Index

Page numbers followed by t refer to tabular entries; page numbers preceded by A refer to appendix references. Absorption analysis, 139 (see also

201t, 203, 233, 263 Abscissa scales, for NMR spectra, 460 Absolute error, E_{a} , A-1 Absolute standard deviation, as figure of merit, 11t, 12 Absolute systematic error, as figure of merit, 11t Absorbance, A, 139, 301t measurement of, 140, 300, 343, 415 effect of slit width on, 311 factors affecting, 217, 303-306, 311, 343 Absorbance detector capillary electrophoresis, 783 HPLC, 319, 733, 734t Absorbance profile, in flames, 208 Absorption charge transfer, 330, 338-340 of electromagnetic radiation, 125, 134-137, 143 in laser, 148 in a magnetic field, 137 (see also Nuclear magnetic resonance spectroscopy)

of X-rays, 276

Ablation methods, atomic spectroscopic,

Absorbance, Absorption spectroscopy, Spectrophotometry) calibration curves for, 343 (see also Beer's law) cleaning of cells for, 314, 343 filters for, 155-157, 319 instrumentation for, 235-241, 314-325 of mixtures, 303, 344 qualitative, 311, 340-342 quantitative, 342-351 solvents for, 313 (see also Solvents) sources for, 145-154, 313 standard addition method, 344 uncertainties in, 303-312 wavelength selection for, 154 Absorption band, 136 (see also Band spectra) Absorption of electromagnetic radiation, 134, 330 (see also Absorption analysis, Atomic absorption spectroscopy) by atomic nuclei, 137 (see also Nuclear magnetic resonance) by mixtures, 303, 344 rate of, 358

relaxation processes in, 131 (see also Relaxation) by solids, 439 Absorption edge, 276, 290 Absorption edge method, X-ray spectrometry, 289 Absorption filters, 155, 156 Absorption spectrometry, 139 (see also Absorption analysis, Absorbance) instruments for, 181-183 (see also Photometer, Spectrophotometer) photoacoustic, 349 ultraviolet/visible, 300 328-351 (see also Ultraviolet/visible spectroscopy) X-ray, 293 Absorption spectrum, 134 (see also specific types) derivative, 345-347 effect of slit width on, 311 false peaks in, 312 X-ray, 276-278 Absorptivity, a, 139, 301t (see also Molar absorptivity) Accelerator, as neutron source, activation analysis, 819, 820

Accelerator plates, mass spectrometer, 502	Alternating currents	microprobe, 296
Acceptance cone, fiber optics, 179	circuits, 28–30	secondary ion
Access time, to computer memory, 86, 87	in electrochemical cells, 567	mass spectrometry, 500t, 547
ac circuits, 29–38	Alumina, as stationary phase, HPLC, 732,	for X-ray photoelectron
Accumulator, of computer, 83	749	spectroscopy, 553
Accuracy, A-1	Amido group, absorption of	Angle of precession, 450
Acetone, as solvent for ultraviolet/visible	electromagnetic radiation by, 333t,	Ångstrom unit, Å, 117
regions, 342	410 <i>t</i>	Angular dispersion, $dr/d\lambda$, of
Acetonitrile, as solvent, 422	Amine group	monochromator, 157, 161
Acetylacetone, as chelating reagent, 224	as auxochrome, 335	Angular frequency
Acetylene flames, temperature of, 207t Acid/base titrations, coulometric, 633,	infrared absorption by, 410 <i>t</i> Ammonia,	of precessing particle, ν_0 , 449 of sinusoidal currents, ω , 28
639t	gas-sensing probe for, 609t, 610	Angular gyrus, 489
Acid error, glass electrode, 602, 616	as supercritical fluid, 769t	Angular momentum, p, of nuclei, 447
Actinide ions, absorption by, 335	Ammonium pyrrolidionedithiocarbamate,	Angular velocity of precession, ω_0 , 449
Activation analysis, 810 (see also Neutron	as chelating reagent, 224	Anharmonic oscillator, 387
activation analysis)	Amperometric detector	Anion exchangers
Active mode, of computer operation, 91,	ĆE, 784	for ion chromatography, 742
93	conductivity, 784	for membrane electrodes, 604
Activity, a, A-25	HPLC, 737	Anions
effect on electrode potentials, 564, 569,	Amperometric titrations, 652	absorption in the uv/visible by, 335
575, 579, 605, 614	Amperostat, 63	order of elution, ion chromatography,
Activity, A, of radionuclides, 813	Amperostatic coulometry, 628 (see also	753
Activity coefficient, γ_X , A-25, A-27 t	Coulometric titrations)	Anion interference, atomic absorption
Addition	Amphiprotic species, 790–792	spectroscopy, 220, 221
circuit for, 65	Ampholyte, 792	Anode, of electrochemical cell, 567, 569,
propagation of error in, A-17t	Amplification	573, 592, 613
Address bus, of computer, 85	with bipolar junction transistor, 42	Anodic/cathodic voltammograms, 649
Adduct ion interference, atomic mass	chemical, 246 of light, in lasers, 147, 150	Anodic peak parameters (E_{pa} , i_{pa}), cyclic
spectrometry, 265 Adjusted retention time, t'_R ,	of transducer signals, 58–63	voltammetry, 656 Anodic stripping analysis, 666
chromatographic, 694t, 717	Amplifier	Anodic surpping analysis, 666 Anodic waves, voltammetric, 649
Adsorption, interference from, GLC, 712	chopper, 104	Anomalous dispersion, 125 (see also
Adsorption chromatography, 677t (see	difference, 61 (see also Difference	Dispersion)
also Liquid-solid chromatography)	amplifier)	Anthracene, excitation spectrum of, 366
Adsorption polarization, of	instrumentation, 103	Antibonding molecular orbital, 331
electrochemical cell, 585	lock-in, 106	Antilogarithm
Adsorptive stripping analysis, 668	operational, 52-68, 391	generation of, 66
Aerosol, 201, 202, 207, 209	Amplifier noise, 308	propagation of error in, A-17t
Agarose gel, capillary gel electrophoresis,	Amplitude, A,	Anti-Stokes shifts, Raman spectroscopy,
788	of electromagnetic radiation, 116, 117,	430
Air, as oxidant, atomic spectroscopy, 207t	120	Aperture time, of boxcar integrator, 109
Air pollution, measurement of, 416	of molecular vibrations, 382	Arc ablation, atomic spectroscopy, 210t,
Alcohols, absorption of electromagnetic	of sinusoidal currents, 28	203
radiation by, 333t, 410t	of a wave, E_0 , 432	Arc lamp as continuous source, 146
Aldehydes, absorption of electromagnetic	Amplitude modulation, 38	Arc source, emission spectroscopy, 201t
radiation by, 333t, 410t	Analog domains, 5, 6, 74	(see also Spark source)
Algorithm, 83 Aliasing, of FT NMR signal, 473	Analog filtering, 104 Analog signals, 26, 74, 87	controlled atmosphere, 248 instrumentation for, 246
Alizarin Garnet R, as fluorometric reagent,	Analog signals, 20, 74, 67 Analog-to-digital converter, ADC, 26, 74,	Area normalization method,
372	80, 87, 173	chromatographic analysis, 697
Alkaline error, glass electrode, 601, 616	Analyte, 1	Area 37, MRI, 489
Alkane group, absorption of	Analyte concentration (c_M, c_S) , in	Argon
electromagnetic radiation by, 333t,	chromatographic column, 694t	as carrier gas, GLC, 703
410 <i>t</i>	Analyte dilution, in chromatographic	as purge gas, thermogravimetric
Alkene group, absorption of	column, 676	analysis, 799
electromagnetic radiation by, 333t,	Analytical columns, HPLC, 731	Argon ion lasers, 151, 435t
410 <i>t</i>	Analytical curve, 15	Argon plasma spectroscopy, 231-234
Alkyne group, absorption of	Analytical sensitivity, γ , as figure of merit,	Arithmetic, binary, 74, 76
electromagnetic radiation by, 333t,	11 <i>t</i> , 13	Arithmetic logic unit, ALU, of computer,
410 <i>t</i>	Analytical signals, 99	85
Alpha decay, 811	Analyzers	Aromatic compounds
Alphanumeric displays, for instruments,	automated elemental, 844	absorption of electromagnetic radiation
46, 49	centrifugal fast scan, 842	by, 334, 336 <i>t</i> , 410 <i>t</i>
Alpha particle, α , 811t	for electron microscopy, 540, 541	fluorescence by, 361
measurement of, $817t$	for mass spectrometer, 514–524	Array-based spectrometer, 237, 369

Array segments, 241	Automation	effect of stray radiation on, 306, 312
Arrays, of data, 107	of analyses, 829	limitations to, 303-306, 415
Aspiration, 202	advantages and disadvantages of,	verification of, for absorption analysis,
Assembly programming, 89	830	343
Association equlibria, in flames, 221	based on multilayer films, 845 (see	Bending vibrations, 383
Asymmetry potential, glass electrode, 599,	also Multilayer films)	Benzene
600, 613	continuous flow analyzers, 831 (see	as solvent, 342, 406, 422
Atomic absorption, 134	also Flow injection analysis)	effect of substitutents on fluorescence
Atomic absorption detector, FIA, 833	of handling solids, 842	of, 362 <i>t</i>
Atomic absorption spectra, 196	of instruments, 92, 400	Benzoin, as fluorometric reagent, 372t
Atomic absorption spectroscopy, AAS	of sampling, 841	Bernoulli effect, 202
139t, 206–225	Auxochrome, 335	Beta decay, 812
comparison with atomic emission	Average linear rate $(\bar{\nu})$, of solute	Beta particle, 811t
spectroscopy, 245t	migration, 679	measurement of, 817
detection limits for, 224, 225t	Average weight, atomic/molecular, 254	Bialkali photoemissive surfaces, 170
instruments for, 213–216	Averaging	Bias,
interferences affecting, 217–223 (see	boxcar, 108 ensemble, 107	figures of merit for, $11t$, 12
also Solvent effects) sources for, 196, 214	Azide group, absorption of	in measurements, A-4 test for, A-14
Atomic emission detector, AED	electromagnetic radiation by, 335	Binary coded decimal (BCD) system, 74,
FIA, 833, 840	Azo group, as chromophore, 333 <i>t</i>	78
GLC, 709	Babington nebulizer, atomic spectroscopy,	Binary counter, 76
Atomic emission spectra, 195	202, 242	Binary encoding, 8
Atomic emission spectroscopy, AES, 139t,	Background correction methods	Binary number system, 8, 74–79
230–251	atomic spectroscopy, 217–220	Binding energy, electronic, E_b , 539, 541
comparison with atomic absorption	in radiochemical analysis, 816	Binnig, G., 553
spectroscopy, 245t	Back-scattering, of electrons, 293, 550,	Binnig/Rohr microscope, 553
detection limits for, 225t	552	Biocatalytic membrane electrode, 609
instruments for, 246, 250	Balance, for thermogravimetry, 798	Bioluminescence, 374
Atomic fluorescence spectra, 196	Band	Biosensor, 609
Atomic fluorescence spectroscopy, AFS,	chromatographic, 675	Bipolar junction transistor, BJT, 41-43
139t, 225	optical, 154	Bit, 8, 76, 83
detection limits for, 225t	Band broadening, 677 (see also Zone	Blackbody radiation, 133, 313, 366, 390
instruments for, 235-241, 246	broadening)	Bleeding, of stationary phase, GLC, 715
interferences in, 227	Band gap energy, E_g , 152	Bloch, F., 445
Atomic force microscopy, AFM, 549, 553,	Band spectra, 131, 132	Blood urea nitrogen, BUN, determination
557–581	atomic spectroscopy, 200	of, 610
Atomic line width, 196	interference from, 221, 248	Blue shift, of absorption spectra, 332
Atomic mass number, A, 811	Bandwidth	Bode diagram, 36, 57, 104
Atomic mass spectrometry, 253–271	of filters, 156	Boiling point, of mobile phase, HPLC,
Atomic mass unit, amu, 254	instrumental, 101	743 <i>t</i> Relemeter 177, 201
Atomic number, Z, 811	of laser, 147 of monochromators, 164, 214	Boltzmann constant k 448
Atomic secondary ion mass spectrometry, 271 (see also Secondary ion mass	of operational amplifier, 57, 101	Boltzmann constant, k, 448 Boltzmann equation, 199
spectrometry)	Barn, b, 820	Bonded-phase chromatography, 739
Atomic spectra, 192	Barrier-layer cell, 169	Bonded stationary phase, GLC, 715
factors affecting, 196–200	Base current, I_B , bipolar junction	Bonding electrons, 330
sources of, 192–196	transistor, 43	Bonding molecular orbitals, 331
Atomic spectroscopy, 116 (see also	Base-line method, quantitative IR	Boundary potential, E_b , glass membrane
specific types)	spectrometry, 416	electrode, 599
detection limits for, 221, 225t	Base peak, mass spectrum, 499, 503, 506,	Boxcar averaging, 108
Atomic weight, 254	522	Boxcar integrator, 109
Atomic X-ray spectrometry, 272–296	Batch inlet system, for mass spectrometer,	Bragg's law, X-ray diffraction, 278
Atomization, 192, 200, 201t, 206	512	Breakdown voltage, of semiconductor
in ICP source, 233	Bathochromic shift, of absorption spectra,	diode, 41, 45
Atomizers	332, 335	Breathing vibrations, molecular, 435, 441
for atomic spectroscopy, 209	Baud, 86t	Bremsstrahlung, 273
for mass spectrometry, 255, 262	Beam splitter	Briquetting, of samples, 246 (see also
Attenuated total reflection, ATR, 418, 420	double-beam spectrometer, 316	Pelleting)
Attenuator, 316, 365, 397	Fourier transform spectrometer, 186,	Broad-band decoupling, carbon-13 NMR,
Auger emission, 293, 541	395 (see also Michelson	480
Auger electron spectroscopy, AES, 537t,	interferometer)	Bromide, solid-state electrode for, 604
543–547	Beat period, P _b , 121, 184	Bromine
Auger microprobes, 546	Becquerel, Bq, 813	amperometric titrations with, 653
Automated systems, 829, 830	Beer's law, 139, 277, 300, 302, 343	effect on fluorescence, 360
Automatic systems, 294, 829, 841	application to mixtures, 303	isotopic abundance of, 505t

Buffers for capillary electrophoresis, 779, 782,	Capillary isotachophoresis, CITP, 786, 789 Capillary zone electrophoresis, CZE, 786,	for IR absorption spectrometry, 405 of memory chip, 83
787	787	for optical spectroscopy, 143 (see also
for capillary isotachophoresis, 789	Capping, of bonded-phase packings, 739	Cuvette)
for operational pH scale, 617t	Capture cross section	for pH measurement, 597
radiation, 218 Bulk methods, electroanalytical, 588	for neutrons, σ , 820 for photons, 302, 329	for photon detection, 169 (see also Detector)
Bulk property detector, HPLC, 733	Carbon	for potentiostatic coulometry, 629
Bulk storage memory, of computer, 87	automated analysis for, 844	for Raman spectroscopy, 436
Bunsen monochromator, 159	isotopic abundance of, 505t	reversible, 567
Burners, for atomic spectroscopy, 209 (see	Carbon-13 NMR, 446, 479-484	trapped-ion analyzer, 520
also Nebulization)	Carbonate ion, uv/visible absorption by,	Central processing unit, CPU, 83, 85
Burning velocity, of flames, 208	335	Centrifugal fast scan analyzer, 842
Bus, computer, 85	Carbon dioxide	Channel
n-Butane, as supercritical fluid, 769t	gas-sensing probe for, 608, 609t	of MOSFET device, 43
Byte, 83	as supercritical fluid, 769t, 771, 776	of pulse-height selector, 286
Cadmium ion, solid-state electrode for, 604t	Carbon dioxide laser, 151, 390 Carbon disulfide, as solvent, IR	Channel electron multiplier array detector
Cadmium selenide, as photoconductor,	spectrometry, 406, 422	electron spectroscopy, 541
176	Carbon tetrachloride as solvent	mass spectrometry, 257
Cadmium sulfide, as photoconductor, 176	IR spectrometry, 406, 422	Charge-coupled device CCD, optical
Calcium ion, liquid membrane electrode	NMR spectrometry, 475	spectroscopy, 172, 174, 175, 240
for, 604, 605t	Carbonyl group, absorption of	Charge-injection device CID, optical
Calibration curves, 15	electromagnetic radiation by, 333t,	spectroscopy, 172, 174, 238
for chromatographic analysis, 696, 759	410 <i>t</i>	Charge-to-size ratio, capillary
for direct potentiometric measurements,	Carboxyl group, absorption of	electrophoresis, 780
615	electromagnetic radiation by 333t, 410t	Charge-transfer absorption, 338
for ICPMS, 262	Carrier gases, for GLC, 703	Charge-transfer device, CTD, optical
least-squares evaluation of, A-18 for optical spectroscopy, 224, 234, 242,	Carrier signal, NMR spectrometer, 473 Cathode, of electrochemical cell, 567, 573,	spectroscopy, 169, 173, 238, 247 Charge-transfer electrons, absorption by,
343, 415	613	330, 338–340
for size-exclusion chromatography, 759	Cathode potential, changes in, during	Charge-transfer overvoltage, 585
for voltammetry, 664	electrolysis, 624	Charge-transfer, overvoltage, in
Calibration sensitivity, as figure of merit,	Cathode-ray tube, CRT	electrochemical cell, 581 (see also
11 <i>t</i> , 12	as read-out device, 46	Polarization)
Calibration standards	for scanning electron microscope, 550	Charging currents
for absorption analysis, 344	Cathodic peak parameters (E_{pc}, i_{pc}) , cyclic	at DME, 658, 662
for chromatographic analysis, 696	voltammetry, 656	in electrochemical cells, 566
for emission spectroscopy, 247, 249	Cathodic stripping methods, 666	at ultramicroelectrodes, 670
for ICPMS, 268 for quantitative mass spectrometry, 532	Cation exchangers ion chromatography, 752	Chelating reagents for absorption analysis, 343
voltammetric, 664	in membrane electrodes, 604	for fluorescence spectrometry, 371
for X-ray analysis, 292	Cation interference, atomic absorption	Chemical amplification, 246
Californium-252, as neutron source, 820	spectroscopy, 221	Chemical analysis
Calomel electrodes, 573 (see also	Cations, order of elution, ion	classification of methods, 1
Saturated calomel electrode)	chromatography, 752	selection of method, 11
Cantilever/tip assembly, AFM, 557	Cell in/cell out method, quantitative IR	unit operations of, 830, 831t
Capacitance, C, in electric circuits, 31	spectroscopy, 415	Chemical atomic weight, A, 254
Capacitative reactance, X_C , 30, 34	Cell-positioning uncertainty, in optical	Chemical deviations, to Beer's law, 303
Capacitors, in electric circuits, 30 Capacity factor, k', chromatographic, 680	spectrometry, 308t, 310 Cell potential E _{cell} , 569, 571	Chemical exchange, effect on NMR spectra, 468
(see also Retention factor)	calculation of, 581	Chemical interferences
Capillary columns, GLC, 704, 705, 711	effect	atomic spectroscopy, 220–223
Capillary constant, DME, 658	of activity on, 569	plasma emission spectroscopy, 244
Capillary electrochromatography, CEC,	of current on, 565 (see also IR drop,	Chemical ionization (CI) source
778, 792	Polarization)	as detector
Capillary electrophoresis, CE, 778,	instruments for measuring, 610	HPLC, 738
779–792	Cells	SFC, 744
Capillary electrophoresis/mass	coulometric, 629, 633	mass spectrometer, 500t, 506
spectrometry, CE/MS, 529, 786	of data, A-2	spectra from, 506
Capillary gel electrophoresis, CGE, 786, 788	electrochemical, 565 (see also Electrochemical cells)	Chemical noise, 100, 531 Chemical shift
Capillary inlet system, mass spectrometry,	electrolytic, 567	NMR spectroscopy, 459, 461, 464 <i>t</i> , 468
512, 514	for fluorescence analysis, 367	in X-ray photoelectron spectroscopy,
Capillary isoelectric focusing	galvanic, 567	541–543
electrophoresis, CIEF, 786, 790-792	ideal polarized and nonpolarized, 584	Chemical shift anisotropy, 462, 482

