, 4-9s being equivalent to 99.99% pure in terms of spectrochemically detectable impurities),

..... to state the particle size of powders or dimensions of materials in other forms where it is possible to do so,

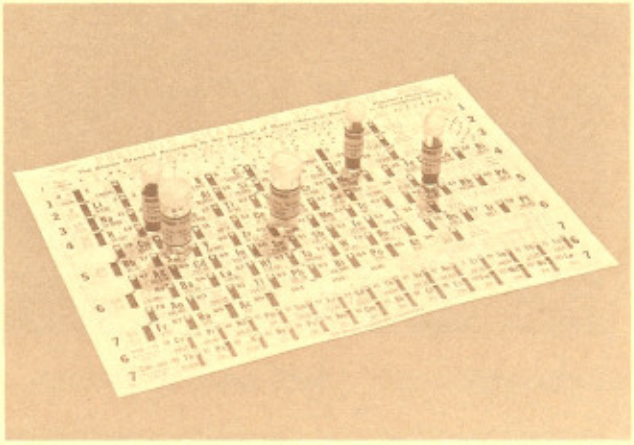
..... to enhance the value of the materials by supplying formulas of compounds where practical; compounds may not be stoichiometric, however, because of

1—indeterminate amounts of water of hydration/crystallization

2—contamination by organic materials such as plastic from mixing or grinding vials

3—slight contamination at edges of sheet, foil, wire, ingots or other forms requiring cutting; an acid dip of the edges or washing of all surfaces with high purity solvents is recommended

4—gases and anionic impurities not detectable by emission spectrographic analysis (S.S. Yamamura, Anal. Chem., **36,** 2515, 1964)



PERIODIC CHART OF THE ATOMS
© THE WELCH SCIENTIFIC CO.

MATERIAL	CAT. NO.	PURITY	FORM	PRICE
ALUMINUM	1112-6	6-9s	Sheet, 1x100mm	5.20/2g 17.70/10g
	1112	5-9s+	Rod, 4x75mm (approx. 7 rods)	8.10/10g 27.50/50g
	1112P	5-9s	Powder, 90-150 microns	4.80/10g 16.30/50g
ALUMINUM OXIDE	1212-6	6-9s	Powder, Al_2O_3	5.00/2g 17.00/10g
	1212-4	4-9s	Powder, $Al_2O_3xH_2O$, 0.01-1 micron	7.00/50g 23.80/250g
ANTIMONY	1113-6	6-9s	Powder	6.00/g 20.40/5g
	1113	5-9s+	Pieces, Irregular	6.50/10g 22.25/50g
ANTIMONY OXIDE	1213-6	5-9s+	Powder, Sb_2O_3, 45 microns	8.00/10g 27.20/50g
	1213	5-9s	Powder, Sb_2O_3	4.40/2g 15.00/10g
ARSENIC	1114-6	6-9s	Lumps, Beta-form, air stable	8.00/2g 27.20/10g
	1114	5-9s+	Pieces, Irregular	7.90/5g 26.75/25g
ARSENIC OXIDE	1214	5-9s+	Powder, As_2O_3	5.00/5g 17.50/25g
BARIUM CARBONATE	1215	5-9s	Powder, $BaCO_3$	8.00/5g 27.25/25g
BERYLLIUM	1116-4	4-9s	Flake	8.90/g 30.25/5g
	1116	3-9s	Chip	4.50/10g 15.30/50g
BERYLLIUM OXIDE	1216	5-9s	Powder, $BeOxH_2O$	7.80/20g 26.60/100g
BISMUTH	1117	6-9s	Shot, Irregular	9.00/50g 30.60/250g
	1117P	6-9s	Powder, 45 microns	7.20/20g 24.50/100g
BISMUTH OXIDE	1217	5-9s+	Powder, Bi_2O_3	5.50/10g 18.70/50g
BORON	1118-5	5-9s+	Granule, 150 microns	146.20/g
	1118	3-9s	Powder	8.75/5g 29.80/25g
BORIC ACID	1218	4-9s	Powder, H_3BO_3	6.00/50g 20.50/250g
BORON OXIDE	1218-0	5-9s	Powder, B_2O_3	9.85/g 33.50/5g
CADMIUM	1119-6	6-9s	Powder, 45 microns	10.00/10g 34.00/50g
	1119	5-9s+	Splatters	6.50/50g 22.10/250g
CADMIUM OXIDE	1219	5-9s+	Powder, CdO	11.60/5g 43.20/25g

Minimum order $10.00

MATERIAL	CAT. NO.	PURITY	FORM	PRICE
CALCIUM CARBONATE	1220	5-9s	Powder, $CaCo_3xH_2O$	6.40/5g 21.75/25g
CERIUM	1165I	3-9s+	Ingot	5.80/10g 19.75/50g
	1165	3-9s	Powder	9.60/g 32.65/5g
CERIUM OXIDE	1265-5	5-9s	Powder, CeO_2	9.40/g 31.95/5g
	1265	3-9s+	Powder, CeO_2	4.40/10g 15.00/50g
CESIUM CHLORIDE	1221	3-9s	Powder	5.50/10g 18.70/50g
CESIUM CARBONATE	1331	3-9s	Powder	5.50/10g 18.70/50g
CESIUM CHROMATE	1441	3-9s	Powder	5.50/10g 18.70/50g
CHROMIUM	1122	5-9s	Shot, Irregular	5.00/20g 17.00/100g
	1122F	5-9s	Flake	5.50/10g 19.70/50g
	1122P	4-9s	Powder, 150 microns	9.00/50g 30.60/250g
CHROMIUM OXIDE	1222	5-9s	Powder	9.30/5g 31.60/25g
COBALT	1123	5-9s	Powder	7.60/5g 25.80/25g
	1123R		Rod, 3mm (approx. 19.6g/ft.)	5.30/2g 18.00/10g
COBALT OXIDE	1223	5-9s	Powder	5.90/5g 20.00/25g
COLUMBIUM			(SEE NIOBIUM)	
COPPER	1125-6	6-9s	Bars	4.80/20g 16.35/100g
	1125	5-9s	Rods, 5x150mm (approx. 27g/Rod)	9.42/rod 32.00/5 Rods
	1125P	5-9s	Powder	8.50/10g 28.90/50g
COPPER OXIDE	1225	5-9s+	Powder	7.25/5g 24.70/25g
COPPER HYDROXY FLUORIDE	1325	4-9s+	Powder, Cu(OH)F, boron-free for determination by carrier dist.	7.20/10g 24.40/50g
DYSPROSIUM	1166	3-9s	Ingot	4.90/2g 16.70/10g
DYSPROSIUM OXIDE	1266	3-9s+	Powder, Dy_2O_3	6.80/5g 22.75/25g
ERBIUM	1167	3-9s	Ingot	6.10/g 20.75/5g
ERBIUM OXIDE	1267	3-9s+	Powder, Er_2O_3	6.20/5g 20.70/25g

MATERIAL	CAT. NO.	PURITY	FORM	PRICE
EUROPIUM	1168	3-9s	Ingot	20.70/g 70.40/5g
EUROPIUM OXIDE	1268-5	5-9s	Powder, Eu_2O_3	106.00/g
	1268	3-9s	Powder, Eu_2O_3	7.75/g 26.50/5g
GADOLINIUM	1169	4-9s	Powder, 250-450 microns	11.50/g 39.10/5g
GADOLINIUM OXIDE	1269-5	5-9s	Powder, Gd_2O_3	7.70/g 26.20/5g
	1269	3-9s+	Powder, Gd_2O_3	7.30/10g 25.00/50g
GALLIUM	1126	6-9s	Splatter	7.10/g 24.10/5g
GALLIUM OXIDE	1226	6-9s	Powder, Ga_2O_3, 1-2 microns	6.13/g 20.80/5g
GERMANIUM	1127	5-9s+	Pieces, Irregular	4.75/5g 16.20/25g
	1127P	5-9s	Powder	8.70/10g 29.60/50g
GERMANIUM OXIDE	1227	5-9s	Powder, GeO_2	7.20/20g 24.50/100g
GOLD	1128P	5-9s	Powder	7.70/g 29.20/5g
	1128	5-9s+	Splatter	6.20/g 21.10/5g
HAFNIUM	1129W	3-9s+	Wire, Excluding Zr, 2-3% (0.125mm dia.)	6.80/2g 23.12/10g
	1129	3-9s	Sponge, Excluding Zr, 1-3%	8.15/5g 27.75/25g
HAFNIUM OXIDE	1229	3-9s	Powder, HfO_2 (Low Zr)	8.00/g 27.20/5g
HOLMIUM	1170	3-9s	Ingot	7.50/g 25.50/5g
HOLMIUM OXIDE	1270	3-9s+	Powder, Ho_2O_3	9.40/5g 32.00/25g
INDIUM	1130	6-9s	Splatter	7.20/5g 24.50/25g
INDIUM OXIDE	1230	5-9s+	Powder, In_2O_3	6.20/10g 21.00/50g
IRIDIUM	1131-5	5-9s	Sponge	98.40/g
	1131	3-9s+	Powder	44.50/g 151.30/5g
IRON	1132-5	5-9s	Sponge	5.50/10g 18.70/50g
	1132P	5-9s	Powder, 150 micron	6.50/10g 12.10/50g
	1132	4-9s	Rod, 5x150mm (approx. 24g/rod)	7.93/rod 26.90/5 rods
IRON OXIDE	1232	5-9s	Powder	5.60/10g 19.10/50g

