

LANDOLT-BÖRNSTEIN

Zahlenwerte und Funktionen
aus Naturwissenschaften und Technik

Neue Serie

Gesamtherausgabe: K.-H. Hellwege

Gruppe II: Atom- und Molekularphysik

Band 10

Ergänzung zu Band 2

Magnetische Eigenschaften der Koordinations-
und metallorganischen Verbindungen
der Übergangselemente

Ergänzungsband 2 (1969, 1970)

E. König und G. König

Herausgeber: K.-H. Hellwege und A. M. Hellwege



Springer-Verlag Berlin · Heidelberg · New York 1979

Table of contents

	page	
	Part 1	Part 2
Part 1: Magnetic susceptibility of coordination and organometallic transition metal compounds	1	-
Part 2: Electron paramagnetic resonance of coordination and organo-metallic transition metal compounds	-	747
Introduction	1	747
List of symbols	1	747
General remarks	3	748
Theoretical basis	3	-
Basis theory	-	748
Definition and fundamental concepts	-	748
The spin Hamiltonian	-	749
Description of individual ions	-	749
Molecular orbital theory of EPR parameters	-	756
Arrangement of tables	3	757
Compounds listed, their designation and order	3	757
Presentation of experimental results	6	757
Selection and accuracy of data	7	-
Experimental methods	7	-
References	8	758
Literature coverage	8	759
Abbreviations	9	-
Selected diamagnetic ionic susceptibilities, Pascal constants, and one-electron spin-orbit coupling constants	12	-
Theoretical nomograms: calculated average magnetic moments as function of temperature, spin-orbit coupling, axial field splitting and orbital reduction	15	-
References to the introduction	25	759
Standard reference texts on magnetochemistry	25	-
Standard reference texts on electron paramagnetic resonance	-	759
Tables of magnetic data on transition metal compounds	25	-
Tables of electron paramagnetic resonance data on transition metal compounds	-	759
Reviews on magnetochemistry of coordination compounds published in 1969 and 1970	25	-
Review on electron paramagnetic resonance of coordination compounds published in 1969 and 1970	-	760
Selected references on theory and experimental methods in the magnetism of transition metal compounds (1969 and 1970)	26	-
Ligand field theory of magnetism	26	-
Theory of intramolecular exchange interaction	26	-
Theory of magnetism at high-spin \rightleftharpoons low spin transitions	26	-
Experimental methods in magnetism	26	-
Important references on the theory of magnetism from Supplement 1 (1964 to 1968)	26	-
Additional references from Supplement 1 (1964 to 1968)	-	760
Selected references on theory of electron paramagnetic resonance in transition metal compounds (1969 and 1970)	-	760
General theory	-	760
Theory with respect to a particular ion	-	760
Additional references to introduction	27	761
References to crystal structure	28	761

	page	
	Part 1	Part 2
Magnetic susceptibility data	29	-
Electron paramagnetic resonance data	-	763
Titanium Ti	29	763
Ti(III)	29	763
<i>Simple compounds</i>	29	763
With chloride	29	-
With sulfate	30	-
With carboxylates	30	-
With thiocyanate	31	-
With other anions	31	-
<i>Coordination compounds with neutral and chelating ligands</i>	31	763
With monamines	-	763
With amines	31	-
With aliphatic monamines	31	-
With aliphatic diamines	32	-
With alcohols	33	764
With ethers	34	-
With acid amides and acid hydrazides	34	-
With cyanides and isocyanides	35	-
With ligands containing phosphorus	35	-
<i>Organometallic compounds</i>	36	764
Ti(IV)	38	-
Zirkonium Zr	39	-
Zr(IV)	39	-
Hafnium Hf	39	-
Hf(I)	39	-
Hf(III)	39	-
Vanadium V	39	767
V(0)	39	767
V(II)	40	768
<i>Simple compounds</i>	40	-
With iodide	40	-
<i>Coordination compounds with neutral and chelating ligands</i>	40	-
With water	40	-
With ligands containing sulfur	41	-
V(III)	41	769
<i>Simple compounds</i>	41	-
With oxygen	41	-
With chloride	42	-
With bromide	43	-
With iodide	43	-
With thiocyanate and selenocyanate	43	-
With other anions	43	-
<i>Coordination compounds with neutral and chelating ligands</i>	44	-
With water	44	-
With amines	44	-
With heterocyclic ligands	45	-
With alcohols	45	-
With ketones	51	-
With amine-N-polycarboxylic acids	51	-
With cyanides and isocyanides	51	-
With ligands containing sulfur	52	-

V (III) continued	page	
	Part 1	Part 2
With ligands containing phosphorus	52	-
With phosphoric acids	52	-
With phosphonic acids	53	-
With thiophosphoric acids	53	-
V (IV)	53	769
Simple compounds	53	769
With oxygen	53	-
With fluoride	54	769
With chloride	54	769
With sulfate	54	770
With carboxylates	55	771
With dicarboxylates	57	-
With phosphates		772
With other anions	58	-
Coordination compounds with neutral and chelating ligands	58	772
With amines	58	772
With heterocyclic ligands	58	-
With pyridine	58	-
With phenanthroline	58	-
With heterocyclic N-oxides	58	-
With alcohols	59	772
With 1,3-diketones		774
With aromatic hydroxy compounds	60	-
With ethers, carboxylic acids, esters	60	-
With ethers	60	-
With carboxylic acids	60	776
With aldehydes	61	-
With ketones	61	-
With Schiff bases and related ligands	61	778
From hydroxy arylaldehydes and aromatic monamines	61	-
From hydroxy arylaldehydes and aliphatic monamines	-	778
From hydroxy arylaldehydes and aliphatic diamines	-	778
From hydroxy arylaldehydes and aliphatic hydroxyamines	62	-
From hydroxy arylaldehydes and aromatic hydroxyamines	62	-
From hydroxy arylaldehydes and diamines	63	-
Binuclear Schiff bases from hydroxy arylaldehydes and diamines	63	779
From hydroxy arylaldehydes and amino acids	63	-
With azo compounds	64	-
With acid amides	65	-
With cyanides and isocyanides	65	-
With ligands containing sulfur	65	780
With sulfoxides	65	-
With monothio 1,3-diketones	65	780
With dithiocarbamates	66	781
With dithiolates	66	780
With thiosemicarbazones	66	-
With ligands containing selenium	66	784
With ligands containing phosphorus	66	782
With ligands containing arsenic	66	-
Organometallic compounds	-	784
V (V)	67	-
Niobium Nb	67	784
Nb (II)	-	784
Nb (IV)	67	785
Simple compounds	67	-
Coordination compounds with neutral and chelating ligands	68	-
With heterocyclic ligands	68	-
With pyridine	68	-
With pyridine derivatives	68	-
With quinoline and derivatives	68	-