Cold vapor atomization, of mercury, 213 on electrochemical cells, 575 (see also Chemical shift parameter, δ, NMR Collector current, BJT, 41, 43 Nernst equation) spectroscopy, 461 on fluorescent intensity, 364 Collector electrode, mass spectrometer, Chemiluminescence, 131, 139t, 143, 355, 514 Concentration flux, 586 374-376 Collimator, 157 Concentration limit Chiral stationary phase, CSP GC, 716 for X-rays, 281 of linearity, LOL, 11t LC, 748 Collision product peaks, mass of quantitation, LOQ, 11t spectrometry, 505, 506 Concentration polarization, 585-587 Chloride, solid-state electrode for, 604t Collisional quenching, 360 during electrolysis, 623, 625, 628 Chlorine, isotopic abundance of, 505t Colorimeter, 181 and voltammetry, 639 Chloroform, as solvent, IR spectrometry, Column Concentration profile chromatographic, 677 bonded-phase chromatographic, 739 Chopper amplifier, for noise reduction, for GLC, 705, 711-716 at microelectrode surface, 645-648 104, 105 for HPLC, 731-733, 741 Concentration range, as figure of merit, 11t Chopping, of source radiation, optical for size-exclusion chromatography, 757 Concomitants, of sample, 15 spectroscopy, 104, 216, 390, 397 Column chromatography, 675 (see also Condenser current, at DME, 658 Chromatic aberration, 125 specific types) Condenser lens, electronic, 550 Chromatogram, 677 Column diameter, effect on band Conductance, G, 25 Chromatographic inlet system, for mass broadening, 686 measurement of, 60 spectrometer, 512, 514 Column length, L, 681, 694t Conduction Chromatographic separations, 673-697 Column efficiency, chromatographic, 680, in electrochemical cells, 565 (see also specific types) 681, 683t, 689, 726-728 in membrane electrodes, 599, 602 Chromatography, 675, 677t (see also optimization of, 687, 689 in semiconductor, 39, 285 specific types) Column packing Conduction band, 152 band broadening in, 677 (see also Zone effect on band broadening, 686 Conductivity detector broadening) for HPLC, 727, 732, 758 for capillary electrophoresis, 784 detectors for, 651, 705-711, 733-739 Column resolution, chromatographic, 688 for HPLC, 734t general elution problem of, 692 for ion chromatography, 750, 754 (see also Resolution) interfacing with mass spectrometry, 718 Combination bands, infrared spectra, 388, Confidence level, A-12 optimization of column performance Confidence interval, A-10 for, 687 Common mode rejection ratio, CMRR, 63 for radiation counting statistics, 815 qualitative, 695 Common terminal, of BJT, 41 Confidence limit, CL, A-10 quantitative, 695 Comparator, 68, 81 Conjugation, effect on absorption spectra, rate theory of, 682 Competing equilibria, effect on electrode Chromophores, 330 potentials, 578-580 Constant-current coulometry, 622 (see also effect of conjugation on absorption of, Compiler, for computer, 89 Coulometric titrations) 333, 335t, 336t Complexation, in membrane electrodes, Constant-current electrolysis, 625 ultraviolet/visible region, 330, 333t 596 Constant-current sources, 63 (see also Circuit common, operational amplifier, 54 Complexation effects Amperostat) Circuits on electrode potentials, 578 Constant-potential coulometry, 622 (see alternating current, ac, 28-38 also Potentiostatic coulometry) on polarographic wave, 659 direct current, dc, 22-28 Complex-formation titrations Constant-potental sources, 63 (see also flip-flop, 77 (see also Flip-flop circuit) amperometric, 653 Potentiostat) operational amplifier, 56 (see also coulometric, 634, 635t Constructive interference, 120, 122, 278, specific types) Compton effect, 812, 819 406 RC. 30-38 Computer, 10 in gratings, 159 switching, 68 applications of, 91-96 in interferometer, 186 Circularly polarized radiation, magnetic Contact mode scanning, AFM, 557 components of, 85-88 moment of, 450 input/output systems for, 87 Contamination, and surface analysis, 537 Clark oxygen sensor, 651 operational modes of, 84 Continuous-dynode electron multiplier, for Clearing, of computer register, 83 Computerized spectrophotometer, 320 mass spectrometer, 257 Clock Computer memory, 86 Continuous-flow analyzers, 830 for coulometer, 632 Computer networks, 94 Continuum-source correction method, for digital counting, 78 Computer programming, 89 AAS, 218 Coaddition, of data, 107 Computer search systems Continuous spectra, 136, 146, 200 Coated packings, ion chromatography, 732 Continuous-wave NMR spectroscopy, 446, for infrared spectra, 414 Coefficient of selectivity, as figure of for mass spectra, 528 merit, 11t Computer terminology, 88 Continuum, 131, 133, 200, 233, 273 Coefficient of variation, CV, 12, A-1, A-6 Concave gratings, 161, 322 Continuum source, for optical as figure of merit, 11t Concentration, substitution for activity, spectroscopy, 146, 313 Coherence, of electromagnetic radiation, Nernst equation, 579 Continuum-source correction method, 124, 147, 148 Concentration effects AAS, 218 Coherent anti-Stokes Raman spectroscopy, Control bus, of computer, 86 on absorbance, 300 (see also Beer's CARS. 443 Controlled potential electrolysis, 626 law) Coherent Stokes Raman spectroscopy, 443 on direct potentiometric methods, Control plates, of CRT, 46 Coils, of transformer, 44 614 Control unit, of microprocessor, 85 Coincidence counter, 817

Convection	Cross-linked stationary phase, GLC, 715	for semiconductor diode, 40
and band shape, FIA, 835	Crossover, of electron beam, 544	voltammetric, 648-650, 657-659
mass transport in solution by, 567, 586,	Cross polarization, of NMR signal, 483	Cut-off filter, 156
645, 835	Crystal field theory, 336	Cut-off wavelength, for X-ray emission,
Converter, data domain, 3	Crystalline compounds, identification of,	278
Convolution integers, 111	by X-гау diffraction, 294	Cuvette
Coolidge tube, 279	Crystalline membrane electrodes, 596t,	care and handling of, 314, 343
Copper(II), solid state electrode for, 604 <i>t</i>	602	Cyanide ion, solid-state electrode for, 604t
Core, of ICP plasma, 233	Crystalline overvoltage, in electrochemical	Cyanogen bands, emission spectroscopy,
Corning 015 glass, 597	cell, 581, 585	248
Cornu prism, 159	Crystallization	Cyclic voltammetry, CV, 654–656
Corrected retention volumes (V_R^0, V_M^0) ,	in membrane electrodes, 596, 602	Cyclohexane, as solvent
702	in polymers, 802	infrared region, 406
Corrected spectra, fluorescence	Crystal monochromator, 281, 540	uv/visible regions, 349t
spectrometry, 369	Crystals, diffraction of X-rays by, 278,	Cyclotron frequency, $\omega_{\rm C}$ 519
Correlation charts	282t	Czerny-Turner grating monochromator,
for chemical shifts, NMR spectroscopy,	Curie (Ci), 813	158, 216
464, 465 <i>t</i> , 483	Curie point, of pyroelectric materials, 178,	Dalton, Da, 254
for infrared spectra, 410, 412–413	392	Dansyl chloride, as fluorometric reagent,
for Raman spectra, 439	Current, <i>i</i> , 31	736
Correlation methods, for processing data,	alternating, 28–38	Dark current, 138, 167, 171, 178, 308
113		Dark current, 138, 107, 171, 178, 308 Dark current adjustment, absorption
	base, BJT, 43	* ·
Coulomb, C, 627	capacitor, 519	spectroscopy, 140
Coulometric analysis, 622 (see also	charging, 566 (see also Charging	Data
Coulometric titrations, Potentiostatic	current)	evaluation of, A-2
coulometry)	collector, BJT, 43	pooling of, A-9
Coulometric detector, for HPLC, 737	condenser, 658	storage of, 94
Coulometric titrations, 622, 628, 632–636	control of, with operational amplifier,	Data domains, 3, 9, 22
comparison with conventional	63	Daughter ion
titrimetry, 634	dark, 138 (see also Dark currents)	mass spectrometry, 503
external generation of reagents for, 633	diaamagnetic, 461	MS/MS, 529
Coulometric titrator, 632	diffusion, i_d , 658	Daughter nuclide, 811
Coulometry, 622–635	direct, 22–28	dc argon plasma spectroscopy, 231-234
amperostatic, 622 (see also Coulometric	in electrochemical cells, 565, 581–587	de circuits, 22–28
titrations)	faradaic, 566, 660	dc plasma (DCP) source, atomic
potentiostatic, 628 (see also	feedback, 56	spectroscopy, 234
Potentiostatic coulometry)	image, ion cyclotron spectrometer, 519	dc potentials, in electrochemical cells,
stripping analysis, 666-669	limiting, i_b 644 (see also Limiting	565, 569
Count digital data, 8	current)	Deactivation, of excited molecular states,
Counter, electronic, 74, 288	measurement of, 26, 27, 37, 58	131 (see also Relaxation)
Counter electrode, 629, 737	nonfaradaic, 566 (see also Nonfaradaic	Dead time
linear scan voltammetry, 642	current)	chromatographic, t_M , 679, 694 t
potentiostatic coulometry, 629	polarographic, 657 (see also	of Geiger tube, 284
potentiostatic electrolysis, 626	Polarographic wave)	of scintillation counter, 285
Counter ion, partition chromatography, 747	residual, 658 (see also Residual current)	Debye-Hückel equation, A-26
Counters, 282 (see also Geiger tube)	ring, 462	Debye-Scherrer powder camera, 294
scintillation, 285 (see also Scintillation	root-mean square, i_{rms} , 29, 101	Decade counting unit, DCU, 78
detector)	in semiconductor, 39, 172, 285	Decay, radioactive, 811 (see also
for X-ray spectrometer, 282–286	sinusoidal, 28	Radioactivity)
Counting, photon, 178	tunneling, STM, 554	Decay constant, I, 813
Counting rate, R, 813	voltammetric, 648	Decibel, dB, 36, 57
Counting statistics, radiochemical,	Current density, 587	Decimal counters, 78
814–817	Current divider, 25	Decoupling, of proton- and ¹³ C atoms,
Coupling, of molecular vibrations, 383,	Current efficiency, 628, 632	468, 469, 480
388, 433	Current gain, B, semiconductor diode, 42	Degeneracy, of quantum states, 288
Coupling constant, J, 463, 466	Current maxima, in polarographic waves,	Degrees of freedom
Critical micelle concentration, 794	660	in data, A-6, A-10
Critical point, 768	Current rectifier, semiconductor diode, 39	for molecular vibrations, 387
Critical pressure, 768	Current-sampled (tast) polarography, 661	d electrons, absorption by, 330, 335
Critical temperature, 768	Current-splitting equation, 25	Delocalization, of electrons, 330-333
Cross contamination, FIA, 830, 831	Current/voltage curve, for semiconductor	Densitometer, for quantitative TLC, 765
Cross dispersion, of echelle grating, 163	diode, 40	Density, of supercritical fluids, 768, 769t
Crossed-coil detector, NMR spectrometer,	Current/voltage relationships	Depletion layer, in semiconductor diode,
472	in electrochemical cells, 583, 622, 623,	39, 172
Cross flow-nebulizer, atomic spectroscopy,	657	Depletion mode, MOSFET transistor, 43
202, 232	in RC circuit, 31–33	Depolarization, of an electrode, 653
202, 232	m re eneult, 31-33	Depointing of all circulous, 000

Depolarization ratio, p, Raman spectroscopy, 434	Diethyl ether, as solvent, ultraviolet/visible regions, 342	Diphenylthiocarbazone, as chelating reagent, 224
Depth profiling, 537	Difference amplifier, 61, 365	Dipolar decoupling, ¹³ C NMR, 482
electron spectroscopy, 546, 547	for reduction of transducer noise, 103	Dipole changes, and infrared absorption,
Derivative spectra	Differences, propagation of error in, A-17	382, 387
Auger spectroscopy, 544	Differential pulse polarography, 661–663,	Direct absorption methods, X-ray analysis,
optical spectroscopy, 345	668	293
Derivativization, partition	Differential scanning calorimetry, DSC,	Direct current
chromatography, 739, 746	798, 808	circuits and measurements, 22-28
Deshielding shifts, in NMR spectra, 462	Differential thermal analysis, DTA, 798,	in electrochemical cells, 565, 569
Desolvation, in flames, 207	801–805	Direct current argon plasma spectroscopy,
Desorption ionization methods, mass	Differential thermogram, 801, 802, 805	201 <i>t</i> , 234
spectroscopy, 499, 500t, 508	Differentiation, circuit for, 66	Direct current plasma mass spectrometry,
Desorption polarization, in	Diffraction	DCPMS, 255t
electrochemical cell, 585	of electromagnetic radiation, 121, 157	Direct current plasma spectroscopy, DCP,
Destabilization, of d orbitals, 337	of X-rays, 278 (see also X-rays)	231, 234
Destructive activation methods, 821, 823	Diffraction order, n, of grating, 160	Direct sample insertion, atomic
Destructive interference, 124, 125, 155,	Diffraction patterns, interpretation of, 295	spectroscopy, 201t, 203
278	Diffuse reflectance, 405t, 418, 423, 847	Directional focusing, mass spectrometer,
in interferometer, 186	Diffusion	255, 516
Detection coefficient, c, 813	eddy, 685	Direct potentiometric measurements,
Detection limits	and FIA, 833, 835	612–618
for atomic spectroscopy, 224, 225t, 245t	longitudinal, 684 (see also Longitudinal	sign convention for, 612
figures of merit for, 11t, 13	diffusion)	Direct probe inlet, mass spectrometer, 512
for ICPMS, 266	mass transport in solution by, 568, 586,	Direct-reading pH meter, 611
for plasma emission spectroscopy, 244	645	Discrete analyzers, 530, 831-844
Detection systems, 9	Diffusion coefficient	Discriminator, X-ray spectrometer, 286
Detector, 9, 143	chromatographic, D_M , D_S , 683 t , 686, 727	Disk electrode, voltammetric, 653
for capillary electrophoresis, 783-787	electrochemical, D, 624	Dispersion
for continuous-flow analysis, 833	electrophoretic, 780	of electromagnetic radiation, 125
for electron microscopy, 540, 541	for supercritical fluids, 769t	D, flow-injection analysis, 835, 836
electrospray, 785	Diffusion current, i_{d} , 624, 658	by monochromators, 157, 161
for emission spectroscopy, 237, 246	Diffusion overvoltage, in electrochemical	of X-rays, dθ/dλ, 282
for FIA, 833, 837	cell, 581, 585	Dispersive instruments
for GLC, 705–711	Digital domains, 5, 7, 74	atomic fluorescence spectroscopy, 226
for HPLC, 319, 733–739	Digital electronics, 73–83	IR, 397–399
for infrared spectrometry, 168 (see also	Digital filtering, 110–113, 453	optical spectroscopy, 314–325
Infrared radiation)	Digital multimeter DMM, 26, 27, 37	X-ray photoelectron spectroscopy, 541
for ion chromatography, 750, 755	Digital signals, 74	Displacement pumps, for HPLC, 730
for mass spectrometer, 256, 260,	Digital-to-analog converter, DAC, 80, 87,	Dissociation, of excited molecules, 360
514–518	556	Dissociation equilibria, in flames, 220, 221
for NMR spectrometer, 473–475	Digital voltmeter, DVM, 26	Dissolved oxygen, effect on fluorescence,
photographic, 246, 294	Dilution methods, quantitative X-ray	360, 364
photon, 282	analysis, 292	Distributed Bragg reflector (DBR) laser
for scanning electron microscopy, 552	Dimethylchlorosilane, DMCS, for	diode, 153
scintillation, 257, 285	silanization of GC column, 712	Distribution coefficient, K, 678 (see also
for SFC, 771	Dimethylformamide, as solvent, IR	Partition coefficient)
Detector cell	spectrometry, 406	Dithizone, as chelating reagent, 224
amperometric, for HPLC, 737	Dimethylglyoxime, complexation with,	Division
nondispersive photometer, 399	343	circuit for, 65
Determinate error, A-2	2,2-Dimethyl-2-silapentane-5-sulfonic	propagation of error in, A-17
Deuterated solvents, for NMR	acid, sodium, salt, as internal standard,	DME, 639 (see also Dropping mercury
spectroscopy, 476	NMR, 460	electrode)
Deuterium lamp, 146, 218, 313, 323, 734	Dimethylsulfoxide, as solvent, 422	Domains, of data, 5–9, 74
Deuterium oxide, as moderator for	Diode, 39	Doping, of semiconductor crystals, 39
neutrons, 818	Diode array instruments	Doppler broadening, 197, 199, 214, 215
Deviation from the mean, A–6	for absorption spectroscopy, 172, 316,	d orbitals
Dialysis, with FIA, 833	323 for CG 700	energy of, 337
Diamagnetic shielding, NMR	for GC, 709	splitting of, 337
spectroscopy, 461	for HPLC, 735	Double-beam instruments
Diamagnetism, 356	Diode laser, 152, 435t	for AAS, 216
Diatomaceous earth, as solid support,	1,4-Dioxane, as solvent infrared region, 406, 422	for IP spectroscopy, 365
GLC, 711, 712 Dialectric 30, 154	ultraviolet/visible regions, 342	for IR spectroscopy, 397
Dielectric, 30, 154 Diethyldithiocarbamate, complexation	Diphenyldithiocarbazone, complexation	multichannel, 172–176, 323 for ultraviolet/visible spectroscopy, 314,
with, 343	with, 343	315, 318, 322
·· 1011, JTJ	11 Ling 5 T 5	J10, J10, J22