Minimum order $10.00

MATERIAL	CAT. NO.	PURITY	FORM	PRICE
LANTHANUM	1171	3-9s	Powder, <150 microns	9.40/g 32.00/5g
LANTHANUM OXIDE	1271	5-9s+	Powder, La_2O_3	4.20/20g 14.25/100g
LEAD	1133	6-9s	Shot, Irregular	8.00/50g 27.20/250g
LEAD OXIDE	1233	5-9s+	Powder, PbO	5.60/10g 19.00/50g
LEAD SULFIDE	1333	4-9s+	Powder	7.75/10g 26.40/50g
LITHIUM CARBONATE	1234	5-9s	Powder, Li_2CO_3, Spectrographic Buffer	7.30/10g 24.80/50g 44.00/100g 85.00/200g 150.00/lb.
LITHIUM FLUORIDE	1134	5-9s+	Powder, LiF	7.75/5g 26.40/25g
LUTETIUM	1172	3-9s	Ingot	140.00/g
LUTETIUM OXIDE	1272	3-9s+	Powder, Lu_2O_3	25.25/g 86.00/5g
MAGNESIUM	1135	4-9s+	Rods, 3x75mm (approx. 1.1g/rod)	5.40/20g 18.40/100g
MAGNESIUM OXIDE	1235	5-9s+	Powder, MgO	5.70/5g 19.30/25g
MANGANESE	1136-4	4-9s+	Flake	8.00/50g 27.20/250g
	1136	3-9s+	Powder	4.00/100g 13.60/500g
MANGANESE OXIDE	1236	5-9s+	Powder	10.00/5g 34.00/25g
MANGANESE SULFIDE	1336	4-9s+	Powder	7.90/2g 26.80/10g
MERCURY	1137-9	9-9s	Liquid	8.20/20g 27.40/100g
	1137	7-9s	Liquid	6.50/50g 22.00/250g
MERCURY OXIDE	1237	5-9s+	Powder, HgO	5.90/2g 20.10/10g
MOLYBDENUM	1138	4-9s+	Powder	8.00/100g 27.25/500g
MOLYBDENUM OXIDE	1238	4-9s+	Powder	7.70/5g 26.20/25g
NEODYMIUM	1173	3-9s	Powder, 250-450 microns	19.90/g 57.70/5g
NEODYMIUM OXIDE	1273-5	5-9s	Powder, Nd_2O_3	10.60/g 36.00/5g
	1273	3-9s	Powder, Nd_2O_3	4.90/10g 16.70/50g

MATERIAL	CAT. NO.	PURITY	FORM	PRICE
NICKEL	1139-5	5-9s	Sponge	7.30/10g 24.80/50g
	1139	4-9s	Powder	4.00/100g 13.60/500g
NICKEL OXIDE	1239	5-9s	Powder, NiO	7.40/20g 25.20/100g
NIOBIUM	1124	3-9s+	Powder	6.40/20g 21.75/100g
NIOBIUM OXIDE	1224	4-9s+	Powder, Nb_2O_5	8.50/50g 29.00/250g
PALLADIUM	1141	5-9s	Powder	15.60/g 53.20/5g
	1141-3	3-9s	Powder	10.00/2g 34.00/10g
PALLADIUM OXIDE	1241		Catalyst Grade Powder	10.60/g 36.00/5g
AMMONIUM PHOSPHATE	1242	5-9s	Powder, $NH_4H_2PO_4$	9.00/100g 30.60/500g
PLATINUM	1143	5-9s	Powder	29.00/g 98.50/5g
POTASSIUM CARBONATE	1244	5-9s	Granules, $K_2CO_3xH_2O$	9.00/20g 30.50/100g
POTASSIUM CHLORIDE	1344	5-9s+	Powder, KCl	6.30/5g 21.40/25g
PRASEODYMIUM	1174	3-9s	Wire, 1mm dia.	128.70/g
PRASEODYMIUM OXIDE	1274-5	5-9s	Powder, Pr_6O_{11}	10.60/g 36.00/5g
	1274	3-9s+	Powder, Pr_6O_{11}	7.80/20g 26.50/100g
RHENIUM	1145	4-9s+	Powder	4.79/g 16.30/5g
AMMONIUM PERRHENATE	1245	4-9s+	Granule	6.50/g 22.10/5g
RHODIUM	1465-5	5-9s	Powder	80.00/g 240.00/5g
	1146	4-9s	Powder	21.12/g 72.00/5g
RHODIUM OXIDE	1246	4-9s	Powder	47.50/g
RUBIDIUM CHLORIDE	1247	3-9s+	Powder	5.50/10g 18.70/50g
RUTHENIUM	1148	3-9s+	Powder	7.58/g 25.80/5g
SAMARIUM	1175	3-9s	Powder, 75-150 microns	16.35/g 55.60/5g
SAMARIUM OXIDE	1275	3-9s+	Powder, Sm_2O_3	4.50/10g 15.30/50g
SCANDIUM	1176-4	3-9s+	Ingot	197.80/g
SCANDIUM OXIDE	1276-5	5-9s	Powder, Sc_2O_3	35.90/g 122.00/5g
	1276	3-9s	Powder, Sc_2O_3	12.41/g 42.10/5g

Minimum order $10.00

MATERIAL	CAT. NO.	PURITY	FORM	PRICE
SELENIUM	1149-6	6-9s	Pellets	6.40/20g 21.80/100g
	1149	5-9s+	Pellets	9.50/50g 32.30/250g
SELENIUM OXIDE	1249	5-9s+	Powder, SeO_2	7.25/5g 24.70/25g
SILICON	1150	6-9s+	Pieces, Irregular	5.20/10g 17.70/50g
	1150P	6-9s	Powder	10.10/5g 33.15/25g
SILICON OXIDE	1250	6-9s+	Powder, SiO_2	9.20/20g 31.25/100g
SILVER	1151	6-9s	Shot	5.65/5g 19.20/25g
	1151P	5-9s	Powder	7.30/2g 24.80/10g
SILVER CHLORIDE	1251	6-9s+	Powder, AgCl Spectrographic buffer	10.00/5g 34.00/25g
SODIUM CARBONATE	1252	5-9s	Powder, Na_2CO_3	7.50/2g 25.50/10g
SODIUM CHLORIDE	1352	5-9s	Powder, NaCl	6.50/10g 22.10/50g
STRONTIUM CARBONATE	1253	5-9s	Powder, $SrCO_3$	9.50/5g 32.40/25g
STRONTIUM CHLORIDE	1353	5-9s	Powder, $SrCl_2$	6.86/2g 23.30/10g
STRONTIUM FLUORIDE	1153	5-9s	Powder, SrF_2	7.10/2g 24.10/10g
TANTALUM	1154	4-9s+	Powder	5.80/20g 19.70/100g
TANTALUM OXIDE	1254	4-9s	Powder, Ta_2O_5	8.80/10g 30.00/50g
TELLURIUM	1155-6	6-9s	Bars	9.10/10g 30.95/50g
	1155	5-9s+	Pieces, Irregular	4.60/20g 15.60/100g
TELLURIUM OXIDE	1255	5-9s	Powder, TeO_2	5.70/2g 19.40/10g
TERBIUM	1177	3-9s	Ingot	14.60/g 39.70/5g
TERBIUM OXIDE	1277-5	5-9s	Powder, Tb_4O_7	36.60/g 123.24/5g
	1277	3-9s	Powder, Tb_4O_7	7.25/g 24.70/5g
THALLIUM	1156	5-9s+	Rods, 10x33mm (approx. 25g/rod)	12.50/25g 43.75/125g
THALLIUM OXIDE	1256	5-9s+	Powder, Tl_2O_3	5.50/10g 18.70/50g
THORIUM	1157	3-9s	Powder	7.80/20g 26.50/100g