Nb(IV) continued

	page	
	Part 1	Part 2
With bipyridyl	69	-
With phenanthroline	69	-
With alcohols	70	-
With ethers, carboxylic acid, esters	70	-
With ethers	70	-
With ketones	71	-
With diketones	71	-
With Schiff bases and related compounds	72	-
With cyanides and isocyanides	72	-
With ligands containing sulfur	72	-
With thioethers	72	-
With thiourea and derivatives	74	-
With dithiocarbamates	74	-
With ligands containing boron	74	-
With ligands containing arsenic	75	-
Nb(V)	75	-
Nb (uncertain oxydation state)	75	785
Simple compounds	75	-
Clusters with fluoride	75	-
Clusters with chloride	76	-
Clusters with bromide	77	-
Tantalum Ta	77	785
Ta(II)	-	785
Ta(IV)	77	-
Coordination compounds with neutral and chelating ligands	77	-
With heterocyclic ligands	77	-
With ketones	77	-
With cyanides and isocyanides	78	-
With ligands containing sulfur	78	-
With ligands containing arsenic	78	-
Ta(V)	79	-
Simple compounds	79	-
Coordination compounds with neutral and chelating ligands	79	-
Ta (uncertain oxydation state)	79	786
Simple compounds	79	-
Clusters with chloride	79	-
Clusters with bromide	80	-
Chromium Cr	81	786
Cr(-III)	-	786
Cr(-I)	-	786
Cr(I)	81	787
Simple compounds	-	787
Coordination compounds with neutral and chelating ligands	81	787
With water	-	787
With ammonia	-	788
With heterocyclic ligands	-	788
With ligands containing sulfur	-	789
With ligands containing arsenic	-	790
Organometallic compounds	81	791
Cr(II)	81	-
Simple compounds	81	-
With oxygen	81	-
With chloride	82	-
With carbonate	82	-
With sulfide and sulfate	83	-

Cr(II) continued

	page	
	Part 1	Part 2
<i>Coordination compounds with neutral and chelating ligands</i>	84	-
With water	84	-
With amines	84	-
With diamines	84	-
With aliphatic triamines	85	-
With heterocyclic ligands	86	-
With porphyrines and related ligands	86	-
With pyridine and pyridine derivatives	86	-
With quinoline and quinoline derivatives	87	-
With bipyridyl	88	-
With terpyridine	88	-
With phenanthroline	88	-
With ketones	88	-
With amino ketones	88	-
With ligands containing sulfur	89	-
With ligands containing phosphorus	89	-
Cr(III).	89	793
<i>Simple compounds</i>	89	793
With fluoride	89	-
With chloride	90	793
With bromide	90	-
With sulfide	90	-
With selenide	90	-
With cyanide and thiocyanate	-	793
With sulfate	-	793
With carboxylate	-	794
With other simple anions	91	795
<i>Coordination compounds with neutral and chelating ligands</i>	91	795
With water	-	795
With ammonia and aliphatic amines	-	795
With amines	91	-
With aliphatic monamines	91	-
With aliphatic diamines	92	-
With heterocyclic ligands	93	-
With bipyridyl	93	-
With phenanthroline	93	-
With pyridine N-oxide and derivatives	93	-
With quinoline N-oxide and derivatives	93	-
With ketones	94	-
With amine-N-polycarboxylic acids	94	-
With Schiff bases and related compounds	95	-
With acid amides	97	-
With cyanides and isocyanides	97	-
With ligands containing sulfur	98	796
With thiols	98	-
With thiourea and derivatives	98	-
With other ligands containing sulfur	99	-
With ligands containing selenium	99	-
With ligands containing phosphorus	99	796
With phosphine oxides	99	-
With phosphoric acids	100	-
With phosphonic acids	100	-
With dithio phosphoric acids	101	-
With ligands containing arsenic	101	-
Cr(IV).	101	797
Cr(V)	101	797
<i>Simple compounds</i>	101	797
With oxygen	101	797
With fluoride	102	797
With chloride	102	798
With phosphates	-	799
With thiocyanate	-	799

Cr(V) continued

	page	
	Part 1	Part 2
<i>Coordination compounds with neutral and chelating ligands</i>	102	799
With monamines	102	-
With heterocyclic ligands	103	799
With alcohols	-	800
With carboxylic acids	103	800
With ligands containing sulfur	-	800
With ligands containing phosphorus	-	801
Cr(VI)	103	-
Cr (uncertain oxydation state)	103	-
Molybdenum Mo	104	803
Mo (-I)	-	803
Mo (0)	104	-
Mo (I)	-	803
Mo (II)	104	-
<i>Simple compounds</i>	104	-
<i>Coordination compounds with neutral and chelating ligands</i>	104	-
Mo (III)	105	803
<i>Simple compounds</i>	105	-
With chloride	105	-
With bromide	107	-
With cyanide and selenocyanate	108	-
<i>Coordination compounds with neutral and chelating ligands</i>	108	-
Mo (IV)	108	-
<i>Simple compounds</i>	108	-
<i>Coordination compounds with neutral and chelating ligands</i>	108	-
With ligands containing sulfur	108	-
With ligands containing phosphorus	108	-
With ligands containing arsenic	109	-
Mo (V)	109	804
<i>Simple compounds</i>	109	804
With fluoride	109	804
With chloride	110	804
With bromide	112	805
With iodide	-	805
With sulfide	114	-
With cyanides	114	-
With cyanide and thiocyanate	-	805
With sulfates	-	806
With phosphates	-	806
<i>Coordination compounds with neutral and chelating ligands</i>	114	807
With heterocyclic ligands	114	807
With alcohols	115	-
With aliphatic alcohols	-	808
With ketones	115	808
With 1,3-diketones	-	808
With amino acids	-	809
With amine-N-polycarboxylic acids	116	-
With oximes and nitroso compounds	-	809
With ligands containing sulfur	-	810
With thiols	-	810
With aliphatic thiol compounds	-	810
With aromatic thiol compounds	-	810
With thiourea	-	812
With ligands containing phosphorus	-	813
With phosphonic acids	-	813
With dithio phosphoric and phosphonic acids	-	814
With dithio phosphinic acids	-	815
With cyanides and isocyanides	116	-
<i>Organometallic compounds</i>	117	816
Mo (uncertain oxydation state)	117	817

	page	
	Part 1	Part 2
Tungsten W	118	817
W(0)	118	-
W(II)	118	-
With ligands containing sulfur	118	-
With ligands containing phosphorus	118	-
W(III)	119	817
W(IV)	119	-
W(V)	120	817
<i>Simple compounds</i>	120	817
<i>Coordination compounds with neutral and chelating ligands</i>	120	818
With alcohols	120	818
With ligands containing sulfur	-	819
With ligands containing phosphorus	-	819
With dithio phosphoric and phosphonic acids	-	819
With dithio phosphinic acids	-	820
<i>Organometallic compounds</i>	-	822
W (mixed oxydation state)	-	822
W (uncertain oxydation state)	121	-
 Manganese Mn	 122	 823
Mn(0)	122	-
Mn(I)	122	-
Mn(II)	122	823
<i>Simple compounds</i>	122	823
With nitrate	122	-
With fluoride	-	823
With chloride	122	823
With bromide	123	-
With sulfate	-	824
With carboxylates	123	-
With cyanide, thiocyanate and selenocyanate	124	-
With other simple anions	125	825
<i>Coordination compounds with neutral and chelating ligands</i>	125	825
With alicyclic amines	-	825
With aliphatic amines	125	-
With alicyclic heteroring compounds	126	-
With diazabicyclo[2.2.2]octanium and derivatives	126	-
With heterocyclic ligands	127	826
With phthalocyanine and derivatives	127	-
With pyridine	128	-
With pyridine derivatives	128	826
With halogeno pyridines	-	826
With 3-chloro pyridine	128	-
With 3-bromo pyridine	128	-
With alkyl pyridines	-	826
With amino pyridines	-	828
With di(2-pyridyl)amine	-	828
With cyano pyridines	129	-
With 4-methyl pyridine	130	-
With 3,5-dimethyl pyridine	130	-
With ethyl pyridine	131	-
With benzoyl pyridine	131	-
With quinoline and derivatives	131	829
With isoquinoline	131	829
With phenanthroline	-	830
With 4,4'-bipyridyl and derivatives	132	-
With heterocyclic N-oxides	132	-
With pyridine N-oxide and derivatives	132	-
With pyridine N-oxide	132	-
With pyridine N-oxide derivatives	132	-

