CONTENTS

ATOMIC PHYSICS AND NUCLEAR CHEMISTRY

I Charge on the electron. Variation of mass with velocity. Wave properties of matter. Moseley's law. Atomic spectra. Rydberg constant. Radioactive decay law—calculation of disintegration constants, half-lives, carbon dating etc. Mass spectrograph. Binding energy. Mass and energy considerations in nuclear reactions. Q values. Activation energy of fission. Neutron irradiation. Range and energy of beta-particles. Gamma dose rates. 1

GASES

II Kinetic theory of gases—molecular velocities, mean free path, collision diameter, collision number. Maxwell distribution law. Equipartition of energy. Partition functions. Heat capacities of gases. Equations of state. Gas constant. The van der Waals equation. Fugacity. Virial coefficients. Boyle temperature. Avogadro number. Limiting densities and compressibility coefficients. 16

SOLIDS

III X-ray diffraction. Lattice dimensions. The Bragg equation. Lattice energies. Born-Haber cycle. Madelung constant. Heat capacities at constant pressure and constant volume. Dulong and Petit's law. Einstein and Debye equations for heat capacity. 32

LIQUIDS AND SOLUTIONS

IV Vapour pressure. Henry's law. Raoult's law. Distillation. Steam distillation. Osmotic pressure. Depression of freezing point. Elevation of boiling point. Ideal solubility. Partition coefficients. Activities. Activity coefficients. 43

CHANGES OF STATE

V Liquefaction of gases. Critical constants and the van der Waals equation. Orthobaric densities. Inversion temperature. Boyle temperature. Joule-Thomson coefficient. Variation of vapour pressure with temperature. Clausius-Clapeyron equation. Heats of sublimation, fusion and vaporisation. Transition temperatures. Thermodynamics of phase changes. 60

THE PHASE RULE

VI Distillation. Two-component systems. Construction and interpretation of phase diagrams. Eutectics. Compound formation. Congruent and incongruent melting points. Solid solutions. Three-component systems. Fractional crystallisation. 73

SURFACE CHEMISTRY

VII Physical adsorption and chemisorption. Freundlich and Langmuir adsorption isotherms. Surface area by B.E.T. equation. Electron microscope. Porosity. Pore size. Surface films. Donnan membrane equilibrium. Electrophoresis. 86

THERMODYNAMICS

VIII First law of Thermodynamics. Hess's law. Heats of reaction at constant pressure and constant volume. Adiabatic and isothermal changes. Heat capacities. Kirchhoff's law. Second law of Thermodynamics. 95

Entropy changes. Free energy change and the tendency for a reaction to occur. Gibbs-Helmholtz equation. Gaseous equilibria. K_p and K_c. Van't Hoff equation for variation of equilibrium constant with temperature. Van't Hoff reaction isotherm. Heat of solution. Third law of Thermodynamics. Determination of entropies of pure substances. Sackur-Tetrode equation. Calculation of equilibrium constants from thermodynamic functions obtained from spectroscopic data.

ELECTROCHEMISTRY

IX Electrolysis. Specific conductance. Equivalent conductance. Ionic conductance. Walden's rule. Law of independent migration of ions. Degree of dissociation. Ostwald dilution law. Solubility of sparingly soluble salts. Debye-Huckel-Onsager equation. Thickness of the ionic atmosphere. Ionic strength. Activity coefficients. Mean effective ionic diameter. Thermodynamic dissociation constant. Solubility product. Solubility and ionic strength. Transport numbers. Electrochemical cells. Cell reactions. Electrode potentials. K_a and K_w from e.m.f. measurements. Buffer solutions and pH. Hydrolysis of salts. Indicators. 116

CHEMICAL KINETICS AND PHOTOCHEMISTRY

X Order of reaction. Velocity constant. Half-life. Guggenheim's method of computing velocity constants. Opposing reactions. Energy of activation. Heterogeneous gas-solid reactions. Reactions in solution. Primary salt effect. Acid-base catalysis. Beer's and Lambert's law. The Einstein. Quantum yield. 146

MOLECULAR STRUCTURE

XI Specific rotation. Molar refraction. Molar polarisation. Dipole moments. Magnetic susceptibility. Molecular 165

spectra. Pure rotation spectra. Moment of inertia. Bond length. Vibration spectra. Characteristic infra-red frequencies. Dissociation energy. Zero point energy. Force constants. Rotational fine structure in vibration spectra. Isotopic effects in infra-red and Raman spectra.

ANSWERS 186

LOGARITHMS 204

PHYSICAL CONSTANTS AND THEIR LOGARITHMS 206