41
Physics

B.A./B.Sc.: Elective

Outlines of Tests

Paper	Title of Course		Marks
A	Section I:	Mechanics	
	Section II:	Waves and Oscillations	50
	Section III:	Optics	
	(Written) :	(Time-three hours)	
B	Section I :	Thermodynamics and Kinetic Theory of Gases	
	Section II:	Electricity	
	Section III:	Magnetism	50
	(Written):	(Time-three hours)	
C	Section I:	Electronics	
	Section II:	Modern Physics	
	Section III:	Atomic and Nuclear Physics	50
	Practical:	(for two days) Time four hours each day:	50
	Practical A:	Mechanics, Thermodynamics, Sound, Optics, Electricity and Magnetism 25	
	Practical B:	Electronics, Modern Physics and Nuclear Physics 25	
	(Time four hours)		
	Total		**200**

Note Out of the Whole Syllabus (for a paper) there will be 10 questions as usual and the candidate will have to attempt 5 out of 10 questions. However,

1: There will be one compulsory question
2:There will be three sections for the remaining 9 questions each section having three questions. The candidate will have to attempt one question from each section.
3: Furthermore there will be 2 to 3 parts of question in each section. One of the parts will be either numerical or a question related to the physics significance of the topic (conceptual question)

Syllabi and Courses of Reading

PAPER A

SECTION-I: MECHANICS, VECTOR OPERATIONS

TOPICS

Vector in 3 dimensions

Vector derivatives and operation

Gradient, Divergence and Curl of a vector

Divergence Theorem

Stokes' Theorem

CONSERVATION OF ENERGY

.**SCOPE**
Introduction Direction Cosines Spherical polar Co-ordinates ; applications, Divergence and curl of a vector and gradient of a scalar.

Physical application of each type Divergence and Flux of a vector field Curl and line integral (mutual relation)
Derivation, physical importance and application to specific cass. Converting from differential to integral form.

Derivations, physical significance and applications to specific cases

SCOPE
Conservative and non Conservative forces.

One dimensional conservative system.
2,3 dimensional conservative systems,

Conservation of energy in a system of particles
Suggested levels

TOPICS
Two particle systems and Generalization to many particle system.
Center of mass of solid object

Momentum Changes in a system of variable mass.

Suggested level.

COLLISIONS

TOPICS

Elastic Collisions
Conservation of momentum during Collision

TOPICS
Elastic properties of Matter,
Suggested levels
Fluid statistics

Definition of either type of force & examples. Work done in a closed path.
1-D conservative system force as the gradient and force of gravity of potential energy : applications to the case a spring and force of gravity.

Obtaining velocity in terms of U and E; stables unstable and neutral equilibrium. Analytic solution for x(t), Change in P.E. for motion in 3-d, Forces as the gradient of the potentials. Work done in 2.3 dimensional motion.

Law of conservation of total energy of an isolated system.
Ch: 8 H.R.K.

SYSTEMS OF PARTICLES

SCOPE

Center of mass, Its position velocity and equations of motion.

Calculation of Center Mass of solid objects using integral calculus. Calculating C.M. of .

(i) Uniform Rod.
(ii) Cylinder
(iii) Sphere

Derivation of basic equation, application to motion of a rocket (determination of its mass as a function of time).

Ch: 9 R.H.K.

SCOPE

(a) One dimension
(b) Two dimensions (Oblique Collisions)

BULK PROPERTIES OF MATTERS

SCOPE

Physical basis of elasticity, Tension, Compress & sharing.
Elastic Modulus, Elastic limit.
Ch: 14 H.R.K.
Variation of pressure in fluid at rest and height in the atmosphere
Surface Tension.

Suggested levels

Fluid Dynamics

Bernoulll Equation

Viscosity

Suggested levels

TOPICS

Trouble with Classical Mechanics

Postulates of Relativity
The Lorentz Transformation Consequences of Lorentz transformation
Relativistic momentum
Relativistic energy.
Suggested levels

TOPICS

Simple harmonic oscillation (SHM)

Application of S H M

S H M and uniform circular motion consideration of Harmonic motions
Damped Harmonic motion

Suggested levels

Physical basis; role information of drops bubbles.

Ch: 17 H.RK.
General concepts of fluid flow : streamline and equation of continuity
Derivation and some applications such as dynamics lift thrust on a rocket.
Physical basis obtaining the Coefficient viscosity practical example of viscosity ; fluid (poisenille's law)
Ch: 18 H.R.K
SPECIAL THEORY OF RELATIVITY
SCOPE
Qualitative discussion of the inadequacy paradoxes in classical ideas of time, length velocity.