Mn(II) continued

	page	
	Part 1	Part 2
With other heterocyclic ligands	133	831
With pyrazole and derivatives	133	831
With imidazole and derivatives	133	831
With pyridazine (1,2-diazine)	133	-
With pyrimidine (1,3-diazine)	133	-
With pyrazine (1,4-diazine) and derivatives	134	-
With alcohols	135	-
With carboxylic acids	-	831
With ethers, carboxylic acids and esters	135	-
With ethers	135	-
With esters	135	-
With ketones	135	-
With amino acids	136	-
With Schiff bases	-	832
With Schiff bases and related compounds	137	-
From hydroxy arylaldehydes and aliphatic monamines	137	-
From heterocyclic aldehydes and amines	137	-
Cyclic Schiff bases from heterocyclic aldehydes and di- or polyamines	138	-
With azo compounds	138	-
With acid amines	-	832
With acid amides and acid hydrazides	138	-
With cyanides	139	-
With cyanides and isocyanides	-	833
With ligands containing sulfur	139	833
With sulfoxides	139	-
With thiourea and derivatives	139	-
With other ligands containing sulfur	140	-
With ligands containing selenium	141	-
With ligands containing phosphorus	141	833
With phosphine oxides	141	833
With phosphoric acids	141	-
With phosphonic acids	141	-
With dithiophosphoric acids	142	-
With other ligands containing phosphorus	-	834
With ligands containing arsenic	142	834
With arsine oxides	-	834
<i>Organometallic compounds</i>	142	835
Mn(III)	142	836
<i>Simple compounds</i>	142	-
With fluoride	142	-
With other simple anions	143	-
<i>Coordination compounds with neutral and chelating ligands</i>	144	-
With heterocyclic ligands	144	-
With carboxylic acids	144	-
With aldehydes	145	-
With ketones	146	-
With amine-N-polycarboxylic acids	146	-
With Schiff bases	146	-
From hydroxy arylaldehydes and aliphatic monamines	146	-
From hydroxy arylaldehydes and aliphatic diamines	147	-
From hydroxy arylaldehydes and aromatic monamines	147	-
With ligands containing sulfur	148	-
With thiols	148	-
With dithiocarbamates	148	-
With ligands containing selenium	149	-
Mn(IV)	149	837
<i>Simple compounds</i>	149	-
<i>Coordination compounds with neutral and chelating ligands</i>	149	-
With Schiff bases	149	-
With ligands containing sulfur	150	-
Mn(V)	150	-
Mn (mixed oxydation state)	150	-

	page	
	Part 1	Part 2
Technetium Tc	150	837
Tc(II)	150	—
Tc(III)	151	—
Tc(IV)	151	837
Tc (mixed oxydation state)	151	—
 Rhenium Re	151	—
Re(I)	151	—
Re(II)	151	—
Re(III)	152	—
Re(IV)	152	—
<i>Simple compounds</i>	152	—
With chloride	152	—
With bromide	156	—
With iodide	157	—
With cyanate	157	—
<i>Coordination compounds with neutral and chelating ligands</i>	158	—
With amines	158	—
With heterocyclic ligands	158	—
With bipyridyl and phenanthroline	158	—
With ethers	158	—
With ligands containing sulfur	158	—
With ligands containing phosphorus	159	—
Re(V)	159	—
<i>Simple compounds</i>	159	—
With chloride	159	—
With cyanide and cyanate	159	—
<i>Coordination compounds with neutral and chelating ligands</i>	159	—
 Iron Fe	160	838
Fe(—I)	—	838
Fe(I)	160	838
<i>Simple compounds</i>	—	838
With fluoride	—	838
With chloride	—	838
With bromide	—	839
With iodide	—	839
With cyanide and thiocyanate	—	839
With other simple anions	—	840
<i>Coordination compounds with neutral chelating ligands</i>	—	841
With heterocyclic ligands	—	841
With ligands containing sulfur	—	841
With xanthates	—	841
With dithiocarbamates	—	842
With dithiooxalate	—	846
With thiourea and derivatives	—	846
With other ligands containing sulfur	—	847
With ligands containing phosphorus	—	848
With monophosphines	—	848
With dithio phosphoric and phosphinic acid	—	849
With ligands containing arsenic	—	849
<i>Organometallic compounds</i>	—	849
Fe(II)	160	850
<i>Simple compounds</i>	160	850
With fluoride	160	—
With chloride	160	—
With silico fluoride	161	—
With cyanide	161	—
With sulfide and sulfate	162	—
With selenide	162	—

Fe(II) continued

	page	
	Part 1	Part 2
With carboxylates	162	-
With other simple anions	162	-
<i>Coordination compounds with neutral and chelating ligands</i>	163	850
With aliphatic amines	163	-
With alicyclic heteroring compounds	163	-
With 1,4-diaza bicyclo octanium and derivatives	163	-
With heterocyclic ligands	164	850
With phthalocyanine and derivatives	164	-
With porphyrines	165	-
With porphyrines and related ligands	-	850
With pyridine and derivatives	165	-
With quinoline and derivatives	166	-
With isoquinoline	168	-
With naphthyridine and derivatives	168	-
With 2,2'-bipyridyl and derivatives	168	-
With 4,4'-bipyridyl	169	-
With terpyridine	169	-
With phenanthroline and derivatives	169	-
With heterocyclic N-oxides	171	-
With other heterocyclic ligands	172	-
With pyrazole and derivatives	172	-
With pyridazine	172	-
With pyrimidine	172	-
With pyrazine and derivatives	172	-
With imidazoline and derivatives	174	-
With imidazole and derivatives	174	-
With tetraaza bicyclo heptadecatriene and derivatives	177	-
With alcohols	177	-
With ethers, carboxylic acids and esters	177	-
With ethers	177	-
With esters	177	-
With ketones	178	-
With amino ketones	179	-
With Schiff bases and related compounds	180	-
From hydroxy arylaldehydes and aliphatic diamines	180	-
From hydroxy arylaldehydes and aromatic monamines	180	-
From hydroxy arylaldehydes and amino acids	180	-
From hydroxy arylaldehydes and hydrazines	180	-
From aromatic aldehydes and amines	181	-
From heteroaromatic aldehydes and amines	181	-
From heteroaromatic aldehydes and hydrazines	182	-
Cyclic Schiff bases from dialdehydes and di- or polyamines	183	-
Cyclic Schiff bases derived from aminoaldehydes	185	-
From dialdehydes and aliphatic amines	185	-
From diketones and aliphatic amines	186	-
With oximes and nitroso compounds	186	-
With acids amides and acid hydrazides	186	-
With cyanides and isocyanides	187	-
With ligands containing sulfur	187	850
With sulfoxides	187	-
With thiols	188	-
With thio diketones	188	-
Cyclic cations derived from dithio diketones	188	-
With thioethers	189	-
With dithiocarbamates	189	-
With other ligands containing sulfur	190	-
With ligands containing phosphorus	190	-
With ligands containing arsenic	191	-
Fe(III) (Part 2: $S = \frac{5}{2}$, $S = \frac{1}{2}$)	191	{ 851 854
<i>Simple compounds</i>	191	851
With oxygen	191	-