MATERIAL	CAT. NO.	PURITY	FORM	PRICE
THORIUM OXIDE	1257	4-9s	Powder, ThO_2	8.40/10g 28.50/50g
THULIUM	1178	3-9s	Powder, 250-350 microns	58.70/g
THULIUM OXIDE	1278	3-9s+	Powder, Tm_2O_3	16.20/g 55.00/5g
TIN	1158	6-9s	Pellets	6.50/10g 22.00/50g
	1158P	6-9s	Powder	8.00/5g 27.20/25g
TIN OXIDE	1258	6-9s+	Powder	10.00/5g 34.00/25g
TITANIUM	1159	3-9s+	Sponge	5.20/20g 17.70/100g
TITANIUM OXIDE	1259	4-9s	Powder, TiO_2	4.40/20g 15.00/100g
TUNGSTEN	1160	4-9s	Powder	3.00/100g 10.20/500g
	1160-5	5-9s	Powder, Low-Molybdenum	7.20/10g 24.50/50g
TUNGSTEN OXIDE	1260	4-9s+	Powder	4.00/100g 13.60/500g
URANIUM	1161	4-9s+	Chunks, Irregular	7.20/10g 24.50/50g
URANIUM OXIDE	1261	3-9s+	Powder	8.60/5g 29.25/25g
VANADIUM	1162	3-9s	Pellets	7.80/20g 26.50/100g
VANADIUM OXIDE	1262	3-9s+	Powder	7.40/10g 25.20/50g
	1262-5	4-9s+	Powder	3.25/g 11.05/5g
YTTRIUM	1179	3-9s	Ingot	4.50/2g 15.30/10g
YTTRIUM OXIDE	1279-6	6-9s	Powder, Y_2O_3	5.00/g 17.00/5g
	1279	5-9s	Powder, Y_2O_3, 1-2 microns	4.50/2g 15.30/10g
YTTERBIUM	1180	3-9s	Powder, 350 microns	10.60/g 36.00/5g
YTTERBIUM OXIDE	1280	3-9s	Powder, Yb_2O_3	4.40/2g 15.00/10g
ZINC	1163	5-9s+	Splatter	4.40/20g 15.00/100g
ZINC OXIDE	1263	4-9s+	Powder, ZnO	8.00/100g 27.25/500g
ZIRCONIUM	1164-4	4-9s	Rod	52.50/rod
	1164	3-9s+	Sponge	9.00/20g 30.50/100g
ZIRCONIUM OXIDE	1264	3-9s+	Powder, ZrO_2, low Hf	11.00/20g 37.50/100g

Minimum order $10.00

POWDER STANDARDS

A GUIDE TO SPEX QUALITATIVE AND SEMIQUANTITATIVE STANDARDS AND PROCEDURES

Unknowns submitted to the spectroscopist for analysis can usually be placed in one of two categories: those with a single major elemental constituent comprising 10%, or more, of the sample; and, those with two or more major elemental constituents. In addition any number of minor constituents may be present at concentration levels of less than 1%.

For the purposes of this catalog we shall call the first of these categories "Pure Materials" and the second category "Mixtures."

Through the years, since the early 1950s, Spex has pioneered in the development of standard materials and procedures which have added immeasurably to spectroscopists' ability to analyze unknowns quickly and accurately. This listing of the latest standards and procedures is presented in light of recent advances which make it possible to perform analyses that more nearly conform to ASTM's latest definition of semiquantitative procedures ". . . those which measure the concentration of an element within a confidence level 2/3 to 1-1/2 times the actual amount present."

SAMPLE CLASSIFICATION WITH SPEX QUAL MIXES AND MASTER PLATE

INTERPRETING SPECTRA QUALITATIVELY

Usually a sample comes with some history providing a clue with which to classify the material. In case no history is available:

(1) Mix equal parts of sample and graphite powder in a #3111 vial with a #3112 ball in our #5100 Mixer/Mill, or similar device.

(2) Load samples into a suitable graphite electrode.

(3) Load each of the applicable Spex Qual Mixes into similar electrodes.

(4) Arc and record spectra in accordance with the instructions on page 17. Include an iron spectrum for wavelength identification purposes and for matching of standard plate with spectrum.

Identification of elements present in the sample is most easily made if a Master Plate, such as the Spex #1103, is employed. The Master Plate denotes many of the *raies ultimes* for each element as provided by the Qual Mixes.

After noting the presence of an element, assign an approximate concentration level such as Faint Trace, approximately 0.01%; Trace, approximately 0.1%; Minor Constituent, approximately 1%; or Major Constituent, >10%. To do this consider the following sensitivities (approximate) obtained in the DC arc using the Stallwood Jet.

Less than 1 ppm Be Ca Mg Ag Cu Si Sc Yb;

1-5ppm Mn Ti B Ba Bi Fe Dy Er Eu Gd Ho La Lu Tm Y Al Au Ce Co Cr Ga Ge In Nb Nd Ni Pb Pd Pr Pt Rh Sn Sr Sm V;

10-50ppm As Cd Hg Hf Ir P Re Ru Sb Tb Tl;

100-1000ppm Cs K Li Na Rb Se Te Th U W.

Estimate the intensity of the analytical line on a 1-10 scale of increasing intensities. Combine the sensitivity and density figures assigned to yield concentration. It should be pointed out that this visual method is dependent directly on the *experience* of the spectroscopist performing this type of analysis; particularly for very sensitive elements because the RU line builds up intensity very quickly for small concentration levels, which could lead to incorrect estimates of concentration. However, as one becomes more experienced such estimates become surprisingly accurate for categorizing unknowns.

If the sample analyzed above is categorized as a "Pure Material" refer to page 11. If categorized as a "Mixture" refer to page 14.

QUALITATIVE STANDARDS

1020 **QUAL MIX.** Proprietary mixture for qualitative spectrochemical analysis, 49 elements (same as in #1000) in a readily arced base, so blended that several lines of each metal will appear in the spectrographic plate in the region 2000 to 4700A **$26.00**

1033 **RARE EARTH QUAL MIX.** Preparation, similar to 1020 except for the determination of 16 Rare Earths **$26.00**

1043 **NOBLE METAL QUAL MIX.** Preparation, similar to 1020 except for the determination of the 10 Noble Metals **$26.00**

BASIC ELEMENT KITS

A library of reference materials for your individualized application.

1010 **ELEMENT KIT,** contains quantities ranging from 100 mg to 2 g of individual compounds of the same 49 elements in #1000 Spex Mix, for quantitative, semiquantitative and qualitative spectrochemical analysis kit **$64.00**

1030 **RARE EARTH ELEMENT KIT,** is like #1010 but contains the 16 elements in #1031 Rare Earth Spex Mix kit **$62.00**

1040 **NOBLE METAL ELEMENT KIT,** contains the 10 elements, some in solution, others as salts or powdered metals, as found in #1041 Noble Metal Spex Mix kit **$62.00**

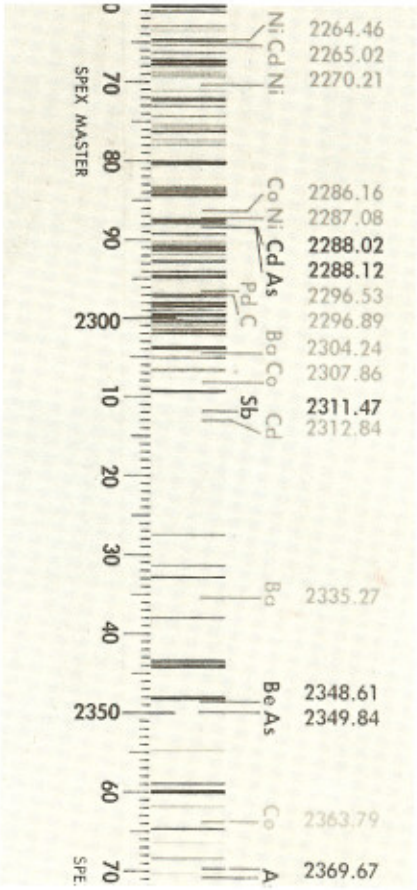
MASTER PLATES

(SPEX SPEAKER, Vol. V—No. 1)

COLOR CODED AND MATCHED TO YOUR SPECTROGRAPH

1103 **MASTER PLATES,** covering any wavelength interval from 1950 to 4600A, individually matched to any linear dispersion spectrograph. Persistent lines of about 70 elements are given with color coded labeling for ease in identification. Arc lines are in green and spark lines in red. To order please send us an iron spectrum covering the region of interest and made under conditions normally used. We recommend that when shipping the glass plate you tape it between ¼" plywood or Masonite sheets; then wrap the sandwich in a suitable buffer such as corrugated cardboard. Also specify 2" x 10" or 4" x 10" plate size for mounting.

10 inches of spectrum $105.00
40 inches of spectrum $360.00



SEMIQUANTITATIVE ANALYSIS OF PURE MATERIALS WITH SPEX MIXES

Analyzing samples of relatively pure materials for minor constituents or residuals is accomplished by "spiking" the sample with measured additions of elements of interest to approximately the 0.1% level and determining the original concentration level of impurities by calculation. Metals and most salts of metallic elements lend themselves to this type of analysis but organic materials, requiring ashing, must be treated as mixtures by a somewhat different method to be described subsequently.

PRELIMINARY SAMPLE PREPARATION

Metals, unless in fine powder form, must be converted to the oxides or salts. It is essential the salt be dried before proceeding so that it will not pop out of the electrode when arced.

SPIKING THE SAMPLE

Standards may now be prepared by adding Spex Mix, Rare Earth Spex Mix or Noble Metal Spex Mix in amounts calculated to approach the anticipated concentration levels. The amount of SM, RESM or NMSM to be added is dependent on (A) amount of spiked sample required, in grams, (B) % concentration of Spex Mix elements, (usually chosen to match levels expected to be encountered in the sample), (C) % concentration of elements in the SM*, RESM** and NMSM*** by the relationship:

$$\text{Wt of SM, RESM, NMSM to be added to sample (in grams)} = \frac{(B)}{(C)} \times (A)$$

$$\text{Sample Wt, in grams (required to prepare quantity (A))} = (A) - \text{Wt of SM, RESM, NMSM}$$

*SM = 1.27% each element
**RESM = 5.28% each element
***NMSM = 9.32% each element

For example: These quantities of Spex Mix and sample combinations are required to produce minor constituent additions of 0.1% to any matrix—

Spex Mixes	Wt of Spex Mix, g	Wt of Sample, g	Dilution Ratio
SM	0.08	0.920	1:11.5
RESM	0.019	0.981	1:51.6
NMSM	0.011	0.989	1:89.9

Weigh the SM, RESM, or NMSM plus sample (reserving sufficient quantity for further dilutions) into a #3111 plastic vial, add a #3112 Ball, and grind for 30-60 seconds in a Spex #5100 Mixer/Mill, or similar device. Call this A-1. Take 100mg of A-1 and add 200mg of the sample; mix as before. Call this A-2. Take 100mg of A-1 and add 900mg of sample; mix. Call this A-3. Take 100mg of A-2 and add 900mg of sample; mix. Call this A-4. Finally, take 100mg of A-3 and add 900mg of sample; mix. Call this A-5.