Double bond	Electric field strength, E, capillary	rotating, voltammetric, 653
force constant for, 386	electrophoresis, 780	of the second kind, 594
molecular orbitals and, 331	Electricity	silver/silver chloride, 573 (see also
Double-dispersing spectrophotometer,	laws of, 22	Silver/silver chloride electrode)
322, 436	quantity of, Q , 31	solid-state, 603, 604 <i>t</i>
Double-focusing mass spectrometer, 255,	Electroanalytical chemistry, 563 (see also	standard hydrogen, 572
261, 270, 516	specific types)	of the third kind, 594, 595
Double-junction electrode, 616	Electrochemical cell, 563–569	ultramicro, 642, 669
Double layer, 566	conduction in, 565	working, 591
Double resonance techniques, NMR	electrolytic, 567	Electrode calibration method, for direct
spectroscopy, 469	free energy changes in, 570	potentiometric measurements, 613
Doublet state, 356	galvanic, 567	Electrodeless discharge lamp, as line
Doubly charged ion interference, atomic	junction potentials in, 567	source, 147, 215, 226
mass spectrometry, 265	mass transfer in, 567 (see also Mass	Electrodeposition step, stripping analysis,
Drift tube, time-of-flight mass	transfer)	667
spectrometer, 260, 517	polarization of, 581–587	Electrode potential, 571, 573, A–28
Drive mechanism, Michelson	potential of, 570 (see also Cell	calculation of, 577–579 (see also Nerns
interferometer, 393	potential, Nernst equation)	equation)
Dropping mercury electrode, DME, 639,	reversibility of, 567	effect
642, 656, 658	schematic representation of, 568	of activity on, 564
advantages and disadvantages of, 658,	without liquid junction, 567	of competing equilibria on, 578
660	Electrochemical detector	of concentration on, 575 (see also
current variations at, 657	for capillary electrophoresis, 784	Nernst equation)
diffusion currents at, 658	for FIA, 833	of temperature on, 575
Dry film analyzer, 846, 848t	for HPLC, 734t, 737	formal, 580, A-28
Dual-wavelength spectrophotometry, 345	Electrochromatogram, 793	limitations to use of, 579–581
Duane-Hunt law, 273	Electrochromatography, EC, 761	measurement of, 576
Dye lasers, 147 (see also Tunable laser)	Electrode, 565	reaction rates and, 580
Dynamic extraction, SFE, 775 Dynamic methods, electrochemical, 588	biocatalytic, 609 calomel, 592 (see also Saturated	sign convention for, 574 standard, E^0 , 570 (see also Standard
	· •	electrode potential)
Dynamic range, of data, 14, 15	calomel electrode)	Electrogravimetry, 622
Dynode, 170 Eagle mounting, grating spectrograph,	collector, mass spectrometry, 257 counter, 626 (see also Counter	Electrogravimenty, 622 Electro injection, capillary electrophoresis
246	electrode)	783
Echelle grating monochromator, 162, 236,	crystalline membrane, 602	Electrolysis
240	dropping mercury, 639 (see also	with constant current, 622, 625
Echellette grating, 159	Dropping mercury electrode)	with constant working electrode
Eddy diffusion, zone broadening by, 685	for electrochemical cells, 565 (see also	potential, 622, 625–627
EDTA	Electrochemical cells)	with fixed applied potential, 622,
as protective reagent, 221	enzyme, 609	623–625
as titrant, 348, 594, 653	of the first kind, 594	stripping analysis, 666–669
Effective band width, 154	fluoride, 602, 604 <i>t</i>	voltammetric, 639 (see also
of filters, 156	gas-sensing membrane, 607, 609t	Voltammetry)
of monochromators, 165, 311	glass, 596t (see also Glass electrode)	Electrolytic cell, 567 (see also
Effective line width, $\Delta \lambda_{1/2}$, 197	generator, coulometric, 632	electrochemical cells)
Effusion, in gas-sensing probe, 608	hanging drop, 642, 667	Electromagnet, for NMR spectrometer,
Einstein, A., 128	hydrogen, 672	471
Elastic scattering	indicator, 591 (see also specific types)	Electromagnetic radiation, 116 (see also
of electromagnetic radiation, 431	inert, 595	specific types)
of electrons, 552	ion selective, 591 (see also specific	absorption of, 125 (see also Absorption
of neutrons, 819	types)	of electromagnetic radiation)
Electrical conduction	liquid membrane, 596t (see also	blackbody, 133 (see also Blackbody
in electrolyte solutions, 565	Membrane indicator electrodes)	radiation)
in membranes, 599, 602	membrane, 594, 602, 605t, 609	coherent, 124, 147, 148
in solids, 565	mercury	diffraction of, 121 (see also Diffraction)
Electrical domains, 4, 5	for polarographic analysis, 639 (see	dispersion of, 125, 157
Electrical double layer	also Dropping mercury	emission of, 131-134, 358
in capillary electrophoresis, 781, 787	electrode)	incoherent, 124
at electrode surface, 566	for potentiostatic coulometry, 629,	intensity, <i>I</i> , of, 118, 301 <i>t</i>
Electrically alterable read only memory,	631	monochromatic, 118, 147
EAROM, 87	metallic indicator, 594, 595	polarization of, 117, 127
Electric excitation, atomic spectroscopy,	microscopic, 642, 669	power, P, of, 118, 301t
201t (see also Arc source, Spark	polarization of, 581	quantum-mechanical properties of,
source spectroscopy)	redox, 594	128–138
Electric field, y, of electromagnetic	reference, 572 (see also Reference	reflection of, 126
radiation, 120	electrode)	refraction of, 125

Electromagnetic radiation (continued)	Ele
scattering of, 125 (see also Raman	Ele
scattering)	Ele
sources for, 143, 145-154, 214, 279,	Ele
313, 389	
thermal, 133	Ele
transducers for, 6, 167–178	Ele
transmission of, 124	
wave properties of, 116-128	Ele
Electromagnetic spectrum, 118	
Electromagnetic waves, superposition of,	Ele
120	
Electrometer, 60	Ele
Electrometric detector, CE, 784t	
Electron	Ela
Auger, 293 (see also Auger spectroscopy)	Ele
back-scattered, 550 internal conversion, 812 (see also	a
Internal conversion)	а
Electron beams	fl
interaction with solids, 537, 543	
as source of X-rays, 273	Ele
Electron capture, 276, 812	210
Electron-capture detector, (ECD), GLC,	fe
708, 709	fe
Electron counting, 541	
Electron density, of d orbitals, 337	n
Electron detection, SEM, 550	Ele
Electron gun, X-ray photoelectron	a
spectroscopy, 544, 550	b
Electronic absorption, 135	b
Electronic counter, 74	b
Electronic excitation, 135	
Electronic relaxation, 137, 330	Elei
Electronics, digital, 73–83	Elu
Electronic states, 131, 330, 356	Elu
Electronic transitions, 134, 330–332 and fluorescence, 356	Elu
Electronic voltmeter, 611	Liu
Electron impact (EI) source, mass	Elu
spectrometer, 500t, 501–505	Elui
reactions in, 503	tl
spectra with, 503–505	Elu
Electron microprobe, EM, 537t, 548	C
for surface analysis, 548	ic
for X-ray spectroscopy, 296	Em
Electron microscopy, 550	
Electron multiplier	ra
for electron spectrometer, 541	Emi
for mass spectrometer, 257, 260	
Electron optics, 550	*
Electron spectroscopy, 537–547	
instrumentation for, 540, 544, 548, 550	F
qualitative, 541, 544, 546	Emi
quantitative, 543	a c
Electron spectroscopy for chemical analysis, ESCA, 537t (see also	fl
Electron spectroscopy)	ic
Electron spin, 356	Enc
and phosphorescence, 355	End
Electron spin resonance, 137	Ene
Electron spin resonance (ESR)	
spectroscopy, 119t	Ene
Electron volt, 130	Ene
Electroosmotic flow, capillary	fe

electrophoresis, 778, 781

Electroosmotic pumping, 792
Electropherogram, 782, 792
Electrophoresis, 779
Electrophoretic inlet system, mass
spectrometer, 512, 514
Electrophoretic mobility, μ_e , 780
Electrospray detection, capillary
electrophoresis, 785
Electrospray ionization, ESI, mass
spectrometer, 500t, 509
Electrostatic analyzer, ESA, mass
spectrometer, 261
Electrostatic forces, mass transport in
solution by, 586 (see also Mass
transfer)
Electrothermal atomic spectroscopy,
210–212
absorption, ETAAS, 225t (see also
Atomic absorption spectroscopy)
fluorescence, ETAFS, 225t (see also
Atomic fluorescence spectroscopy)
Electrothermal vaporization, ETV, 201t,
202, 203
for atomic spectroscopy, 210–212
for inductively coupled plasma
spectroscopy, 233
matrix interferences with, 210
Elemental analysis
automated, 844
by mass spectrometry, 271, 531
by NMR, 477
by X-ray photoelectron spectroscopy,
541
Element coloration detector LIDIO 724
Element-selective detector, HPLC, 734t
Eluent, column chromatography, 675
Eluent, column chromatography, 675 Eluent strength, ϵ^0 , chromatographic, 743 t ,
Eluent, column chromatography, 675 Eluent strength, ϵ^0 , chromatographic, 743 t , 749
Eluent, column chromatography, 675 Eluent strength, ε ⁰ , chromatographic, 743 <i>t</i> , 749 Eluent suppression, ion chromatography,
Eluent, column chromatography, 675 Eluent strength, ϵ^0 , chromatographic, 743 t , 749 Eluent suppression, ion chromatography, 750, 754
Eluent, column chromatography, 675 Eluent strength, ϵ^0 , chromatographic, 743 t , 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743 <i>t</i> , 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743 <i>t</i> , 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682
Eluent, column chromatography, 675 Eluent strength, ϵ^0 , chromatographic, 743 t , 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order
Eluent, column chromatography, 675 Eluent strength, ϵ^0 , chromatographic, 743 t , 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782
Eluent, column chromatography, 675 Eluent strength, ϵ^0 , chromatographic, 743 t , 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743t, 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation,
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743t, 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131–134, 143
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743t, 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131–134, 143 rate of, 358
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743t, 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131–134, 143 rate of, 358 Emission spectroscopy, 138, 139t (see also
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743 <i>t</i> , 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131−134, 143 rate of, 358 Emission spectroscopy, 138, 139 <i>t</i> (<i>see also</i> Atomic emission spectroscopy,
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743 <i>t</i> , 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131–134, 143 rate of, 358 Emission spectroscopy, 138, 139 <i>t</i> (<i>see also</i> Atomic emission spectroscopy, Infrared emission spectroscopy, Arc-
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743t, 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131−134, 143 rate of, 358 Emission spectroscopy, 138, 139t (see also Atomic emission spectroscopy, Infrared emission spectroscopy, Arcand Spark source emission
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743t, 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131−134, 143 rate of, 358 Emission spectroscopy, 138, 139t (see also Atomic emission spectroscopy, Arcand Spark source emission spectroscopy, Arcand Spark source emission spectrometry)
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743t, 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131−134, 143 rate of, 358 Emission spectroscopy, 138, 139t (see also Atomic emission spectroscopy, Arcand Spark source emission spectroscopy, arcand Spark source emission spectrometry) Emission spectrum, 131
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743t, 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131−134, 143 rate of, 358 Emission spectroscopy, 138, 139t (see also Atomic emission spectroscopy, Infrared emission spectroscopy, Arcand Spark source emission spectrometry) Emission spectrum, 131 atomic, 195 (see also specific types)
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743 <i>t</i> , 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131−134, 143 rate of, 358 Emission spectroscopy, 138, 139 <i>t</i> (see also Atomic emission spectroscopy, Infrared emission spectroscopy, Arcand Spark source emission spectrometry) Emission spectrum, 131 atomic, 195 (see also specific types) chemiluminescence, 374
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743 <i>t</i> , 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131−134, 143 rate of, 358 Emission spectroscopy, 138, 139 <i>t</i> (<i>see also</i> Atomic emission spectroscopy, Infrared emission spectroscopy, Arcand Spark source emission spectrometry) Emission spectrum, 131 atomic, 195 (<i>see also specific types</i>) chemiluminescence, 374 fluorescence, 364, 366
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743 <i>t</i> , 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131−134, 143 rate of, 358 Emission spectroscopy, 138, 139 <i>t</i> (see also Atomic emission spectroscopy, Infrared emission spectroscopy, Arcand Spark source emission spectrometry) Emission spectrum, 131 atomic, 195 (see also specific types) chemiluminescence, 374 fluorescence, 364, 366 ionic, 193, 233
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743t, 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131−134, 143 rate of, 358 Emission spectroscopy, 138, 139t (see also Atomic emission spectroscopy, Infrared emission spectroscopy, Arcand Spark source emission spectrometry) Emission spectrum, 131 atomic, 195 (see also specific types) chemiluminescence, 374 fluorescence, 364, 366 ionic, 193, 233 Encoding, of information, 3, 74
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743t, 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131−134, 143 rate of, 358 Emission spectroscopy, 138, 139t (see also Atomic emission spectroscopy, Infrared emission spectroscopy, Infrared emission spectroscopy, Arcand Spark source emission spectrometry) Emission spectrum, 131 atomic, 195 (see also specific types) chemiluminescence, 374 fluorescence, 364, 366 ionic, 193, 233 Encoding, of information, 3, 74 Endothermic processes, DTA, 802
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743t, 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131−134, 143 rate of, 358 Emission spectroscopy, 138, 139t (see also Atomic emission spectroscopy, Infrared emission spectroscopy, Arcand Spark source emission spectroscopy, 138, 139t (see also Atomic 195 (see also spectfic types) chemiluminescence, 374 fluorescence, 364, 366 ionic, 193, 233 Encoding, of information, 3, 74 Endothermic processes, DTA, 802 Energy dispersive instruments, X-ray
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743t, 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131−134, 143 rate of, 358 Emission spectroscopy, 138, 139t (see also Atomic emission spectroscopy, Arcand Spark source emission spectroscopy, Arcand Spark source emission spectroscopy chemiluminescence, 374 fluorescence, 364, 366 ionic, 193, 233 Encoding, of information, 3, 74 Endothermic processes, DTA, 802 Energy dispersive instruments, X-ray spectroscopy, 279, 288, 289, 552
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743t, 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131−134, 143 rate of, 358 Emission spectroscopy, 138, 139t (see also Atomic emission spectroscopy, Arcand Spark source emission spectroscopy, Arcand Spark source emission spectrometry) Emission spectrum, 131 atomic, 195 (see also specific types) chemiluminescence, 374 fluorescence, 364, 366 ionic, 193, 233 Encoding, of information, 3, 74 Endothermic processes, DTA, 802 Energy dispersive instruments, X-ray spectroscopy, 279, 288, 289, 552 Energy focusing, mass spectrometer, 516
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743 <i>t</i> , 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131−134, 143 rate of, 358 Emission spectroscopy, 138, 139 <i>t</i> (<i>see also</i> Atomic emission spectroscopy, Infrared emission spectroscopy, Arcand Spark source emission spectrometry) Emission spectrum, 131 atomic, 195 (<i>see also specific types</i>) chemiluminescence, 374 fluorescence, 364, 366 ionic, 193, 233 Encoding, of information, 3, 74 Endothermic processes, DTA, 802 Energy dispersive instruments, X-ray spectroscopy, 279, 288, 289, 552 Energy focusing, mass spectrometer, 516 Energy level diagram, 131, 192−196, 275
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743t, 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131−134, 143 rate of, 358 Emission spectroscopy, 138, 139t (see also Atomic emission spectroscopy, Infrared emission spectroscopy, Arcand Spark source emission spectrometry) Emission spectrum, 131 atomic, 195 (see also specific types) chemiluminescence, 374 fluorescence, 364, 366 ionic, 193, 233 Encoding, of information, 3, 74 Endothermic processes, DTA, 802 Energy dispersive instruments, X-ray spectroscopy, 279, 288, 289, 552 Energy focusing, mass spectrometer, 516 Energy level diagram, 131, 192−196, 275 for photoluminescent molecules, 357
Eluent, column chromatography, 675 Eluent strength, € ⁰ , chromatographic, 743 <i>t</i> , 749 Eluent suppression, ion chromatography, 750, 754 Elution, 675, 728, 765 Elution chromatography, 675 theories of, 680, 682 Elution order capillary electrophoresis, 782 ion exchange, 752 Emission of electromagnetic radiation, 131−134, 143 rate of, 358 Emission spectroscopy, 138, 139 <i>t</i> (<i>see also</i> Atomic emission spectroscopy, Infrared emission spectroscopy, Arcand Spark source emission spectrometry) Emission spectrum, 131 atomic, 195 (<i>see also specific types</i>) chemiluminescence, 374 fluorescence, 364, 366 ionic, 193, 233 Encoding, of information, 3, 74 Endothermic processes, DTA, 802 Energy dispersive instruments, X-ray spectroscopy, 279, 288, 289, 552 Energy focusing, mass spectrometer, 516 Energy level diagram, 131, 192−196, 275

130-137 Enhancement effect, X-ray fluorescence spectrometry, 292 Enhancement mode, MOSFET transistor, Ensemble averaging, 107 (see also Signal averaging) Environmental effects, high-resolution NMR, 458 Environmental noise, 100, 102 Enzyme analysis, automated, 843 Enzyme electrode, 609 Enzyme sensor, 652 Equation solver software, 90 Equilibria in flames, 220-223 ion exchange, 752 Equivalent circuit, 25 Erasable program read only memory, EPROM, 87 Error, A-1 loading, 26 propagation of, A-17 Error function, A-8 ESCA, 537t (see also X-ray photoelectron spectroscopy) Ester group, absorption of electromagnetic radiation by, 410t Ethanol as solvent for ultraviolet/visible regions, NMR spectrum for, 458 as quench gas, Geiger tube, 284 Ether group, absorption of electromagnetic radiation by, 410t Evanescent wave, internal-reflectance spectroscopy, 420 Evaporative light scattering detector (ELSD), HPLC, 736 Exact mass, m, of isotopes, 254 Excitation, of atoms and molecules, 131 Excitation filter, for fluorometer, 365 **Excitation signal** NMR, 470 voltammetric, 640, 641 **Excitation spectra** fluorescence, 364 luminescence, 374 Raman, 430 uv/visible, 131 Excited molecular states, 131 (see also Electronic transitions) deactivation of, 137 (see also Relaxation) Exclusion limit, size-exclusion chromatography, 759 Eximer laser, 151 Exothermic processes, DTA, 802 Exponentiation, propagation of error in, A-17tExternal conversion, deactivation by, 360 Extinction, E, 301t (see also Absorbance) Extinction coefficient, k, 301t (see also Absorptivity)