Fe(III) continued

	page	
	Part 1	Part 2
With fluoride	191	-
With chloride	193	-
With bromide	193	-
With cyanide	193	-
With other simple anions	194	-
<i>Coordination compounds with neutral and chelating ligands</i>	194	{851 854
With aliphatic amines	-	851
With aliphatic monamines	194	-
With other aliphatic amines	195	-
With aromatic monamines	195	-
With heterocyclic ligands	195	{852 854
With phthalocyanine	195	-
With porphyrins	196	-
With porphyrines and related ligands	-	852
With pyridine carboxylic acids	197	-
With bipyridyl	197	-
With bipyridyl and derivatives	-	854
With phenanthroline	197	854
With heterocyclic N-oxides	197	853
With pyridine N-oxide	-	853
With other heterocyclic ligands	198	-
With quinoline and derivatives	198	-
With benzimidazole and derivatives	198	-
With alcohols	199	-
With ethers, carboxylic acids and esters	200	-
With ethers	200	-
With carboxylic acids	200	-
With amine-N-polycarboxylic acids	205	853
With ketones	205	-
With monoketones	205	-
With diketones	205	-
With aliphatic diketones	205	-
With aromatic and heterocyclic diketones	207	-
With Schiff bases and related compounds	208	-
From hydroxy arylaldehydes and aliphatic hydroxy amines	208	-
Binuclear Schiff bases from hydroxy arylaldehydes and aliphatic hydroxy amines	209	-
From hydroxy arylaldehydes and hydroxy arylamines	209	-
From hydroxy arylaldehydes and aliphatic diamines	212	-
Binuclear Schiff bases from hydroxy arylaldehydes and aliphatic diamines	216	-
From hydroxy arylaldehydes and aromatic diamines	217	-
Binuclear Schiff bases from diketones and diamines	220	-
Cyclic Schiff bases from dialdehydes and di- or polyamines	220	-
With oximes and nitroso compounds	221	853
With acid amides and acid hydrazides	221	-
With ligands containing sulfur	221	{853 855
With sulfoxides	221	-
With thiols	222	855
With aromatic thiol compounds	222	-
With dithiolates	222	855
With thioketones	223	855
With xanthates and thioxanthates	224	-
With xanthates	224	-
With thioxanthates	226	-
With dithiocarbamates	226	855
With aliphatic dithiocarbamates	226	-
With alicyclic dithiocarbamates	233	-
With aromatic dithiocarbamates	233	-
With thiocarboxylic acids	237	-

Fe(III) continued

	page	
	Part 1	Part 2
With thiosemicarbazones	240	-
With sulfinates	240	-
With ligands containing selenium	240	-
With ligands containing boron	241	-
With ligands containing phosphorus	241	856
With phosphine oxides	241	-
With phosphoric and phosphonic acids	242	-
With phosphinic acids	242	-
With dithiophosphoric acids	242	-
With dithiophosphinic acids	244	-
With ligands containing arsenic	244	857
Organometallic compounds	245	857
Biological compounds	-	853
Fe(IV)	245	859
Coordination compounds with neutral and chelating ligands	-	859
With ligands containing sulfur	-	859
Fe(V)	-	860
Fe(VI)	245	-
Fe (uncertain oxydation state)	246	861
Fe(III, IV) (mixed oxydation state)	-	861
Ruthenium Ru	246	861
Ru(II)	246	861
Ru(III)	247	861
Simple compounds	247	-
Coordination compounds with neutral and chelating ligands	247	861
With water	-	861
With heterocyclic ligands	-	862
With aliphatic amines	247	-
With ketones	247	862
With diketones	247	-
With azo compounds	248	-
With ligands containing sulfur	248	862
With ligands containing selenium	249	-
With ligands containing phosphorus	249	863
With ligands containing arsenic	250	864
Ru(IV)	250	-
Osmium Os	250	864
Os(III)	250	864
Coordination compound with neutral and chelating ligands	-	864
With heterocyclic ligands	-	864
With ligands containing phosphorus	-	865
With ligands containing arsenic	-	865
Os(IV)	251	-
Cobalt Co	252	866
Co(0)	252	-
Co(I)	252	-
Co(II) (Part 2: $S = \frac{1}{2}$, $S = \frac{3}{2}$)	252	866
Simple compounds	252	866
With fluoride	252	-
With chloride	253	-
With sulfide and sulfate	254	-
With selenide	254	-
With cyanide and thiocyanate	255	-
With phosphates and phosphonates	255	-
With other simple anions	256	-

Co(II) continued

	page	
	Part 1	Part 2
<i>Coordination compounds with neutral and chelating ligands</i>	257	866
With ammonia	257	-
With aliphatic monamines	257	-
With aliphatic diamines	257	-
With ethylene diamine derivatives	257	-
With trimethylene diamine derivatives	258	-
With other aliphatic diamines	258	-
With triamines	259	-
With tetramines	259	-
With aromatic amines	260	-
With aromatic monamines	260	-
With diamines	261	-
With 1,2-diamines	261	-
With 2,2'-diaminobiphenyl	261	-
With 1,8-diaminonaphthalene	262	-
With alicyclic heteroring compounds	262	-
With lactams and derivatives	262	-
With quinuclidine	262	-
With diazabicyclo[2.2.2]octanium and derivatives	263	-
With morpholine and morpholine derivatives	263	-
With heterocyclic ligands	264	866
With phthalocyanine	264	866
With porphine derivatives and related ligands	-	866
With pyridine	264	-
With pyridine derivatives	265	-
With cyano pyridines	265	-
With monoalkyl pyridines	266	-
With 3-methyl pyridine	266	-
With 4-methyl pyridine	266	-
With amino pyridines and derivatives	266	-
With amino pyridines	266	-
With aminomethyl pyridines	267	-
With other aminoalkyl pyridines	268	-
With aminoaryl pyridines	268	-
With tris(2-pyridyl)amine	268	-
With pyridine carboxylic acids	268	-
With benzoyl pyridine	268	-
With quinoline and derivatives	269	-
With iso-quinoline	269	-
With quinoxaline and derivatives	269	-
With bipyridyl	-	874
With 2,2'-bipyridyl	270	-
With 4,4'-bipyridyl	271	-
With terpyridine	271	-
With phenanthroline	274	-
With heterocyclic N-oxides	274	-
With pyridine N-oxide and derivatives	274	-
With acridine N-oxide and terpyridine trioxyde	276	-
With other N heterocyclic ligands	276	-
With pyrazole and derivatives	276	-
With pyrazole	276	-
With methyl pyrazoles	277	-
With other pyrazole derivatives	279	-
With imidazoline derivatives	280	-
With imidazole and derivatives	281	-
With imidazole	281	-
With imidazole derivatives	281	-
With benzimidazole and derivatives	282	-
With benzoxazole and derivatives	283	-
With benzoxazole	283	-
With benzoxazole derivatives	283	-
With purine and derivatives	284	-