Statements and Discussion
Derivation, Assumption on which derived application of the same Transformation of velocity
Relativity of time, relativity of length

Derivation
Derive $E = mc^2$
Partially covered by Ch: 21 of H.R.K.

SECTION-II
WAVES AND OSCILATIONS

SCOPE
Obtaining and solving the basis equation motion x(t), v(t),
Energy. Consideration in SHM (Viscous) forces: terminal velocity. Projectile motion/air resistance.

Torsional, Oscillator : physical pendulum, simple pendulum.

Lissajous patterns

Equation of damped harmonic motion, discussion of its solution.

Ch: 15 H.R.K.

TOPICS
Mechanical waves
Traveling waves
Waves speed
Waves equation
Power and intensity in wave motion
Principle of superposition. (basic ideas).
Suggested level

TOPICS
Beats phenomenon
Doppler Effect

TOPICS
Nature of light
Light as an Electro-magnetic
Wave
Suggested level
Interference

Adding of Electromagnetic wave using phasors.
Interfernece from thin films
Michelson Interferometer

Fresnel Biprism and its use.
Suggested level
Diffraction

SCOPE
Phase velocity of traveling waves sinusoidal
Waves Group speed and dispersion.
Mechanical analysis
Discussion of solution
Derivation and discussion

Interference of waves, standing waves phase changes on reflection , natural frequency, resonance
Ch: 19 of H.R.K.

SOUND

SCOPE
Analytical treatment
Moving source, moving observer, both object and Source moving.

OPTICS

SCOPE
Visible light (physical characteristics)
Speed of light in matter, physicala spects difference
Phase difference etc.

Ch: 42 H.R.K
Coherence of sources: Double slit interference analytical
treatment.
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Newton's rings (analytical treatment)
(Discussion to include use of a compensating plate: Michelson Interferoment use in determining velocity
Of light)

Ch: 45 H.R.K.

Diffraction at single slit Intensity in single slit
Diffraction using phasor treatment and analytical
Treatment using addition of waves. Slit interference
Diffraction combined. Diffraction at a circular aperture.

Diffraction from multiple slits
Diffraction grating

Suggested level
Holography
Polarization

Description of polarization states Rotation of plane of polarization
Suggested level

TOPICS
Kinetic theory of the ideal gas, Work done on an ideal gas
Internal energy of an ideal gas
Intermolecular forces.
Quantitative discussion
Suggested level

TOPIC
Statistical, Distribution and Mean Values
Distribution of molecular speeds
Brownian motion
Suggested level

TOPIC
Review of previous concepts
First law of thermodynamics Transfer of heat.
Suggested level

Discussion to include width of the maxima.
Discussion use inspectrographs. Dispersion and resolving power of gratings.

Ch:46, 47 H.R. K
Qualitative discussion
Basic definition production of polarization by polarizing sheets, by reflection, b double refraction and double scattering.

Linear, Circular, elliptic polarization
Uasc of polarimeter

Ch: 48 H.R.K.

PAPER B

SECTION-I
THERMODYNAMICS AND KINETIC
THEORY OF GASES, TEMPERATURE
SCOPE
Review of previous concepts

To include the Equipartition of energy

Van der waals equation of state.

Ch: 23 H.R.K.

STATISTICAL MECHANICS
SCOPE
Mean free path and microscopic calculations of mean free
Path
Maxwell distribution Maxwell Boltzmann energy
Distribution internal energy of an ideal gas;
Qualitative description.
Diffusion, Conduction and viscosity
Ch: 24 H.R.K
HEAT

SCOPE
First law of Thermodynamics and its application cyclic and free expansion

Ch: 24 H.R.K
ENTROPY AND SECOND LAW OF THERMODYNAMICS
TOPIC
Reversible and irreversible
Processes, Second Law
Cycle Carnot engines
Thermodynamics Temperature
Seale
Entropy

Suggested level
Low Temperature Physics

TOPIC
Electric Charge
Conductors and insulators

SCOPE
Definition discussion
definition

Heat engine Refrigerators
and Second Law
Calculation of efficiency of
heat engines.
Absolute zero negative
temperature, (discussion)

Entropy in reversible
process
Entropy in reversible
process
Entropy and second Law
Entropy and probability
Ch: 26 H.R.K
Liquefaction of gases, joule-
Thomson effect

SECTION-II
ELECTRICITY
ELECTROSTATICS

SCOPE
(Review of previous
concepts) coulombs Law for
Point charges)

Vector form of Coulomb's Law

Suggested level

TOPICS

Electric field of continous charged stribution

Point charge in an electric field
Dipole in an electric field.