BUFFERING

Add a suitable buffer to each of the spiked standards so prepared. The original sample should also be mixed with the same buffer. A series of "standards" results containing: nothing added, (sample); 10ppm, (A-5); 33ppm, (A-4); 100ppm, (A-3); 330ppm, (A-2); and 1000ppm, (A-1) minor constituents added. The series is ready for arcing. See page 17.

INTERPRETATION OF SPECTRA AND REPORTING OF RESULTS

Concentration level of elements originally present in the sample is ascertained by visually comparing its spectrum with those of the sample plus added "spiking" standards.

In the simplest case, starting at the 1000ppm added level scan the intensity of the *raies ultimes* through all spectra. If the intensity decreases uniformly and continuously from step to step and is lowest in the original sample, the original concentration is lower than the least amount added.

> For example: Boron added is easily detectable at the 10ppm level in most materials. If the prepared series of standards shows decreasing intensity for boron lines at 2500A (approx.) for all five steps in the series and just the trace of a line in the sample, it is safe to report a level of 10ppm or less.
>
> On the other hand, if the analytical line chosen for Ca, not a particularly sensitive element in most materials, is very weak at the 330ppm added level, then disappears in other steps, it is safe to report less than 300ppm only.

When the analytical line chosen shows a decreasing intensity for only one or two added steps, then appears to remain constant, the residual amount in the sample exceeds any of the added amounts up to the point of greatest change of intensity between steps.

> For example: Consider again boron. If the intensity shows gradation down to the 100ppm added level, then remains fairly constant, an estimate of 50-100ppm can be made.

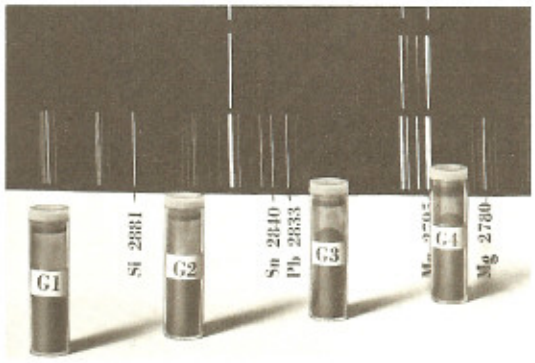
SPEX MIXES

Otherwise called spiking standards. Added to relatively pure materials, these will provide series of standards for determination of contaminants in the pure materials.

1000 **SPEX MIX** is 1.27% each of the following 49 elements Ag Al As B Ba Be Bi Br Ca Cd Ce Cl Co Cr Cs Cu F Fe Ga Ge Hg I In K Li Mg Mn Mo Na Nb Ni P Pb Rb Sb Se Si Sn Sr Ta Te Th Ti Tl U V W Zn Zr — 2g **$43.00**, 10g **195.00**

1031 **RARE EARTH SPEX MIX** is 5.28% each of the following 16 elements Ce Dy Er Eu Gd Ho La Lu Nd Pr Sc Sm Tb Tm Y Yb — 2g **$43.00**, 10g **195.00**

1041 **NOBLE METAL SPEX MIX** is 9.32% each of the following 10 elements Au Ga Hf In Ir Pd Pt Re Rh and Ru — 2g **$46.00**



SEMIQUANTITATIVE ANALYSIS OF PURE MATERIALS WITH SPEX TIME SAVERS

Continuing our attempt to pioneer the development of standards which make life a little bit easier for the harried spectroscopist we are busily at work on a new series of standards which will spare you the chores of performing the spiking operations. Accordingly, we call them TIME SAVERS. They are calibrated mixtures of one of our pure materials plus a Spex Mix.

When the total level of impurities in a pure material, resulting from the amounts of minor constituents present plus those added by the Spex Mixes, rises above the 10% level, serious errors in the analysis of the material can result, because of increasing matrix effect. This is especially true for the elements whose concentrations equal or exceed the 0.1% impurities added. However, if direct comparison standards are made by adding the Spex Mixes to matrix materials, which are of proven quality, this problem is eliminated. So, we offer a series of "Time Savers." Starting with our 5-9s and 6-9s pure materials as matrices, we have added the appropriate amount of one of the Spex Mixes for a set of standards containing from 1000ppm down to 10ppm. There is no longer a question regarding the purity of the matrix involved in estimating concentrations of unknowns. Analysis can be made by direct comparison between standards and samples.

TIME SAVER STANDARDS

These are 5-part sets of electrode-ready comparison standards containing 0.1%, 0.033%, 0.01%, 0.0033%, 0.001% of each element of the #1000, 1031 or 1041 Spex Mix you specify (Common Element, Rare Earth or Noble Metal).

Prepared from 6-9s pure materials

1007	ALUMINUM OXIDE STANDARDS	set $85.00	1106	SILICON METAL STANDARDS	set 85.00
1009	GALLIUM OXIDE STANDARDS	set 64.00	1038	TIN OXIDE STANDARDS	set 79.00
1008	GERMANIUM OXIDE STANDARDS	set 55.00	1039	YTTRIUM OXIDE STANDARDS	set 123.00
1006	SILICON OXIDE STANDARDS	set 73.00			

Prepared from 5-9s pure materials

1005	ANTIMONY OXIDE STANDARDS	set 81.00	1026	COPPER OXIDE STANDARDS	set 111.00
1016	ARSENIC OXIDE STANDARDS	set 73.00	1012	INDIUM OXIDE STANDARDS	set 59.00
1017	BARIUM CARBONATE STANDARDS	set 77.00	1027	IRON OXIDE STANDARDS	set 58.00
1018	BISMUTH OXIDE STANDARDS	set 56.00	1028	LEAD OXIDE STANDARDS	set 58.00
1019	BORON OXIDE STANDARDS	set 161.00	1013	NICKEL OXIDE STANDARDS	set 55.00
1021	CADMIUM OXIDE STANDARDS	set 82.00	1029	SELENIUM OXIDE STANDARDS	set 70.00
1014	CALCIUM CARBONATE STANDARDS	set 53.00	1022	SODIUM CARBONATE STANDARDS	set 59.00
1034	CERIUM OXIDE STANDARDS	set 153.00	1035	STRONTIUM CARBONATE STANDARDS	set 75.00
1023	CHROMIUM OXIDE STANDARDS	set 78.00	1036	TELLURIUM OXIDE STANDARDS	set 81.00
1024	COBALT OXIDE STANDARDS	set 81.00	1037	THALLIUM OXIDE STANDARDS	set 58.00

NOTE: For any of the above specify type of Spex Mix (#1000, #1031 or #1041) to be added.

SEMIQUANTITATIVE ANALYSIS OF MIXTURES WITH SPEX G, L AND Z STANDARDS

In 1962 we introduced an article in THE SPEX SPEAKER, Vol. VII, No. 4 on emission spectrochemical analysis, stating:

"Instrumental analytical methods, offering indirect measurements, usually require comparison standards to be run along with an unknown. Because the emission intensity of a particular element is far different in a steel alloy than say an aluminum alloy, the proverbial sample of "gook" defies comparison with any standardized material even for the spectrographer fortunate enough to have accumulated a library-sized assortment of reference materials. Long ago recognized as the "matrix effect," this remains the most significant and economically important problem in spectrochemical analysis."

The matrix effect still plagues spectrochemists who analyze these samples of "gook." Unlike metallurgical samples for which the black-burn technique largely overcomes the matrix effect, unknowns are usually too complex and varied to relinquish so easily their influence on dc arc temperature, volatilization rates of minor elements and variations in background intensity. When the history of the sample, or the qualitative analysis described previously categorizes it as a mixture, the intransigent matrix should be replaced with one more amenable to arcing. This "new" matrix should be easily handled and lend itself to blending smoothly with a mixture of many elements, its spectrum should be simple in order to minimize interference with spectra of elements sought. Zinc oxide, lithium carbonate and graphite usually meet these criteria.

In the early 1950s Spex initiated a line of semiquantitative standards consisting of about 30 elements as oxides, carbonates and chlorides blended with graphite in concentrations of 0.1%, 0.01%, 0.001% and 0.0001% and in zinc oxide or lithium carbonate without the 0.0001%. Since that time the standards have been expanded to include 49 elements in the basic set and a series for Rare Earths and Noble Metals as ever more materials were being analyzed. The G, L and Z standards are adequate, providing accuracies from 1/2 to 2 times the amount of unknown present, when "eyeball" measurements suffice. But as we aspire to higher tolerances and materials come under closer scrutiny, more sophisticated techniques and standards are called for.

