C Physics

Programma
General Physics: Thermodynamics, waves and optics

1. Thermodynamics
1.1 Introduction
Thermodynamic system. Thermodynamic coordinates. The equation of state. Thermodynamic processes.
1.2 Thermology and macroscopic properties of gases
Zero-th law of Thermodynamics, thermal equilibrium. Temperature; temperature measurement and scales. Thermal expansion of solids and liquids. Macroscopic properties of gases. Equation of state of the ideal gas. Gas thermometer at constant volume.
1.3 Heat and First law
Heat. Specific heat capacity; latent heat capacity. Heat transfer. The calorimeter. Mechanical equivalent of heat. The thermodynamic work. First law of Thermodynamics. Examples of processes and reversible cycles. Applications to the case of the ideal gas. Internal energy of an ideal gas. The Mayer relation.
1.4 Kinetic theory of gases
Kinetic interpretation of pressure and temperature of an ideal gas. Heat capacity of an ideal gas. Molecular degrees of freedom and equipartition theorem. The distribution of molecular speeds. Molecular mean free path. Adiabatic process of an ideal gas. The Van der Waals equation of real gases.
1.5 Heat engines and Second law
Reversible and natural processes. Heat engines and refrigerators. Thermodynamic efficiency. The statements of second law due to Kelvin-Planck and to Clausius. Reversible Carnot's cycle. Thermodynamic efficiency of the Carnot's cycle. The Carnot theorem. The Kelvin temperature scale. The Clausius theorem.
1.7 Entropy
Entropy. The entropy formulation of second law. Examples of deduction of the entropy change in reversible and natural processes. Statistical interpretation of entropy. Third law of thermodynamics.

2. Waves
2.1 General properties of wave motion
Wave characteristics. Longitudinal and transverse waves. Wave Fronts. Wave function. General wave equation. Phase. Phase velocity. Sinusoidal waves.
2.2 Superposition of waves
The principle of superposition. The Fourier theorem. Interference of sinusoidal waves. Standing waves. Beats. Propagation in dispersive media: group velocity.
2.3 Propagation of mechanical transverse and longitudinal waves
The speed of a transverse wave in a tight string. Equation of the transverse wave. Energy flow and wave intensity for a transverse wave. Reflection and refraction of transverse waves in a string. Transverse standing waves in a string. The speed of a longitudinal wave in the ideal gas. Propagation of acoustic waves.
2.4 Electromagnetic waves
Mathematical derivation of electromagnetic wave equation from the Maxwell’s equations. Plane electromagnetic wave. Polarized waves: linear, circular and elliptical polarization. Spectrum of the electromagnetic waves.
2.5 Energy and momentum of electromagnetic waves
The Poynting vector. Intensity of an electromagnetic wave. Momentum of an electromagnetic wave and radiation pressure.
2.6 Sources of electromagnetic waves
Radiation from an oscillating electric dipole. Short account of radiation from accelerated charges.
2.7 Propagation of electromagnetic waves in matter
Refraction index. Propagation of electromagnetic waves in dispersive media: (1) dielectrics and (2) system of free charges.

3. Optics
3.1 The light
Double nature of the light. Huygens’s principle. Introduction to the concept of ray. Fermat’s principle.
3.2 Wave geometry: plane surfaces
Reflection and refraction of electromagnetic waves at plane surfaces. Derivation of the reflection and the refraction laws from the Huygens’s principle. Dispersion and prisms. The total reflection.
3.3 Wave geometry: spherical surfaces
Reflection and refraction at spherical surfaces. Lenses. Optical systems: the microscope and the telescope.
3.4 Polarization
Methods to obtain linearly polarized waves: (i) selective absorption (dichroism), (ii) reflection at the Brewster angle, (iii) diffusion.

3.5 Interference
Coherence. Interference of waves produced by two synchronous sources. Interference of several synchronous sources. Interference due to a thin layer. Michelson interferometer.
3.6 Diffraction
Fraunhofer diffraction by a rectangular aperture. Resolving power. Fraunhofer diffraction by two equal parallel slits. Diffraction grating.