CURRICULUM FOR

PHYSICS

GRADES XI-XII

2019

GOVERNMENT OF SINDH

SCHOOL EDUCATION AND LITERACY

DEPARTMENT

DIRECTORATE OF CURRICULUM, ASSESSMENT & RESEARCH

CONTENTS

PREFACE TO REVISED EDITION 2019

PHYSICS curriculum for grades XI – XII (2019) is the revised and updated version of National Curriculum 2006. The Provincial Curriculum and Textbook Review Committee accessed and intensively reviewed the regional and international education system curricula and schemes of studies and guiding material to update this document.

The sections are created, units are specified and students learning outcomes are rearranged in to new order of the units. Physics curriculum for grades XI-XII is now divided in to eight section and twenty-eight units. Four sections (General Physics, Mechanics, Electricity and Waves & Communication) are designated for grade-XI, and the rest of four sections (Thermal Physics, Magnetism, Electronics and Modern Physics) are to be taught in grade-XII. Fourteen units will be covered in each academic year.

The learning outcomes are divided level wise; knowledge, understanding and application (K, U, A) is indicated against each SLO to guide the teachers, learners, authors and assessment experts and test paper developers.

The committee made its efforts to include updated venues of information and common concepts, simultaneously align the curriculum with regional and international curricula so as the learners studying in Sindh can easily carry out further education at any regional or international institution without need of covering any deficiency semester or bridging courses in physics.

The ink never dries on curriculum. We welcome feedback on curriculum from teachers, learners, scholars, practitioners and other stakeholder to improve the document further and keep it up to date.

INTRODUCTION

The course in physics lays stress on the development of scientific temper, the cultivation of social, ethical, moral and aesthetic values and development of sensitivity to possible uses and misuses of science and concern for clean and sustainable environment. At this higher secondary level, the students take up physics, as a discipline, with a purpose of pursuing their future careers in basic sciences or pre-professional courses like medicine, engineering and technology at the higher level.

The study of physics involves the students working individually and with others in active, practical, field and interactive media experiences that are related to the theoretical concepts considered in the course. It is expected that students studying physics will apply investigative and problem-solving skills, effectively communicate the theoretical concepts studied in the course and appreciate the contribution that study of physics makes to our understanding of the world.

An understanding of physics, and the development of new applications of this understanding, will help students to appreciate the factors that influence the pursuit of science and have a significant impact on the way people live. Physics, therefore, contributes to people's understanding and appreciation of the natural world and to their ability to make informed decisions about technological applications.

RATIONALE

Recent advancement in information and communication technology has enhanced the access to updated information. The youth is more comfortable with use of these sources of information. The changes in education, curriculum, and society necessitate revision of the national education curriculum which is a fundamental mechanism for the development of national education quality. Need has been realized to restructure the curriculum so that the abilities and skills of inquiry become the vehicles for acquiring scientific knowledge.

The structure of the syllabus is based on logical sequencing of the subject matters kept by proper placement of the concepts, appropriate to the comprehension level of students. Due care has been taken that the syllabus is not heavy and at the same time, it is comparable to the international standards. Curriculum load has been reduced by reinforcing overlapping of concepts within the discipline of physics or with other disciplines making room for contemporary core topics and emerging curricular areas in order that students may easily grasp the ideas by repeated learning. The scientific method has been practiced as a method of inquiry in a way that stimulates curiosity and interest. Every opportunity has been taken to expose the students to the applications of physics to technology and environmental issues. Emphasis has been to promote process-skills, problem-solving abilities and application of concepts, useful in real life situations for making Physics learning more relevant, meaningful and interesting.

CURRICULUM REVISION

The provincial government constituted the curriculum council headed by the Senior Minister for Education. The curriculum wing is established in the School Education and Literacy Department. The subject related curriculum and textbook review committees are notified including Physics.

The curriculum and textbook review committee for physics grade IX-XII is comprised of the experts of the subject, curriculum, assessment, working teachers of different educational systems teaching at school, college and university, representatives of teacher training institutions and Sindh Textbook Board.

The provincial review committee adopted the scientific method, similar to that adopted at the time of development of the curriculum. Orientation workshops for committee members were conducted. Consultative meeting with working teachers of different level and system of education were conducted. Feedback from experts of subject as well as experts I curriculum, assessment and testing and examination was collected. Research reports were accessed and intensive review of related literature, syllabus, course outlines and curricula was carried out.

The initial document National Curriculum for Physics (2006) was developed through following stratagem;

1- Formation of curriculum development team comprising of experts and teachers.

2- Orientation and training workshops on curriculum development.

3- Survey for feedback from students, teachers, community and other stakeholders.

4- Critical review of existing curriculum.

5- Collection of feedback and critique received through different media.