Some Limitations of the 3 and 4 Part 10:1 Dilution Standards are:

(1) Interpolation of line intensities between samples and standards is difficult when the standards differ by factors of ten.

(2) Spectroscopic emulsions which have a contrast factor of around 1.5 overall but vary with wavelength so the accuracy of visual estimation depends on compensation for the changing contrast.

(3) The latitude of an emulsion accommodating a concentration range of only 100:1 while our G standards exceed this by a factor of 10; only two steps of the standards can be resolved by the emulsion.

(4) Non linearity of emulsion above 85%T and below 5%T. The upper and lower concentration steps of our 4-part standards approach both these limiting values and the resulting analysis suffers accordingly.

(5) An analytical curve requires at least three points, preferably over a concentration range of <100:1 for plotting curves. This is difficult to achieve over the concentration range of 1000:1 with steps of 10:1.

ADVANTAGES OF NEW 5 AND 7 PART STANDARDS

Thus the implication is clear! Standards which differ by factors of less than 10:1 will improve accuracy of analysis because they:

(1) More easily bracket sample dilutions when visual estimates are made;

(2) Remain within the latitude of spectroscopic emulsions, and

(3) Allow for a plot of the analytical curve encompassing at least three standard concentrations.

The dilution factor which best satisfies all these criteria is 3:1. (Actually $\sqrt{10}$ is theoretically superior but not as practical.) Our expanded series of 7 and 5-part standards, designated G-7, L-5 and Z-5 with 3:1 dilutions overcome the limitations cited.

To improve accuracy still further, Indium, an internal standard element has been added to each of the standards. Variations in arcings from one sample to the next can be largely overcome by taking ratios to this element which is added at the same concentration to standard and samples alike.

PRELIMINARY SAMPLE PREPARATION

The accuracy and precision of an analysis are largely dependent on how closely standards and samples match in form, history and concentration levels of the elements sought. Spex methods suggest controls of these three parameters to achieve a match. Coarse particles and chunks of material may be reduced to powders simply by grinding. The sample may still "remember" that it is carbonaceous but that becomes a secondary consideration. Or, the sample may be dissolved, dried, ignited to an oxide and ground, rendering both prior form and history harmless in affecting the analysis, since the standards are primarily oxides. Such precautions taken to match samples with standards assure improvement in accuracy.

PREPARATION OF THE SAMPLE

For most inorganic materials simple drying of the sample, where necessary, to prevent its popping out of the electrode, is sufficient. Organic materials should be ashed first. Wet ashing usually adds impurities from the acid treatment of the sample. Dry ashing may cause the loss of some elements because of the elevated temperatures required. By similarly treating the standards an automatic correction factor is introduced for the gain or loss of the same elements. Weigh 100 mg of the sample into a #3111 vial, add a #3112 ball and 900 mg of #1263 high purity ZnO, #1234 Li_2CO_3 or #4061 Graphite. Grind for about 30 seconds in a #5100 Mixer/Mill; call this mix D-1. Place 200 mg of D-1 in another vial with ball and add 400 mg of the same diluent. Mix as before; call this D-2. Add and mix 900 mg of diluent to 100 mg of D-1; call this D-3. To 100 mg of D-2 add and mix 900 mg of diluent; call this D-4. To 100 mg of D-3 add and mix 900 mg of diluent; call this D-5. The D's are the sample diluted 10, 30, 100, 300 and 1000 times. When arced these prepared samples will now closely resemble the Z, L or G standards. See page 17 for procedure.

If highest accuracy is required, indium oxide can be added as an internal standard to the sample and each of its dilutions to the extent of 0.10% indium (gravimetric factor for indium is 1.21).

INTERPRETATION OF RESULTS

Choose an analytical line of the particular impurity elements of interest. Check for interference in wavelength tables. Proceed with one of these alternative schemes in order of increasing accuracy:

(1) Visually match intensities of the standard and analytical line. Multiply by the dilution factor.

(2) Obtain transmittance data for samples and standards. Plot analytical curve as %T vs. Concentration, for the standards, and read results for samples from it. Multiply by the appropriate dilution factor.

(3) Obtain microphotometer data for samples and standards on a recording microphotometer. Estimate the areas under the line tracing and plot analytical curve from the standards as Area Under Curve vs. Concentration. Read results for samples from it. Multiply by the proper dilution factor.

(4) Take intensity ratios of element line to suitable indium internal standard line and plot vs. concentration. Emulsion calibration is necessary in this case.

You will note that plate calibration is not suggested in all of the above procedures. The additional work involved cannot be justified in terms of the improvement in accuracy.

COMMON ELEMENT STANDARDS

These are for the determination of major and minor constituents of unknowns by the dilution technique we have described. They contain the 49 elements in #1000 Spex Mix in the concentrations indicated.

1001	**Z STANDARDS,** 0.1%, 0.01%, 0.001% of each element in zinc oxide (for analysis of organic materials)	set	**$ 43.00**
10015	**Z-5 STANDARDS,** 0.1%, 0.033%, 0.01%, 0.0033%, 0.001%, Indium internal standard added	set	**86.00**
1002	**G STANDARDS,** 0.1%, 0.01%, 0.001%, 0.0001% of each element in graphite (for analysis of inorganic materials)	set	**53.00**
10027	**G-7 STANDARDS,** 0.1%, 0.033%, 0.01%, 0.0033%, 0.001%, 0.00033%, 0.0001%, Indium internal standard added	set	**106.00**
1004	**L STANDARDS,** 0.1%, 0.01%, 0.001% of each element in lithium carbonate (for analysis of organic materials particularly petroleum products)	set	**43.00**
10045	**L-5 STANDARDS,** 0.1%, 0.033%, 0.01%, 0.003%, 0.001%, Indium internal standard added	set	**86.00**

RARE EARTH STANDARDS

When rare earths are sought in unknowns they are usually associated with only one or two of our 49 common elements. So to avoid interference of common element lines with the complex spectra of the rare earths, separate standards are prepared for their determination. These contain the 16 elements of the #1031 Rare Earth Spex Mix in the concentrations indicated.

1032	**RARE EARTH L STANDARDS,** 0.5%, 0.05%, 0.005%, 0.0005% of each element in lithium carbonate (for the determination of rare earth elements in an unknown material)	set	**$59.00**
10327	**RARE EARTH L-7 STANDARDS,** 0.5%, 0.167%, 0.05%, 0.0167%, 0.005%, 0.00167%, 0.0005%, Indium internal standard added	set	**118.00**

NOBLE METAL STANDARDS

Noble metals, like rare earths, are seldom encountered in ordinary materials. Therefore, we prepare separate standards to simplify their determination. Each of the standards contains the 10 elements of the #1041 Noble Metal Spex Mix in the concentrations indicated.

1042	**NOBLE METAL G STANDARDS,** 0.5%, 0.05%, 0.005%, 0.0005% of each element in graphite	set	**$57.00**
10427	**NOBLE METAL G-7 STANDARDS,** 0.50%, 0.167%, 0.05%, 0.0167%, 0.005%, 0.00167%, 0.0005%, Indium internal standard added	set	**92.00**

NOTE: We can prepare special order sets of standards as well as those listed. For example, if you prefer a mixture of lithium carbonate and graphite or some other material as a diluent and buffer, please contact us for further information.

ARCING AND RECORDING OF SPECTRA

To minimize differences in instrumentation, laboratory technique, plate processing and the like we recommend:

(1) Arc standards and samples singly or in replicate depending on accuracy requirements. The short-cut approach of preparing a plate with all the standards on it today, for instance, recording all data and plotting analytical curves, then comparing this with a series of samples run two weeks later is the least quantitative.

(2) If more than one person is involved in the preparation of material for analysis, particularly in loading the electrodes, take some precaution in ascertaining that the weight of sample loaded is uniform. Be sure electrodes are packed solid. A loosely packed electrode tends to have some of its charge blown away during the initial few seconds of arcing. Extreme intensity variations result and make an accurate analysis impossible in some cases.

(3) Attenuate all spectra with at least a two-step neutral density filter. This assures a readable line on almost all dilution steps of standards and samples.

(4) Excite the sample under an inert atmosphere controlled by the Stallwood Jet. (30% O_2 - 70% Ar mixture has proven quite useful in our laboratory.) The Stallwood Jet reduces arc-wander; promotes more uniform volatilization of elements by causing the sample to burn off in successive layers; reduces overall background which increases S:N hence sensitivity of many elements; practically eliminates the cyanogen bands which usually obscure the *raies ultimes* of a number of elements making their determination more difficult.

(5) Work with the smallest possible electrode diameter commensurate with the analysis. The anode spot diameter is a function of current. When it fills the cross-section of the electrode a "high-intensity" DC arc results. This is much more steady than the normal arc. For a 1/8" dia. electrode, the cross-over point from ordinary to high intensity occurs at around 13 amp. This rises to 26 amp and 52 amp for 3/16" dia. and 1/4" dia. electrodes, respectively.