Gauss's Law

Application of Gauss's Law
(Integral Form)

Suggested level

TOPICS

Calculating the field from the potential!

Suggested level

Capacitors and dielectrics

Quantization and conservation of charge.
(Discussion)

Ch: 27 H. R. K.

ELECTRIC FIELD
SCOPE

Field due to a point charge; due to several point charge, Electric dipole.
e.g Ring of charge' disc of charge ; infinite line of charge.

Torque on, and energy of , a dipole in uniform field

Electric flux; Gauss's Law; (Integral and differential form)

Charge isolated conductors; conductor with a cavity field near a charged conducting sheet.

Field of infinite line of charge; Field of infinite sheet of charge. Field of spherical shell. Field of spherical charge distribution.
Ch: 28 & 29 H. R. K.

Electric Potential

SCOPE

Potential due to point charge. Potential die to collection of point charges. Potential due to dipole. Electric Potential of continuous charge distribution. Equipotential surfaces.

Field as the gradient or derivative of potential. Potential and field inside and outside an isolated conductor.

Ch: 30 H. R. K.

Capacitance; calculating the electric field in a capacitor, Capacitors of various shapes, cylindrical, spherical etc. Energy stored in an electric field, Energy Per unit Volume.

Capacitor with dielectric.

Suggested level

ELECTRIC CURRENT

Topics

Electric Current

Ohm's Law

Energy transfers in the electric current.

Semiconductors, Super conductor
Suggested level

DC CIRCUITS

TOPICS

Calculating the current in a single loops, multiple loops; voltage at various elements of a loop.

RC circuits

Suggested level

Use Kirchoff's voltage and current laws

Growth and Decay of current in an RC circuit.
Analytical treatment
Ch: 33 H. R. K.

SECTION-III
MAGNETISM AND MAGNETIC FIELD EFFECTS
TOPICS
Magnetic field, B.

Magnetic force on a charged particle magnetic force on a current.
Torque on a current loop
Magnetic dipole.

SCOPE
Basic idea

Recall the previous results. Do not derive.

Define, Energy of magnetic dipole in field. Discuss quantitatively

AMPERE'S LAW

TOPICS

Biot-Savart Law

Ampere's Law

Suggested level

Electric field of dielectric:
(1) An atomic view
(2) Application of Gauss's Law to capacitor with dielectric.

Ch: 31 H. R. K

SCOPE

Current density, Resistance, resistivity, conductivity (Microscopic & macroscopic view of resistivity).

Basic definitions. Analogy between current and heat flow.
Microscopic view of Ohms Law.

Descriptive, giving basic idea

Ch: 32 H. R. K

FARADAY'S LAW OF ELECTROMEGNETIC INDUCTION

TOPICS
Farady's Law
Lenz's Law
Montional E.M.F
Induced electric fields.
Suggested level

TOPICS

Gauss's Law for Magnetism

Origin of Atomic and Nuclear magnetization

Magnetic Materials

Suggested level

INDUCTANCE

SCOPE

TOPICS

Inductance
LR Circuits
Energy stored in a magnetic field

SCOPE
Basic definition inductance of a Soleoid, Toroid, Growth and Decay of current; analytical treatment. Derive, Energy density and the magnetic field.

Electromagnetic Oscillation

Qualitative discussion.

Qualitative analysis using differential equations. (without considering damped and force oscillations). Forced electromagnetic oscillations and resonance.

Suggested level

Ch: 38 H. R. K

ALTERNATING CURRENT CIRCUIT

SCOPE

Analytical treatment and application to a current loop, force on two parallel current changing conductors.

Integral and differential forms, application to Solenoids and toriods. (Integral form)

Ch: 35 H. R. K

TOPICS

Alternating current

Single loop RLC circuit

Power in a.c circuits
Transformer

Suggested level

MAXWELL'S EQUATIONS

SCOPE
Magnetic Flux, Consequence of Farady 's Law .
Discussion, Eddy currents etc.
Quantitative analysis
Calculation and application
Ch: 36 H.R.K

TOPICS
Summarizing the electromagnetic equations.

Induced magnetic fields and Displacement current.

