CONTENTS

L	Intr	oduction		
	1.1	Scope of Aquatic Chemistry		
	1.2	The Solvent Water		
	1.3	Solute Species		
		Suggested Readings	- 1	
		Appendix 1.1: Some Useful Quantities, Units, Conversion		
		Factors, Constants, and Relationships	1	
2.	Chemical Thermodynamics and Kinetics			
	2.1	Introduction	1	
	2.2	Chemical Thermodynamic Principles	2	
	2.3	Systems of Variable Composition: Chemical		
		Thermodynamics	2	
	2.4	Gibbs Energy and Systems of Variable Chemical		
		Composition	3	
	2.5	Chemical Potentials of Pure Phases and Solutions	3.	
	2.6	Chemical Potentials of Aqueous Electrolytes	3	
	2.7	The Equilibrium Constant	4	
	2.8	The Gibbs Energy of a System	4	
	2.9	Driving Force for Chemical Reactions	4	
	2.10	Temperature and Pressure Effects on Equilibrium	5	
	2.11	Equilibrium Tools	5	
	2.12	Kinetics and Thermodynamics: Time and Reaction		
		Advancement, §	5	
	2.13	Rate and Mechanism	6	
	2.14		6	
	2.15	Theory of Elementary Processes	6	
	2.16	Elementary Reactions and ACT	7	
	2.17	Equilibrium Versus Steady State in Flow Systems	7	
		Suggested Readings	8	
		Problems	8	
		Answers to Problems	8	

3.	Aci	ds and Bases	88
	3.1	Introduction	88
	3.2	The Nature of Acids and Bases	90
	3.3	The Strength of an Acid or Base	
	3.4	Activity and pH Scales	97
	3.5	Equilibrium Calculations	105
	3.6	pH as a Master Variable; Equilibrium Calculations Using	
		a Graphical Approach	118
	3.7	Ionization Fractions of Acids, Bases, and Ampholytes	127
	3.8	Titration of Acids and Bases	130
	3.9	Buffer Intensity and Neutralizing Capacity	134
	3.10	Organic Acids	140
		Suggested Readings	144
		Problems asipoga stufoz	144
		Answers to Problems	147
4.	Diss	olved Carbon Dioxide	148
	4.1	Introduction schools has admenybourself leader	148
	4.2	Dissolved Carbonate Equilibria (Closed System)	150
	4.3	Aqueous Carbonate System Open to the Atmosphere	157
	4.4	Alkalinity and Acidity, Neutralizing Capacities	163
	4.5	Alkalinity Changes	172
	4.6	Analytical Considerations: Gran Plots	179
	4.7	Equilibrium with Solid Carbonates	186
	4.8	Kinetic Considerations	192
	4.9	Carbon Isotopes and Isotope Fractionation	195
		Suggested Readings	202
		Problems manage and diliup and of T	202
		Answers to Problems	204
-		osphere-Water Interactions	200
э.	Aum	osphere-water interactions	206
	5.1	Introduction	206
	5.2	Anthropogenic Generation of Acidity in the Atmosphere	207
	5.3	Gas-Water Partitioning: Henry's Law	212
	5.4	Gas-Water Equilibria in Closed and Open Systems	216
	5.5	Washout of Pollutants from the Atmosphere	227
	5.6	Fog TOA ban Reactions and ACT	229
	5.7	Aerosols and the state of the s	
	5.8	Acid Rain-Acid Lakes	235
	5.9	The Volatility of Organic Substances	238
	5.10	Gas Transfer Across Water-Gas Interface	241
		Suggested Readings	248
		Problems	249
		Answers to Problems	251

		C	ontents	xiii
ı	Met	al Ions in Aqueous Solution: Aspects of Coordination	noM To	
		Potentionetro Determination of Individual Sol vitale		252
	61	Introduction against bases		252
	62	Protons and Metal Ions		258
	6.3	Hydrolysis of Metal Ions		263
	5.4		1	
		Oxides		272
	65	Chelates		275
	6.6	Metal Ions and Ligands: Classification of Metals		281
	5.7	and the second s		289
	6.8			305
	6.9			311
		Suggested Readings		319
		Problems about the state of the		320
		Answers to Problems		322
		Appendix 6.1: Stability Constants		325
		Appendix 6.2: The Various Scales for Equilibrium		
		Constants, Activity Coefficients, and p	Н	335
Z.	Pres	cipitation and Dissolution		349
	7.1	Introduction		349
	72	The Solubility of Oxides and Hydroxides		359
	7.3	Complex Formation and Solubility of (Hydr)oxides		368
	7.4			370
	7.5		ide	370
		Carbonates appropriate name W-160		389
	7.6	Sulfides and Phosphates		398
	7.7	The Phase Rule: Components, Phases, and Degrees of	f	
		Freedom (actiguidad bins consistings) a publicy of part		409
	7.8	Solubility of Fine Particles		413
	7.9	Solid Solutions		416
		Suggested Readings		420
		Problems		420
		Answers to Problems		424
£		dation and Reduction; Equilibria and Microbial		
	Med	in Interaction of Trace Metalls with Physioparetics		425
	8.1	Introduction have I relime to May		425
	8.2	Redox Equilibria and the Electron Activity		426
	8.3	The Electrode Potential: The Nernst Equation and the		
		Electrochemical Cell		GOT ME
	8.4	pε-pH, Potential-pH Diagrams		455
	8.5	Redox Conditions in Natural Waters		
	8.6	Effect of Complex Formers on the Redox Potential		489