6- Consultation with Textbook Board and teacher trainers

7- Study and comparison with regional and international curricula available or accessed and downloaded from internet.

8- Determination of philosophy of curriculum design, aims and objectives, standards and benchmarks

9- Drafting of core syllabus: The structure, units, contents, learning outcomes with time frame and weighting including identification of investigations / practicals and demonstrations and assessment pattern.

10- Drafting suggestions on the other components of curriculum such as, instructions for writing teaching-learning materials/textbooks, Teaching strategies and methodology and Teachers training

The Physics Curriculum Team carried out comparative study of National Curriculum 2006 in line with the following international curricula before drafting of Physics Curriculum. The updated version of these documents were now accessed for revision of curriculum in 2019.

- ✓ Physics GCE "A" Level, University of Cambridge International Examinations (CIE), U.K.
- ✓ Australian Curriculum, Assessment and Reporting Authority (ACARA) Curriculum.
- ✓ Physics Syllabus, Malta
- ✓ Physics Curriculum Secondary Level, Hong Kong
- ✓ NBSE Physics Curriculum 2018 of India for classes XI-XII
- ✓ Grades Nine through Twelve – Physics, California State Board of Education, U.S.A
- ✓ Physics Curriculum Guidelines of Ontario, Canada
- ✓ South Australia Certificate of Education Physics Curriculum 2019
- ✓ New South Wales Australia Physics Curriculum 2017
- ✓ National Science Curriculum Standards, The Institute for the Promotion of Teaching Science and Technology, Thailand
- ✓ NEBRASKA Science Standards Grades K-12
- ✓ Star Science Standards, Nebraska Department of Education
- ✓ Physics Secondary School Curriculum, State of Utah
- ✓ Michigan State Board of Education Standards and draft Benchmarks (2015)
- ✓ Sequoia Union High School District Physics Curriculum Guide (U.S.A.)
- ✓ Mississippi Science Framework 2018 U.S.A.
- ✓ Science Curriculum Reforms in U.S.A.
- ✓ Coal city High School Physics Curriculum, U.S.A.
- ✓ San Ramon Valley Unified School District Physics Curriculum Grades 9-12 (2019)
- ✓ The Higher Education Commission, Curriculum for Graduates classes.

VISION STATEMENT

Promotion of process, skills, problem solving abilities and application of concepts, useful in real life situation for making physics learning more relevant, meaningful and stimulating.

AIMS

The Aims of Physics at higher secondary level are to enable student to:

- Develop among the students the habit of scientific and rational thinking and an attitude to search for order and symmetry in diverse phenomena of nature and thereby to appreciate the supreme wisdom and creative powers of the creator.
- Become lifelong learner, effective problem solver, responsible and productive citizens in a technological world.
- Strengthen the concepts developed at the secondary level to lay firm foundation for further learning of physics at the tertiary level, in engineering or in other physics dependent and vocational courses.
- Develop process skills and experimental, observational, manipulative, decision making and investigatory skills in the students.
- Understand and interpret scientific information presented in verbal, mathematical or graphical form and to translate such information from one form to another.
- Understand and appreciate the inter relationship and balance that exists in nature, the problems associated with the over exploitation of the environmental resources and disturbance because of the human activities in the ecological balance, thus taking care of the environment.

CURRICULUM DESIGN

The curriculum is designed to emphasize on the understanding and application of physics concepts and principles to prepare the learners for rapidly changing technological as well social scenario of the world and requirements of the market and society.

. This approach has been adopted in recognition of the need for students to develop skills that will be of long term value in an increasingly technological world.

The curriculum framework is based on the **standards** and **benchmarks** framed by Provincial Curriculum Council. It comprises of eight main themes/sections. Each section is further divided into "units" showing their conceptual linkages. Each unit is furthermore divided into Students Learning Outcomes which not only covers the fundamental laws/principles of physics but also cutting edge technological application used in our daily life.

In order to specify the syllabus as precisely as possible and also to emphasize the importance of higher order abilities and skills other than recall, **learning outcomes** have been used throughout. Each unit of the syllabus is specified by **content section/major concepts** followed by detailed **learning outcomes**. The intended level and scope of treatment of a content is defined by the stated **learning outcomes** with easily recognizable domain of (i) **recalling** (ii) **understanding** (iii) **applying** (iv) **analyzing** (v) **evaluating** (vi) and **creating**, under the subhead "**skills**" measuring, observing, manipulating, recording and interpreting /analyzing, predicting and **communicating abilities/ skills** are expected to be developed through related **investigations, activities and practical work**.

Unit-wise weighting and time allocation for each section has been proposed. A separate list of standard practicals, and required equipments are given. Assessment pattern has also been included in the curriculum document.

