31. PHYSICS

APPENDIX A'
(Outlines of Tests)

<table>
<thead>
<tr>
<th>Paper 'A'</th>
<th>Section I: Mechanics</th>
<th>50</th>
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<tbody>
<tr>
<td></td>
<td>Section II: Waves and Oscillations</td>
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<td>Section III: Optics</td>
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<td>(Written): (Time-three hours)</td>
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<tr>
<td>Paper 'B'</td>
<td>Section I: Thermodynamics and Kinetic Theory of Gases</td>
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<td>Section II: Electricity</td>
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<td>Section III: Magnetism</td>
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<td>(Written): (Time-three hours)</td>
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<td>Paper 'C'</td>
<td>Section I: Electronics</td>
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<td>Section II: Modern Physics</td>
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<td>Section III: Atomic and Nuclear Physics</td>
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<td>(Written): (Time-three hours)</td>
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<tr>
<td>Practical</td>
<td>(for two days) Time-four hours each day:</td>
<td>50</td>
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<tr>
<td>Practical 'A':</td>
<td>Mechanics, Thermodynamics, Sound, Optics, Electricity and Magnetism</td>
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<td>(Time-four hours)</td>
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<tr>
<td>Practical 'B':</td>
<td>Electronics, Modern Physics and Nuclear Physics</td>
<td>25</td>
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<td>(Time-four hours)</td>
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Grand Total: 200

Note(*) :
"Out of the Whole Syllabus (for a paper) there will be 10 question 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 Section 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 Physical significance of the topic (conceptual question)."

*(Proceedings of the Meeting of the Academic Council held on 10th May, 2003)*
Appendix 'B'
(Syllabi and Courses of Reading)

Paper 'A':
Mechanics, Waves and Oscillation, Optics

Paper 'B':
Thermodynamics and Kinetic theory of Gases, Electricity, Magnetism

Paper 'C':
Electronics, Modern Physics, Atomic and Nuclear Physics

Practical:

Practical Paper 'A':
Mechanics, Thermodynamics, Sound, optics, Electricity and Magnetism.
(Time-four hours)

Practical Paper 'B':
Electronics, Modern Physics and Nuclear Physics
(Time-four hours)

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

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 cases. Converting from differential to integral forms.

Derivations, Physical significance and applications to specific cases.
PARTICLE DYNAMICS

TOPOICS

Advanced application of Newton's laws; Dynamics of Uniform motion

Equations of motion

Time dependent forces

Effect of drag forces on motion

Non inertial frames and Pseudo forces

Limitations of Newton’s Laws

Suggested Level

SCOPE

Frictional forces; microscopic basis of this force

Conical pendulum: the rotor, circular the banked curve.

Deriving Kinetic equations $x(v)$, $v(t)$ using integrations. Constant and Non constant Forces and special examples.

Obtained $x(t)$, $v(t)$ for this case using integration method.

Applying Newton’s Laws to obtain $v(t)$ for the case of motion with time dependent drag (viscous).

Qualitative discussion to develop understanding.

Calculation of pseudo forces for simple cases (linearly accelerated references frame). Centrifugal force as an example of pseudo force; Coriolis force.

Discussion

Ch: 6 R.H.K.

WORK AND ENERGY

TOPOICS

Work done by a constant force.

work done by a variable force (1-dimension).

Work done by a variable (2-dimensional case)

Work energy theorem. General proof of work energy theorem.

Power

Reference Frames

Suggested level

SCOPE

(Essentially a review of grade-XII concepts use of integration technique to calculate work done (e.g. in vibration of a spring obeying Hooke's Law)

Obtaining general expression force and applying to simple cases e.g. pulling a mass at the end of a fixed string against gravity.

Qualitative Review of work energy theorem.

Derivation using integral calculus. Basic formula; and applications.

Energy changes with respect to observers in different inertial frames.

Ch. 7 of R.H.K.
CONSERVATION OF ENERGY

TOPICS
Conservative and non-conservative forces.

One-dimensional conservative system.

2, 3 dimensional conservative systems.

Conservation of energy in a system of particles.

Suggested level

SYSTEMS OF PARTICLES

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

SCOPE

Definition of either, type of force & examples: work done in a closed path.