(6) Burn the sample to completion. If the reproducibility of burn is such that it can be timed automatically so much the better. If not, tend the arc more closely and cut if off manually for each sample. In any case if the burn deviation is more than around 5-10% of the usual 60-90 second burn check on the uniformity of your mix of sample and diluent, or electrode packing procedures.

(7) Fast photographic emulsions, popular belief to the contrary, do not always provide for the best results in the typical analysis encountered here. Their graininess and attendant fog reduce S:N, and thus sensitivity, for many elements. On the other hand a slow emulsion tends to have a high gamma thus limiting the acceptable concentration range. Choose accordingly.

PELLEMENTARY STANDARDS

The spectroscopist who is fortunate enough to have available a direct reading emission spectrometer, or automated x-ray emission spectrometer will attest to their excellent qualities in determining many elements in hundreds of matrices at the flick of the proverbial switch. Occasionally these instruments require minor adjustments, however, to maintain their sensitivity and selectivity. These may be difficult to make without a readily available line to tune on. A reference standard to produce this might be handled frequently so should be fairly rugged. It should be selective to reduce interelement interference but would be desirable in a wide variety of elements and provide scattered radiation in the region of interest. Our Pellements are all this plus inexpensive so they are readily replaced if lost or destroyed.

1015 **PELLEMENT,** 1-1/4" od x 3/16" thick, containing 1% of any of these elements in graphite, (specify): Ag, Al, As, Au, B, Ba, Be, Bi, Br, Ca, Cd, Ce, Cl, Co, Cr, Cs, Cu, Dy, Er, Eu, F, Fe, Ga, Gd, Ge, Hf, Hg, Ho, I, In, Ir, K, La, Li, Lu, Mg, Mn, Mo, Na, Nb, Nd, Ni, P, Pb, Pd, Pr, Pt, Rb, Re, Rh, Ru, Sb, Sc, Se, Si, Sm, Sn, Sr, Ta, Tb, Te, Th, Ti, Tl, Tm, U, V, W, Y, Yb, Zn, Zr each **$15.00**

QUANTITATIVE EMISSION AND X-RAY STANDARDS

We maintain a stock of the following British Bureau of Analysed Samples standards. The information, extracted from the BBAS most recent catalog, is continually being updated. Please contact us for any additional information you may require on other standards.

BSS 21, 23, AND 24

LOW TUNGSTEN STEEL SERIES,
Rods, 3/4" dia. by 3" long — Set of 3 **$50.00**

TYPICAL ANALYSIS
(ITALICIZED FIGURES ARE APPROXIMATE)

S. S. No.	W %	C %	Si %	S %	P %	Mn %	Mo %	V %
21	**0.70**	*0.02*	*0.13*	*0.036*	*0.014*	*0.07*	*0.02*	*<0.01*
23	**2.16**	*0.18*	*0.21*	*0.036*	*0.018*	*0.07*	*0.04*	*<0.01*
24	**3.41**	*0.18*	*0.22*	*0.036*	*0.018*	*0.07*	*0.02*	*0.03*

BSS 41/1-46/1

NODULAR IRON SERIES, Bars, 1-3/16" dia. x 1-1/2" long — Set of 6 **$115.00**

TYPICAL ANALYSIS
(ITALICIZED FIGURES ARE APPROXIMATE)

S. S. No.	Mg %	Ni %	C %	Si %	Mn %	S %	P %
41/1	**0.013**	**0.28**	*3.40*	*2.38*	*0.32*	*0.010*	*0.017*
42/1	**0.024**	**0.38**	*3.30*	*1.93*	*0.31*	*0.010*	*0.016*
43/1	**0.038**	**0.51**	*3.06*	*2.39*	*0.36*	*0.006*	*0.010*
44/1	**0.051**	**0.63**	*3.08*	*2.40*	*0.36*	*0.007*	*0.013*
45/1	**0.079**	**0.92**	*3.02*	*2.30*	*0.37*	*0.006*	*0.011*
46/1	**0.105**	**1.27**	*3.24*	*2.29*	*0.30*	*0.006*	*0.016*

BSS 50-55

'GROUP A' **MILD RESIDUAL STEEL STANDARDS,**
Discs, 1-1/2" dia. x 3/4" thick — Set of 6 **$96.00**

TYPICAL ANALYSIS

S.S. No.	Ni %	Cr %	Mo %	W %	Ti %	As %	Sn %	Al %	Sb %
50	**0.022**	**0.131**	**0.22–**	**0.17–**	**0.021**	**0.031**	**0.085**	**0.013**	...
51	**0.099**	**0.106**	**0.068**	**0.077**	**0.13–**	**0.003**	**0.014**	...	...
52	**0.194**	**0.039**	**0.045**	**0.048**	**0.042**	**0.012**	**0.24–**	**0.093**	...
53	**0.172**	**0.22–**	**0.100**	**0.25–**	**0.018**	**0.058**	**0.024**	...	...
54	**0.050**	**0.077**	**0.17–**	**0.106**	**0.033**	**0.084**	**0.13–**	...	...
55	**0.23–**	**0.22–**	**0.16–**	**0.12–**	**0.013**	**0.013**	**0.046**	**0.028**	**0.002**

BSS 56-60

'GROUP B' **MILD RESIDUAL STEEL STANDARDS,**
Discs, 1-1/2" dia. x 3/4" thick — Set of 6 **$80.00**

TYPICAL ANALYSIS

S.S. No.	Mn %	Cu %	V %	Co %	Al %	Pb %	B %	Sb %
56	**0.32**	**0.36–**	**0.057**	**0.023**	**0.005**	**0.014**	**0.001**	**0.005**
57	**0.16**	**0.16–**	**0.14–**	**0.006**	**0.020**	**0.010**	**0.003**	**0.033**
58	**0.43**	**0.084**	**0.19–**	**0.17–**	**0.050**	**0.015**	**0.004**	**0.026**
59	**0.12**	**0.072**	**0.083**	**0.070**	**0.058**	**0.050**	**0.008**	**0.018**
60	**0.45**	**0.047**	**0.027**	**0.020**	**0.019**	**0.003**	**0.007**	**0.018**

BSS 61-68

AUSTENITIC STAINLESS STEEL SERIES, Discs, 1-3/4" dia. Set of 8 **$145.00**

TYPICAL ANALYSIS

S. S. No.	C %	Si %	S %	P %	Mn %	Ni %	Cr %	Mo %	Co %	Ti %	Nb %	Ta %	Pb %
61	0.062	0.42	0.016	0.016	0.78	6.26	15.2$_0$	...	0.040	...	...	...	...
62	0.063	0.44	0.020	0.015	0.80	12.4$_5$	12.8$_0$	...	...	...	...	...	...
63	0.066	0.45	0.020	0.016	0.79	9.49	18.7$_0$	...	...	...	...	...	...
64	0.079	0.45	0.022	0.012	0.85	20.6$_0$	25.6$_0$		0.052	...	...	...	0.0011
65	0.093	0.67	0.023	0.018	0.94	9.47	18.4$_5$	...	0.034	0.46	...	0.0017	0.0015
66	0.083	0.51	0.023	0.020	0.81	9.48	17.6$_0$	2.43	0.063	...	...	...	0.0007
67	0.081	0.50	0.018	0.016	0.87	9.52	17.8$_0$	...	...	...	1.02	0.048–	0.0012
68	0.163	1.42	0.028	0.027	1.59	9.33	18.5$_0$	...	...	...	...	...	...

BSS 69-72

FERRITIC STAINLESS STEEL SERIES, Discs, 1-3/4" dia. Set of 4 **$65.00**

TYPICAL ANALYSIS

S. S. No.	C %	Si %	S %	P %	Mn %	Ni %	Cr %	Mo %
69	0.29–	0.36	0.022	0.022	0.41	0.37	12.4$_0$	...
70	0.18–	0.35	0.020	0.024	0.38	0.40	16.3$_5$	...
71	0.10$_5$	0.31	0.024	0.016	0.43	0.56	24.0$_0$	...
72	0.18–	0.92	0.026	0.030	0.91	2.16	16.1$_5$	0.69

BSS 431-435

PLAIN CARBON STEELS, Discs, 1-1/2" dia. x 3/4" thick Set of 5 **$80.00**

TYPICAL ANALYSIS

S.S. No.	C %	Si %	S %	P %	Mn %	Nb %
431	0.019	0.033	0.014	0.009	0.95	0.022
432	0.093	0.042	0.053	0.016	1.10	0.029
433	0.19$_0$	0.20–	0.073	0.070	0.60	0.032
434	0.37–	0.51–	0.010	0.056	1.54	0.100
435	0.49–	0.57–	0.037	0.025	0.37	0.020

BSS 481-486

HIGH-SPEED STEEL SERIES, Discs, 1-3/4" dia. x 1/2" thick Set of 6 **$132.00**

TYPICAL ANALYSIS

S.S. No.	W %	Cr %	V %	Mo %	Co %	C %	Si %	S %	P %	Mn %
481	14.2–	3.56	0.52	0.22	0.21	0.69	0.14	0.027	0.021	0.29
482	18.1–	4.09	0.98	0.27	0.24	0.70	0.13	0.025	0.021	0.28
483	10.8–	3.21	0.54	0.17	1.94	0.67	0.11	0.025	0.019	0.29
484	22.4–	5.17	0.94	1.07	10.2–	0.85	0.20	0.024	0.030	0.21
485	18.2–	4.15	1.05	0.67	5.06	0.89	0.42	0.043	0.046	0.50
486	6.48	4.53	1.92	5.23	0.13	0.74	0.14	0.029	0.021	0.12

NOTE: A series of LOW ALLOY STEELS, the supply of which was exhausted during early 1968, will again be offered in 1969. The new set will be standardized for: **C, Si, S, P, Mn, Ni, Cr, Mo, V and Cu.** Please call us for further details.