STANDARDS, BENCHMARKS AND LEARNING OUTCOMES

This curriculum document is built upon Standards, Benchmarks, and Learning Outcomes for the benefit of student growth and progress.

STANDARDS are what students should know and be able to do. Standards are broad descriptions of the knowledge and skills students should acquire in a subject area. The knowledge includes the important and enduring ideas, concepts, issues, and information. The skills include the ways of thinking, working, communicating, reasoning, and investigating that characterize a subject area. Standards may emphasize interdisciplinary themes as well as concepts in the core academic subjects. The Standards are based on:

- ⇨ *Higher Order Thinking:* instruction involves students in manipulating information and ideas by synthesizing, generalizing, explaining or arriving at conclusions that produce new meaning and understanding for them
- ⇨ *Deep Knowledge:* instruction addresses central ideas of a topic or discipline with enough thoroughness to explore connections and relationships and to produce relatively complex understanding.
- ⇨ *Substantive Conversation:* Students engage in extended conversational exchanges with the teacher and / or peers about subject matter in a way that builds an improved and shared understanding of ideas or topics.
- ⇨ *Connections to the World Beyond the Classroom:* Students make connections between substantive knowledge and either public problems or personal experiences.

BENCHMARKS indicate what students should know and be able to do at various developmental levels. The benchmarks are split into five developmental levels:

1- ECE to grade 3.

2- Grade 4 to Grade 5

3- Grade 6 to Grade 8

4- Grade 9 to Grade 10

5- Grade 11 to Grade 12

LEARNING OUTCOMES indicate what students should know and be able to do for each topic in any subject area at the appropriate developmental level. The Learning Outcomes sum up the total expectations from the student.

Students Learning Outcomes SLOs in this curriculum document are divided in three levels Knowledge (K), Understanding (U) and Application (A) as indicated against each SLO.

PHYSICS GRADES XI – XII
STANDARDS, BENCHMARKS

The content standards provide descriptions of what students should know, understand and be able to do in a specific content area.

In addition, benchmarks in each content areas are drafted to further clarify the content standards. They define our expectations for students' knowledge, skills and abilities along a development continuum in each content area. They are meant to define a common denominator to determine how well students are performing.

Standard 1.

Students will be able to display a sense of curiosity and wonder about the natural world and demonstrate an increasing awareness that this has lead to new developments in science and technology.

Benchmarks:

BM-1. Ask questions that can be investigated empirically.

BM-2. Develop solutions to problems through reasoning, observation, and investigations.

BM-3. Design and conduct scientific investigations.

BM-4. Recognize and explain the limitations of measuring devices.

BM-5. Collect and synthesize information from books and other sources of information.

BM-6. Discuss topics in groups by making clear presentations, restating or summarizing what others have said, asking for clarification or elaboration, taking alternative perspectives, and defending a position.

Standard 2 .

Students will be able to demonstrate an understanding of the impact of science and technology on society and use science and technology to identify problems and creatively address them in their personal, social and professional lives.

Benchmarks:

BM-1. Justify plans or explanations on a theoretical or empirical basis.

BM-2. Describe some general limitations of scientific knowledge.

BM-3. Show how common themes of science, mathematics, and technology apply in real world contexts.

BM-4. Discuss the historical development of the key scientific concepts and principles.

BM-5. Explain the social and economical advantages and risks of new technology.

BM-6. Develop an awareness and sensitivity to the natural world.

BM-7. Describe the historical and social factors affecting developments in science.

Standard 3.

Student will be able to understand the processes of scientific investigation. They will be able to identify a problem, design and conduct experiments and communicate their findings using a variety of conventional and technological tools.

Benchmarks:

