

Exam topics

Part 3: Chromatography and Electrochemistry

1 Chromatography

definition; classification by the physical state of the mobile phase, the spatial arrangement of the mobile and stationary phase, the type of interaction; detailed description of the various chromatography methods; detectors; theory of the gas chromatography

2 Homogeneous electrochemistry

electric current; electric current density; elementary charge; Faraday constant; electric field; electric field strength; electric potential; charge number; electrochemical system; activity; activity coefficient; electrolytes; chemical potentials in electrolyte solutions; ionic atmosphere; Debye-Hückel limiting law; electrochemical potential; electrical charge transport; conductivity; specific resistivity; conductance; drift speed; ionic mobility; transport number; electrophoresis

3 Electrochemical cells

electrode; electrochemical cell; cell diagram; classification of electrodes; galvanic cell; electrolytic cell; electrolysis; anode; cathode; terminal voltage; electromotive force; measurement methods of the electromotive force; electrode potential; junction potential; potential of the cell reaction; standard potential of the cell reaction; potential of the electrode reaction; Nernst equation; potentiometry; potential of the Ag, Ag/AgCl and hydrogen electrodes; measurement of pH; glass electrode; concentration cells; batteries

4 Electrochemical cells

reaction rates; steps of electrochemical processes; polarization; equilibrium potential; polarization potential; exchange current density; overpotential; charge transfer polarization, diffusion polarization; Erdey-Grúz – Volmer – Butler equation; Levich equation

Part 4: Measurements and Spectroscopy

1 Experiments, measurements

models; experiment; measurement; sensor; classification of sensors; off-line, on-line and automatic data acquisition systems; systematic error; random error; accuracy; precision; absolute error; instrument limit of error; least count; relative error; propagation of error; number of significant digits; statistical population and sample; normal distribution; standard deviation; corrected sample standard deviation with Bessel's correction; confidence interval; degrees of freedom;

2 Interaction of light and materials

properties of light; speed of light; wavelength; frequency; wave number; photoelectric effect; visible spectrum; fundamental processes of light and material interaction; color of materials; spectroscopy; classification of spectroscopy by the nature of interaction, the type of material; interaction with different spectral regions; absorption and emission spectroscopies; absorption; spontaneous and stimulated emission; lasers

3 Absorption spectroscopies

incoming radiation intensity; outgoing radiation intensity; optical path length; transmittance; percentage transmission; absorbance; Beer-Lambert's law; derivation and limitations of the Beer-Lambert's law; where to measure absorbance; reference (blank) system; classification of the absorption spectrophotometers

4 Infrared spectroscopy

interaction with IR light; spring and ball model; simple harmonic oscillator; vibration of diatomic molecules; anharmonic oscillator; vibrational selection rule for harmonic and anharmonic oscillators; typical vibrational motions; normal modes; number of vibrations; physical condition for IR light absorption; the Raman effect; isotope effect on the vibrational frequencies; rovibrational spectrum; IR spectrometers; FTIR spectrometers; IR light sources, detectors; IR sample handling; absorption bands in IR

5 Ultraviolet and visible spectroscopies

interaction of materials with UV and VIS light; Planck relation; Bohr's atomic model; Rydberg equation; quantummechanical atomic model; quantum numbers; Zeeman effect; Born-Oppenheimer approximation; vibration relaxation; LCAO-MO model; sigma and pi orbitals; chromophores; HOMO – LUMO states; fluorescence; phosphorescence; chemiluminescence; photolysis; UV/VIS spectrophotometer; light sources, wavelength selectors, detectors

6 Rotational spectroscopy

interaction of materials with microwave light; torque; moment of inertia; angular acceleration; angular momentum; rigid rotor model; rotational energy; selection rules for MW transitions; peak separation in the MW spectrum; temperature dependency of the rotational line intensities;

7 Electric properties of materials

electric field; electric field strength; electric field lines; parallel plate capacitor; capacitance; dielectric; effective electric field; absolute permittivity; permittivity of the material; relative permittivity; electric dipole moment; permanent and induced dipole moments; electric polarization; types of electric polarization; polarization density; absolute refractive index; relative refractive index; optical density; total reflection; critical angle; dispersion; measurement methods of the refraction index