1. Transmission Electron Microscopy

-Units and unit conversion: length, angle, solid angle

-Small-angle approximation

-Relativistic electron wavelength

2. Scattering and Diffraction

-Terminology: elastic/inelastic, coherent/incoherent, forward/back scattering

-Scattering cross-section (units), mean free path

-Two-slit interference, diffraction from single slit, Rayleigh criterion

-Convergence & collection angles

3. Elastic Scattering

-Wave parameters: amplitude, phase, wavelength, frequency, velocity, wave number, wave vector

-Complex exponential form of a wave, finding magnitude squared (intensity)

-Atomic scattering amplitude (form factor), nature of the interaction of electrons with atomic matter

-Weak-phase-object approximation, structure factor, Bragg law

4. Inelastic Scattering

-Inelastic scattering processes: collective excitations, X-ray emission, secondary electrons, excitons,…

-Effects of ionization: characteristic X-ray emission, Auger electron emission

-Bremsstrahlung: braking radiation

5. Magnification and Electron Sources

-Ideal lens equation

-Lateral and angular magnification

-Brightness definition, conservation of brightness

-Thermionic and field-emission types

6. Electron Lenses

-Depths of field and focus

-Spherical aberration, effect on focal length, effect on image resolution

-Factors affecting practical resolution

-Principles of a magnetic electron lens, axially symmetric B-field, Lorentz force

7. Instrument Operation

-Condenser system, lateral demagnification

-Influences of C1, C2, and C3 on probe size; influence of CA on convergence angle

-Deflection lenses: beam tilt and shift

-Lens planes, back focal plane vs. image plane

-Imaging modes: bright-field, off-axis dark-field, centered dark-field

8. Vacuum Systems and TEM Holders

-Vacuum terminology: LV, HV, UHV

-Pumps: Mechanical rotary; oil diffusion, turbomolecular, ion getter

-Gauges: Pirani (thermal), Penning (ion)

-Specimen loading, tilt axes

9. Diffraction

-Direct lattice, reciprocal lattice

-Miller indices, interplanar spacing, **g** vector

-Selected-area diffraction

Significant Figures and Round-Off Criteria for Numerical Expressions

-Reasonable number of significant figures based on information available

-Rules for rounding off

Labs

1. TEM Magnification Calibration

2. TEM Diffraction Calibration

3. TEM Analysis of Carbon Nanotubes

4. TEM Analysis of Nanoparticles

5. Individual TEM