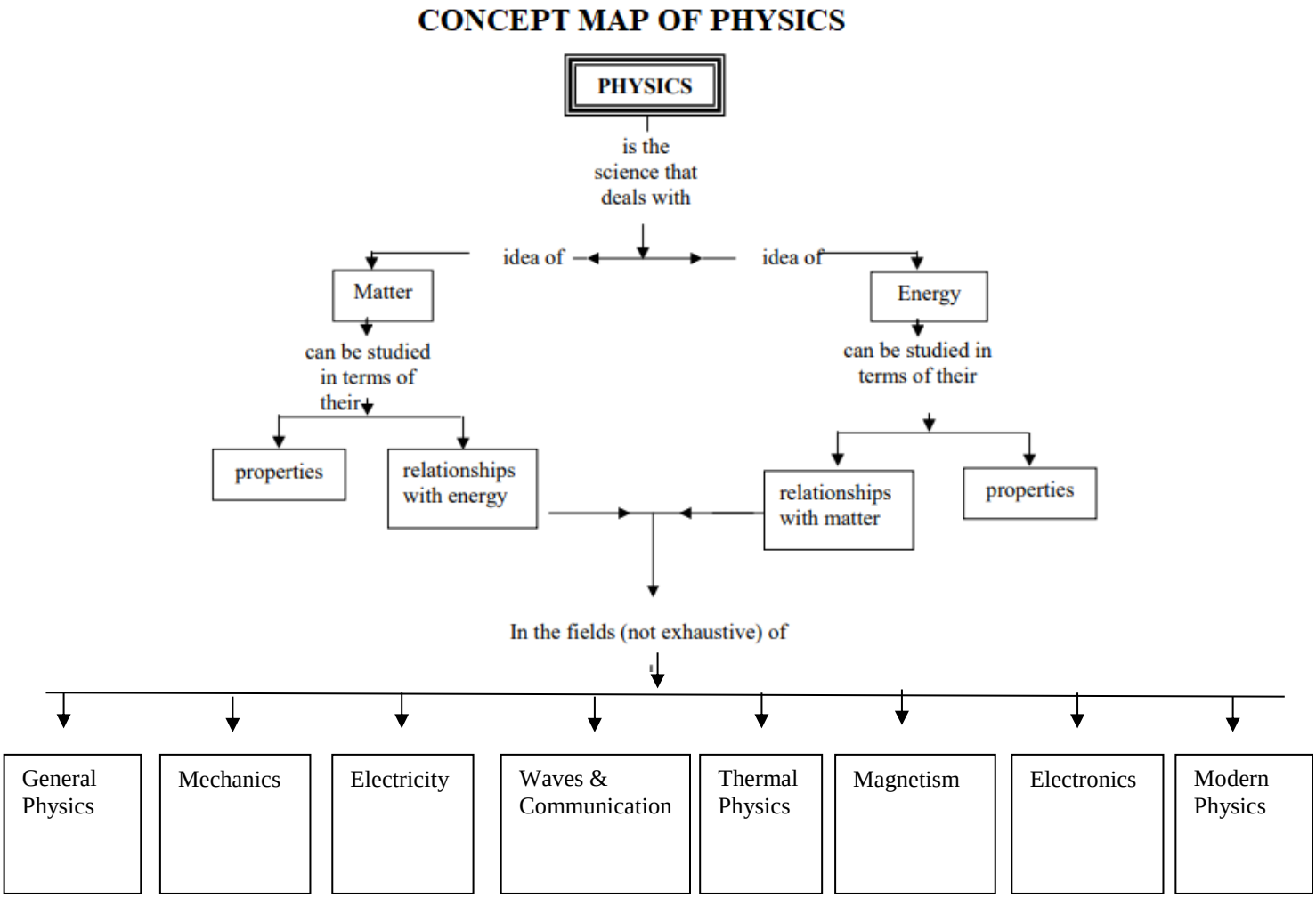
BM-1.	**A**ppreciate the ways in which models, theories and laws in physics have been tested and validated
BM-2.	Assess the impacts of applications of physics on society and the environment.
BM-3.	Justify the appropriateness of a particular investigation plan.
BM-4.	Identify ways in which accuracy and reliability could be improved in investigations.
BM-5.	Use terminology and report styles appropriately and successfully to communicate information.
BM-6.	Assess the validity of conclusions from gathered data and information.

Standard 4.

Students will be able to describe and explain common properties, forms and interactions of energy and matter, their transformations and applications in physical systems.

BM-1.	Explain events in terms of Newton's laws and law of conservation of momentum.
BM-2.	Explain the effects of energy transfers and energy transformations.
BM-3.	Explain mechanical, electrical and magnetic properties of solids and their significance.
BM-4.	Demonstrate an understanding of the principles related to fluid statics/dynamics and their applications.
BM-5.	Explain that heat flow and work are two forms of energy transfers between systems and their significance.
BM-6.	Understand wave properties, analyze wave interactions and explain the effects of those interactions.
BM-7.	Demonstrate an understanding of wave model of light as e.m waves and describe how it explains diffraction patterns, interference and polarization. The utilization of electromagnetic waves, especially that of microwaves in communication and industry and application of sound waves are given special emphasis. Fiber optics which has wide applications in industry is new topics introduced in the physics curriculum with special emphasis on how they can be utilized in the field of communication.
BM-8.	Explain the effects of electric, magnetic and gravitational fields.
BM-9.	Demonstrate and understand the properties, physical quantities, principles and laws related to electricity and magnetism and make use of them.
BM-10.	Investigate and explain basic properties of semi-conductors devices (diodes and transistors) and make electronic circuits and make use of them.
BM-11.	Search, for information and explain nuclear reactions, fission, fusion, interaction between matter and energy benefits and risks of nuclear energy. Describe quantum theory, special theory of relativity and other modern concepts in Physics. It also describes the key features and components of the standard model of matter including hadrons, leptons and quarks.