1-D conservative system: force as the gradient of potential energy; applications to the case of a spring and force of gravity.

Obtaining velocity in terms of U and E; stable, 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 of H.R.K.

SCOPE

Center of mass: Its position, velocity and equation 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)
173

One and two dimensions.

Simple applications: obtaining Velocities in c.m. frame.

Ch: 10 of H.R.K.

SCOPE
Definition, Conservation of angular momentum, effects of Torque.

Relationships between linear & angular variables; scalar and vector form.
Kinetic energy of rotation: Moment of Inertia.

Prove and Illustrate; apply to simple cases.
Equations of rotational motion and effects of application of torques.

Rolling without slipping.

Discussion with examples.
Effects of torque on the angular momentum, precessional motion.

Ch: 12 & 13 H.R.K.

SCOPE
Mathematical treatment.

Develop using integration techniques; calculation of escape velocity.

Develop the idea of field of force.

Motion of plants and Kepler’s laws. (Derivation & explanation) Motion of Satellites. Energy considerations in planetary and satellite motion, qualitative discussion on application of gravitational law to the Galaxy.

Ch: 16 H. R. K.
BULK PROPERTIES OF MATTERS
TOPICS
Elastic Properties of Matter.
Suggested levels
Fluid Statistics
Surface Tension.
Suggested levels,
Fluid Dynamics
Bernoulli Equation
Viscosity

Suggested level

SPECIAL THEORY OF RELATIVITY
TOPICS
Trouble with Classical Mechanics
Postulates of Relativity
The Lorentz Transformation
Consequences of Lorentz transformation
Relativistic momentum
Relativistic energy
Suggested level

SCOPE
Physical basis of elasticity Tension, Compression & sharing
Elastic Modulus; Elastic limit
Ch: 14 H. R. K.
Variation of Pressure in fluid at rest and height in the atmosphere.
Physical basis; role information of drops bubbling.
Ch: 17 H. R. K.
General concepts of fluid flow: streamline and equation of continuity.
Derivation and some applications such as dynamic lift on a rocket.
Physical basis; obtaining the Coefficient of viscosity; fluid flow (Poiseuille’s law)
Ch: 18 H. R. K.

SCOPE
Qualitative discussion of the inadequacy of paradoxes in classical ideas of time, length, and velocity.

Statements and Discussion
Derivation, Assumption on which derivation is based: 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 OSCILLATIONS
HARMONIC OSCILLATIONS

TOPICS
Simple harmonic oscillation (SHM)

SCOPE
Obtaining and solving the basic 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.

SCOPE
Phase velocity of traveling waves; Sinusoidal waves; Group speed and dispersion.
Mechanical analysis
Discussion of solution
Derivation & discussion.

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

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

SCOPE
Visible light (Physical characteristics).
Speed or light in matter: physical aspects, difference, phase difference etc.
Ch: 42 H. R. K.

Coherence of sources: Double slit interference analytical treatment.
Adding of Electromagnetic wave using phasors.
Interference from thin films
Michelson Interferometer

Fresnel Biprism and its use.
Suggested level
Diffraction

Diffraction from multiple slits
Diffraction grating

Suggested level
Holography
Polarization

Description of polarization states
Rotation of plane of polarization
Suggested level

PAPER B:
SECTION I
THERMODYNAMICS AND KINETIC THEORY OF GASES TEMPERATURE

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

Suggested level

Newton's rings (analytical treatment).
(Discussion to include use of a compensating plate;
Michelson interferometer 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.

Discussion to include with 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, by double refraction
and double scattering.

Linear, Circular, elliptic polarization.
Usage of polarimeter.

Ch: 48 H.R.K.

SCOPE
Review of previous concepts.

To include the Equipartition of energy
Van der waals equation of state.

Ch: 23 H. R. K.
STATISTICAL MECHANICS

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

HEAT

TOPICS
Review of previous concepts.
First law of Thermodynamics,
Transfer of heat.
Suggested level:

ENTROPY AND SECOND LAW OF THERMODYNAMICS

TOPICS
Reversible and irreversible Processes, Second Law
Cycle; Carnot engines
Thermodynamic temperature scale
Entropy

Suggested level:
Law Temperature Physics

SECTION-II

ELECTRICITY

ELECTROSTATICS

TOPICS
Electric Charge:
Conductors and Insulators

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.