Energy states, of atoms and molecules,

Extra-column band broadening, liquid	First-order spectra, NMR, 466	Fluorescence spectroscopy, 355 (see also
chromatography, 727, 733	rules governing, 466	Fluorescence)
effect (H_{ex}) on plate height, 727	Fission, nuclear, 811, 820	instruments for, 182, 365–370
Extraction	Flame atomization, 201t, 206, 210	reagents for, 371
with chelates, 224	Flame emission source, atomic	standards for, 371
by FIA, 834	spectroscopy, 250	Fluorescence spectra, 196
supercritical, SFE, 768, 774	Flame ionization detector, FID	X-ray, 278, 280
Fabry-Perot filter, 155 (see also	GLC, 706	Fluoride electrode, 602, 604t
Interference filter)	SFC, 771, 773	Fluorine-19, NMR of, 446, 447 <i>t</i> , 479, 484
False peak, in absorption spectra, 312	Flame photometric detector, FPD	Fluorolube, 408
Farad, F, 31	GLC, 710	Fluorometer, 182, 365, 367
Faradaic current, 566, 662	SFC, 771	Fluorophore, 371
Faraday, F, 570, 627	Flame profiles, 208	f-number, of monochromator, 162
Faraday cup, for mass spectrometer, 257	Flames	Focal plane, of monochromator, 157
Far-infrared region, 380	reactions in, 207	Folding, of NMR signal, 473
spectrometry in, 405t, 424	structure of, 208	Forbidden transitions, 195, 329, 358
Fast atom bombardment (FAB) source	temperature of, for atomic spectroscopy,	Force constant, k, 383
for capillary electrophoresis, 785	207	of chemical bonds, 386
for mass spectrometer, 500t, 511	Flame spectrometry, 206 (see also Atomic	Formal potential, 580, A-28
Fast neutrons, 819, 823	absorption spectroscopy, Atomic	Forward biasing, of semiconductor diode,
Fast-scan analyzer, 842–844	emission spectroscopy, Atomic	40
Fatigue, of photocell, 169	fluorescence spectrometry)	Forward scan, cyclic voltammetry, 655
Feedback	sample atomization for, 209–213	Fourier transform, FT, 121, 182–189
in computer, 94	Flat response photoemissive surfaces, 170	digital filtering by, 110
in operational amplifier circuit, 56	Flavanol, as fluorometric reagent, 372	of interferogram, 187
f-electrons, absorption by, 330, 335	Flicker (1/f) noise, 100, 101, 184, 201,	Fourier transform instruments, 189
Fellgett advantage, 184, 289	308t, 310, 321	advantages of, 182, 396
FIA, 831 (see also Flow injection analysis)	effect on measurement of transmittance,	as detector
Fiber membrane suppressor, ion	310	GLC, 711, 720
chromatography, 754	Flip-flop circuit, 77, 78	HPLC, 734t, 735
Fiber optics	Flow-injection analysis, FIA, 831–840	mass spectrometric, 718
for fluorescence spectroscopy, 370	detectors for, 651, 833	diffuse reflectance, DRIFT, 418
for optical spectroscopy, 179–181	dispersion in, 835	infrared absorption spectroscopy, FTIR
for Raman spectroscopy, 436	instrumentation for, 832	381, 392–396, 418, 419, 425
Fiber optic sensor, 179, 370	principles of, 834, 836	mass spectrometry, 519–521 (see also
Field desorption (FD) source, mass	Flow-injection titrations, 839	Mass spectrophotometric detector)
spectrometry, 500 <i>t</i> , 508	Flow path, in chromatographic column,	NMR, 446, 470
Field-effect transistor, FET, 43, 286, 391	684	performance characteristics of, 396
Field emission, of electrons, 545	Flow profile	photoacoustic, 351
Field/frequency lock system, NMR	electroosmotic, 781, 792	plasma emission spectroscopy, 235, 241
spectrometer, 471	laminar, 647, 835	Raman spectroscopy, 437
Field ionization (FI) source, mass	Flow rate, F , of mobile phase, 694 t , 704,	resolution of, 189
spectrometry, 500t, 506	730	uv/visible, 241
Field ionization spectra, 506	Fluoborate ion, membrane electrode for,	Fourier transform spectroscopy, 184 (see
Field strength, E, and ionic migration, 780	605 <i>t</i>	also specific types)
Figures of merit, 11, 12t	Fluorescence, 143, 148, 355	Four-level laser, 150
Film thickness, of stationary phase, GLC,	atomic, 225 (see also Atomic	Four-solvent system, for optimizing
715	fluorescence spectroscopy)	resolution, partition chromatography, 744
Filtering	and concentration, 364	Fragmentation patterns, mass
analog, 104	electronic transitions in, 361	•
digital, 110 (see also Digital filtering)	factors affecting, 363 interference with Raman spectra, 429,	spectrometry, 503 structural information from, 527
Filter photometer, 250 (see also		Free diffusion junction (FDJ) glass
Photometer) Filters	437, 442	electrode, 616
selection of, 319	and molecular structure, 361–364 relaxation via, 137, 330	Free energy changes, in electrochemical
		cells, 570
cut-off, 156 for electrical signals, 35, 44	theory of, 356–360 X-ray, 278 (see also X-ray fluorescence)	Free induction decay (FID) system, FT
	Fluorescence detector	NMR, 453, 454, 470
for fluorometers, 365, 367 interference, 156 (see also Interference	capillary electrophoresis, 356, 783,	Frequency
	784	• •
filters)	chromatographic, 356	of alternating current, f , 28 cyclotron, ω_c , 519
optical, 155 for X-rays, 280	for dry film analyzer, 845	of electromagnetic radiation, ν , 116, 11°
Filter wedge, 156, 316	for FIA, 833	Larmor, 449
Fingerprint region	for HPLC, 734 <i>t</i> , 735	vibrational, 384
in infrared spectrum, 409, 411	for SFC, 771, 773	Frequency domain spectroscopy, 184
Raman, 439	for TLC, 763	Frequency doubling, of laser output, 154
Mainall, 407	101 1LC, 705	rrequency according, or laser output, 134

E CAR CEENING CO.	1-4616	Committee for maintain and maties and
Frequency folding, of FT NMR signal,	interfacing of	Grounding, for noise reduction, 26
473	with infrared spectroscopy,	Ground state, 131, 195
Frequency modulation, 38	GC/FTIR, 720	Group frequency region
Frequency of precession, 449 (see also	with mass spectrometry, GC/MS, 528	infrared spectrum, 409, 410t
Larmor frequency)	polarity effects in, 713	Raman spectrum, 439
Frequency response, of operational	qualitative, 716	Guard column, HPLC, 732
amplifier, 57	quantitative, 717	Hadamard transform, optical spectroscop
Frictional retardation, of ions, 780	stationary phase for, 711, 713	393
Fritted disk nebulizer, atomic	Gas-phase source, mass spectrometer, 499,	Half-cell potential, 571 (see also Electroc
spectroscopy, 202	500t	potential)
Fronting, of chromatographic peak, 681	Gas-sensing probes, 607, 651	Half-cell reactions, 567 (see also
Fuel/oxidant mixtures, for flame	Gas-solid chromatography GSC, 677t,	Electrochemical cells)
		·
spectroscopy, 207	701, 721	Half-life, $t_{1/2}$, 813
Fuel regulators, for flame spectroscopy,	Gate, electronic, 43, 76	Half-wave potential, $E_{1/2}$, 644, 649
209	Gauss, G, 446	Hanging mercury drop electrode, HMDE
Functional group detection/identification	Gaussian distribution	642, 667
IR spectroscopy, 408–413	of chromatographic peaks, 678, 681, 758	Hard source, mass spectrometer, 500
NMR spectroscopy, 477	of pulse heights, X-ray detectors, 286	Hardware, computer, 84
Raman spectroscopy, 439	of random errors, A-2	for improvement of S/N ratio, 102–107
uv/visible, 342	Geiger range, of gas-filled transducer, 283	Harmonic oscillator, 383, 384
Functional magnetic resonance image,	Geiger tube, for measurement of	Heat transducers, for infrared radiation,
fMRI, 489	beta activity, 817	176-178 (see also Thermal
Furnace, for thermal analysis, 798, 799,	X-rays, 283, 284	transducers)
801	Gel chromatography, GC, 725, 760 (see	Heat flux, DSC, 805, 806
	also Size-exclusion chromatography)	
Fused-silica cells, for optical spectroscopy,	U 1 • ·	Heavy-atom effect, 360 (see also
166, 314	General elution problem, column	Intersystem crossing)
Fused-silica open tubular (FSOT) column,	chromatography, 692	Heisenberg, W., 138
GLC, 711, 713t	Generator electrode, coulometric, 632	Helium as carrier gas, GLC, 703, 708
Gain	Germanium semiconductor, properties of,	Helium/neon laser, 151, 393, 435t, 548
of BJT, β, 42	39, 40	Heptane, as solvent, 422t
of operational amplifier circuit, 54, 57	Germanium transducer	Hertz, H., 128
Gain bandwidth product, operational	for gamma rays, 822	Hertz, Hz, 117
amplifier, 57	for Raman spectroscopy, 437	Heteronuclear decoupling, NMR
Galvanic cell, 567 (see also	Ghosts, in output of grating, 161	spectroscopy, 470, 480
Electrochemical cells)	Glass cells, for absorption spectroscopy,	n-Hexane, as solvent, for
Gamma rays, 272, 276, 811t, 812	166 (see also Cuvette)	ultraviolet/visible regions, 342t
emission of, 276	Glass electrode, 597-602, 615	Heyrovsky, J., 639
measurement of, 819	acid error, 602	High-pass filter, 35, 216
	alkaline error, 601	for noise reduction, 104, 105
Gamma ray spectrometry, 119t		High-performance liquid chromatography
Gas amplification, of photocurrent, 283	asymmetry potential, 599, 613	
Gas analysis	in gas-sensing probe, 608	HPLC, 725 (see also specific types)
chemiluminescence, 375	hygroscopicity of membrane, 598, 616	column efficiency for, 726
electron spectroscopy, 541	pH measurements with, 597, 615	columns for, 726, 731–733
infrared spectroscopy, 399, 405, 416,	potential of, 600	detectors for, 319, 733–739
417 <i>t</i> , 421	selectivity coefficient for, 601	extra-column band broadening in,
Gas-bonded phase chromatography,	for univalent cations, 602	727
677 <i>t</i>	Glass transition, of polymers, 802	instruments for, 728–730
Gas chromatography GC, 675, 677t (see	Globar, 389	mobile phases for, 740, 743t
also Gas-liquid chromatography, gas-	Glow-discharge GD plasma atomization,	High-performance plates, thin-layer
solid chromatography)	201 <i>t</i> , 270	chromatography, 762
Gas chromatography/infrared	Glow-discharge source	High-resolution NMR spectroscopy, 456
spectroscopy, GC/FTIR, 720	atomic spectroscopy, 201t, 204, 212,	(see also Nuclear magnetic resonance
	251	spectroscopy)
Gas chromatography/mass spectrometry,		
GC/MS, 528, 718–720	mass spectrometry, GDMS, 255t, 262,	High-sensitivity photoemissive surfaces,
Gas diffusion, in FIA, 833, 834	270	170
Gases	Goniometer, 281	Histogram, A-2
emission of electromagnetic radiation	Gradient elution, column chromatography,	Holes, in semiconductors, 39, 172, 174,
by, 131	693, 728	175
overvoltage associated with, 587	Graphite furnace, for atomic spectroscopy,	Hollow cathode lamp, as line source, AAS
sampling of, 405, 541, 841	210	147, 215, 226
Gas-filled transducer, 282–284, 817	Grating, reflection, 157, 159	Holographic grating, 161, 235, 323
Gas laser, 147, 151	Grating monochromator, 159–163 (see	Homogeneous membrane, for gas-sensing
Gas-liquid chromatography GLC, 677t	also Monochromator)	probe, 608
detectors for, 705–711	Grating normal, 159	Homonuclear decoupling, NMR
effect of flow rate on, 703–705	Gross error, A-2	spectroscopy, 469
instrumentation for, 703–711	Ground connection, amplifier circuit, 54	Hooke's law, 383

HPLC, 725 (see also High-resolution	Incoherence, of electromagnetic radiation,	Inorganic species
liquid chromatography)	124, 148	absorption of electromagnetic radiation
Human Genome Project, 779	Indeterminate error, A-2, A-15	by, 335, 343
Hundred percent <i>T</i> adjustment, absorption spectroscopy, 140, 307, 314, 318, 320	Indicator electrode, 591 (see also specific types)	chemiluminescence analysis of, 376 fluorometric determination of, 371
Hydration, of glass membranes, 598	Indirect absorbance detection, 784	polarographic analysis of, 665
Hydride generation, atomic spectroscopy, 201t, 203, 213	Indirect fluorescence detection, CE, 784 Indium antimonide, as pyroelectric	Raman spectra of, 438 Input current, BJT, 41
Hydride transfer, chemical ionization MS, 506	detector, 392, 396	Input/output systems, for computers, 87
Hydrodynamic voltammetry, 644–654	Induced dipole, in scattering of radiation, 432	Input transducer, 6 (see also Detector) Instrumental deviations, to Beer's law,
Hydrogen	Inductance, in electrical circuits, 30	303, 306
automated analysis for, 844	Inductively coupled plasma detector, FIA,	Instrumental errors, A-4
as carrier gas, GLC, 703, 708	837	Instrumental methods, 1, 2t
evolution of, during electrolysis, 625	Inductively coupled plasma optical	Instrumental noise, 100, 178
isotopic abundance of, 505t	emission spectroscopy, ICPOES, 268	effect on spectrophotometric analysis,
overvoltage effects with, 587, 642	Inductively coupled plasma source, mass	306–311
Hydrogen-1, NMR of, 446 (see also Nuclear magnetic resonance	spectrometry, ICPMS, 255t, 262–269 instrumentation for, 262	Instrumental rise time, 306–311 (see also Rise time)
spectroscopy)	Inductively coupled plasma (ICP)	Instrumentation amplifier, 103
Hydrogen cyanide, gas-sensing probe for,	spectroscopy, 201t, 231	Integrated circuit, 38
609t	calibration curves for, 242–244	Integration, circuit for, 66
Hydrogen electrode, 572	detection limits for, 225t, 245t	Integrator, for potentiostatic coulometry,
Hydrogen flame, temperature of, 207t	sequential spectrometer for, 235	629, 631
Hydrogen fluoride, gas-sensing probe for,	source for, 231	Intensity, I, of electromagnetic radiation, 118
609t Hydrogen ion, external generation of, 633	Inductive reactance, 30 Inductor, 29, 30	Intercept, b, of calibration curve, A-18
Hydrogen lamp, 313, 313	Inelastic scattering, of electrons, 552	standard deviation of, s_b , A-19
Hydrogen peroxide, complexation with,	Inert electrode, 595	Interdomain conversion, 5
343	Infrared absorbance detector	Interface, 84
Hydrogen sulfide, gas-sensing electrode	GLC, 711, 720	Interfacial electroanalytical chemistry, 588
for, 609t	HPLC, 734t, 735	Interference effects, electromagnetic
Hydroxide interference	SFC, 771	radiation, 120, 122, 278
atomic spectroscopy, 221	Infrared absorption spectrometry, 119t,	Interference filters, 155
ICPMS, 265	380-401, 404-426	Interference fringe, 406
Hydroxide ion, external generation of, 633	Fourier transform, FTIR, 392–396 (see	Interferences
Hydroxyl group	also Fourier transform)	atomic spectroscopy, 217–223
absorption of electromagnetic radiation	instrumentation for, 392 (see also	ICPMS, 264–266 plasma emission spectroscopy, 244
by, 410t as auxochrome, 335	specific types) interfacing with gas-liquid	Interference wedge, 156 (see also Optical
2-(o-Hydroxyphenyl)benzoxazole, as	chromatography, GC/IR, 720	wedge)
fluorometric reagent, 372t	internal reflectance, 418	Interferent, 15
8-Hydroxyquinoline	photoacoustic, 349 (see also	Interferogram, 187
as chelating reagent, 221, 224, 653,	Photoacoustic spectrometry)	Fourier transformation of, 187-189
834	qualitative, 408–415	Interferogram frequency, f, and optical
fluorescence of, 372	quantitative, 415–418	frequency, v, 187
as protective agent, atomic	sample handling for, 405	Interferometer
spectroscopy, 221	theory of, 381–389	for absorption spectroscopy, 393, 437
Hyper Raman effect, 443	transducers for, 390	Michelson, 185
Hyphenated methods, 255, 718	Infrared emission spectroscopy, 425	Internal conversion
GCIR, 720 GCMS, 528, 718	Infrared microspectrometry, 425 Infrared radiation	nuclear, 812 relaxation by, 359, 363, 371
ICPMS, 255t	excitation by, 135	Internal conversion electron, 813
Hypsochromic shift, of absorption spectra,	sources for, 147, 313, 389, 396	Internal reflectance spectroscopy, 418, 420
332	transducers for, 176–178, 390–392,	Internal standard method, 18
Ilkovic equation, 658	396	for column chromatography, 697
Image current, ion cyclotron spectrometer,	Infrared spectra	for electron spectroscopy, 543
519	comparison with Raman spectra, 431	for emission spectroscopy, 243, 249,
Immobilized liquid membrane electrode,	computer search systems for, 414	251
596 <i>t</i> , 609	correlation charts for, 410, 412–413	for ICPMS, 262, 266, 268
Impedance, Z	dependence on physical state, 721	for NMR spectroscopy, 460, 476
measurement of, 37	Infrared spectrum, regions of, 404	for quantitative mass spectrometry, 332
in operational amplifier, 58	Injection port, GLC, 704	for SSMS, 270
in RC circuits, 34 Incandescent wire source, for infrared	Inlet system, for mass spectrometer, 255, 512	for X-ray analysis, 292 for X-ray photoelectron spectroscopy,
radiation, 390	In-line instrument operation, 84	543
	<u>-</u>	

