CentraleSupélec

Accelerated Engineering Degree Programme
Master's level

Scope of the Physics exam

Physicists (Bachelor in physics)

Written exam

I - Wave optics

(Based on "Fundamentals of Physics", 10th edition, David Halliday, Robert Resnick and Jearl Walker, ed. Wiley)

1 Interference *(chap. 35)*

light as a wave, young's interference experiment, interference from thin films, michelson's interferometer

2 Diffraction *(chap. 36-1 to 36-5)*

single-slit diffraction, intensity in single-slit diffraction, diffraction by a circular aperture, diffraction by a double slit, diffraction gratings

II - Quantum Physics

(Based on "Introduction to quantum mechanics", 2nd edition, David J. Griffiths, Pearson Publishing Hall, ed. Pearson, chap. 1 to 5)

1 The Wave Function

The Schrödinger equation, the statistical interpretation, probability, normalization, momentum, the uncertainty principle.

2 The Time-Independent Schrodinger Equation

Stationnary states, the infinite square well, the harmonic oscillator, the free particle, the delta function potential, the finite square well.

3 Formalism

Hilbert space, observables, eigenfunctions and a hermitian operator, generalized statistical interpretation, the uncertainty principle, dirac notation.

4 Quantum Mechanics in Three Dimensions

Schrödinger eqaution in spherical coordinates, the hydrogen atom, angular momentum, spin.

5 Identical Particles

Two-Particle Systems, atoms, solids, quantum statistical mechanics.

Oral exam

I – Mechanics

(Based on "Fundamentals of Physics", 10th edition, David Halliday, Robert Resnick and Jearl Walker, ed. Wiley, chap. 1 to 11 and 15)

1 Measurements

2 Motion in One to Three Dimensions

3 Force and Motion—

newton's first and second laws, some particular forces, applying newton's laws, friction, the drag force and terminal speed, uniform circular motion

4 Kinetic Energy, Work and Power

5 Potential Energy and Conservation of Energy

6 Center of Mass and Linear Momentum

center of mass, newton's second law for a system of particles, linear momentum, collision and impulse, conservation of linear momentum, momentum and kinetic energy in collisions, elastic collisions in one dimension, collisions in two dimensions, systems with varying mass: a rocket

7 Rotation

rotational variables, kinetic energy of rotation, calculating the rotational inertia, torque, newton's second law for rotation, work and rotational kinetic energy

8 Rolling, Torque, and Angular Momentum

rolling as translation and rotation combined, forces and kinetic energy of rolling, angular momentum, newton's second law in angular form, angular momentum of a rigid body, conservation of angular momentum, precession of a gyroscope

9 Oscillations

simple harmonic motion, energy in simple harmonic motion, pendulums, circular motion, damped simple harmonic motion, forced oscillations and resonance

II – Thermodynamics

(Based on "Fundamentals of Physics", 10th edition, David Halliday, Robert Resnick and Jearl Walker, ed. Wiley)

1 Temperature, Heat, and the First Law of Thermodynamics *(chap. 18)*

temperature (and the zeroth law of thermodynamics), thermal expansion, absorption of heat, the first law of thermodynamics, heat transfer mechanisms

2 The Kinetic Theory of Gases *(chap. 19-1 to 19-2 and 19-7 to 19-9)*

avogadro's number, ideal gases, pressure, temperature, and rms speed, translational kinetic energy, mean free path, the distribution of molecular speeds, the molar specific heats of an ideal gas, degrees of freedom and molar specific heats, the adiabatic expansion of an ideal gas

3 Entropy and the Second Law of Thermodynamics *(chap. 20)*

Entropy, entropy in the real world: engines, refrigerators and real engines

III – Electromagnetism

(Based on "Fundamentals of Physics", 10th edition, David Halliday, Robert Resnick and Jearl Walker, ed. Wiley, chapter 33)