CONCEPT MAP


CONCEPT MAP OF PHYSICS
PHYSICS
is the science that deals with
idea of
idea of
Matter
Energy
can be studied in terms of their
can be studied in terms of their
properties
relationships with energy
relationships with matter
properties
In the fields (not exhaustive) of
General Physics
Mechanics
Electricity
Waves & Communication
Thermal Physics
Magnetism
Electronics
Modern Physics

PHYSICS GRADE – XI

- SECTIONS
- UNITS
- STUDENTS LEARNING OUTCOMES

LIST OF SECTIONS GRADE – XI

SECTION	UNITS
GENERAL PHYSICS	1. Physics and Measurements
MECHANICS	2. Kinematics 3. Dynamics 4. Rotational & Circular Motion 5. Work, Energy and Power 6. Fluid Statics 7. Fluid Dynamics
ELECTRICITY	8. Electric Fields 9. Capacitors 10. D.C. Circuits
WAVES AND COMMUNICATIONS	11. Oscillations 12. Acoustics 13. Physical Optics 14. Communication

SECTION NO. 01 GENERAL PHYSICS

Contents	Students should be able to	Cognitive level
1.1 Scope of Physics	1.1.1 Describe Physics 1.1.2 Describe the scope of Physics in science, technology and society.	**A** **U**
1.2. S. I Base, Supplementary and derived units	1.2.1 State SI base units, derive units, and supplementary units for various measurements. 1.2.2 Express derived units as products or quotients of the base units. 1.2.3 State the conventions for indicating units as set out in the SI units. 1.2.4 Measure, using appropriate techniques, the length, mass, time, temperature and electrical quantities by making use of both analogue scales and digital displays particularly short time interval by ticker timer and by C.R.O.	**K** **U** **K** **A**
1.3 Dimensionality	1.3.1 Check the homogeneity of physical equations by using dimensionality and base units. 1.3.2 Derive formulae in simple cases using dimensions.	**A** **A**
1.4 Errors and uncertainty	1.4.1 Why all measurements contain some uncertainty. 1.4.2 Distinguish between systematic errors (including zero errors) and random errors. 1.4.3 Measure the diameters of a few ball bearings of different sizes and estimate their volumes. Mention the uncertainty in each result. 1.4.4 Analyze and evaluate the above experiment and suggest improvements. 1.4.5 Assess the uncertainty in a derived quantity by simple addition of actual, fractional or percentage uncertainties	**U** **U** **A** **A** **A**
1.5 Graphs	1.5.1 Identify dependent and independent variables 1.5.2 Draw line of best fit and error bar	**A** **U**

	1.5.3	Draw extrapolation	**U**
1.6 Significant figures	1.6.1	Write answers with correct scientific notation, number of significant figures and units in all numerical and practical work.	**U**
1.7 Precision and accuracy	1.7.1	Identify that least count or resolution of a measuring instrument is the smallest increment measurable by it.	**U**
	1.7.2	Differentiate between precision and accuracy.	**U**
	1.7.3	Explain why it is important to use an instrument of smallest resolution.	**U**
	1.7.4	Explain the importance of increasing the number of readings in an experiment.	**U**
	1.7.5	Interpret the information from linear or nonlinear graphs/curves by measuring slopes and intercepts	**A**

SECTION NO. 02 MECHANICS

Contents		Students should be able to	Cognitive level
2.1	**Vectors**	2.1.1 Describe a vector and its representation	**U**
2.2	**Addition by rectangular components system**	2.2.1 Describe the Cartesian coordinate system. 2.2.2 Resolve a vector into two perpendicular components.	**U** **U**
2.3	**Displacement / Distance with graphical representation**	2.3.1 Describe vector nature of displacement. 2.3.2 Analyze and interpret patterns of motion of objects using displacement-time graph, velocity-time graph acceleration-time graph	**U** **A**
2.4	**Speed and velocity with graphical representation**	2.4.1 Determine the instantaneous velocity of an object moving along the same straight line by measuring the slope of displacement-time graph.	**A**
2.5	**Acceleration, equations of uniformly accelerated motion**	2.5.1 Derive equation of uniformly accelerated motion 2.5.2 Solve the problems.	**U** **A**
2.6	**Projectile Motion**	2.6.1 Understand projectile motion 2.6.2 Calculate height, range and time of flight using equations of projectile motion	**U** **A**