8.	/ Measuring the Redox Potential in Natural Waters	49
8.	8 The Potentiometric Determination of Individual Solutes	498
	Suggested Readings	500
	Problems	50
	Answers to Problems	512
	Appendix 8.1: Activity Ratio Diagrams for Redox Systems	513
	Typeson out the same and the same of the s	4.8.10
9. TI	ne Solid-Solution Interface	510
9.	1 Introduction	516
9.:		519
9.:		521
9.4		321
615	Ions, and Ligands	533
9.		549
9.0		247
CAC THE	Surface Charge	568
9.	TO DO STORE THE PROPERTY OF THE PROPERTY OF A STORE AND ADDRESS OF THE PROPERTY OF THE PROPERT	500
	Bearing Particles	575
9.8		586
9.9		300
61614	and Soil Systems	594
	Suggested Readings	599
	Problems	601
	Appendix 9.1: The Gouy-Chapman Theory	604
	Appendix 9.2: Contact Angle, Adhesion and Cohesion, the	2.7134
	Oil-Water Interface	608
		0.002
10. Tr	ace Metals: Cycling, Regulation, and Biological Role	614
10.	1 Introduction: Global Cycling of Metals	614
10.		615
10.		200
10.	of Life	625
10.		628
10.		632
10.	THE REPORT OF A COURT OF THE PROPERTY OF THE PARTY OF THE	637
10.		031
10.	the Molecular Level	641
10.		0.835
10.	Interface in Surface Waters	648
10.		241
10.	and Oceans	654
10.		666
984	Suggested Readings	670

		Contents	AV
11.	Kine	tics of Redox Processes	672
	11.1	Introduction Could Stability Qualitative Considerations 4	672
	11.2	How Good an Oxidant Is O ₂ ?	672
	11.3	Can pe Be Defined for a Nonequilibrium System?	677
	11.4	Kinetics of Redox Processes: Case Studies	679
	11.5	Oxidants Used in Water and Waste Technology: A Few	
		Case Studies	691
	11.6	Linear Free Energy Relations (LFERs) The Marcus Theory of Outer-Sphere Electron Transfer:	702
		An Introduction	703
	11.8	Nucleophile-Electrophile Interactions and Redox	
		Reactions Involving Organic Substances	710
	11.9	Corrosion of Metals as an Electrochemical Process	720
		Suggested Readings	725
12.	Photo	ochemical Processes	726
	12.1	Introduction	726
	12.2	Absorption of Light	729
	12.3	Photoreactants	735
	12.4	Photoredox Reactions: Photolysis of Transition Metal Complexes	743
	12.5	Photochemical Reactions in Atmospheric Waters: Role of	
		Dissolved Iron Species	744
	12.6	Heterogeneous Photochemistry	748
	12.7	Semiconducting Minerals	753
		Suggested Readings	759
13.		tics at the Solid-Water Interface: Adsorption, lution of Minerals, Nucleation, and Crystal Growth	760
	13.1	Introduction	760
	13.2	Kinetics of Adsorption	760
	13.3	Surface-Controlled Dissolution of Oxide Minerals: An	700
		Introduction to Weathering	771
	13.4	Simple Rate Laws in Dissolution	776
	13.5	Rates of CaCO ₃ Dissolution (and of CaCO ₃ Crystal Growth)	
	13.6	Inhibition of Dissolution	788
			795
	13.7	Nucleation and Crystal Growth Suggested Readings	800 816
14.	Parti	cle-Particle Interaction: Colloids, Coagulation, and	
	Filtra		818
	14.1	Colloids	818
	14.2	Particle Size Distribution	826

XVI	Content

14.3	Surface Charge of Colloids	834
14.4	Colloid Stability: Qualitative Considerations	837
14.5	Effects of Surface Speciation on Colloid Stability	842
14.6	Some Water-Technological Considerations in	042
14.0	Coagulation, Filtration, and Flotation	050
5 11 679		852
14.7	Filtration Compared with Coagulation	857
14.8	Transport in Aggregation and Deposition	858
	Suggested Readings	866
	Appendix 14.1: A Physical Model (DLVO) for Colloid Stability	867
	An Englishment I have an interesting a little and the administration of the annion of	
15. Regu	lation of the Chemical Composition of Natural Waters	872
15.1	Introduction Application and the second and the sec	872
15.2	Weathering and the Proton Balance	875
15.3	Isothermal Evaporation	880
15.4	Buffering Assessment A	884
15.5	Interactions Between Organisms and Abiotic	
	Environment: Redfield Stoichiometry	886
15.6	The Oceans: Relative Constancy of the Composition and	
	Chemical Equilibria	895
15.7	Constancy of Composition: Steady State	897
15.8	Hydrothermal Vents	901
15.9	The Sediment-Water Interface	903
15.10	Biological Regulation of the Composition	908
15.11	Global Cycling: The Interdependence of Biogeochemical	
	Cycles	914
15.12	The Carbon Cycle	916
15.13		927
15.14	The Sulfur Cycle	932
	Suggested Readings	933
Reference	1 Introduction started in surface intentily sortestioned 2 Kinetics of Adsorption 2 Kinetics of	935
	3. Surface-Controlled Dissolution of Oxide Minerals, An	
Appendix	es: Thermodynamic Data	976
	vised Chemical Equilibrium Data for Major Water-	628
	neral Reactions	977
	ermodynamic Data for Trace Metal Speciation in Seawater	984
3 Th	ermodynamic Properties	990
Index		1005