Co(II) continued

	page	
	Part 1	Part 2
With pyridazine	284	-
With pyrimidine	285	-
With pyrazine and pyrazine derivatives	285	-
With pyrazine	285	-
With pyrazine derivatives	285	-
With diazanaphthalene	288	-
With naphthyridine derivatives	288	-
With 1,3,5-triazine derivatives	288	-
With S heterocyclic ligands	291	-
With thiazole and derivatives	291	-
With thiazole	291	-
With alkyl thiazols	291	-
With benzthiazole and alkyl benzthiazoles	291	-
With amino benzthiazoles	292	-
With O heterocyclic ligands	293	-
With furan carboxylic acids	293	-
With alcohols and amino alcohols	293	-
With aromatic hydroxy compounds	293	-
With esters	294	-
With carboxylic acids	295	-
With ethers	296	-
With aldehydes and derivatives	298	-
With ketones	298	-
With monoketones	298	-
With alicyclic ketones	298	-
With aromatic and heterocyclic ketones	298	-
With diketones	299	-
With acetylacetone and derivatives	299	-
With other diketones	300	-
With triketones	300	-
With aminoketones	300	874
With alicyclic aminoketones	300	-
With arylamino aromatic ketones	301	-
With Schiff bases and related compounds	302	875
From hydroxy arylaldehydes and aliphatic monamines	302	-
From hydroxy arylaldehydes and aromatic monamines	302	-
From hydroxy arylaldehydes and heterocyclic amines	303	-
From hydroxy arylaldehydes and aliphatic diamines	304	-
From hydroxy arylaldehydes and aromatic diamines	305	-
Binuclear Schiff bases from hydroxy arylaldehydes and diamines	305	-
From hydroxy arylaldehydes and aminoacids	306	-
From arylaldehydes and aromatic amines	306	-
From arylaldehydes and diamines	306	-
From arylaldehydes and aminothiols	307	-
From thioarylaldehydes and monamines	307	-
From heteroaromatic aldehydes and monamines	307	-
From heteroaromatic aldehydes and di- or polyamines	308	-
From heteroaromatic aldehydes and alkylthiophenylketones	308	-
From heteroaromatic aldehydes and aminothiols	311	-
From ketones and diamines	311	-
From diketones and arylamines	311	-
From diketones and diamines	313	-
Cyclic Schiff bases from dialdehydes and di- or polyamines	313	-
Cyclic Schiff bases from dithio dialdehydes and di- or polyamines	315	-
Oxo-bridged binuclear Schiff bases from hydroxy arylaldehydes and diamines	315	-
From arylaldehydes and hydrazine	316	-
From aldehydes and heteroaromatic hydrazines	317	-
From ketones and heteroaromatic hydrazines	318	-
With azo compounds	319	-
With aminoaromatic azo compounds	319	-
With azo pyridines	319	-
With triazenes	320	-

Co(II) continued

	page	
	Part 1	Part 2
With formazanes	321	-
With oximes and nitroso compounds	323	-
With aldoximes	323	-
With ketoximes	323	-
With nitroso compounds	324	-
With acid amides and acid hydrazides	324	-
With urea and related compounds	324	-
With aliphatic acid amides	325	-
With aromatic and heteroaromatic acid amides	325	-
With dicarboxylic acid dihydrazides	327	-
With cyanides and isocyanides	327	875
With methylcyanide	327	-
With other cyanides and isocyanides	328	-
With cyanamide derivatives	328	-
With ligands containing sulfur	328	876
With sulfoxides	328	-
With thiols	328	-
With aliphatic thio compounds	328	-
With alicyclic thio compounds	329	-
With aromatic and heteroaromatic thio compounds	329	-
With thioamines	329	-
With aliphatic thioamines	329	-
With alicyclic thioamines	330	-
With aromatic thioamines	330	-
With heteroaromatic thioamines derived from pyridine	331	-
With sulfides	331	-
With monothio 1,3-diketones	331	-
With dithio 1,3-diketones	332	-
With cyclic cations derived from dithio 1,3-diketones	333	-
With heterocyclic thiones	334	-
With thio carboxylic acids	335	-
With monothio carboxylic acids	335	-
With monothio dicarboxylic acids	335	-
With dithio dicarboxylic acids	335	-
With tetrathio tetracarboxylic acids	335	-
With thioesters	336	-
With thioethers	336	-
With thiourea and derivatives	336	-
With thiosemicarbazones	337	-
With sulfates	338	-
With thioacid amides	338	-
With ligands containing selenium	338	-
With ligands containing boron	338	-
With ligands containing phosphorus	339	876
With phenyl phosphines	339	-
With alkyl phenyl phosphines	339	-
With tertiary heterocyclic phosphines	341	-
With ditertiary phosphines	341	-
With tritertiary phosphines	341	-
With tetratertiary phosphines	342	-
With ditertiary phosphine cations	342	-
With phosphine oxides	342	-
With tertiary alkyl phosphine oxides	342	-
With tertiary aryl phosphine oxides	343	-
With tertiary heterocyclic phosphine oxides	343	-
With bisdiphenyl phosphine oxides	343	-
With phosphine sulfides	344	-
With alkyl phosphine sulfides	344	-
With alkylamino phosphine sulfides	344	-
With phosphine selenides	345	-
With diphenylphosphino amines	345	-
With diphenylphosphino aliphatic amines	345	-

Co(II) continued

	page	
	Part 1	Part 2
With diphenylphosphino heterocyclic amines	346	-
With diphenylphosphino amine cations	347	-
With bis(diphenylphosphino)ethers	348	-
With mono- and bis(diphenylphosphino) thioethers	349	-
With phosphoric acids	350	-
With phosphonic acids	350	-
With thiophosphoric acids	350	-
With dithiophosphinic acids	351	-
With phosphorous containing heterocycles	351	-
With phosphorous containing Schiff bases	351	-
With ligands containing arsenic	351	877
With monoarsines	351	-
With arsine oxides	352	-
With tertiary alkyl arsine oxides	352	-
With tertiary aryl arsine oxides	352	-
With alkyl phenyl arsine oxides	352	-
With bis(diphenyl)arsine oxides	353	-
With arsine sulfides	354	-
With diphenylarsino amines	354	-
With diphenylarsino aliphatic amines	354	-
With dialkyl or diaryl arsino carboxylic acids	354	-
With arsenic containing heterocycles	355	-
With arsenic containing Schiff bases	355	-
<i>Organometallic compounds</i>	355	-
Co(III)	356	878
<i>Simple compounds</i>	356	878
<i>Coordination compounds with neutral and chelating ligands</i>	356	878
With aliphatic amines	356	-
With heterocyclic ligands	356	878
With porphine derivatives and related ligands	-	878
With amino ketones	-	879
With Schiff bases	-	880
With Schiff bases and related compounds	356	-
From aromatic diketones and monamines	356	-
Monomeric dioxygen adducts of Schiff bases from diketones and aliphatic diamines	357	-
With oximes	-	882
With oximes and nitroso compounds	357	-
With cyanides and isocyanides	-	883
With amine-N-polycarboxylic acids	358	-
With acid amides	358	-
With ligands containing sulfur	359	-
With ligands containing selenium	359	-
With ligands containing phosphorus	-	883
Co(IV)	359	883
<i>Coordination compounds with neutral and chelating ligands</i>	-	883
With carboxylic acid	-	883
With ligands containing sulfur	-	884
Co(V)	360	-
Co(III, IV) (mixed oxidation state)	361	886
Co (uncertain oxydation state)	361	887
Rhodium Rh	361	887
Rh(II)	361	-
Rh(III)	362	887
Rh(IV)	363	-
Iridium Ir	363	888
Ir(0)	363	-
Ir(IV)	363	888
Ir (mixed oxydation state)	364	-