Contents	Students should be able to	Cognitive level
3.1 Newton's Laws of Motion	3.1.1 Apply Newton's laws to explain motion of objects	**A**
	3.1.2 Define inertia (as the property of a body which resists change in motion).	**K**
	3.1.3 Describe and use of the concept of weight as the effect of a gravitational field on a mass.	**U**
	3.1.4 Apply Newton's laws of motion as the rate of change of momentum	**A**
3.2 Momentum and Impulse	3.2.1 Describe the Cartesian coordinate system.	**U**
	3.2.2 Represent a vector into two perpendicular components.	**U**
3.3. Law of Conservation of Momentum	3.3.1 Explain law of conservation of Momentum	**U**
	3.3.2 Describe elastic and inelastic collision with examples	**U**
	3.3.3 Solve different problems of elastic and inelastic collisions between two bodies in one dimension by using law of conservation of momentum.	**A**
	3.3.4 Describe that momentum is conserved in all situations. (Rocket Situation)	**U**

UNIT-04 ROTATIONAL AND CIRCULAR MOTION STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
4.1. Kinematics of Angular Motion	4.1.1 Define angular displacement, angular velocity and angular acceleration and express angular displacement in radians.	(K)
	4.1.2 Solve problems by using $S= r\theta$ and $v=r\omega$.	(A)

4.2. Centripetal Force and Centripetal Acceleration	4.2.1 Describe qualitatively motion in a curved path due to a perpendicular force. 4.2.2 Derive and use centripetal acceleration a = $r\omega^2$, a = v^2/r. 4.2.3 Solve problems using centripetal force F = $mr\omega^2$, $F = \frac{mv2}{r}$. 4.2.4 Describe situations in which the centripetal acceleration is caused by a tension force, a frictional force, a gravitational force, or a normal force. 4.2.5 Explain when a vehicle travels round a banked curve at the specified speed for the banking angle, the horizontal component of the normal force on the vehicle causes the centripetal acceleration. 4.2.6 Describe the equation $\tan\theta = v^2/rg$, relating banking angle θ to the speed v of the vehicle and the radius of curvature r.	**U** **A** **A** **U** **U** **U**
4.3. Orbital velocity	4.3.1 Define the term orbital velocity and derive relationship between orbital velocity, the gravitational constant, mass and the radius of the orbit.	**K**
4.4. Moment of Inertia	4.4.1 Define moment of inertia 4.4.2 Use the formulae of moment of inertia of various bodies for solving problems.	**K** **A**
4.5. Angular Momentum	4.5.1 Define angular momentum 4.5.2 Explain the law of conservation of momentum	**K** **U**
4.6. Torque	4.6.1 Define torque as the cross product of force and moment arm 4.6.2 derive a relation between torque, moment of inertia and angular acceleration	**K** **A**

UNIT-05 WORK ENERGY AND POWER STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
5.1. Work as Scalar Product of Force and Displacement	5.1.1 Describe the concept of work in terms of the product of force F and displacement d in the direction of force (Work as scalar product of F and d). 5.1.2 Distinguish between positive, negative and zero work with suitable examples. 5.1.3 Calculate the work done from the force-displacement graph.	**U** **U** **A**
5.2. Work done by a variable force graphical method	5.2.1. Define work by variable force 5.2.2. Calculate the work done from the force-displacement graph.	**U** **A**
5.3. Kinetic Energy	5.3.1 Recall the concept of K.E 5.3.2 Derive the equation of K.E by using W = **F.d**	**K** **U**
5.4. Potential Energy	5.4.1 Recall the concept of potential Energy 5.4.2 Derive the equation of P.E from W = **F. d**	**K** **U**
5.5. Work done against Gravitational Field	5.5.1 show that the work done in gravitational field is independent of path 5.5.2 Calculate gravitational potential energy at a certain height due to work against gravity	**U** **A**
5.6. Absolute Potential energy	5.6.1 Describe that the gravitational PE is measured from a reference level and can be positive or negative, to denote the orientation from the reference level. 5.6.2 Use equations of absolute potential energy to solve problems	**U** **A**
5.7. Escape Velocity	5.7.1 Explain the concept of escape velocity in term of gravitational constant G, mass m and radius of planet r.	**U**
5.8. Power	5.8.1 Express power as scalar product of force and velocity. 5.8.2 Explain that work done against friction is dissipated as heat in the environment.	**U** **U**
5.9. Work Energy Theorem	5.9.1 State Work Energy theorem 5.9.2 Utilize work – energy theorem in a resistive medium to solve problems.	**K** **A**

5.10. Transformation of Energy	5.10.1 State law of conservation of energy 5.10.2 Explain Law of conservation of energy with the help of suitable examples	**K** **U**