QUANTITATIVE CHEMICAL STANDARDS

Although we do not stock the following list of standards they are available from us; allow 3-4 week delivery. Note that they duplicate many of the standards previously listed for Emission and X-Ray, except they are in the form of millings. We will be pleased to furnish analyses of any of these materials at your request.

HIGH PURITY IRONS

B.C.S. Sample No.	Description	Special Features	PRICES 100g.
149/2	High Purity Iron	0.002% C	$11.00
260/2	High Purity Iron	0.001% C	15.00

CARBON STEELS

317	0.03%C 3.5%Si	C, Si, S & P standard	$11.00
152/2	0.25 %S	Free Cutting	11.00
237/1	0.1 %C	C, Mn & N Standard	9.30
306	0.15%S	0.4%C Free Cutting	11.00
218/3	0.15%C	Complete Analysis	11.00
232/1	0.1 %S	Semi-Free Cutting	10.30
238/2	0.2 %C	C and Si Standard	10.30
239/3	0.3 %C	Complete Analysis	11.00
240/2	0.4 %C	C, S & P Standard	9.30
159/2	0.5 %C	Complete Analysis	11.00
221/1	0.6 %C	Complete Analysis	11.00
161/3	0.8 %C	Complete Analysis	11.00
215/2	0.9 %C	Complete Analysis	11.00
163/1	1.2 %C	Complete Analysis	11.00
264/1	0.01%N	C and N Standard	11.00
265/2	0.02%N	C and N Standard	11.00
270	0.09%P	C and P Standard	9.30
431 to 435	Plain Carbon Steels containing Nb	A series containing increments of C, Si, S, P, Mn & Nb.	15.00
320 to 330	Mild Steels	Second residual series	17.65

LOW ALLOY STEELS

B.C.S. Sample No.	Description	PRICES 100g.
252/1–257/1	A special series of Low Alloy Steels standardized for Si, Mn, Ni, Cr, Mo, V, Cu	$16.20
281–284	Low Tungsten Steels 0.70 to 3.41% W	11.00

ALLOY STEELS

B.C.S. Sample No.	Description	Special Features	PRICES 100g.
222/1	Nickel Steel	Ni only	$10.30
212/1	Leaded Steel	0.22% Pb Free Cutting	13.75
224/1	Cr-V Steel	Complete Analysis	13.75
214/2	Mn-Mo Steel	Complete Analysis	13.75
225/2	Ni-Cr-Mo Steel	Complete Analysis	13.75
219/3	Ni-Cr-Mo Steel	Complete Analysis	13.75
241/2	Cr-V-W-Co-Mo	High Speed Steel	20.60
220/1	7% W 4% Mo	High Speed Steel	19.10
235/2	18/8+Ti	Ti bearing Stainless	18.00
261	Nb Stabilized 18/12	Nb bearing Stainless low in Mo, Cu & W	15.90
211/1	13% Cr	Rustless	15.00
290	13% Mn	Complete Analysis	18.00
233	11% Ni 24% Co +Ti	Permanent Magnet	19.10
312	13% Ni 24% Co +Ti & Nb	Permanent Magnet	19.10
331 to 338	Austenitic Stainless Steels	Standardized for C, Si, S, P, Mn, Ni, Cr and Co, Mo, Ti, Nb, Ta, Pb in certain samples.	19.10
339 to 342	Ferritic Stainless Steels	Standardized for C, Si, S, P, Mn, Ni, Cr (and Mo in 342)	17.65
481 to 486	High Speed Steels	A special series standardized for W, Cr, V, Mo, Co, C, Si, S, P & Mn	20.60

CAST IRONS

236/3	Hematite	Si, Mn, S, P, Ti	$11.00
169/1	Hematite	Low P, Titaniferous	11.00
170/3	Foundry	Si, Mn, S & P	11.00
234/7	High Duty	Compl. Anal. High S	11.00
206/2	High Si and P	Complete Analysis	11.00
172/2	Alloy	Compl. Anal. Ni-Cr-Mo	13.75
173/1	Austenitic	High Ni-Cr-Cu	15.90
247/3	White Iron	Combustion C & S Std.	9.30
311/1	Nodular Iron	Mg, Ni & S	16.20

FERRO-ALLOYS

242/1	Ferro-Tungsten	Tungsten, Low C	$12.95
231/4	Ferro-Molybdenum	Molybdenum, Low C	15.00
203/4	Ferro-Chromium	Low C & S	16.20
204/2	Ferro-Chromium	High C	12.95
205/3	Ferro-Vanadium	Vanadium only	12.95
208/1	Ferro-Manganese	High C	12.95
280/1	Ferro-Manganese	Low C	15.90
243/3	Ferro-Titanium	Ti, Al, C, Cu, Si and Mn	12.95
305/1	Ferro-Silicon	Si, Al, Ca and P	13.25
362	Ferro-Niobium	Nb, Ta, C, Si, Al & Sn	17.65

SLAGS

B.C.S. Sample No.	Description	Special Features	PRICES 100g.
174/2	Basic Slag	Complete Analysis	$17.65

ORES

175/2	Nimba Iron Ore	Complete Analysis	$13.75
301	Lincolnshire Iron Ore	Complete Analysis	13.75
302	Northants. Iron Ore	Complete Analysis	13.75
303	Iron Ore Sinter	Complete Analysis	13.75
176/1	Manganese Ore	Mn, MnO_2, SiO_2, P, Fe	13.75
308	Grecian Chrome Ore	Cr_2O_3, FeO, SiO_2, Al_2O_3 CaO, MgO	17.65

REFRACTORY MATERIALS

313	High Purity Silica	Complete Analysis	$17.65
314	Silica Brick	Complete Analysis	17.65
267	Silica Brick	Complete Analysis	17.65
269	Firebrick	Complete Analysis	17.65
315	Firebrick	Complete Analysis	17.65
319	Magnesite	Si_2O, TiO_2, Al_2O_3, Fe_2O_3, CaO, MnO	17.65
309	Sillimanite	Complete Analysis	17.65

NON-FERROUS ALLOYS

177/1	Lead Base White Metal	Complete Analysis	$11.00
178/1	Tin Base White Metal	Complete Analysis	19.10
179/1	High Tensile Brass	Complete Analysis	12.95
180/1	Cupro-Nickel	Complete Analysis	13.75
183/2	Bronze	Complete Analysis	13.75
364	Leaded Bronze	Complete Analysis	17.65
207/1	Bronze	Complete Analysis	12.10
304	Aluminium Bronze	Complete Analysis	15.00
310	Nimonic '90'	Complete Analysis	19.10
181/2	4% Cu Alum. Alloy	Complete Analysis	17.65
182/2	11% Si Alum. Alloy	Compl. Analysis High Si	17.65
216/2	Duralumin Alloy	General Purpose	17.65
262	10% Mg Alum. Alloy	Complete Analysis	13.75
263/1	5% Mg Alum. Alloy	Complete Analysis	15.00
268	5% Si Alum. Alloy	Complete Analysis	13.75
300	6%Zn Alum. Alloy	Complete Analysis	15.00
307	Magnesium Alloy	Rare Earths, Zn & Zr	15.00
316	8%Al Magnesium Alloy	Complete Analysis	15.00

alpha

ALPHA METALS INC. SPECTROCHEMICAL STANDARDS

Alpha spectrochemical standards for analysis of non-ferrous metals are designed specifically for both optical emission spectrographs, employing a point-to-plane excitation system, and X-Ray emission spectrographs. Because of the effects of metallurgical history in methods of this type, samples to be analyzed must be in chill-cast form. Metal in any other form (extruded, rolled, punched, drawn, spherized etc.) should be remelted and cast in disk form. Spex **No. 3904 BOOK MOLD ($72.00)** accomplishes this.

Compositions listed are only approximate since successive batches vary to some degree. Each batch is analyzed and composition is furnished with each standard. For elements present at relatively high concentrations primary reliance is placed on wet chemical methods of analysis. However, optical emission, atomic absorption and X-Ray emission techniques are used when appropriate.

All standards are 1⅝″ diameter by ¾″ thick, chill-cast in a specially designed water cooled mold to insure maximum uniformity. All batches are evaluated for uniformity within and among specimens by extensive testing.

LEAD WITH ANTIMONY

	Pb	Sb	Price
LA-.5	Remainder	.48	**$25.00**
LA-1.0	Remainder	.99	**$25.00**
LA-2.0	Remainder	2.02	**$25.00**
LA-3.5	Remainder	3.52	**$25.00**
LA-7.0	Remainder	6.96	**$25.00**
LA-10.0	Remainder	9.86	**$25.00**
LA-13.0	Remainder	(12.99)	**$25.00**

( ) — Some segregation noted.