Maxwell's equations.

Suggested level.

MAGNETIC PROPERTIES OF MATTER

SCOPE

Discussion and developing of concepts conservation of magnetic Flux:
Differential form of Gauss's Law.
Defining M'B.'u.

Paramagnetisms, diamagnetism, ferromagnetism
Discussion, Hysteresis in Ferromagnetic materials,
Ch: 37 H. R. K.

ELECTROMAGNETIC WAVE

TOPICS

Generating an electromagnetic wave

Travelling waves and Maxwell's equations.

Energy transport and the Poynting Vector.
Suggested level.

PAPER C:

TOPIC
Semiconductor materials

Idea of energy bands and energy gaps (qualitative). P-type, n-type materials.
Junction diode
Transistor
Transistor, biasing

SCOPE

AC current resistive, inductive and capacitive elements.

Transistor as an amplifier
Amplification with feedback oscillators.

Analytical expression for time dependent solution.
Graphical analysis, phase angles.

Logic gates

Power: Phase angles; RMS values Power factor.
Basis transformer equation.

Suggested level

Ch: 39 H.R. K

TOPICS

Thermal Radiations
(Back body radiation)

SCOPE
Gauss's law for electromagnetism; Faraday's Law;
Ampere's Law

The quantization of Energy
The Photoelectric effect.

Einstein's photon theory

Development of concepts and applications.

The Compton effect

Line Spectra

(Integral & Differential forms)
Discussion and implications.
Ch: 40 H.R. K

Suggested level

TOPICS

SCOPE

Wave behavior of particles

Testing De Broglie's hypothesis. Waves, Waves packets and Particles

Analytical treatment; obtaining differential form Maxwell's equations; obtaining the velocity of light from Maxwell's equations.

Heisenberg's uncertainty principle (HUP)
Wave Function

Schrödinger Equation

Analytical treatment and discussion of physical concepts.

Structure, characteristics and application as rectifiers. Basic structure and operation.
Biasing for amplifiers; Characteristics of common base, common emitter, common collector, load line, operating point, hybrid parameters.

Ch: 41 H. R. K

SECTION-I
ELECTRONICS
SCOPE

Common emitter mode.
Positive and Negative feedback , Oscillators.
Multivibrators.

Trapped Particles and Probability Densities.

OR, AND, NOT, NAND, NOR gates and their basic application.

The correspondence principles
Dual nature of matter (wave & particles)

Basic Electronics by **B. Grob**.

Suggested level.

SECTION- II
MODERN PHYSICS
QUANTUM PHYSICS

SCOPE

TOPICS

Stefan Boltzmann, Wien and Planek's Law Consequences.

Bohr's theory

Angular Momentum of Electrons

Quantum Numbers; Correspondence Principle.

Electron Spin

Explanation of Photoelectric effect.

X-ray Spectrum

Analytical treatment.

X-ray & Atomic number
Development of periodic table

Quantitative discussion; Explanation using quantum theory.

Laser
Suggested level

Ch: 49 H. R. K

WAVE NATURE OF MATTER
SCOPE

TOPICS

Discovering the nucleus
Some nuclear properties.

De Broglie's hypothesis

Davisson-Germer Expt. and Explanation
Localizing a wave in space and time

H.U.P for momentum-position and Energy Time;
HUP, applied to single slit diffraction.
Definition, relation to probability of particle.

STATES AMD EMERGU LEVELS
SCOPE

Particles in a well, Probability Density using wave function of states. Discussion of particles in a well Barrier tunneling .

To be presented without derivation and applied to specific cases e.g. step potentials and free particle, Barrier, Tunneling. (basic idea).

Discussion

Discussion
Ch: 50 H.R.K

TOPICS

ATOMIC AND NUCLEAR PHYSICS
ATOMIC STURCTUE OF HYDROGEN

SCOPE

Derivation and quantitative discusson : Franck Hertz experiment. Energy levels of electrons: Atomic Spectrum (Vector atom model)
Orbital angular momentum; Space quantization. Orbital angular momentum& magnetism, Bohr's magnetor.

Dipole in nonuniform field ; Stern-Gerlach experiment, experimental results.

Continous and Discrete Spectrum-Explanation
Moseley's Law
Pauli exclusion principle and its use in developing the periodic table.