UNIT-06 FLUID STATICS STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
6.1. Pascal's Law	6.1.1 Describe Pascal's Law 6.1.2 Describe applications of Pascal's law	**U** **U**
6.2. Archimedes' Principal	6.2.1 State Archimedes' principal 6.2.2 Derive the equation of up thrust acting on a body in fluid	**K** **A**
6.3. Buoyancy and Law of Floatation	6.3.1 Describe the basic concepts of buoyancy 6.3.2 State law of floatation	**U** **K**
6.4. Surface Tension	6.4.1 Describe surface tension along with suitable examples	**U**

UNIT-07 FLUID DYNAMICS STUDENTS LEARNING OUTCOMES		
S. No Contents	**Students should be able to**	**Cognitive level**
7.1. Fluid Friction	7.1.1 Describe that real fluids are viscous fluids. 7.1.2 Describe that viscous forces in a fluid cause a retarding force on an object moving through it. 7.1.3 Explain how does the Magnitude of the viscous force on an object moving in fluid depend on the size and velocity of the object.	**U** **U** **U**
7.2. Terminal Velocity	7.2.1 Apply Stokes' law to derive an expression for terminal velocity of spherical body falling through a viscous fluid. 7.2.2 Use the equation of terminal velocity to solve problems	**A** **A**
7.3. Streamline and Turbulent Flow	7.3.1. Define the terms: steady (streamline or laminar) flow, incompressible flow and non-viscous flow as applied to the motion of an ideal fluid. 7.3.2 Explain that at a sufficiently high	**K**

	velocity, the flow of viscous fluid undergoes a transition from laminar to turbulence conditions. 7.3.3 Describe that the majority of practical examples of fluid flow and resistance to motion in fluids involve turbulent rather than laminar conditions.	**U** **U**
7.4. Equation of Continuity	7.4.1. Identify that the equation of continuity is a form of the principle of conservation of mass. 7.4.2 Solve problems by using the equation of continuity	**A** **A**
7.5. Bernoulli's Equation and its Application	7.5.1 Describe that the pressure difference can arise from different rates of flow of a fluid (Bernoulli Effect). 7.5.2 Interpret and apply Bernoulli Effect in the: filter pump, Venturi meter, in, atomizers, flow of air over an aerofoil and in blood physics.	**U** **U**

SECTION NO. 03 ELECTRICITY

UNIT-08 ELECTRIC FIELDS STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
8.1. Force between Two Charges	8.1.1 Define Electrostatic force 8.1.2 Explain Coulomb's law 8.1.3 Describe the coulombs force in different mediums 8.1.4 Solve problems using Columbus Law	**K** **U** **U** **A**
8.2. Electric Field	8.2.1 Describe the concept of an electric field as an example of a field of force. 8.2.2 Derive the expression $E = 1/4\pi\varepsilon_o\ q/r^2$ for the magnitude of the electric field at a distance 'r' from a point charge 'q'. 8.2.3 Define electric field strength as force per unit positive charge. 8.2.4 Solve problems and analyze information using $E = F/q$. 8.2.5 Solve problems involving the use of the expression. $E = 1/4\pi\varepsilon_o\ q/r^2$	**U** **A** **K** **A** **A**
8.3. Electric Field due to Dipole	8.3.1 Describe the concept of electric dipole. 8.3.2 Calculate the magnitude and direction of the electric field at a point due to two charges with the same or opposite signs. 8.3.3 Sketch the electric field lines for two-point charges of equal magnitude with same or opposite signs.	**U** **A** **U**
8.4. Electric Flux	8.4.1 Describe electric flux. 8.4.2 Explain electric flux through a surface enclosing a charge.	**K** **U**

8.5. Electric Potential	8.5.1 Define absolute electric potential and the unit of electric potential. 8.5.2 Define potential difference and its unit 8.5.3 Solve problems by using the expression V =W/q. 8.5.4 Calculate the potential in the field of a point charge using the equation V = 1/4πε$_o$ q/r. 8.5.5 Show that the electric field at a point is given by the negative of potential gradient at that point. 8.5.6 Solve problems by using the expression E = - V/d. 8.5.7 Define electron volt.	**K** **K** **A** **A** **A** **A** **K**

UNIT-09 CAPACITORS **STUDENTS LEARNING OUTCOMES**		
Contents	**Students should be able to**	**Cognitive level**
9.1. Capacitor	9.1.1 Explain capacitors as Charge storing Devices 9.1.2 Identify types of capacitors used in different field 9.1.3 Identify factors affecting the capacitance of a parallel plate capacitor and use equations $\varepsilon_r = C/C_o$; $C = \varepsilon_o\varepsilon_r A/d$. 9.1.4 Calculate combined capacitance of capacitors in series and in parallel.	**U** **K** **A** **U**
9.2. Energy stored in a Capacitor.	9.2.1 Demonstrate charging and discharging of a capacitor through a resistance. 9.2.2 Prove that energy stored in a capacitor is $W = \frac{1}{2}QV$ and hence $E = \frac{1}{2}CV^2$	**U** **U**