SCOPE
First law of Thermodynamics & its applications cyclic and free expansion.
Ch: 24 H. R. K.

SCOPE
Definition, discussion. Definition.
Calculation of efficiency of heat engines.
Absolute zero; negative temperature, (discussion)
Entropy in reversible process
Entropy in irreversible process
Entropy & Second Law
Entropy & probability
Ch: 26 H. R. K.
Liquefaction of gases: Joule-Thomson effect

SCOPE
(Review of Previous concepts) Coulomb's Law for point charges).
Vector form of Coulomb's Law

Suggested level

ELECTRIC FIELD

TOPICS

Electric field of continuous charged distribution
Point charge in an electric field
Dipole in an electric field
Gauss's Law

Application of Gauss's Law
(Integral Form)

Quantization and conservation of charge.
(Discussion)
Ch: 27 H. R. K.

SCOPE

Field due to a point charge; due to several point charges, 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)

Charged 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

TOPICS

Calculating the field from the potential.

Suggested level

Capacitors and dielectrics

SCOPE

Potential due to point charge. Potential due 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.

Electric field of dielectric:
(1) An atomic view
(2) Application of Gauss’ Law to capacitor with dielectric.
Ch: 31 H. R. K.

ELECTRIC CURRENT

TOPICS
Electric Current
Ohm’s Law
Energy transfers in the electric circuit.
Semiconductors. Super conductor
Suggested level

SCOPE
Current density, Resistance, resistivity, conductivity (Microscopic & macroscopic view of resistivity).
Basic definition. Analogy between current and heat flow. Microscopic view of Ohms Law.
Descriptive, giving basic idea
Ch: 32 H. R. K.

DC CIRCUITS

TOPICS
Calculating the current in a single loop, multiple loops; voltages at various elements of a loop.
RC circuits
Suggested level

SCOPE
Use of 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
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

FARADAY'S LAW OF ELECTROMAGNETIC INDUCTION

TOPICS

Faraday's Law
Lenz's Law
Motional E.M.F.
Induced electric fields.
Suggested level

MAGNETIC PROPERTIES OF MATTER

TOPICS

Gauss' Law for Magnetism

Origin of Atomic and Nuclear magnetization
Magnetic Materials

Suggested level

INDUCTANCE

TOPICS

Inductance
LR Circuits
Energy stored in a magnetic field
Electromagnetic Oscillation

Suggested level

SCOPE

Analytical treatment and applications to a current loop, force on two parallel current changing conductors.
Integral and differential forms, application to Solenoids and toroids. (Integral form)
Ch; 35 H.R.K.

SCOPE

Magnetic Flux, Consequences of Faraday's Law.
Discussion, Eddy currents etc.
Quantitative analysis
Calculation and application
Ch; 36 H.R.K.

SCOPE

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

Paramagnetism, diamagnetism, ferromagnetism.
Discussion. Hysteresis in Ferromagnetic materials.
Ch; 37 H.R.K.

SCOPE

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

Qualitative discussion.
Quantitative analysis using differential equations.
(without considering damped and forced oscillations). Forced electromagnetic oscillations and resonance.
Ch: 38 H.R.K.
ALTENATING CURRENT CIRCUITS

TOPICS
- Alternating current
- Single loop RLC circuit
- Power in a.c. circuits
- Transformer

Suggested level

MAXWELL'S EQUATIONS

TOPICS
- Summarizing the electromagnetic equations
- Induced magnetic fields & displacement current.
- Maxwell's equations

Suggested level

ELECTROMAGNETIC WAVES

TOPICS
- Generating an electromagnetic wave.
- Travelling waves and Maxwell's equations
- Energy transport and the Poynting Vector

Suggested level

PAPER C:
SECTION-1
ELECTRONICS

TOPICS
- Semiconductor materials

SCOPE
AC current resistive, inductive and capacitive elements.
Analytical expression for time dependent solution.
Graphical analysis, phase angles.
Power: Phase angles; RMS values; Power factor.
Basic transformer equation
Ch: 39 H.R.K

SCOPE
Gauss's law for electromagnetism; Faraday Law; Ampere's Law.
Development of concepts, applications.
(Integral & Differential forms) Discussion and implications.
Ch. 40 H.R.K

SCOPE
Analytical treatment; obtaining differential form
Maxwell's equations; obtaining the velocity of light
from Maxwell's equations.
Analytical treatment and discussion of physical concepts.
Ch. 41 H. R. K.