	page	
	Part 1	Part 2
Nickel Ni	364	889
Ni(-I)	-	889
Ni(0)	364	-
Ni(I)	365	889
Ni(II)	365	889
<i>Simple compounds</i>	365	889
With oxygen	365	-
With chloride	366	-
With sulfides and sulfates	367	-
With selenide and thioselenate	369	-
With cyanide and thiocyanate	370	-
With nitrate	370	-
With phosphates and phosphonates	371	-
With carboxylates	371	-
With other simple anions	371	-
<i>Coordination compounds with neutral and chelating ligands</i>	372	890
With ammonia	372	-
With hydrazines	373	-
With aliphatic monamines	373	-
With simple aliphatic monamines	373	-
With aliphatic hydroxyamines	374	-
With aliphatic diamines	375	-
With ethylene diamine	375	-
With ethylene diamine derivatives	375	-
With alkyl ethylene diamines	375	-
With hydroxyalkyl ethylene diamines	377	-
With D,L-2-phenyl-1,2-diamino butane	379	-
With N,N,N'-trimethyltrimethylene diamine	380	-
With aliphatic triamines	381	-
With simple aliphatic triamines	381	-
With aliphatic hydroxy triamines	381	-
With aliphatic tetramines	382	-
With aromatic amines	382	-
With monamines	382	-
With diamines	383	-
With stilbendiamine	383	-
With alicyclic heteroring compounds	385	-
With lactams	385	-
With aziridine (ethylenimine)	385	-
With diazacycloheptane (homopiperazine)	385	-
With diazabicyclo[2.2.2]octanium and derivatives	385	-
With morpholine and morpholine derivatives	386	-
With heterocyclic ligands	386	890
With pyridine	386	-
With pyridine derivatives	387	-
With cyano pyridines	387	-
With 4-methyl pyridine (γ -picoline)	387	-
With amino pyridines	388	-
With aminomethyl pyridine and derivatives	388	-
With 2-aminoethyl pyridine and derivatives	390	-
With di(2-pyridyl) amine derivatives	390	-
With di(2-pyridylmethyl) amine and derivatives	391	-
With tri(2-pyridylmethyl) amine and derivatives	393	-
With other amino pyridines	394	-
With benzoyl pyridine	394	-
With pyridine carboxylic acids	394	-
With quinoline and derivatives	395	-
With quinoline	395	-
With quinoline derivatives	395	-
With quinoxaline and derivatives	397	-
With 2,2'-bipyridyl	398	-
With 4,4'-bipyridyl	398	-

Ni(II) continued

	page	
	Part 1	Part 2
With terpyridine	398	-
With phenanthroline and derivatives	399	-
With phenanthroline derivatives	399	-
With heterocyclic N-oxides	399	-
With pyridine N-oxide and derivatives	399	-
With acridine N-oxide and terpyridine trioxide	400	-
With other N heterocyclic ligands	400	-
With pyrazole and derivatives	400	-
With pyrazole	400	-
With methyl pyrazoles	401	-
With other pyrazole derivatives	403	-
With imidazoline derivatives	404	-
With imidazole and derivatives	405	-
With imidazole	405	-
With imidazole derivatives	405	-
With benzimidazole and derivatives	407	-
With benzoxazole and derivatives	407	-
With benzoxazole	407	-
With benzoxazole derivatives	408	-
With pyridazine and derivatives	409	-
With pyridazine	409	-
With pyridazine derivatives	409	-
With pyrimidine	411	-
With pyrazine and derivatives	412	-
With pyrazine	412	-
With pyrazine derivatives	412	-
With diaza naphthalene	413	-
With naphthyridine derivatives	413	-
With phthalazine derivatives	413	-
With 1,3,5-triazene derivatives	416	-
With S heterocyclic ligands	416	-
With thiazole and derivatives	416	-
With thiazole	416	-
With alkyl thiazols	417	-
With benzthiazole and benzthiazole derivatives	417	-
With alcohols	-	891
With alcohols and amino alcohols	418	-
With simple alcohols	418	-
With oxyalcohols	423	-
With aromatic hydroxy compounds	423	-
With phenol and phenol derivatives	423	-
With naphthol and naphthol derivatives	424	-
With camphor derivatives	426	-
With esters	426	-
With aliphatic esters	426	-
With carboxylic acids	427	-
With ethers	428	-
With aldehydes	429	-
With amino aldehydes	430	-
With ketones	430	-
With monoketones	430	-
With alicyclic ketones	430	-
With aromatic and heterocyclic ketones	430	-
With diketones	432	-
With acetylacetone and derivatives	432	-
With triketones	433	-
With aminoketones	433	-
With alicyclic aminoketones	433	-
With alkylamino aromatic ketones	434	-
With heterocyclic amino aliphatic ketones	434	-
With amino acids	434	-
With amine-N-polycarboxylic acids	435	-