International Centre for Diffraction Data, Ion-sensitive photoplate, for mass Laminar flow, in solutions, 647, 835 spectrometer, 257, 270 Laminar flow burners, for atomic Ion source, for mass spectrometer, 255t spectroscopy, 209 International Union of Pure and Applied Chemistry, IUPAC, 574 (see also (see also specific types) Lanthanide ions, absorption by, 336 IUPAC) Ion trajectory, in quadupole, 258 Large dispersion, FIA, 836 Internuclear double resonance, 469 Ion trap, 517, 519 Larmor frequency, 449, 453 Intersystem crossing, relaxation by, 360, Ion trap detector, ITD, mass spectrometer, Laser, as source, 147-154 361, 364, 371, 373 718 for fluorescence spectroscopy, 226, 367 Interzonal region, of flame, 208 IR drop, in electrochemical cells, 581-583, for infrared radiation, 390 Intrinsic germanium detector, for X-rays, 611 for photoluminescent spectroscopy, 367 for Raman spectroscopy, 435 286 Iron-55, radioactive decay of, 276 Intrinsic zone, semiconductor detector, Iron(III) complexes, charge transfer in, Laser ablation atomic spectroscopy, 201t, 204 286 Inverse Raman spectroscopy, 443 Irreversible reactions, current/voltage mass spectrometry, 262, 263 Laser desorption (LD) source, mass Inverter circuit, 57 relationships for, 649 Inverting and noninverting terminals, in Isobaric interferences, atomic mass spectrometer, 508 operational amplifier, 54 spectrometry, 265 Laser excitation, emission spectroscopy, Isobaric profile, SFC, 770 435 Iodide ion Isocratic elution, 728 complexation with, 343 Laser fluorescence detection, CE, 784 solid-state electrode for, 604t Isoelectric point, pI, 791 Laser-fringe reference system, Fourier Iodine Isomers, resolution by liquid-solid transform spectrometer, 393 absorption analysis for, 343 chromatography, 750 Laser microprobe effect on fluorescence, 360 Isotope dilution emission spectroscopy, 251 Ion chromatography, IC, 677t, 725, ICPMS, 262, 269 mass spectrometry, LMMS, 255t, 271, radiochemical, 810, 823-825 750-756 537t, 548 equilibria in, 752 Isotope peaks, in mass spectra, 504 Raman, 441 packings for, 753 Isotope ratio methods Laser sampling, ICPMS, 263 ICPMS, 269, 505 Ion cyclotron resonance trap, mass Laser systems, three- and four-level, 150 spectrometer, 519 radiochemical, 810, 823 Lattice, of absorbing nuclei, NMR Ion-exchange, in membrane electrode, radioactive, 810 (see also Radioactive spectroscopy, 451 596, 599 Lead(II), solid-state electrode for, 604t isotopes) naturally occurring, 505t Ion exchangers, chromatographic, 732 Leading buffer, CITP, 789 Ion-exclusion chromatography, 756 stable, 811 Lead sulfide, as photoconductor, 176, 323, IUPAC sign convention 392, 422 for mass spectrometer, 545 for electrical currents, 584 Least significant bit, binary numbering, for surface analysis, 537, 547, 548 for electrode potentials, 574 76, 80 Ionic spectra, 193, 233 Jaquinot advantage, Fourier transform Least-squares method, 16, A-18 Ionic strength, μ , A-25 spectroscopy, 182 Least-squares polynomial data smoothing, 110-112 effect on response of glass electrode, Jet separator, GC/MS, 718 JK flip-flop circuit, 77 615, 616 Lifetime measurement, of phosphorescent Ionic velocity, in an electric field, 780 Johnson noise, 100 (see also Thermal species, 373 Ionization noise) Ligand field strength, 338, 340t desorption, 508 Joule heating, capillary electrophoresis, Light amplification, in laser, 147, 150 Light-emitting diode, LED, 49, 77, 153 in flames, 220, 222 in ICP source, 233 Junction plugging, 593 Light-gathering power, of monochromator, Ionization chamber, 283, 284 Junction potential, 565 (see also Liquid 162 for detection of α particles, 817 junction potential) Light pipe, 720 Ionization chamber region, of gas-filled Katharometer, 707 Light-scattering transducer, HPLC, 734t, transducer, 283 K capture, 276, 812 736 Ionization source, mass spectrometer, 255t Ketones, absorption of electromagnetic Limit radiation by, 333t, 410t chemical, 506 of linearity, LOL, as figure of merit, 11t, Kinetic methods, FIA, 839 electron impact, 500t, 505 field desorption, 500t, 508 Kinetic polarization, 585 (see also of quantitation, LOQ, as figure of merit, Overvoltage) field ionization, 500t, 506 11t. 14 Ionization suppressors, atomic absorption Kinetic processes, in chromatographic Limited dispersion, FIA, 886 band broadening, 683-687 Limiting current, i_b 644, 648, 658 spectroscopy, 223 Limiting-current transducer, 651 1on laser, 151 Kinetic theory, of elution chromatography, Ion meter, 611 680 Limiting mean, A-6 Kirchoff's laws, 23 Ion microprobe analysis, 547 Linear absorption coefficient, µ, X-ray Ion-molecule collisions, mass Krypton ion laser, 435t spectroscopy, 277 spectrometry, 505 K series of X-rays, 274 Linear chromatography, 678 Ion-pair chromatography, 739, 747 Laboratory Information Management Linear dispersion, D, of monochromator, Ion-selective field effect transistor, ISFET, Systems, LIMS, 95 157, 161 606 Laboratory recorder, 46 Linear mobile-phase velocity, u, column LabView®, 87 Ion-selective membrane electrodes, 591, chromatography, 679, 683t, 684, 694t 596, 847 LabWindows®, 87 Linear optical effects, 154

Linear scan voltammetry, 640 (see also Polarography)	Macromolecules, scattering of radiation by, 347	for surface analysis, 547 tandem, 529, 531
Linear solute migration rate, $\overline{\nu}$, 679	Magic angle spinning, 483	Mass-to-charge ratio, of ions, m/z, 254,
Line broadening, 196–199 of NMR spectra, 452, 468, 482	Magnet, for NMR spectrometer, 470 Magnetic anisotropy, and chemical shifts,	511, 522 Mass transfer
Line scanning, Auger electron	462, 483	chromatographic, 681, 683, 684, 686
spectroscopy, 546	Magnetic field, B (formerly H), 448, 515	in electrochemical cells, 567, 585, 586,
Line selection, plasma emission	absorption in, 137 (see also Nuclear	645
spectroscopy, 242	magnetic resonance spectroscopy)	extractive, 775
Line sources, optical spectroscopy, 146,	energy levels in, 447	Mass transfer terms (C_S, C_M) ,
147, 215 Line spectra, 131	Magnetic moment, nuclear, 447, 450 Magnetic quantum states, distribution of	chromatographic, 686 Master grating, 159
width of, 196, 214	particles among, 448	Mathcad® equation solver, 90
X-ray, 274–276	Magnetic resonance imaging, MRI,	Matrix, 15
Liquid-bonded phase chromatography,	486–491	Matrix assisted desorption/ionization
677 <i>t</i>	Magnetic sector analyzer, mass	(MALDI) source, mass spectrometry,
Liquid chromatography, 675, 677t (see	spectrometer, 261, 514, 718	500t, 508
also High-performance liquid	Magnetic susceptibility, 462	Matrix effects
chromatography) extra-column band broadening, 727	Magnetogyric ratio, γ, 447, 451, 479 Magnification, (M), SEM, 550	in absorption spectroscopy, 344 in atomic spectroscopy, 210, 217,
Liquid chromatography/mass	Majority carrier of current, in	249
spectrometry, LC/MS, 528, 738	semiconductor, 39	in plasma emission spectroscopy, 244,
Liquid-crystal display, LCD, 49	Manhattan project, 750	266
Liquid junction potential, 565, 567, 570,	Mars Pathfinder mission, 293, 297, 298	in X-ray fluorescence spectrometry,
573, 613, 616	Martin, A.J.P., 674, 681, 701	292
Liquid-liquid chromatography, 677t, 728,	Mass absorption coefficient, μ_M , 277	Mattauch-Herzog geometry, mass
739 Liquid membrane electrode, 603–606	Mass analyzer, 256, 258–261, 511, 514–518	spectrometer, 270, 516
Liquid memorane electrode, 603-600 Liquids	Mass detector, GC, 718	Mean, 107 of small sets, \bar{x} , A=3
automatic sampling of, 841	Mass filter, 258 (see also Quadrupole mass	standard deviation of, A-9 (see also
infrared absorption analysis of, 407	spectrometry)	Standard deviation)
Raman analysis of, 436	Mass number, A, 811	true, μ, A-3
Liquid scintillation counter, 817	Mass-sensitive detector, GLC, 707	standard error of, A-9
Liquid-solid chromatography, 677t, 725,	Mass spectra, 264	Mean activity coefficient, f_{\pm} , $A=26$
748–750	collections of, 524, 525, 528	Mean square noise, 107
Lithium, as internal standard, AES, 251 Lithium-drifted detector, for X-rays, 285	identification of compounds by, 524–528	Mechanical oscillator, vibrational frequency of, 384
Littrow prism, 159	molecular, 499	Medium-dispersion FIA, 836, 838
Loading error, in electrical measurements,	Mass spectrometer, 255 (see also specific	Megabore columns, GLC, 712, 716
26, 27	types)	Membrane indicator electrodes, 594,
Local area network, LAN, 94	computerized, 521	596–606, 847
Local diamagnetic currents, molecular,	FT, 520	classification of, 596
461	inlet system for, 255, 512	potential of, 599
Lock-in amplifier, 106 Logarithm	ion sources for, 255 (see also Ionization source)	Memory, computer, 86 Memory chip, 86
generation of, 66	molecular, 524	Mercury
propagation of error in, A-17t	resolution of, 512 (see also Resolution)	automated monitoring for, 839
Logic state, binary counting, 76	transducers for, 256, 511	cold vaporization of, 213
Longitudinal diffusion	Mass spectrometric detectors	Mercury arc source, 146
chromatographic, 684, 686	capillary electrophoresis, 531, 784t, 785	for fluorescence spectrometry, 366
FIA, 835	chromatographic, 531, 711, 718, 734 <i>t</i> ,	for HPLC, 319, 734
Longitudinal diffusion term, B/u, 684, 685, 703	738, 771 Mass spectrometry, 192, 253–271	for infrared absorption spectroscopy, 390
Longitudinal relaxation, NMR, 451	daughter ion, MS/MS, 529	Mercury/cadmium telluride photon
Low-pass filter, 35	elemental surface analysis by, 271	detector, 392
for linear-scan polarography, 657	Fourier transform, 520 (see also Fourier	Mercury electrode
for noise reduction, 104, 107	transform instruments)	coulometric, 629, 631, 634
L section filter, 44	hyphenated, 528–531	as detector, HPLC, 738
L series, of X-rays, 274	identification of pure compounds by,	hanging drop, 667 (see also Hanging
Luminescence methods, 139t, 355–376 Luminol, as chemiluminescence reagent,	524 inductively coupled plasma, ICPMS,	drop electrode) polarographic, 642 (see also Dropping
376	262–269	mercury electrode)
L'vov platform, 210	parent ion, MS/MS, 530	potentiometric, 594
Machine code, 89	quantitative, 531	Mercury film electrode, stripping analysis,
Macrocyclic compounds, in liquid	secondary ion, SIMS, 255t, 547	668
membranes, 604, 605	spark source, SSMS, 255t, 269	Metallic indicator electrodes, 594, 595

Metal oxide semiconductor field-effect for HPLC, 740, 741 dispersion of, $dr/d\lambda$, 157, 161 selection of, for partition chromatogratransistor, MOSFET, 43 for fluorometer, 365, 367 phy, 689, 742, 743t, 749 Metastable states grating, 159-163 in laser materials, 148 for SFC, 771 for HPLC detector, 734 for TLC, 762 and phosphorescence, 137 light-gathering power of, 162 Metering layer, dry film analyzer, 846 Mobile-phase reservoir, HPLC, 728-731 performance characteristics of, 161, Methane, as quench gas, Geiger tube, 284 Mobile-phase transfer term, $(C_M u)$, Method errors, A-4, A-5 column chromatography, 685t, 686 prism, 159 Mobile-phase velocity, m, 679, 683, 686 Method of least squares, A-18 for Raman spectroscope, 436 Methyl cellulose gel, CGE, 788 Mobile-phase volume, V_M , 694tresolving power, R, of, 162 Methylene chloride, as solvent, 422t Mobility, ionic, 570 for X-rays, 281, 294 Mobilization, of focused bands, CIEF, 792 Micellar electrokinetic capillary Morphology, of surfaces, 536 chromatography, MECC, 778, 792, Modem. 8 MOSFET transistor, 43 Moderation, of neutrons, 819 Most significant bit, in binary numbering, Micelle, 373, 374 Modulated single-filament conductivity 76, 80 Michelson interferometer, 185, 393 detector, GLC, 707 Mull, 407 Microbalance, quartz crystal (QCM), 10 Modulation Multichannel instruments Microcomputers, in chemical for noise reduction, 104 for electron spectrometry, 541 instrumentation, 10, 83, 216, 799 of output, hollow cathode lamp, 215 optical spectrometry, 314, 316 of frequency-domain signals, 185 Microelectrode plasma emission spectroscopy, 235, 237 planar, current/concentration Molar absorptivity, ϵ , 138, 301t, 329 Raman spectroscopy, 436 relationships for, 645, 647 effect of refractive index on, 303 spark source spectroscopy, 246, 247 voltammetric, 639, 640, 642 Molar extinction coefficient, 301t (see also X-ray fluorescence, 288, 294 Microinjection tip, capillary Molar absorptivity) Multichannel photon transducer electrophoresis, 783 k, reflectance spectrometry, 419 for electron spectroscopy, 541 Micrometer, µm, 117, 380 Molecular absorption, 135, 139t, 200 for optical spectroscopy, 172 Molecular fluorescence, 139t (see also Micron, 117, 380 Multichromophores, absorption in the Microporous membrane, for gas-sensing Fluorescence) uv/visible by, 335t probe, 608 Molecular florescence spectroscopy, 355 Multielement analysis Microprobe, (see also Fluorescence spectroscopy) emission spectroscopy, 247 electron, 296, 536, 537t, 546, 548 Molecular formula, determination by mass ICPMS, 266 laser, 251 (see also Laser microprobe) spectrometry, 525 Multilayer films Microprobe analyzer, mass spectrometry, Molecular gas laser, 151 for automated analysis, 845-849 547, 842 Molecular ion, mass spectrometry, 499, for p-ion electrodes, 610 Microprocessors, in chemical Multipath term, A, Van Deemter equation, instrumentation, 10, 83 Molecular ion peaks, identification of, 525 684, 686t Microscopic electrodes, voltammetric, Molecular luminescence spectrometry, Multiplet peaks, in NMR spectra, 463-467 642, 669 355-376 Multiplex advantage, 184, 241 Microspectrometry, IR, 425 Molecular mass spectrometry, 498 (see Multiplex disadvantage, 184, 241 Microwave absorption spectroscopy, 119t, also Mass spectrometry) Multiplex instruments, optical Molecular orbitals, 331-335 spectroscopy, 182 (see also Fourier Microwave-induced plasma (MIP) source, and absorption of radiation, 331 transform spectrometers) 201t, 231 and fluorescence, 361 Multiplication for atomic mass spectrometry MIPMS, Molecular secondary ion spectrometry circuit for, 65 255t (SIMS), 255t (see also Secondary ion propagation of error in, A-17t Mid-infrared region, 380 mass spectrometry) Multiplicity spectrometry in, 396, 404-418 Molecular selective electrode systems, of NMR peaks, 466 Migration, mass transport in solution by, 607--609 spectral, 357 567, 586, 645 Molecular sieves Nanometer, nm, 117 Narrow-band electronic filters, for noise Migration rates, chromatographic, 677, 780 for capllary gel electrophoresis, 788 and resolution, 677, 688 for gas-solid chromatography, 721 reduction, 104 Migration velocity, v, ionic, 780, 782 Molecular spectra, 135 National Institute of Science and Millikan, R., 128 in flames, 221 Technology (NIST), as source for Minority carriers, of current in Molecular vibrations, 383, 385 standard materials, 617, A-5 semiconductors, 39 dipole changes in, 382 Natural frequency, ν_{m} of mechanical Mixtures Molecular weight oscillator, 385 analysis for average, 254 Natural gas, flame temperature of, 207t by absorption spectroscopy, 303, determination Natural line width, of atomic spectra, 197 344, 416 by mass spectrometry, 524-528 n-channel MOSFET, 43 by hyphenated methods, 528-531 by size exclusion chromatography, Near infrared spectrometry, NIR, 380, by NMR spectroscopy, 476 405t, 422-424 voltammograms for, 649 Monochromatic radiation, 118 detector for, 422 Mobile phase, 675 (see also specific types) dependence of Beer's law on, 305 radiation sources for, 422 Monochromator, 155, 157-162 effect of flow rate on column efficiency, solvents for, 422 683, 703 components of, 157, 163 Nebulization, for atomic spectroscopy, for GLC, 703, 708 crystal, 281, 540 201-204, 209-213, 232

Negative feedback, in operational	Nonbonding (n) electrons, 330, 331	proton, 476-479
amplifier, 56, 57	Noncrystalline membrane electrodes, 596t	quantum description of, 446
Negatron, 811t (see also Beta particle)	Nondestructive activation analysis, 821,	sample handling for, 475
Nd: Yag laser, 151, 154, 367, 435t, 548	822	wide-line, 456
Nephelometry, 139t	Nondestructive readout (NDRO) mode, of	Nuclear Overhauser effect, NMR
Nernst diffusion layer, 647	charge injection device, 175	spectroscopy, 469, 480
Nernst equation, 570, 575	Nondispersive instruments,	Nuclear relaxation, in a magnetic field,
calculation of half-cell potentials with,	atomic fluorescence, 226	450
570, 577–579	infrared, 392, 399	Nuclear spin, 446
effect of substituting concentrations for	X-ray fluorescence, 288, 289	Nuclei
activities, 579	Nonelectrical domain, 4	magnetic properties of, 447
Nernst, W., 570	Nonfaradaic currents, 566	precession of, 449
Nernst glower, 389	polarographic, 658, 660, 662	Nujol, 408
Nernstian behavior, 600, 613	Nonfilter photometer, IR, 399	Null instruments, for absorption
Network, computer, 94	Nonflame analyzer, atomic spectroscopy,	spectroscopy, 316
Neutral atom gas laser, 151	210–213	Numbering, binary, 8, 74–79
Neutralization titrations, coulometric, 633,	Noninverting booster amplifier, 64	Number of theoretical plates, N, 681, 689,
635 <i>t</i>	Noninverting terminal, of operational	694 <i>t</i> , 742
Neutrino, n, 811 <i>t</i> , 812	amplifier, 54	capillary electrophoresis, 781
Neutron, <i>n</i> , 811 <i>t</i>	Nonlinear laser output, 154	evaluation of, 682, 689
interactions with matter, 820	Nonlinear Raman spectroscopy, 443	thin-layer chromatography, 762
sources for, 819–820	Nonradiative relaxation, of excited	Numerical aperture, of fiber optics, 179
Neutron activation analysis, 810, 819–823	species, 137	Nyquist theorem, 108, 473
accuracy of, 823	Nonresonance fluorescence, 137	Objective lens, electronic, 550
methods, 821	Normal dispersion, 125 (see also	Obstruction factor, k_D , chromatographic,
sensitivity of, 823	Dispersion)	685
theory of, 820	Normal error curve, A-2, A-8	Occluder, 320
Neutron capture, 820	Normal error law, A-7	Occupational Safety and Health
Neutron flux, φ, 820	Normal hydrogen electrode, NHE, 572	Administration (OHSA), tolerance
Newton, N., 386	Normalization integer, 111	limits of, 417 <i>t</i> , 418
Nier-Johnson geometry, mass	Normal modes, of molecular vibration,	Octahedral configuration, of transition-
spectrometer, 516	387	element complexes, 337
Nitrate group, as chromophore, 333t, 335	Normal-phase chromatography, 739	Off-line collection
Nitrate ion	Normal Raman peaks, 434	of data, 84
membrane electrode for, 605t	Notch filter, 437	SFC, 776
uv/visible absorption by, 335, 343	npn transistors, 41	Off-resonance decoupling, carbon-13
Nitrile group, absorption of	$n \to \pi^*$ transitions, 331, 332, 335, 361	NMR, 480
electromagnetic radiation by, 410t	$n \rightarrow \sigma^*$ transitions, 331, 332	Offset trim, operational amplifier, 54
Nitrite ion, uv/visible absorption by, 335,	n-type semiconductor, 39	Offset voltage, operational amplifier,
343, 410 <i>t</i>	Nuclear fission, 811	54
Nitrogen	Nuclear magnetic moment, μ , 447	Ohmic potential, IR, in electrochemical
automated analysis for, 844	Nuclear magnetic resonance, NMR	cell, 581–583 Ohm's law, 22, 581, 790 (see also <i>IR</i>
as carrier gas, GLC, 703	classical description of, 449–452	
isotopic abundance of, 505t	quantum description of, 446–449	drop)
as purge gas, 650, 728, 799	relaxation and saturation in, 450	On-column derivatization, CE, 784t
Nitrogen laser, 151, 367	theory of, 446–449	On-column detection, capillary
Nitrogen oxides, determination of, 375, 608	Nuclear magnetic resonance spectra	electrophoresis, 783 One hundred percent <i>T</i> adjustment, 140,
Nitro group, absorpton of electromagnetic	abscissa scales for, 460	307, 314
radiation by, 333t, 410t	environmental effects on, 457 (see also	One-over- $f(1/f)$ noise, 100 (see also
Nitroso group, absorption of	Chemical shift)	Flicker noise)
electromagnetic radiation by, 333t	interpretation of, 463, 466 line broadening in, 468, 482	Ones complement, of computer register,
Nitrous oxide as oxidant, flame spectroscopy, 207, 218	of solids, 476, 481	83
as supercritical fluid, 769t		On-line collection
NMR, 137 (see also Nuclear magnetic	types of, 456 Nuclear magnetic resonance spectroscopy,	of data, 84
resonance)	119t, 137, 445–491	SFC, 776
Nodal plane, of π electrons, 331	carbon-13, 479–484	Open-loop gain, A, of amplifier, 54
Noise, N, 6, 99	chemical shifts, 459 (see also Chemical	Open tubular column
effect on precision of	shift)	GLC, 705, 711
spectrophotometric analysis,	continuous-wave, 446	SFC, 771
306–311	fluorine-19, 484	Operational amplifiers, 53–68
reduction of, 102–113	Fourier transform, 446, 452–456	circuits incorporating, 56, 58 (see also
sources of, 100, 102	high-resolution, 456, 457	specific types)
Nominal mass, of atoms, 254	instrumentation for, 470–476	frequency dependence of, 57
Nonabsorbing species, photometric	for isotopes other than protons, 479–485	general characteristics of, 54
determination of, 335, 343	phosphorus-31, 484	symbols for, 53
the state of the s		