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

Transistor as an amplifier
Amplification with feedback
oscillators.
Logic gates

Suggested level

SECTION-II
MODERN PHYSICS
QUANTUM PHYSICS

TOPICS
Thermal Radiations
(Black body radiation)
The quantization of Energy
The Photoelectric effect.
Einstein's photon theory
The Compton effect
Line Spectra

Suggested

WAVE NATURE OF MATTER
TOPICS
Wave behavior of particles
Testing De Broglie's hypothesis
Waves, Waves packets and
Particles
Heisenberg's uncertainty principle
(HUP)
Wave Function
Schrodinger Equation

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.
Common emitter mode.
OR, AND, NOT, NAND, NOR and their basic application.

Basic Electronics by B. Grob

SCOPE
Stefan Boltzmann, Wien and Planck's Law consequences.
Quantum Numbers; Correspondence Principle.
Explanation of Photoelectric effect.
Analytical treatment.
Quantitative discussion; Explanation using quantum theory.
Ch: 49 H. R. K.

SCOPE
De Broglie hypothesis
Davison-Germer Expt. and Explanation.
Localizing a wave in space and time.
H.U.P. for momentum-position and Energy Time;
H.U.P. applied to single slit diffraction.
Definition, relation to probability of particale.
To be presented without derivation and applied to specific cases e.g. step potentials, and free part particle, Barrier. Tunneling.(basic idea).
STATES AND ENERGY LEVELS

TOPICS
- Trapped Particles and Probability Densities.
- The correspondence principles
- Dual nature of matter (waves & particles)

Suggested level

SECTION-III

ATOMIC AND NUCLEAR PHYSICS

ATOMIC STRUCTURE OF HYDROGEN

TOPICS
- Bohr’s theory

Angular Momentum of Electrons

Electron Spin

X-ray Spectrum
- X-ray & Atomic number
- Development of periodic table

Laser

Suggested level

NUCLEAR PHYSICS

TOPICS
- Discovering the nucleus
- Some nuclear properties

SCOPE
- Discussion

Ch: 50 H.R.K.

SCOPE
- (Vector atom model) orbital angular momentum; Space quantization. Orbital angular momentum & magnetism, Bohr's magnetor.
- Dipole in nonuniform field; Stern-Gerlach experiment, Experimental results.
- Continuous 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 defect.
  (e) Nuclear Spin & Magnetism.
Radioactive decay
Alpha decay
Beta decay
Measuring ionizing radiation (Units)
Natural Radioactivity

Nuclear Reactions

Energy from the nucleus
Nuclear fission

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

Practicals: (for two days)

Practical Paper 'A': Mechanics, Thermodynamics, Sound, Optics and Electricity or 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. Elastic constants by spiral spring.

Heat:

5. Therm-couple, Thermal e.m.f. and temperature diagram.

Sound:

7. Frequency of A.S. supply.
8. Velocity of sound by Kundt’s tube.
Optics:
9. Use of sextant and measurement of altitude with it.
10. Wavelengths of sodium D lines by Newton's Rings.
11. Wavelength of light by Fresnel's biprism.
12. Wavelength of light by diffraction grating.
14. Resolving power of diffraction grating.
15. Determination of the radius of Lycopodium Particles.

Electricity and Magnetism:
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.
22. Comparison of capacities by ballistic galvanometer.
23. Determination of temperature coefficient of a resistance.
24. Measurement of magnetic field by fluxmeter or by search coil method.

Practical Paper 'B': Electronics, Modern Physics, (Practicals) and Nuclear Physics (Time-Four Hours):

List of Experiments for Practical Paper "B",
1. Variation of photo-electric current with the intensity of light.
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 characteristics of a semi-conductor diode and compare it with that of a vacuum tube diod.

12. Setting up a single stage transistor amplifier and measurement of 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 pressures.

17. Production of vacuum and its roughed 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 its frequency, with a wave meter

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