Ni(II) continued

	page	
	Part 1	Part 2
With Schiff bases and related compounds	436	-
From hydroxy arylaldehydes and aliphatic monamines	436	-
From hydroxy arylaldehydes and heterocyclic amines	438	-
From hydroxy arylaldehydes and aliphatic diamines	439	-
From hydroxy arylaldehydes and aromatic diamines	440	-
Binuclear Schiff bases from hydroxy arylaldehydes and diamines	441	-
From hydroxy arylaldehydes and amino acids	441	-
From arylaldehydes and aromatic amines	442	-
From arylaldehydes and aliphatic diamines	443	-
From arylaldehydes and aromatic diamines	445	-
From arylaldehydes and aliphatic triamines	445	-
From thio arylaldehydes and monamines	446	-
From heteroaromatic aldehydes and aliphatic amines	446	-
From heteroaromatic aldehydes and aromatic amines	447	-
From heteroaromatic aldehydes and alkylthiophenyl ketones	448	-
From heteroaromatic aldehydes and aminothiols	448	-
From alicyclic aldehydes and aliphatic amines	449	-
From alicyclic aldehydes and aromatic amines	449	-
From ketones and monamines	450	-
From ketones and diamines	454	-
From diketones and monamines	455	-
Cyclic Schiff bases from dialdehydes and di- or polyamines	455	-
Cyclic Schiff bases from dithio dialdehydes and di- or polyamines	458	-
Cyclic Schiff bases derived from aminobenzaldehyde	459	-
Cyclic Schiff bases from diketones and di- or polyamines	459	-
Binuclear Schiff bases from aldehydes or ketones and aminothiols	460	-
From arylaldehydes and hydrazine	461	-
From heteroaromatic aldehydes and hydrazine	462	-
From aldehydes and heteroaromatic hydrazines	463	-
From ketones and hydrazine	464	-
From ketones and heteroaromatic hydrazines	464	-
With azo compounds	465	-
With aminoaromatic azo compounds	465	-
With azo pyridines	465	-
With triazenes	466	-
With formazanes	467	-
With oximes and nitroso compounds	469	-
With aldoximes	469	-
With ketoximes	469	-
With hydroxylamines	471	-
With nitroso compounds	471	-
With acid amides and acid hydrazides	474	-
With aromatic and heteroaromatic acid amides	474	-
With dicarboxylic acid dihydrazides	476	-
With cyanides and iso cyanides	477	892
With alkyl cyanides	477	-
With cyanamide derivatives	477	-
With ligands containing sulfur	477	892
With sulfoxides	477	-
With thiols	479	-
With aliphatic thio compounds	479	-
With alicyclic thio compounds	479	-
With aromatic and heteroaromatic thio compounds	479	-
With thioamines	479	-
With aliphatic thioamines	479	-
With alicyclic thioamines	480	-
With aromatic thioamines	481	-
With heteroaromatic thioamines derived from pyridine	481	-
With cyclic cations derived from dithio 1,3-diketones	482	-
With heterocyclic thiones	482	-
With amino thioketones	483	-
With thioesters	484	-

Ni(II) continued

	page	
	Part 1	Part 2
With thio carboxylic acids	485	-
With monothio carboxylic acids	485	-
With monothio dicarboxylic acids	486	-
With dithio dicarboxylic acids	486	-
With tetrathio tetracarboxylic acids	486	-
With carbothioic acids	487	-
With thioethers	488	-
With aliphatic and alicyclic thioethers	488	-
With macrocyclic thioethers	488	-
With thiourea and derivatives	489	-
With thiosemicarbazides	492	-
With thiosemicarbazones	493	-
With thioacid amides	494	-
With ligands containing selenium	496	-
With ligands containing boron	496	-
With ligands containing phosphorus	497	-
With alkyl phosphines	497	-
With phenyl phosphines	497	-
With alkyl phenyl phosphines	497	-
With tertiary heterocyclic phosphines	502	-
With disecundary phosphines	502	-
With ditertiary phosphines	503	-
With tritertiary phosphines	504	-
With ditertiary phosphine cations	504	-
With phosphine oxides	504	-
With tertiary alkyl phosphine oxides	504	-
With tertiary aryl phosphine oxides	505	-
With tertiary heterocyclic phosphine oxides	505	-
With phosphine sulfides	505	-
With alkyl amino phosphine sulfides	505	-
With phosphine selenides	505	-
With diphenylphosphino amines	505	-
With diphenylphosphino aliphatic amines	505	-
With diphenylphosphino heterocyclic amines	506	-
With diphenylphosphino amine cations	506	-
With bis(diphenylphosphino)ethers	507	-
With phosphoric acids	508	-
With phosphonic acids	508	-
With thiophosphoric acids	509	-
With dithio phosphinic acids	510	-
With phosphorus containing heterocycles	511	-
With phosphorus containing Schiff bases	511	-
With ligands containing arsenic	512	-
With arsine oxides	512	-
With tertiary alkyl arsine oxides	512	-
With tertiary aryl arsine oxides	512	-
With alkyl phenyl arsine oxides	512	-
With arsine sulfides	513	-
With alkyl or aryl arsino amines	514	-
With dialkyl or diaryl arsino carboxylic acids	514	-
With arsenic containing heterocycles	514	-
With arsenic containing Schiff bases	515	-
Organometallic compounds	515	-
Ni(III).	516	892
Coordination compounds with neutral and chelating ligands	-	892
With aliphatic diamines	-	892
With heterocyclic ligands	-	894
With ligands containing sulfur	-	894
With ligands containing selenium	-	896
With ligands containing arsenic	-	896
Ni(IV).	517	-

	page	
	Part 1	Part 2
Palladium Pd	518	897
Pd(II)	518	-
<i>Simple compounds</i>	518	-
<i>Coordination compounds with neutral and chelating ligands</i>	518	-
Pd(III)	-	897
 Platinum Pt	519	898
Pt(III)	-	898
Pt(IV)	519	-
 Copper Cu	519	898
Cu(0)	-	898
Cu(I)	519	-
Cu(II)	520	899
<i>Simple compounds</i>	520	899
With nitrite	-	899
With nitrite and nitrate	520	-
With chloride	520	899
With bromide	524	901
With fluoride	-	899
With sulfates	-	901
With sulfide and sulfate	525	-
With carboxylates	-	901
With aliphatic monocarboxylates	526	-
With aliphatic dicarboxylates	536	-
With aromatic acid anions	537	905
With benzoate and derivatives	537	-
With 1- and 2-naphthoate	543	-
With hydroxy aryl acid anions	544	-
With other aromatic mono carboxylates	547	-
With aromatic di- and tricarboxylates	548	-
With cyanate	548	-
With tungstates	549	-
With other simple anions	549	906
<i>Coordination compounds with neutral and chelating ligands</i>	549	907
With ammonia	549	907
With aliphatic monamines	550	-
With simple aliphatic monamines	550	-
With aliphatic hydroxy amines	550	-
With aliphatic diamines	551	908
With simple aliphatic diamines	551	-
With ethylene diamine	551	908
With propylene diamine	553	-
With trimethylene diamine	555	-
With other aliphatic diamines	-	911
With triamines	-	913
With tetramines	-	914
With other simple aliphatic diamines	557	-
With aliphatic hydroxy diamines	559	-
With aromatic monamines	559	-
With aromatic diamines	559	-
With alicyclic heteroring compounds	560	-
With lactams	560	-
With diaza cycloheptane (homopiperazine) and derivatives	560	-
With quinuclidine	561	-
With diaza bicyclo[2.2.2]octanium and derivatives	561	-
With morpholine and morpholine derivatives	562	-
With heterocyclic ligands	563	915
With porphine derivatives and related ligands	-	915
With phthalocyanine	563	-