Optical activity detector, HPLC, 734t	Oxygen automated analysis for, 844	Peak width (W_A, W_B) , 692, 694 t Pelleting, of samples, 246, 407
Optical atomic spectroscopy, 192-204	coulometric monitoring of, 631	Pellicular packings
Optical density, 301t (see also	effect on fluorescence, 360, 364	for HPLC, 732
Absorbance)	evolution during electrolysis, 623	for ion chromatography, 753
Optical fibers, 179, 370 Optical frequency, ν , and interferogram	isotopic abundance of, 505t overvoltage effects with, 587, 623	Percent reflectance, %R, 847 Percent transmittance, %T, 139
frequency, f, 187	as oxidant, atomic spectroscopy, 207	of filters, 156
Optical multichannel analyzers, 172	as purge gas, 799	Perchlorate ion, membrane electrode for,
Optical scanning, surface spectroscopy,	sensor for, 651	605t
537	Oxygen-hydrogen bond, absorption by,	Perfluoro compounds, for calibration of
Optical spectroscopy, 119, 192	410 <i>t</i>	mass spectrometer, 523
cells for, 143 (see also Cuvette)	Oxygen waves, polarographic, 650	Period
instruments for, 143, 181–189 (see also	Ozone, analysis for, 343, 375	of alternating current, t_p , $28t$
specific types) radiation sources for, 145–154 (see also	Packed columns for capillary chromatography, 792	of electromagnetic radiation, p, 117 (see also Beat period)
Sources)	electrochromatographic, 793	of time-domain transitions, 6
transducers for, 167–178	for GLC, 705, 712, 713 <i>t</i>	Periodicity, of waves, 121, 184
wavelength selectors for, 154-166	for HPLC, 727, 732	Peristaltic pump, continuous-flow
Optical wedge, 316	for ion chromatography, 753	analyzer, 832
Optics, electron, 550	for partition chromatography, 739	Permanent magnet, NMR spectrometer,
Optoacoustic spectroscopy, 349	for SFC, 771	471
Optrode, 179	for size-exclusion chromatography, 757,	Permeation limit, size-exclusion
Orbital energy, of <i>d</i> electrons, 336	758t Paired ion chromatography (PC) 747	chromatography, 759 Personal errors, A–4
Order, n of diffraction, 160	Paired-ion chromatography (PC), 747 Pair production, 812	p-function, 594
of interference, 123, 136	Paper chromatography, 761	pH
Organic analysis	Paraffin, as moderator for neutrons, 819	operational definition of, 616
automated, 844	Parallel circuit, 23, 24	potentiometric measurement of, 597,
chemiluminescent, 376	Parallel digital data, 9	615–617
coulometric, 631	Paramagnetism, 356, 461	pH effects
fluorometric, 372	effect on fluorescence, 360, 364, 371	on chromatographic selectivity, 692
Organic functional group	Parent ion, MS/MS, 530	on fluorescence, 363
detection/analysis	Parent nuclide, 811	on organic polarography, 665
HPLC, 741 IR, 412	Particle size, effect on column efficiency, 686, 712, 727	on partition chromatography, 741 Phase angle, φ
NMR, 477	Partition chromatography, 677t, 725,	of electromagnetic radiation, 120
polarographic, 665	739–747	of sinusoidal currents, 29
Raman, 439	column selection for, 741	Phase transition, thermal analysis of, 804
uv/visible, 342	packings for, 739–741	1,10-Phenanthroline, complexation with,
Organic solvents, effect on AAS, 224 (see	Partition coefficient, K, chromatographic,	343
also Solvent effects)	678, 679, 694 <i>t</i> , 702, 713, 759	Phenols, absorption of infrared radiation
Oscillator	Passivation, of metal surfaces, 546	by, 410
anharmonic, 387 harmonic, 383	Passive data processing, 91, 92 Path length, b, 139, 301t	pH meter, 611 Phosphorescence, 143, 355, 360, 373
Oscilloscope, 46	evaluation, infrared absorption	factors affecting, 370 (see also
OSHA, 417 <i>t</i>	spectrometry, 406	Fluorescence)
Osmotic flow pumping, 792	Pauli, W., 445	relaxation by, 137, 330
Output signal, of electrothermal analyzer,	Pauli exclusion principle, 356	theory of, 356–360
211	Peak, chromatographic, 677	Phosphorescence spectroscopy, 139t (see
Output transducer, 6 (see also Readout)	Peak area	also Phosphorescence)
Overpotential, 585 (see also Overvoltage)	column chromatography, 695	Phosphorimeter, 370
Overtone effects, in infrared spectra, 387, 422	DTA thermogram, 803 mass spectrometry, 531	Phosphorus-31, NMR of, 446, 447 <i>t</i> , 484 Photoacoustic (PAS) spectroscopy, 349
Overvoltage, η, 585, 587, 623	Peak broadening, chromatographic, 677	infrared, 351
Oxidation, in electrochemical cell, 566	(see also Band broadening)	Photoarray (PDA) detector, 172
Oxidation potential, 574	Peak current, I _m 28	Photocathode, 129
Oxidation/reduction titrations	Peak height, evaluation of	Photochemical reaction, 330, 340, 397,
amperometric, 653	column chromatography, 695	434, 435, 442
coulometric, 634, 635t	mass spectrometry, 532	Photoconduction, 168, 177
Oxidation state, effect on ESCA spectra,	X-ray spectrometry, 290	Photoconductivity transducer
541 Oxide formation in flames 200	Peaks, mass spectrometric	for infrared spectroscopy, 390, 392, 425
Oxide formation, in flames, 209 Oxide interference	base, 499, 522 collision product, 503 <i>t</i> , 505, 506	for optical spectroscopy, 169, 176 for Raman spectroscopy, 436
atomic spectroscopy, 221	molecular ion, 499 (see also Molecular	for scanning electron microscope, 552
ICPMS, 265	ion)	for X-radiation, 282, 285, 817

Di	Di	Delegacione de detectos for LIDI C. 727
Photocurrent, 129	Planar chromatography, 675 (see also	Polarographic detector, for HPLC, 737
Photodecomposition, 340 (see also	Thin-layer chromatography)	Polarographic wave, 648, 658
Photochemical reaction)	Planar electrode, current/concentration relationships for, 645	current maxima in, 660 effect
Photodiode, spectral range for, 170	•	
Photodiode array (PDA) transducer, 172 Photoelectric transducer	Planck, M., 130 Planck constant, h, 30, 273	of complex formation on, 659 of pH on, 665
	Plane-polarized electromagnetic radiation,	for irreversible reactions, 649
for emission spectroscopy, 247 for optical spectroscopy, 168	117 (see also Polarization)	for mixtures, 649
Photoelectric effect, 128, 812	Plasma, 231, 233	for organic functional groups, 665
Photoelectron, 277, 283	Plasma desorption (PD) source, mass	Polarography,
Photographic detection	spectrometer, 500t	current sampled, 639
emission spectrometry, 182, 246, 248	Plasma emission spectroscopy, 231	differential pulse, 661–663
mass spectrometry, 257, 261, 270, 515,	analyte atomization for, 233	instrumentation for, 640
516	instruments for, 235–241	linear scan, 657
optical spectroscopy, 172	interferences, 244	square wave, 662, 663
X-ray spectroscopy, 282, 294	quantitative, 242	stripping methods, 666, 669
Photoionization detector	Plasma source spectrometer, 235	Polyatomic ion interference, atomic mass
GLC, 711	Plate, of capacitor, 30	spectrometry, 265
HPLC, 734	Plate calibration, emission spectroscopy,	Polychromatic radiation, 118
Photoluminescence, 355 (see also	247	effect on Beer's law, 305
Fluorescence, Phosphorescence)	Plate count, N, 681 (see also Number of	Polychromator, 182, 237, 247
Photoluminescence detectors, for liquid	theoretical plates)	Polycrystalline gel, CGE, 788
chromatography, 356, 735	Plate development, thin-layer	Polycrystalline membrane electrode, 696t
Photometer, 60, 181, 250, 317	chromatography, 762	Polyethylene glycol, as stationary phase,
for absorption analysis, 317	Plate height, <i>H</i> , 681, 682, 691, 694 <i>t</i>	GLC, 714 <i>t</i>
for atomic emission spectroscopy, 250	capillary electrophoresis, 780	Polyethylene glycol gel, CGE, 788
for chemiluminescence spectroscopy,	evaluation of, 682	Polymers
374	factors affecting, 684–687	porous, for gas-solid chromatography,
infrared filter, 399, 416	packing size and, 725, 727	722
nondispersive, 399	sample size and, 727	for size-exclusion chromatography, 756
probe-type, 319	TLC, 764	thermal methods of analysis for, 800,
reflective, 847	Plate, theoretical, 681	803
ultraviolet absorption, 319	Plate theory, 682	Polysiloxanes, as stationary phase, GLC,
Photometer detector	Platinum	714 <i>t</i>
FIA, 833, 834	as redox indicator electrode, 595	Pooling, of data, A-9
HPLC, 319	as voltammetric microelectrode, 652,	Population, of data, A-6
ion chromatography, 755	656	Population inversion, in laser, 150
Photometric analysis, 139 (see also	Pneumatic nebulization, atomic	Population mean, μ, A-6
Absorption analysis)	spectroscopy, 201t, 202	Population standard deviation, σ, A-6
Photometric titrations, 347–349	Pneumatic pump, for HPLC, 730	Population variance, σ^2 , A=6
Photomultiplier tube, PMT, 169, 170–172,	pn junction, 39, 45, 172	Porous layer open tubular column (PLOT),
216, 235, 236, 237, 285, 367, 374,	pnp transistor, 41	gas-solid chromatography, 721
436	Poisson distribution, 814	Porous particle packing, HPLC, 732, 753,
Photon, of electromagnetic radiation, 117,	Polarity effects	758
128, 273, 513	absorption spectroscopy, 332	Porous polymers, for gas-solid
Photon counting	GLC, 713	chromatography, 722
uv/visible spectroscopy, 178	partition chromatography, 740, 741	Positron, 811t (see also Beta decay)
X-ray spectroscopy, 282	Polarity index, P' , partition	Postcolumn derivatization, CE, 784t
Photon transducer, 168–176	chromatography, 742, 743t, 749	Potassium ion, liquid membrane electrode
multichannel, 172	Polarizability, α , of chemical bond, 432	for, 605
noise in, $308t$	Polarization	Potential, 22 (see also Voltage)
Photoplate, ion-sensitive, for mass	of atoms and molecules, 125, 154	asymmetry, 599
spectrometer, 270	electrochemical, 581–587, 639	boundary, E_b , glass electrode, 599
Phototube, 128, 169	of electromagnetic radiation, 117, 125,	cell, 569 (see also Cell potentials)
Photovoltaic cell, 169	127, 154, 219, 434, 450	changes in, during electrolysis, 622
Pi (π) electrons, 330	Polarization interaction, NMR	control of, 63 (see also Potentiostat)
Piezoelectric effect, 10, 78	spectroscopy, 460	electrode, 571 (see also Electrode
Piezoelectric transducer, 555, 556, 557	Polarized radiation	potential)
Pi (π) line, of Zeeman splitting pattern,	and Raman spectra, 434	formal, 580, A-28
219	and Zeeman splitting, 219	of glass electrode, 600
Pi (π) molecular orbitals, 331	Polarogram, 658 (see also Polarographic	half-cell, 571 (see also Electrode
$\pi \to \pi^*$ transitions, 331, 332, 361	wave)	potential)
plon electrodes, 596 (see also Membrane	Polarographic analysis	half-wave, voltammetric, 644, 649
indicator electrodes)	oxygen waves in, 650	liquid junction, 565 (see also Liquid
pIon meter, 611	quantitative, 664–666	junction potential)
Pixel, 174, 241, 488	Polarographic currents, 657	measurement of, 60, 591

Potential (continued)	Proportional counter region, gas-filled	Quotients, propagation of error in, A-17t
of membrane electrode, 599 (see also	transducer, 283	Radial diffusion, FIA, 835
specific types) ohmic, of electrochemical cells, 581	Protective agents, atomic absorption spectroscopy, 221	Radiant intensity, <i>I</i> , of electromagnetic radiation, 118, 301 <i>t</i>
(see also Ohmic potential)	Proton decoupling, 468, 469, 480	Radiant power, P, of electromagnetic
saturation, vacuum phototube, 170	Proton NMR spectroscopy, 445 (see also	radiation, 118, 138, 301 <i>t</i>
switching, cyclic voltammetry, 655	Nuclear magnetic resonance	Radiation, electromagnetic, 116 (see also
thermodynamic, 569, 623	spectroscopy)	Electromagnetic radiation)
Potential energy	Proton transfer, chemical ionization mass	Radiation buffers, 218
of harmonic oscillator, 384	spectra, 506	Radiation sources, 143 (see also
nuclear, 448	Pseudostationary phase, MECC, 795 p-type semiconductor, 39	Electromagnetic radiation) for atomic absorption spectroscopy, 147
Potential well, 174 Potentiometer, 24, 611	Pulsed decoupling of ¹³ C NMR spectra,	(see also Hollow cathode lamp)
Potentiometric detector, CE, 784t	480	for infrared spectroscopy, 389 (see also
Potentiometric titrations, 85, 818	Pulsed input, effect on RC circuit, 37	Infrared radiation)
Potentiometry, 591-618, 847 (see also	Pulsed laser sampling, for ICPMS, 263	for ultraviolet/visible spectroscopy,
Direct potentiometric analysis)	Pulsed nitrogen laser, 151, 367	145-154 (see also Deuterium
instruments for, 847	Pulsed nuclear magnetic resonance	lamp)
Potentiostat, 63, 627, 630	spectra, 446 (see also Fourier	Radiation transducers, 167 (see also
Potentiostatic coulometry, 628–632	transform nuclear magnetic resonance	Transducer)
Potentiostatic electrolysis, 626 Power, P, of electromagnetic radiation, 118	spectroscopy) Pulse excitation	Radical ion, mass spectrometry, 499 Radicals, band spectra of, 131, 132
(see also Radiant power)	of nuclei, 454	Radioactive decay processes, 811
Power compensated differential scanning	voltammetric, 661–664	Radioactive isotopes, 810
calorimetry, 805	Pulse generator, NMR spectrometer, 472	Radioactivity
Power gain, P_o/P_i , of operational	Pulse-height analyzer	decay products of, 812
amplifier, 58	for α particles, 817	decay rates of, 813
Power law, 23	for X-rays, 284, 287	units of, 813
Power supply, laboratory, 44 Precession, of nuclei in a magnetic field,	Pulse-height discriminator, 283	Radiochemical methods activation, 810 (see also Neutron
449	Pulse-height distribution, X-ray transducer, 286	activation)
Precipitation reactions, effect on electrode	Pulse-height selector, for X-ray	counting statistics for, 814–817
potentials, 578	spectrometer, 286	instrumentation for, 817–820
Precipitation titrations	Pulse polarography, 661–664	isotope dilution, 810 (see also Isotope
amperometric, 653	Pulse width, of analytical signal, 6	dilution)
coulometric, 634, 635t	Pumping, laser activation, 147, 148	Radio-frequency source, for NMR
Precision	Pumping rate, effect on dispersion, FIA, 836	spectrometer, 470
figures of merit for, 11t, 12	Pumping system for FIA, 830	Radioisotopes, as source for neutrons, activation analysis, 819
of quantitative mass spectral methods, 532	for HPLC, 729–731	for X-rays, 276, 279, 280
Predissociation, of excited molecules, 360,	Purcell, E., 445	Radiometric detector, for capillary
361	Purge gas, thermogravimetry, 798	electrophoresis, 784t
Pressure broadening, 197, 198	Pyroelectric transducer, 177, 390, 391, 396	Raman, C.V., 429
Pressure drop correction factor, j, GLC,	Pyrolytic carbon, 210	Raman depolarization ratio, p, 434
702	1-Pyrrolidinecarbodithioic acid, as	Raman detector, CE, 784t
Pressure effects, SFC, 770	protective agent, atomic spectroscopy, 221	Raman scattering, 127 mechanism of, 432
Pressure injection, capillary electrophoresis, 783	Quadrature detection system, FT NMR, 474	Raman shifts and IR peak frequencies, 414
Primary beam, surface analysis, 536	Quadrupole mass spectrometer, 255, 258,	Raman spectra
Primary coil, of transformer, 44	516, 521, 718	collections, 439
Primary combustion zone, of flame, 208	Quanta, of electromagnetic radiation, 128	comparison with IR spectra, 431
Principle of superposition, 120	Quantity of electricity, Q, 31, 627	excitation of, 430
Prism, 157	Quantum detector, 168	intensity of peaks in, 435
Prism monochromator, 159 (see also	Quantum-mechanical properties, of	Raman spectroscopy, 119t, 139t, 429–443
Monochromator) Probe	electromagnetic radiation, 128–138, 385	instrumentation for, 435–438 nonlinear, 443
gas-sensing, 607	Quantum yield, φ, for fluorescent	theory of, 430
NMR spectrometer, 472	emission, 360	Random access memory, RAM, 86
Probe-type photometer, 319	Quartz cells, for optical spectroscopy, 166,	Random error, A-2, A-3
Products, propagation of error in, A-17t	314	statistical treatment of, A-5
Programming, 89	Quartz crystal microbalance, QCM, 10	Raster pattern, 537, 549, 554, 557
Prompt γ-ray emission, 820	Quench gas, in Geiger tube, 284	Rate theory, of elution chromatography,
Proportional counter	Quenching, of fluorescence, 364, 371	680, 682 Rayleigh scattering, 127, 440
for α particles, 817 for β particles, 817	Quinhydrone, charge-transfer in, 340 Quinine sulfate, as standard fluorophore,	Rayleigh scattering, 127, 440 mechanism of, 430
for X-rays, 283, 284	371	wave model of, 432