1 Electromagnetic Waves

electromagnetic waves, energy transport and the Poynting vector, radiation pressure, polarization

III – Statistical Phyics

(Based on "Elementary Statistical Physics", Charles Kittel, Dover Books on Physics. Chapters 1 to 22)

1 Fundamental principle of Statistical Mechanics

Review of classical mechanics, systems and Ensembles, Liouville theorem, the microcanonical ensemble, entropy in statistical mechanics, rlementary example of probability distribution and entropy, conditions for equilibrium, connection between statistical and thermodynamic quantities, calculation of the entropy of a perfect gas using the microcanonical ensemble, quantum mechanics considerations, the canonical ensemble, thermodynamic functions for the canonical ensemble, Maxwell velocity distribution and the equipartition of energy, grand canonical ensemble, chemical potential in external fields, chemical reactions, thermodynamic properties of diatomic molecules, thermodynamics and statistical mechanics of magnetization, Fermi-Dirac distribution, heat capacity of a free electron gas at low temperatures, Bose-Einstein distribution and the Einstein condensation, black body radiation and the Planck radiation law

Mathematicians (Bachelor in mathematics)

Oral exam

I – Mechanics

(Based on "Fundamentals of Physics", 10th edition, David Halliday, Robert Resnick and Jearl Walker, ed. Wiley, chap. 1 to 11 and 15)

1 Measurements

2 Motion in One to Three Dimensions

3 Force and Motion—

newton's first and second laws, some particular forces, applying newton's laws, friction, the drag force and terminal speed, uniform circular motion

4 Kinetic Energy, Work and Power

5 Potential Energy and Conservation of Energy

6 Center of Mass and Linear Momentum

center of mass, newton's second law for a system of particles, linear momentum, collision and impulse, conservation of linear momentum, momentum and kinetic energy in collisions, elastic collisions in one dimension, collisions in two dimensions, systems with varying mass: a rocket

7 Rotation

rotational variables, kinetic energy of rotation, calculating the rotational inertia, torque, newton's second law for rotation, work and rotational kinetic energy

8 Rolling, Torque, and Angular Momentum

rolling as translation and rotation combined, forces and kinetic energy of rolling, angular momentum, newton's second law in angular form, angular momentum of a rigid body, conservation of angular momentum, precession of a gyroscope

9 Oscillations

simple harmonic motion, energy in simple harmonic motion, pendulums, circular motion, damped simple harmonic motion, forced oscillations and resonance

II – Thermodynamics

(Based on "Fundamentals of Physics", 10th edition, David Halliday, Robert Resnick and Jearl Walker, ed. Wiley)

1 Temperature, Heat, and the First Law of Thermodynamics *(chap. 18)*

temperature (and the zeroth law of thermodynamics), thermal expansion, absorption of heat, the first law of thermodynamics, heat transfer mechanisms

2 The Kinetic Theory of Gases *(chap. 19-1 to 19-2 and 19-7 to 19-9)*

avogadro's number, ideal gases, pressure, temperature, and rms speed, translational kinetic energy, mean free path, the distribution of molecular speeds, the molar specific heats of an ideal gas, degrees of freedom and molar specific heats, the adiabatic expansion of an ideal gas

3 Entropy and the Second Law of Thermodynamics *(chap. 20)*

Entropy, entropy in the real world: engines, refrigerators and real engines

10 Temperature, Heat, and the First Law of Thermodynamics **514**

temperature (and the zeroth law of thermodynamics), thermal expansion, absorption of heat, the first law of thermodynamics, heat transfer mechanisms

11 The Kinetic Theory of Gases

avogadro's number, ideal gases, pressure, temperature, and rms speed, translational kinetic energy, mean free path, the distribution of molecular speeds, the molar specific heats of an ideal gas, degrees of freedom and molar specific heats, the adiabatic expansion of an ideal gas

12 Entropy and the Second Law of Thermodynamics

Entropy, entropy in the real world: engines, refrigerators and real engines