Cu(II) continued

	page	
	Part 1	Part 2
With pyrrole and derivatives	563	-
With pyridine.	563	-
With pyridine and derivatives	564	916
With halogeno pyridines	564	-
With mono methyl pyridines	564	-
With dimethyl pyridines	565	-
With bis(2-pyridyl)ethane.	565	-
With other pyridine derivatives	566	-
With amino pyridines	566	-
With aminomethyl pyridines and derivatives	566	-
With 2-aminoethyl pyridine and derivatives	567	-
With pyridine carboxylic acids	568	-
With quinoline and derivatives	569	-
With quinoline	569	-
With quinoline derivatives	569	-
With isoquinoline and isoquinoline derivatives	572	-
With quinoxaline	-	917
With quinoxaline and derivatives	573	-
With bipyridyl	-	917
With 2,2'-bipyridyl	574	-
With 4,4'-bipyridyl	575	-
With terpyridine	575	-
With phenanthroline.	-	919
With phenanthroline and derivatives	576	-
With heterocyclic N-oxides	577	919
With pyridine N-oxides and derivatives.	577	-
With pyridine N-oxide	577	919
With halogeno pyridine N-oxides	579	-
With nitro and cyano pyridine N-oxides	580	-
With hydroxy and hydroxymethyl pyridine N-oxides	582	-
With methyl pyridine N-oxides	583	-
With di- and trimethyl pyridine N-oxides	585	-
With ethyl pyridine N-oxides	585	-
With methoxy and ethoxy pyridine N-oxides	586	-
With other pyridine N-oxide derivatives	587	-
With quinoline N-oxide and derivatives	590	-
With isoquinoline N-oxide	591	-
With other heterocyclic N-oxides	591	-
With other N heterocyclic ligands	591	-
With other heterocyclic ligands	-	920
With pyrazole and pyrazole derivatives	591	920
With imidazole and imidazole derivatives	592	920
With imidazole	592	-
With methyl imidazoles	593	-
With other imidazole derivatives	594	-
With benzimidazole and derivatives	594	-
With purine and derivatives.	596	921
With pyrazine and derivatives.	596	921
With pyrimidine	597	921
With pyridazine.	598	921
With diaza naphthalene	598	-
With phthalazine	-	922
With phthalazine and derivatives	598	-
With triazole	601	922
With benzoxazole and derivatives	601	-
With tetraazacyclotetradecane and derivatives	-	922
With S-heterocyclics	-	923
With thiazolidine and derivatives	-	923
With S heterocyclic ligands	602	-
With thiazole and derivatives	602	-
With thiazole and alkyl thiazols	602	-
With benzthiazole and benzthiazole derivatives	602	-

Cu(II) continued

	page	
	Part 1	Part 2
With O heterocyclic ligands	603	-
With furan carboxylic acids	603	-
With alcohols	-	923
With alcohols and amino alcohols	605	-
With aromatic hydroxy compounds	-	924
With esters	605	925
With carboxylic acids	607	924
With ethers	607	-
With aldehydes	607	927
With ketones	608	928
With monoketones	608	928
With alicyclic ketones	608	928
With aromatic and heterocyclic ketones	608	929
With diketones	609	929
With acetylacetone and derivatives	609	929
With other aliphatic diketones	-	932
With aromatic diketones	-	933
With heteroaromatic diketones	-	933
With thenoyl trifluoroacetone	610	-
With triketones	610	934
With amino ketones	613	-
With alkyl amino aromatic ketones	613	-
With heterocyclic amino aliphatic ketones	614	-
With amino di- or polyketones	614	-
With amino acids	614	934
With amine-N-polycarboxylic acids	-	938
With Schiff bases and related compounds	615	938
From hydroxy arylaldehydes and aliphatic monamines	615	938
Binuclear Schiff bases from hydroxy arylaldehydes and aliphatic monamines	617	-
From hydroxy arylaldehydes and aromatic monamines	621	938
Binuclear Schiff bases from hydroxy arylaldehydes and aromatic monamines	625	-
From hydroxy arylaldehydes and heterocyclic amines	-	939
From hydroxy arylaldehydes and aliphatic diamines	629	939
Binuclear Schiff bases from hydroxy arylaldehydes and diamines	629	-
From hydroxy arylaldehydes and aromatic diamines	631	941
From hydroxy arylaldehydes and amino acids	631	-
From hydroxy aryldialdehydes and aromatic amines	634	-
From aromatic aldehydes and hydrazine	-	941
Binuclear Schiff bases from hydroxy aryldialdehydes and aromatic amines	635	-
From arylaldehydes and amines	636	-
From thio arylaldehydes and monamines	637	-
From heteroaromatic aldehydes and aliphatic monamines	637	-
From heteroaromatic aldehydes and aromatic amines	638	-
From heteroaromatic aldehydes and aliphatic diamines	639	-
From heteroaromatic aldehydes and alkylthiophenyl ketones	640	-
From aliphatic ketones and amines	641	-
From aromatic ketones and amines	641	-
From aliphatic diketones and amines	641	-
Cyclic Schiff bases from dialdehydes and di- or polyamines	642	-
Cyclic Schiff bases derived from aminobenzaldehyde	643	-
From arylaldehydes and hydrazine	644	-
From aldehydes and heteroaromatic hydrazines	644	-
From ketones and heteroaromatic hydrazines	645	-
Cyclic Schiff bases from ketones and di- or polyamines	-	942
With azo compounds	645	942
With azo pyridines	645	-
With triazenes	647	-
With formazanes	648	-
With oximes and nitroso compounds	650	942
With aldioximes	650	-
With ketoximes	651	-

Cu(II) continued

	page	
	Part 1	Part 2
With hydroxylamines	652	-
With nitroso compounds	652	-
With acid amides and acid hydrazides	653	944
With urea and derivatives	-	944
With urea and related compounds	653	-
With aliphatic acid amides	654	945
With monocarboxylic acid amides	654	-
With dicarboxylic acid amides	654	-
With aromatic and heterocyclic acid amides	656	-
With semicarbazide	658	946
With semicarbazones	658	946
With biuret	-	946
With biguanide and derivatives	659	947
With amidines	-	951
With dicarboxylic acid dihydrazides	660	-
With cyanides and isocyanides	660	952
With ligands containing sulfur	660	952
With sulfoxides	660	952
With thiols	661	953
With alicyclic thio compounds	-	953
With aromatic and heteroaromatic thio compounds	-	953
With dithiolates	-	954
With thioketones	-	955
With thiocarboxylic acids	-	956
With dithiocarbamates	-	956
With thio amines	661	-
With aliphatic thio amines	661	-
With aromatic thio amines	662	-
With sulfides	662	-
With cyclic cations derived from thio 1,3-diketones	662	-
With thio carboxylic acids	663	-
With monothio carboxylic acids	663	-
With monothio dicarboxylic acids	663	-
With dithio dicarboxylic acids	664	-
With tetrathio tetracarboxylic acids	664	-
With dithiocarbamates	664	-
With thioacid amides	665	-
With thiosemicarbazide	665	957
With thiosemicarbazones	665	957
With ligands containing selenium	666	964
With diselenocarbamates	-	964
With diselenetenes	-	967
With selenosemicarbacide	-	967
With ligands containing phosphorus	667	958
With phosphines	-	958
With phosphine oxides	-	958
With dithiophosphoric acids	-	958
With dithiophosphonic acids	-	963
With dithiophosphinic acids	-	963
With ligands containing arsenic	667	964
Biological compounds	-	967
Cu(II) (Exchange coupled bimolecular units)	-	967
Binuclear complexes with chloride	-	967
Binuclear complexes with aliphatic carboxylate anions	-	968
Binuclear complexes with aromatic acid anions	-	970
Binuclear complexes with heterocyclic N-oxides	-	972
Binuclear complexes with Schiff bases	-	972
Binuclear complexes with oximes	-	972
Cu(IV)	668	-

	page	
	Part 1	Part 2
Silver Ag	668	973
Ag(II)	668	973
Ag(III)	668	—
Ag (mixed oxydation state)	668	974
 Gold Au	—	974
Au(II)	—	974
 Diagrams	669	975
 References	731	976