RC circuits, 30–33	Refractive index detector	Retention volume, V_R , GLC, 702
effect of pulsed inputs on, 37	for FIA, 833	effect on resolution, 689
as filters, 35	for HPLC, 734t, 736	and partition ratio, 679
impedance in, 34	Refractory oxide ion interference, atomic	Reverse biased pn junction, 40, 172
phase shifts in, 32, 33	mass spectrometry, 265	Reversed-phase chromatography, 739, 747
response of, to sinusoidal signals, 33	Register, of computer, 83	Reverse scan, cyclic voltammetry, 655
•		-
time constant for, 32	Relative error, A-1	Reversible cells, 567, 648
RC filter, for noise reduction, 104	Relative half-cell potential, 572	Reversible pump sampler, 841
Reactance	Relative reflectance intensity, $f(R_{\infty})$, 419	Reversible reactions, electrochemical, 567
in a capacitor, 34	Relative retention factor, R_{∞} 765	current/voltage relationships for, 648
in electrical circuits, 29	Relative standard deviation, RSD, 99, A-6	Ring current, 462
Reactant concentration, and concentration	as figure of merit, 11t, 12t	Ring disk electrode, 654
polarization, 587	Relative systematic error, as figure of	Ring substitution, and uv/visible
Reaction overvoltage in electrochemical	merit, 11t	absorption, 335
cell, 581, 585	Relaxation	Ripple, 44
		Rise time, t_r , 57, 101
Reactor, as neutron source, activation	of excited species, 131, 137, 330, 358,	
analysis, 819	499	Robotics, 842
Reactor coil, FIA, 832	in a magnetic field, 450	Rocking vibrations, molecular, 383
Read-only memory, ROM, 86	Relaxation times, T_1 , T_2 , nuclear magnetic	Root mean square (rms)
in thermobalance, 800	resonance spectroscopy, 450-453	currents, 29, 101
Readout devices, 10, 46 (see also specific	Releasing agents, atomic absorption	noise, 101, 108
types)	spectroscopy, 221	Rotameter, 210
Read window, charge-injection	Repeller, electron impact source, 502	Rotary sampling valve, column
spectrometer, 238	Replica grating, 159	chromatography, 697, 704
Read/write memory, 86	Residual current, in polarographic wave,	Rotating electrodes, voltmmetric, 653, 654
Reagent layer, dry film analyzer, 846	558, 560	Rotational motion, molecular, 387
Real time processing, of data, 84, 719	Residuals, of data, A-18	Rotational spectra, 131, 136, 425
Receiver system, NMR spectrometer, 473	Resistance	Rotational states, molecular, 131, 136, 382
Reciprocal linear dispersion, D^{-1} , 162	effect on thermal noise, 101	Rotational transitions, 137, 382
Reciprocating pump, HPLC, 729	in an electrochemical cell, 581	Rowland circle, 237
Recorders, 47	measurement of, 26, 60	Ruby laser, 150
Rectification, 38	Resolution	Sadtler collection
Rectifier, 39, 44	chromatographic, R _s , 677, 688, 694t	of infrared spectra, 414
Redox indicator electrodes, 594, 595	effect of slit width on, 164	of Raman spectra, 439
Red sensitive photoemissive surfaces, 170	electrophoretic, 780	of retention indexes, GLC, 717
Red shift, of absorption spectra, 198, 332	of Fourier transform spectrometer, 183,	Salt bridge, 565, 571, 614
Reduced mass, μ , of mechanical oscillator,	189, 521	Sample, statistical, A-6
385	of mass spectrometer, R, 260, 512, 514	Sample-and-hold
Reduction, in electrochemical cell, 566	optical, 164	amplifier, 83
Reference beam	Resolution elements, of multiplex	circuit, TAST polarography, 661
of atomic absorption spectrophotometer,	spectrum, 183	Sample application, thin-layer
216	Resonance fluorescence, 137, 196, 356	chromatography, 762
of fluorometer, 365	Resonance line	Sample atomization, atomic spectroscopy,
· · · · · · · · · · · · · · · · · · ·		200–204
of infrared spectrophotometer, 397	absorption of, 196	
Reference electrode, 572, 573, 737	emission of, 195	Sample handling
for linear scan voltammetry, 640	Resonance Raman spectroscopy, 430, 441	atomic spectrometry, 223–225, 245
for potentiometry, 591–594	Restrictor, supercritical fluid	infrared spectrometry, 405
precautions in use of, 593	chromatographic column, 770, 775	NMR spectroscopy, 475
for potentiostatic coulometry, 626,	Retardation, δ , in interferometer, 187	SEM, 551
630	Retardation factor, R_F , thin-layer	TLC, 762
Reference junction, for thermocouple, 177,	chromatography, 763, 764	X-ray photoelectron spectroscopy, 540
391	Retention factor, k' , 680, 691, 694 t	Sample illumination system, Raman
Reflectance, R, 408, 847	effect	spectroscopy, 435
Reflectance photometer, 847	on adsorption chromatography, 749	Sample injection
Reflection, of electromagnetic radiation,	on column resolution, 689, 690, 691	capillary electrophoresis, 783
126	on partition chromatography, 683t,	column chromatography, 695
Reflection grating, for monochromator,	686, 742, 749, 753	FIA, 833
157, 159	on SFC, 770	GLC, 704
Reflection losses, at air-glass interfaces,	on TLC, 763	HPLC, 731
127, 300	and stationary mass-transfer term, Van	ICP emission spectroscopy, 232
Reflection spectrometry, 418–421, 845	Deemter equation, 686	TLC, 762
Refraction, of electromagnetic radiation,	Retention index, I, GLC, 717	Sample inlet system, for mass
125, 157	Retention time, chromatographic, t_R , 679,	spectrometer, 255, 512–514
Refractive index, η, 124, 156	694 <i>t</i> , 702, 713, 753	Sample mean, \bar{x} , A-3, A-6

effect on resolution, 689

and partition ratio, 679

Sample probe

mass spectrometer, 512

effect on molar absorptivity, 303 of mobile phases, 743t

Sample probe (continued) Segmented flow systems, 831 Signal averaging, 107, 183, 325, 470 Selected ion monitoring, mass NMR spectrometer, 472 Signal chopping Sample size, and column efficiency, spectrometry, 531 for atomic absorption instruments, 215 **HPLC, 727** Selection rules (see also Modulation) Sample spinning, NMR spectrometry, 452, for atomic emssion spectra, 195 for noise reduction, 104 for vibrational transitions, 386 Signal detection, FT NMR, 473 Sample splitter, GLC, 704, 712 Selectivity, figures of merit for, 11t, 14 Signal integration, NMR spectroscopy, Sample standard deviation, s, A-6 Selectivity coefficient, $K_{A,B}$, of membrane 474 Sample surface map, scanning electron electrodes, 601 Signal processor, 9 microscopy, 550 Selectivity factor, a, chromatographic, for optical spectroscopy, 143, 178 680, 6941, 716, 742, 744, 772 Sample variance, s², A-6 for X-ray spectrometer, 282, 286 Sample volume, effect on dispersion, FIA, effect on resolution, 689, 690, 691, 749, Signal shaper, 76 836 Signal-to-noise (S/N) ratio, 99 (see also Sampling Self-absorption characteristics of specific instruments) of audio signal, FT NMR, 473 atomic spectroscopy, 243 improvement of, 102-113, 179, 184, automation of, 841 of fluorescence, 364 220, 289, 307, 311, 325, 380, 663 in continuous-flow analyzers, 833 Sign conventions in hollow cathode lamp, 220 for direct potentiometry, 612 fiber optic, Raman spectroscopy, 436 Self-quenching, of fluorescence, 364 plasma spectroscopy, 232 Semiconductor, 38, 39 for half-cell potentials, 574 Silanization, of chromatographic columns Sampling cone, ICPMS, 263 Semiconductor diode, 38 Sampling loop, 704, 731, 833 current/voltage curves for, 40 bonded-phase, 740 Saturated calomel electrode, SCE, 573, Semiconductor diode laser, 152 GC, 712 592, 640 Semiconductor transducer, 172, 285, 552, Silica, as column packing, 732, 739, 749, Saturation, of energy states, NMR 817 (see also Photoconductivity 758 spectroscopy, 450, 470 transducer) adsorption chromatography, 749 Saturation factor, S, neutron activation Semiquantitative methods, emission HPLC, 733, 749 analysis, 821 spectroscopy, 248 Silica cells, 166 (see also Quartz) Saturation potential, of phototube, 170 Sensitivity, figures of merit for, 11t, 12 Silicon, isotopic abundance of, 505t Scaler, 78 Sensor, 9, 10 Silicon diode, as photoelectric transducer, for X-ray spectrometer, 288 biocatalytic, 609 169, 172, 316, 736 fiber optic, 179 Silicon semiconductor, properties of, 39, Scanning of mass spectra, 260 voltammetric, 651 of optical spectra, 157 Sensor cell, 400 Siloxanes, as stationary phase Scanning echelle spectrometer, 236 Separations GLC, 714t chromatographic, 673, 697 Scanning electron microscope, SEM, 549, SFC, 771 550-553 in continuous-flow analyzer, 833 Silver halide membrane electrodes, 603 Scanning probe microscopy, SCP, 549, 553 electrophoretic, 778 (see also specific Silver ion Scanning tunneling microscopy, STM, types) amperometric titrations with, 653 549, 553-557 Sequential scan instruments solid-state electrode for, 604t Silver/silver chloride electrode, 573, 593, Scattered radiation, effect on absorbance for plasma emission spectroscopy, 235 measurements, 161, 218, 312 for X-ray fluorescence spectroscopy. 594, 849 Scattering coefficient, s, reflectance Simple harmonic motion, 383 spectrometry, 419 Serial-coded binary data, 8 SIMS, 255t (see also Secondary ion mass Scattering of electromagnetic radiation, Series circuit spectrometry) 125, 127, 143, 300 (see also Raman dc, 22, 23 Simultaneous multielement analyzer, 235 spectroscopy) RC. 30-38 (see also Multichannel instruments) Scattering spectroscopy, 139t Servosystem, 47 Single-beam instruments Schmidt cross-dispenser element, 241 Shaper, electronic, 76 for atomic absorption spectroscopy, 216 for FTIR spectroscopy, 396 Scintillation transducer, 282 Shielding for mass spectrometer, 257 for noise reduction, 103 for ultraviolet/visible absorption for scanning electron microscope, 552 of nuclei, NMR spectroscopy, 461 spectroscopy, 314, 318, 320 for radiation, 282, 817, 819 Shift register, of PDA detector, 173 Single bond, force constant for, 383, 386 for X-rays, 285 Shim coils, NMR spectrometer, 472 Single-channel instruments, X-ray Scissoring vibrations, molecular, 383, 388 Shot noise, 100, 101, 168, 184, 308t, 309 fluorescence, 288 Screening constant, σ , NMR spectrometry, Side bands, in NMR spectra, 472 Single-coil detector, in NMR spectrometer, 459 Siegbahn, K., 538 Secondary beam, surface analysis, 536 Sigma (σ) electrons, 330 Single-column ion chromatography, 755 Secondary coils, of transformer, 44 Sigma (σ) line, Zeeman splitting pattern, Single-crystal membrane electrodes, 596t, Secondary combustion zone, 208 Secondary electrons, 536, 552, 553 Sigma (σ) molecular orbitals, 331 Single-focusing mass spectrometer, 516 Secondary fluorescence, as radiation $\sigma \rightarrow \sigma^*$ transitions, 331 Singlet state, 194, 219, 356 source, 279, 280 Singlet/triplet excited states, 356 Secondary ion mass spectrometry, SIMS, analog, 6, 74 (see also Analog signals) Sinusoidal currents, 28 255t, 271, 500t, 537t, 547 analytical, 5 (see also Domains) Size-exclusion chromatography, 677t, 725, Second-order NMR spectra, 467 digital, 7, 74 756-761 Sector mirror, 316 mean blank, S_{bl}, 13 column packing for, 756, 758t

Skimmer	for infrared absorption spectroscopy,	photoacoustic, 350
GC/MS, 718	405, 406 <i>t</i> , 422	plasma source, 232–241
ICPMS, 263	for NMR spectroscopy, 475	Raman, 436
Slab electrophoresis, 779	for organic polarography, 666	slew-scan, 236
Sleeve-type calomel electrode, 593	for partition chromatography, 743t	uv/visible, 320-325
Slew rate, of amplifier, 58	for ultraviolet/visible regions, 341	X-ray, 279, 288
Slew scan spectrometer, 236	for X-ray spectroscopy, 292	Spectrometric detector, CE, 784t
Slits, for monochromator, 157, 163, 237,	Solvent treatment systems, HPLC,	Spectronic 20® spectrophotometer, 320
322	728–731	Spectrophotometer, 182
Slit width	Source flicker noise, 100 (see also Flicker	for atomic absorption spectroscopy, 216
of diode array instruments, 316	noise)	for atomic emission spectroscopy,
effect on absorption measurements, 164,	Source modulation, atomic absorption	235–241
311	spectroscopy, 215	double-dispersing, 322
selection of, 166	Sources	effect of scattered radiation in, 161
Slope, m, of calibration curve, A-18	for atomic absorption spectroscopy, 214	Fourier transform, 182 (see also Fourier
standard deviation of, s_y , A-19	(see also Hollow cathode lamp)	transform instruments)
Slurry, 201	for atomic emission spectroscopy,	for infrared spectroscopy, 392–399
Smith-Hieftje correction method, atomic	231–235	for Raman spectroscopy, 436
absorption spectroscopy, 220	for atomic fluorescence spectroscopy,	for ultraviolet/visible regions, 320–325
Smoothing, of data, 110-113	226	Spectrophotometric analysis 139 (see also
Smooth width, n, of data points, 111	of electromagnetic radiation, 145 (see	Absorption analysis)
Snell's law, 126	also specific types)	derivative, 345
Soap bubble meter, 702, 704	for electron microscopy, 540	effect of instrumental noise on precision
Sodium chloride windows, infrared	for fluorometric spectroscopy, 366	of, 306–311
absorption spectroscopy, 166	for IR spectroscopy, 389, 395	ultraviolet/visible, 342-351
Sodium dodecyl sulfate, as reagent,	for mass spectrometry, 255t (see also	Spectrophotometric detector, FIA, 833
micellar electrokinetic capillary	Ionization source)	Spectroscope, 181
chromatography, 794	for Raman spectroscopy, 435	Spectroscopic interferences, ICPMS,
Soft source, mass spectrometer, 500	for uv/visible spectrometry, 145-154,	265
Software, computer, 84, 89-94	313, 320	Spectroscopy, 115, 119t (see also specific
for improving S/N ratio, 107–113	for X-ray spectrometry, 279-281	types)
Solar blind photomultiplier detector, 226	Source self-absorption, of hollow cathode	Spectrum
Solenoid, 471	lamp, 220	absorption, 134 (see also Absorption
Solids	Soxhlet extractor, 774	spectrum)
atomic spectroscopy involving, 203,	Sparging, 650, 728	arc, 247
212, 245	Spark ablation	continuous, 136
automatic handling of, 842	atomic spectroscopy, 201t, 203	derivative, 345
conduction in, 565	mass spectrometry, 262	electromagnetic, 118
NMR of, 476, 481	Spark source emission spectroscopy, 201t,	mass, 264, 503, 506
ICPMS of, 263	244–251	NMR, 456
infrared absorption analysis of, 407,	instruments for, 246	photoacoustic, 350
418	Spark source mass spectrometry, SSMS,	survey, 541
photoacoustic spectroscopy of, 350	255t, 269	Specular reflection, 418, 847
Raman analysis of, 436	Specific ion detector system	Speed, of monochromator, 162
Solid-state detector, for α counting, 817	dry film analyzer, 849	Spike, 16, 269
Solid-state electrodes, 603, 604t	FIA, 837	Spin, nuclear, 446
Solid-state lasers, 147, 150	Specific retention volume, V_g , GLC, 702	Spin decoupling, of NMR spectra, 468,
Solid supports, GLC, 712	Spectra, 131 (see also specific types,	469
Solute property detector, HPLC, 733	Spectrum)	Spinning, of sample, NMR spectroscopy,
Solutes, migration through	Spectral interferences, atomic	452, 472
chromatographic column, 675, 680	spectroscopy, 217	Spinning sidebands, NMR spectroscopy,
Solvent effects	Spectral overlap	472
on atomic spectroscopy, 218, 224	electron spectroscopy, 541	Spin-lattice relaxation, NMR, 451, 483
on fluorescence, 363	optical spectroscopy, 163	Spin quantum number, I, 446
on ¹⁹ F NMR, 485	Spectrochemical methods, 116, 139t, 300	Spin-spin relaxation, NMR, 451, 452
on molecular absorption, 332, 335, 341	Spectrofluorometer, 182, 365, 367–370	Spin-spin splitting, in NMR spectra, 459,
on resolution, column chromatography,	Spectrograph, 182, 246	460, 463
691, 730, 749	Spectrometer, 182	Spin tickling, NMR spectroscopy, 469
on retention factor, 691	electron, 540	Splitting, of <i>d</i> orbitals, 337
on selectivity factor, 691	Fourier transform, 182 (see also Fourier	Splitting pattern, Zeeman, 219
Solvent programming, column	transform instruments)	Spontaneous emission, of laser, 148
chromatography, 693, 730	gamma ray, 819, 822	Spreading layer, dry film analyzer, 846
Solvents	IR, 392	Spreadsheet, 90
for adsorption chromatography, 749	mass, 255, 511 (see also Mass	Sputtering, 204
classification of, for partition	spectrometer)	in depth-profiling, surface analysis, 537,
chromatography, 742	NMR, 470–476	547