63A10-12 **SOLDER STANDARDS** Set of 3 **$150.00**

	63 A 10	63 A 11	63 A 12
Sb	.15	.36	.58
As	.009	.019	.031
Bi	.038	.094	.23
Fe	(.006)	(.016)	(.018)
In	.005	.01	.022
Ni	.001	.0025	.007
Al	(.001)	(.0025)	(.007)
Cu	.05	.10	.25
Ag	.019	.036	.049
Cd	.0057	.01	.025
Zn	.0005	.0013	.003
Au	.04	.10	.25
Sn*	63.0	63.2	63.5
Pb	Balance	Balance	Balance

( ) — Subject to segregation effects. Not intended for calibration purposes.
* — Tin values are listed for the purpose of alloy identification only.

TIN/LEAD SOLDER

	Sn	Sb	Cu	Au	Price
S.S.C.A. #1	59.08	.12	<.0001 ND	(.10)	**$25.00**
S.S.C.A. #2	60.05	.30	.053	(.01)	**$25.00**
S.S.C.A. #3	61.19	.50	.10	.040	**$25.00**
S.S.C.A. #4	62.36	.13	.25	.10	**$25.00**
S.S.C.A. #5	63.08	.30	.42	.25	**$25.00**
S.S.C.A. #6	64.72	.49	.51	.50	**$25.00**

( ) — Not for calibration purposes.

BM-1 **BABBITT METAL** Each **$30.00**

Pb	Remainder
Sb	13.96
Sn	.97
As	.94

TIN WITH ANTIMONY

	Sn	Sb	Price
TA-1	Remainder	1.03	**$25.00**
TA-2	Remainder	2.01	**$25.00**
TA-3	Remainder	3.05	**$25.00**
TA-5	Remainder	5.09	**$25.00**
TA-8	Remainder	8.02	**$25.00**
TA-10	Remainder	10.09	**$25.00**
TA-12	Remainder	12.42	**$25.00**

PRE-WEIGHED CHEMICALS

In many laboratories, spectroscopy is a production operation and the director is expected to turn out analytical results like any other product, at the lowest cost. Toward this end, we at Spex Industries have tried over the years to introduce time-saving ideas, instruments and standards. With pre-weighed powders, which are ordinarily weighed out in the laboratory one portion for each analysis, we can save you money and free your technicians for more important work than repetitive weighings.

Typically, a weighing in a spectrographic lab takes at least one minute including the transfer to the container. At a cost of $20.00 per hour—a figure often quoted to us by laboratory managers who include salary plus overhead—this means that each weighing costs 33 cents. On a large scale, using an expensive automatic balance, we can weigh with equal accuracy, at a fraction of that cost and pass the savings on to you.

Further to reduce costs, we package the chemicals in containers ready for the addition of a sample and either blending or fluxing depending on the application. For the emission laboratory, you can purchase 100 mg units of graphite powder already packaged in plastic vials with a ball included, at a price per 100 of $23.45. You merely add your weighed sample and shake it in a Mixer/Mill or Wig-L-Bug. For the infrared laboratory you can have high-purity KBr of the proper particle size and sealed to prevent moisture pickup. It is in a glass container into which you not only mix the sample but can finally store the 13 mm pellet. For fluxing techniques in both X-ray and emission laboratories, you can choose the convenience of having weighed amounts of lithium tetraborate.

PRICE LIST ..... SPECIFY ACTUAL WEIGHT REQUIRED

GRAPHITE POWDER, highest purity Cat. #4061 (-100 mesh) #4064 (-200 mesh) or #4062 (for briquetting); in 3111 vial (polystyrene 1/2" dia. x 1" long) with 3112 ball (Lucite, 3/8" dia.)

		100	500	1000	5000
30-100 mg	±2.0 mg	23.45	83.50	134.50	557.25
101-150 mg	±2.0 mg	24.55	89.00	139.00	589.25
151-200 mg	±2.0 mg	25.65	90.50	146.50	622.25

GRAPHITE POWDER, same as above except in 1/2" dia. x 2" long plastic vial (3116) with 3/8" dia. Lucite ball (3112)

up to		100	500	1000	5000
400 mg	±2 mg	31.30	108.75	181.95	777.15
900 mg	±2 mg	42.30	135.25	246.95	1082.15

LITHIUM CARBONATE, spectrographic grade in 3111 vial with 3112 ball

		100	500	1000	5000
30-100 mg	±2.0 mg	33.15	102.25	158.25	684.00
101-150 mg		39.15	108.25	179.25	838.00
151-200 mg		45.15	115.25	200.25	866.00

LITHIUM CARBONATE-GRAPHITE, -100 mesh powder 1:1 weight

		100	500	1000	5000
30-100 mg	±2.0 mg	29.15	92.25	147.25	636.00
101-150 mg		32.15	97.75	159.25	692.00
151-200 mg		35.15	103.25	173.25	748.00

POTASSIUM BROMIDE, infrared grade, in glass vial (3/4" dia. x 1" long) with stainless steel ball, 1/8" dia.*

up to		100	500	1000	5000
200 mg	±2 mg	25.20	92.25	157.25	Special quote for 5000 quantity
300 mg		26.70	99.75	163.25	
400 mg		28.20	107.25	179.25	
500 mg		29.70	114.75	187.25	

LITHIUM TETRABORATE, 1000 mg or less in 3116 vial, (no ball); over 1000 mg in 6133 vial, (no ball).

		100	500	1000	5000
100 mg	±5 mg	22.90	89.50	138.30	570.15
500 mg		24.50	97.50	145.80	616.15
1000 mg		28.00	106.50	173.15	800.15
1500 mg		30.10	114.60	186.40	882.00
1800 mg		31.30	118.50	194.25	921.25

*These vials are sealed in containers together with silica gel to maintain extreme dryness of the KBr. They may be shaken in our No. 5100 Mixer/Mill directly. In the Wig-L-Bug a special adapter (3113K at $8.50) is required.

PLEASE CONSIDER THIS PRICE LIST AS A GUIDE. IF YOU REQUIRE SPECIAL MIXTURES OR WEIGHTS WE SHALL GLADLY QUOTE. WE CAN WORK EITHER WITH OUR MATERIALS OR YOURS.

ORDERING INFORMATION

Minimum order $10.00

Terms are net 30 days to rated firms. To avoid delays purchasers who have not transacted any previous business with Spex Industries should include commercial references or remittance with the initial order.

Shipments will be made F.O.B. Destination anywhere within the continental United States via our choice of transportation. Any premium transportation, packaging or invoicing requested will be additionally invoiced.

Foreign orders will be accepted subject to U.S.A. regulations and shipped F.O.B. Metuchen, N.J. 08840.

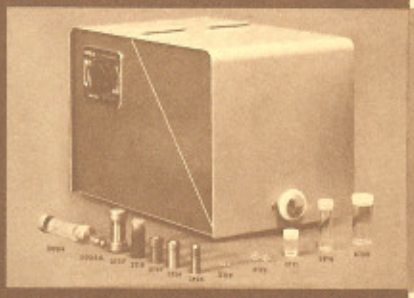
NYLON-LUCITE SIEVE SETS

On unique telescoping frames, 100, 200, 325 and 400 mesh screens separate up to four fractions in one operation, leaving no metallic contamination.

BORON CARBIDE & SILICON CARBIDE MORTARS & PESTLES

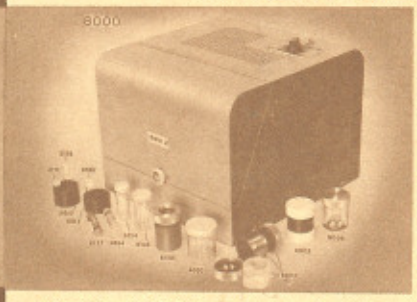
For hand grinding of unusually hard substances choose among bowl diameters from 1/2" to 3", all smooth, chemically inert, free of bonding agents and near the top of the list in Knoop hardness.

MIXER/MILL® No. 5100



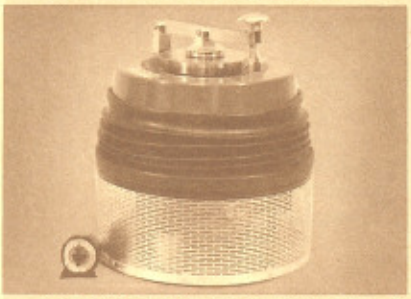
Put electricity to work grinding or mixing powders. The No. 5100 will take care of quantities up to 10 ml.....

MIXER/MILL® No. 8000



the No. 8000 handles up to 25 ml. Both 5100 and 8000 have an assortment of plastic, alumina, steel and tungsten carbide vials for quickly getting problems down to reasonable size—like —325 mesh.

SHATTERBOX®



This is the big, really tough machine for fast action. Not much will withstand the onslaught of the tungsten carbide puck and ring in its tungsten carbide grinding container. Two or three minutes do the job for up to 100 ml.

FREEZER/MILL®

Our cool new grinder makes powder from the gummiest things such as animal tissue, plastic or wax by impact-grinding under liquid nitrogen. We'll gladly send literature, of course, but if you would really like convincing send us your problem sample to test grind.

SPEX INDUSTRIES, INC./BOX 798/METUCHEN, N. J. 08840/ ☎ (201) 549-7144

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