Basic Concepts & Working of He-Ne Laser.
Ch: 51 H.R. K

SCOPE

Review, Rutherford's experiment and interpretation

(a) Nuclear systematics (Mass No., Atomic No. Isotopes).
(b) Nuclear Force (Basic ideas).
(c) Nuclear Radii
(d) Nuclear Masses Binding Energies Mass deficietor.
(e) Nuclear Spin & Magnetism.

Radioactive decay
Alpha decay
Beta decay
Measuring ionizing radiation (Units)

Natural Radioactivity

Nuclear Reaction

Energy from the nucleus
Nuclear fission

Nuclear Reactors
Thermonuclear Fusion(T.N.F)
Controlled Thermonuclear Fusion

Suggested level.

:

Law of decay; half life, mean life.
Basic ideas.
Basic ideas.
Curie, Rad; etc.

Discussion, radioactive dating.

Basic ideas e.g. reaction energy, Q. values, exothermic-endothermic (Some discussion of reaction energies in the contact of nuclear stationary states).

Basic process: Liquid drop model, description,
Theory of N. Fission

Basic principles.
Basic process; T.N.F. in stars.

Basic Ideas and requirements for a T.N. reactor.

Ch: 54 H. R. K

Practical's: (for two days) **(Time 4 hours each day):**

Practical paper 'A': Mechanics, Thermodynamics, Sound, Optics and Electricity & Magnetism

Time: (Four Hours):

List of Experiments for Practical Paper "A"

Properties of Matter:

1. Surface tension by capillary rise.
2. Study of compound pendulum and estimate of value of 'g'.
3. Blastic constants by spiral spring.
4. Modulus of rigidity by dynamics method and static method of Maxwell's Needle.

Heat:

5. Thermo-couple, Thermal e.m.f. and temperature diagram.
6. Determination of "J" Electrical Method (Callender and Barnes Method) with compensation for heat loss.

Sound:

7. Frequency of A.C supply.
8. Velocity of sound by Kundt's tube.

Optics:

9. Use of sextant and measurement of altitude with it.
10. Wavelength of sodium d line by Newton's Rings.
11. Wavelength of light by Fresnel's biprism.
12. Wavelength of light by diffraction grating.
13. Measurement of the Rotation of the Plane of Polarisation.
14. Resolving power of diffraction grating.
15. Determination of the radius of Lycopodium Particles.

Electricity & Magnetism:

16. Measurement of resistance using a neon flash bulb and condencer.
17. I-H Curve by Magnetometer.
18. Conversion of a Pointer Galvanometer into a voltmeter and an ammeter.
19. Calibration of a meter and voltmeter by potentiometer.
20. Low resistance by Carey Foster bridge.
21. Charge sensitivity of a ballistic galvanometer taking into account Logarithmic decrement.
22. Comparison of capacitors by ballistic galvanometer.
23. Determination of temperature coefficient of a resistance.
24. Measurement of magnetic field by fluxmeter or by search coil method.
25. Measurement of H by earth inductor.

Practical Paper 'B' : Electronics, Modern Physics, and Nuclear Physics

(Time- Four Hours):

List of Experiments for Practical Paper "B"

1. Variation of photo-electric current with the intensity of light.
2. Measurement of Plank's constant using spectermeter.
3. Determination of e/m. of electron by deflection method.
4. Determination of ionization potential of mercury.
5. Acceptor circuit.
6. Rejector circuit.
7. Characteristic curves of a G.M. Counter.
8. Setting up half and full wave rectifiers and the study of the waveshape on oscilloscope. Effect of smoothing circuit on ripple voltage.
9. To set up a transistor as an oscillator and to measure its frequency by an oscilloscope.
10. Triode valve as a single stage voltage amplifier and measurement of its gain by an oscilloscope.
11. To draw the characteristic of a semi-conductor diode and compare it with that of a vacuum tube diode.
12. Setting up a single stage transistor amplifier and measurement of its voltage gain.
13. Determination of range of Alpha particles.
14. Stopping power for alpha particles in air equivalent of Mica, Ag, Cu and Al.
15. Absorption coefficient of Beta-particles, using and End-on-Geiger Counter.
16. To study the voltage current characteristics of an electric Discharge in gases at low pressure.
17. Production of vacuum and its rought measurement with a manometer.
18. Production of X-rays and the demonstration of their effect on a fluorescent screen.
19. To set up a High-Frequency Oscillator and measure it frequency, with a wave meter.

Note: Minimum of 30 experiments should be perfomed, at least 10 from List of Experiments for Practical Paper "A" and 10 from List of Experiments for Practical Paper "B".