Sputtering (continued)	Stopping voltage, V_0 , 129	instruments for, 530
in hollow cathode lamp, 215 (see also	Stray radiation	Tapping mode, AFM, 558
Glow-discharge source)	effect on Beer's law, 306	Target, in X-ray tube, 273
Square planar configuration, of transition-	in monochromators, 161	TAST polarography, 661
metal complexes, 337	Stretching vibrations	Temperature 247
Square-wave polarography, 662, 663	mechanical model of, 383	of arc source, 247
Stable isotopes, 811	molecular, 383, 424, 440	critical, 768
Stack plot, 370	Stripping analysis, voltammetric, 666–669 Strong solvents, partition chromatography,	measurement of, thermal analysis, 799 of plasma sources, 233, 234
Staircase ADC, 80, 662, 664 Staircase voltage signal, 81	742, 743 <i>t</i>	of spark sources, 249
Standard addition method, 15–18	Structural rigidity, and fluorescence, 363	Temperature effects
for absorption analysis, 344	Structure determination ¹³ C NMR, 481	on atomic spectra, 199, 221
for atomic spectroscopy, 224	Subtraction	on chromatographic column efficiency,
for direct potentiometric measurements,	circuit for, 65	683t, 690, 692, 732
615	propagation of error in, A-17t	on electrode potentials, 570, 573, 575
for neutron activation analysis, 822	Successive approximation, ADC, 80, 82	on flame profiles, 208
for polarographic analysis, 664	Sulfied ion, solid-state electrode for, 604t	on fluorescence, 360, 363
Standard deviation, σ , A-1	Sulfur	on gas-liquid chromatography, 687,
in concentration, σ_c , absorption	automated analysis for, 844	705
spectrometry, 307	differential thermogram for, 804	on output of tungsten filament lamp,
of computed results, A-17	isotopic abundance for, 505t	313
of counting data, radiochemical	Sulfur compounds, chemiluminescence	on overvoltage, 587
analysis, 814–817	analysis for, 375	on permanent magnets, 471
of the mean, 12t	Sulfur dioxide, gas-sensing probe for, 609t	on phosphorescence, 360, 370
method of least-squares, A-18	Sulfur luminescence detector, SLD, 708	on Raman spectra, 432 on supercritical-fluid chromatography,
as measure of column efficiency, 682 (see also	Summing point, S, in operational amplifier, 56	770
Column efficiency)	Sums, propagation of error in, A-17	on thermal noise, 101
of signal noise, 100	Superconducting solenoid, FT NMR	Temperature profiles, of flames, 208
of transmittance, s_T , 307	spectrometer, 471	Temperature programming, column
Standard electrode potential, E^0 , 570, 573,	Supercritical-fluid chromatography, SFC,	chromatography, 693, 705
575, A-28	675, 677 <i>t</i> , 768–774	Terminating buffer, CITP, 789
limitations to use of, 579	comparison with other column methods,	Tesla, T, 446
Standard error, of a mean, S_m , A-5	771	Tesla coil, 231
Standard hydrogen electrode, SHE, 572	Supercritical fluid extraction, SFE, 768,	Tetrachloroethylene, as solvent, IR
Standard reference materials, SRM, A-5	774–777	spectroscopy, 406
Standard samples, for arc/spark	Superposition, principle of, 120	Tetrahedral configuration, of transition-
spectroscopy, 249	Support-coated open tubular column	metal complexes, 337
Star coupler, optical spectroscopy, 180	(SCOT), GLC, 711, 712 <i>t</i>	Tetramethylsilane (TMS) as internal
Static extraction, SFC, 775	Supporting electrolyte, linear scan	standard, NMR spectroscopy, 460
Static methods, electrochemical, 588	voltammetry, 640, 645, 665	Theoretical plates, 681 (see also Number
Stationary phase, 675, 677t chemically bonded, 715	Supressor column, ion chromatography, 752, 753	of theoretical plates) Thermal conductivity detector, TCD
chiral, partition chromatography, 716,	Surface analysis, 535, 561	for automated elemental analysis, 844
748	by electron spectroscopy, 537–547	for GLC, 707
and column efficiency, 683t	by mass spectrometry, 271	Thermal dark currents, 171
for GLC, 711, 713–716	Surface-enhanced Raman spectroscopy,	Thermal decomposition curve, 798 (see
selection of, 690, 741	SERS, 443	also Thermogram)
for SFC, 771	Surfactants, for MECC, 794	Thermal ionization mass spectrometry,
for TLC, 762	Survey spectrum, X-ray photoelectron	TIMS, 255t
Stationary phase mass transfer term, $C_s u$,	spectroscopy, 541	Thermal lens detector, CE, 784t
column chromatography, 685t	Switching, with operational amplifier, 68	Thermalization, of neutrons, 819
Stationary phase volume, V_S , 694 t	Switching potential, cyclic voltammetry,	Thermal methods, 798–808
Statistics	655	Thermal neutrons, 819
counting, 814	Switching regulator, 46	Thermal noise, 100, 168, 308, 390
evaluation of data with, A-1	Synchronous demodulator, for lock-in	Thermal radiation, emission of, 133
Stimulated emission, in laser, 147, 148	amplifier, 107	Thermal transducers, for infrared
Stimulated Raman gain, 443	Synchronous modulation/demodulation,	radiation, 168, 176–178, 390
Stimulated Raman scattering, 443	for noise reduction, 105 Synge, R.L.M., 674, 681, 701	Thermionic detector, TID for GLC, 710
Stockholm convention, for electrode potentials, 574	Syringe-based sampler, 731, 841	for SCF chromatography, 771
Stokes shift, 137, 356, 358	Systematic error, A-2, A-4	Thermistor, 177, 391
in Raman spectroscopy, 430	t, values for, A-13	Thermobalance, 798, 799
Stopped-flow methods	Tailing, of chromatographic peaks, 681,	Thermocouple, 63, 177, 799, 802
FIA, 838	712, 763	as infrared transducer, 391
HPLC, 731	Tandem mass spectrometry (MS/MS), 529	in thermobalance, 799

Thermodynamic cell potentials, 568, 569,
622 calculation of, 581
Thermogram,
differential, 802 (see also Differential
thermogram) Thermogravimetry, TG, 798–801
Thermopile, 177, 391
Thermospray detector, HPLC, 738
Thermospray source, TS, mass spectrometer, 500t, 738
Thin-layer chromatography, TLC, 749,
761–765
qualitative, 764
quantitative, 765 two-dimensional, 761, 765
Thiocyanate ion
complexation with, 340, 343
solid-state electrode for, 604 <i>t</i> Three-level laser, 150
Throughput advantage, Fourier transform
spectroscopy, 182
Time, measurement of, 78
Time constant, in <i>RC</i> circuits, 32 Time-correlated photon counting, 180
Time domains, 5, 6, 74
Time-domain spectroscopy, 184 (see also
specific types) Time-of-flight (TOF) mass spectrometer,
255, 260, 517
Time-resolved detector, optical
spectroscopy, 180
Tip, for STM, 557 Tiselius, A., 779
Titration
amperometric, 652
coulometric, 628 (see also Coulometric titrations)
flow-injection, 839
photometric, 347
potentiometric, 618
Torch, ICP spectroscopy, 231, 262, 263 Total internal reflection, 179
Total ionic strength adjusting buffer,
TISAB, 615
Total luminescence spectrum, 370 Tracers, radiochemical, 810, 825
Transducer, 6, 167–178, 390, 396 (see also
specific types)
amperometric, 737
diode array, 172 electrospray, 785
for emission spectroscopy, 237, 246
for fluorometer, 367
general response, 771 germanium, 285
IR, 168
for optical spectroscopy, 169 (see also
specific types)
photoconductive, 169 photon, 282
pyroelectric, 177
scintillation, 257, 285
semiconductor, 169 (see also Photoconductivity transducer)
thermal, 168

ultraviolet/visible, 169
voltammetric, 651, 737
for X-rays, 282, 294
Transducer junction, of thermocouple, 177
Transducer signals, amplification and
measurement of, 58–63
Transfer function, of transducer, 6, 10
Transformer, 44
Transistor, 38, 41
Transitions, electronic, 134 (see also
Electronic transitions)
Transition-metal ions, absorption of
radiation by, 336
Translational motion, molecular, 387
Transmission, T, 301t
of electromagnetic radiation, 124
Transmission grating, 159
T
Transmittance, T, 301t
effect of instrumental noise on, 307
measurement of, 140, 300, 307
Transmittance overshoot, in infrared
absorption instruments, 398
Transmitter/receiver coils, NMR
spectrometer, 470, 472
Transverse relaxation, 451
Trapped ion analyzer cell, FT mass
spectrometer, 520
Trigger control, for oscilloscope, 47
Triglycine sulfate, as pyroelectric
transducer, 177, 391
Triple bond, force constant for, 386
Triple-bond region, infrared spectrum,
410
Triplet state 137 194 356 360 373
Triplet state, 137, 194, 356, 360, 373
Trithiocarbonate ion, uv/visible absorption
Trithiocarbonate ion, uv/visible absorption by, 335
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography)
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography)
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography) Two-dimensional FT NMR spectroscopy, 485
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography) Two-dimensional FT NMR spectroscopy, 485 Two-line correction method, atomic
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography) Two-dimensional FT NMR spectroscopy, 485 Two-line correction method, atomic absorption spectroscopy, 218
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography) Two-dimensional FT NMR spectroscopy, 485 Two-line correction method, atomic absorption spectroscopy, 218 Tyndall effect, 127
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography) Two-dimensional FT NMR spectroscopy, 485 Two-line correction method, atomic absorption spectroscopy, 218 Tyndall effect, 127 Ultramicro electrodes, 642, 669
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography) Two-dimensional FT NMR spectroscopy, 485 Two-line correction method, atomic absorption spectroscopy, 218 Tyndall effect, 127 Ultramicro electrodes, 642, 669 Ultrasonic nebulization, atomic
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography) Two-dimensional FT NMR spectroscopy, 485 Two-line correction method, atomic absorption spectroscopy, 218 Tyndall effect, 127 Ultramicro electrodes, 642, 669 Ultrasonic nebulization, atomic spectroscopy, 201t, 202
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography) Two-dimensional FT NMR spectroscopy, 485 Two-line correction method, atomic absorption spectroscopy, 218 Tyndall effect, 127 Ultramicro electrodes, 642, 669 Ultrasonic nebulization, atomic spectroscopy, 201t, 202 Ultraviolet absorption detector
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography) Two-dimensional FT NMR spectroscopy, 485 Two-line correction method, atomic absorption spectroscopy, 218 Tyndall effect, 127 Ultramicro electrodes, 642, 669 Ultrasonic nebulization, atomic spectroscopy, 201t, 202
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography) Two-dimensional FT NMR spectroscopy, 485 Two-line correction method, atomic absorption spectroscopy, 218 Tyndall effect, 127 Ultramicro electrodes, 642, 669 Ultrasonic nebulization, atomic spectroscopy, 201t, 202 Ultraviolet absorption detector
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography) Two-dimensional FT NMR spectroscopy, 485 Two-line correction method, atomic absorption spectroscopy, 218 Tyndall effect, 127 Ultramicro electrodes, 642, 669 Ultrasonic nebulization, atomic spectroscopy, 201t, 202 Ultraviolet absorption detector for HPLC, 319, 734 for SFC, 771
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography) Two-dimensional FT NMR spectroscopy, 485 Two-line correction method, atomic absorption spectroscopy, 218 Tyndall effect, 127 Ultramicro electrodes, 642, 669 Ultrasonic nebulization, atomic spectroscopy, 201t, 202 Ultraviolet absorption detector for HPLC, 319, 734 for SFC, 771 Ultraviolet photoelectron spectroscopy,
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography) Two-dimensional FT NMR spectroscopy, 485 Two-line correction method, atomic absorption spectroscopy, 218 Tyndall effect, 127 Ultramicro electrodes, 642, 669 Ultrasonic nebulization, atomic spectroscopy, 201t, 202 Ultraviolet absorption detector for HPLC, 319, 734 for SFC, 771 Ultraviolet photoelectron spectroscopy, UPS, 537t, 538
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography) Two-dimensional FT NMR spectroscopy, 485 Two-line correction method, atomic absorption spectroscopy, 218 Tyndall effect, 127 Ultramicro electrodes, 642, 669 Ultrasonic nebulization, atomic spectroscopy, 201t, 202 Ultraviolet absorption detector for HPLC, 319, 734 for SFC, 771 Ultraviolet photoelectron spectroscopy, UPS, 537t, 538 Ultraviolet-sensitive photoemissive
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography) Two-dimensional FT NMR spectroscopy, 485 Two-line correction method, atomic absorption spectroscopy, 218 Tyndall effect, 127 Ultramicro electrodes, 642, 669 Ultrasonic nebulization, atomic spectroscopy, 201t, 202 Ultraviolet absorption detector for HPLC, 319, 734 for SFC, 771 Ultraviolet photoelectron spectroscopy, UPS, 537t, 538 Ultraviolet-sensitive photoemissive materials, 170
Trithiocarbonate ion, uv/visible absorption by, 335 Tswett, M., 674, 725, 748 Tube length, effect on dispersion, FIA, 836 Tunable laser, 151, 390 Tungsten filament lamp, as radiation source, 146, 313, 323, 390, 734 Tungsten/halogen lamp, 314 Tunneling current, STM, 553, 554 Tunneling tip, STM, 545, 554 Turbidimetry, 139t Turbulent flow, in stirred solutions, 647 Twisting vibrations, molecular, 383 Two-dimensional chromatography, 765 (see also Thin-layer chromatography) Two-dimensional FT NMR spectroscopy, 485 Two-line correction method, atomic absorption spectroscopy, 218 Tyndall effect, 127 Ultramicro electrodes, 642, 669 Ultrasonic nebulization, atomic spectroscopy, 201t, 202 Ultraviolet absorption detector for HPLC, 319, 734 for SFC, 771 Ultraviolet photoelectron spectroscopy, UPS, 537t, 538 Ultraviolet-sensitive photoemissive

sources of, 146-154 species that absorb, 330 Ultraviolet/visible spectroscopy, 119t absorption, 300 applications, 329-351 emission, 230 (see also specific types) instruments for, 181, 312 (see also Photometer, Spectrophotometer) solvents for, 341, 342t Uncertainty in measurement of transmittance, 307 propagation in calculations, A-15 Uncertainty principle, 138, 197 Uncompensated resistance, in potentiostat, R_{ν} 632 Unit gain bandwidth, 57 Unit operations, chemical analysis, 830, 831t Universe, of data, A-6 Unsegmented continuous-flow analysis, 831 (see also Flow injection analysis) Vacuum lock, mass spectrometer, 512 (see also Phototube) Vacuum ultraviolet spectroscopy, 119t. 242, 330 Valence band, 152 Valinomycin, in membrane electrode for potassium, 605 Van Deemter equation, 684 Van Deemter plot, 683 Variable current coulometry, 631, A-1 Variance, σ^2 , 12 τ^2 , 682 as figure of merit, 11t, 12 as measure of chromatographic column efficiency, 682 (see also Column efficiency) of a signal, 107 Velocity, c, of electromagnetic radiation, 116, 117 Vibrational absorption, 136 Vibrational coupling, 383, 388 Vibrational energy, molecular, 131, 136 Vibrational frequency of a chemical bond, 385 of mechanical oscillator, 384 Vibrational modes molecular, 383, 387-389 and Raman effect, 433 Vibrational quantum number, v. 385 Vibrational relaxation, deactivation by, 133, 137, 358 Vibrational/rotational transitions, molecular, 383 Vibrational states, molecular, 131 Vibrations, molecular, 385-389, 429, Virtual ground, of amplifier circuit, 56 Virtual states, molecular, 431 Viscosity of mobile phase, HPLC, 743t of supercritical fluids, 765, 769t Viscosity effects on diffusion coefficient, column chromatography, 683t, 690 on fluorescence, 363

Visible/ultraviolet region, 119t (see also	of X-ray emission lines, 274	ultraviolet/visible spectroscopy, 146,
Ultraviolet/visible spectroscopy)	Wavelength dispersion, by	314
Void volume, of microporous membrane,	monochromators, 157-161	X-ray absorption methods, 119t, 277
gas-sensing probe, 608	Wavelength dispersive instruments	X-ray diffraction methods, 294–296
Volatility effects, AAS, 220	for absorption spectroscopy, 320	X-ray fluorescence, XRF, 276, 278,
Voltage, 22 (see also Potential)	for scanning electron microscopy, 552	288–294, 543, 550
control of, with operational amplifier,	for X-ray spectrometry, 279, 288	X-ray monochromator, 281 (see also
63 (see also Potentiostat)	Wavelength modulation, in	Pulse-height analyzer)
measurement of, 26, 37	spectrophotometer, 346	X-ray photoelectron spectroscopy, XPS,
in RC circuit, 30	Wavelength selection, for optical	537t (see also Electron spectroscopy)
stopping, 129	spectroscopy, 143, 154-166, 343	X-rays, 272
Voltage divider, 24, 626	Wave model, Raman/Rayleigh scattering,	absorption of, 119t, 276, 293
Voltage-follower circuit, 58, 60, 391	432	detection of, 282
Voltage gain, A, of amplifier, 56	Wavenumber, $\overline{\nu}$, of electromagnetic	diffraction of, 278, 282t, 294-296
Voltage gate, V _{DS} , 43, 76	radiation, 118, 188, 189	emission of, 272, 278, 550, 552, 553,
Voltage regulator, 44	Wave properties, of electromagnetic	812
Voltammetric currents, 648	radiation, 117-128	filters for, 280
Voltammetric detector	Waves	generation of, 132, 272-276
chromatographic, 651	mathematical description of, 120	sources for, 276t
FIA, 651, 837	polarographic, 661 (see also specific	X-ray spectrometry, 119t, 192, 272-296
Voltammetric sensor, 651	types)	instrumentation for, 279-290
Voltammetric wave, 644	superposition of, 120	radioisotopic sources for, 276, 294
Voltammetry, 639-670	Wave trains, of electromagnetic radiation,	X-ray transducers, 119t, 277
amperometric, 652	124	pulse height distribution from, 286
cyclic, 654–656	Wedge	X-ray tubes, 279
differential, 662	interference, 156	x-y recorder, 48
hydrodynamic, 644–654	optical, 316, 400	z, values for, A-12
with microscopic electrodes, 669	Wehnelt cylinder, 544	Zeeman background correction, AAS, 218,
with solid electrodes, 644-648	Weighted-resistor ladder network, 80	219
square wave, 662	Weighting coefficients, 111	Zeeman effect, 197, 219
stripping analysis, 666–669	Well-type scintillation counter, 819	Zener breakdown voltage, for
Voltammogram, 644, 648-650, 663	Wet-ashing, 223	semiconductor diode, 41
Voltmeter, 26	White-light interferometer system, FT	Zener diode, 45, 48, 68
Volume correction, for photometric	spectrometer, 393	Zero percent T adjustment, absorption
titrations, 348	White noise, 101	spectroscopy, 140, 307, 314
Voxel, 489	White radiation, X-ray region, 273	Zip® drive, 87
Wagging vibrations, molecular, 383	Wide-line NMR spectra, 456	Zones chromatographic, 675
Wall-coated open tubular column	instruments for, 470	of flame, 208
(WCOT), GLC, 711, 713t	Window, of pulse-height selector, 286	Zone broadening
Water	Wiper, of potentiometer, 24	capillary electrophoresis, 780
polarity of, 741	Word, of computer data, 83	chromatographic, 677
role	Work function	and column efficiency, 680-687
in functioning of glass electrode, 598	for electron spectrometer, w, 539	extra-column, HPLC, 727, 733
as moderator for neutrons, 819	photoelectric effect, ω, 130	factors affecting, 683
as solvent, uv/visible regions, 342t	Working curve, 15	FIA, 835
Water hardness, membrane electrode for,	Working electrode, 591, 625, 628, 629,	SFC, 771
6051	630, 640, 737	Zone profile, FIA, 835
Wavelength, λ, of electromagnetic	Xenon arc lamp, as source	Zwitterion, 790
radiation, 116, 117	fluorescence spectroscopy, 366	•
	- ••·	