UNIT-10 D.C CIRCUITS STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
10.1. Resistors and its Types	10.1.1 Recall concept of resistance 10.1.2 Indicate the value of resistance by reading color code on it.	**K** **K**
10.2. Resistivity, and its Dependence upon Temperature	10.2.1 Define resistivity and explain its dependence upon temperature and also derive the mathematical relationship between them. 10.2.2 Define conductance and conductivity of conductor. 10.2.3 Solve problems using the equations of resistivity	**U** **K** **A**
10.3. Internal Resistance	10.3.1 Understand the effects of the internal resistance of a source of e.m.f. on the terminal potential difference 10.3.2 Distinguish between e.m.f. and p.d. using the energy considerations. 10.3.3 Explain the internal resistance of sources and its consequences for external circuits. 10.3.4 Describe some sources of e.m.f.	**U** **A** **U** **U**
10.4. Power Dissipation in Resistors	10.4.1 Describe the conditions for maximum power transfer.	**U**
10.5. Thermoelectricity	10.5.1 Describe thermocouple and its function. 10.5.2 Explain variation of thermoelectric e.m.f. with temperature. 10.5.3 Identify the function of thermistor in fire alarms and thermostats that control temperature.	**K** **U** **A**
10.6. Kirchhoff's Laws	10.6.1 State Kirchhoff's first law and appropriate the link to conservation of charge 10.6.2 State Kirchhoff's second law and appropriate the link to conservation of energy 10.6.3 Derive equations by using Kirchhoff's laws, a formula for the combined resistance of two or more resistors connected in series and parallel 10.6.4 Solve problems by using Kirchhoff's laws for the combined resistance of two or more resistors in series and parallel	**U** **U** **A** **A**

10.7. Balanced Potential	10.7.1 Describe Wheatstone bridge and how it is used to find unknown resistance. 10.7.2 Describe the working of rheostat as a potential divider in circuit. 10.7.3 Describe the function of potentiometer to measure and compare potentials without drawing any current from the circuit.	**U** **U** **U**

SECTION NO. 04 WAVES & COMMUNICATION

UNIT-11 OSCILLATIONS STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
11.1. Simple harmonic Motion (SHM)	11.1.1 Describe necessary conditions for execution of simple harmonic motion. 11.1.2 Investigate the motion of an oscillator using experimental and graphical methods	**U** **A**
11.2. Uniform Circular Motion and SHM	11.2.1 Describe necessary conditions for execution of simple harmonic motions. 11.2.2 Describe that when an object moves in a circle, the motion of its projection on the diameter of the circles is SHM. 11.2.3 Define the terms amplitude, period, frequency, angular frequency and phase 11.2.4 Identify and use the equation; $a = -\omega^2 x$ as the defining equation of SHM.	**U** **U** **K** **A**
11.3. Practical SHM Systems Mass-Spring & Simple Pendulum	11.3.1 Prove that the motion of mass attached to a spring is SHM. 11.3.2 Analyze the motion of a simple pendulum is SHM and calculate its time period. 11.3.3 Interpret time period of the simple pendulum varies with its length	**A** **A** **A**
11.4. Energy Conservation in SHM	11.4.1 Describe the interchanging between kinetic energy and potential energy during SHM.	**U**
11.5. Free and Forced Oscillation	11.5.1 Describe practical examples of free and forced oscillations (resonance). 11.5.2 Describe graphically how the amplitude of a forced oscillation changes with frequency near to the natural frequency of the system. 11.5.3 Describe practical examples of damped oscillations with particular reference to the efforts of the degree of damping and the importance of critical damping in cases such as a car suspension system. 11.5.4 Describe qualitatively the factors which determine the frequency response and sharpness of the resonance.	**U** **A** **U** **U**

UNIT-12 ACOUSTICS STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
12.1. Speed of Sound in Air	12.1.1 Explain that speed of sound depends on the properties of medium in which it propagates and describe Newton's formula of speed of waves. 12.1.2 Describe the Laplace correction in Newton's formula for speed of sound in air. 12.1.3 Identify the factors on which speed of sound in air depends. 12.1.4 Solve problems using the formula $V = \sqrt{\frac{T}{273}}$	**U** **U** **U** **A**
12.2. Superposition of Sound Waves	12.2.1 Describe the principle of superposition of two waves from coherent sources. 12.2.2 Describe the phenomenon of interference of sound waves. 12.2.3 Describe the phenomenon of formation of beats due to interference of non-coherent sources. 12.2.4 Explain the tuning of musical instruments by beats. 12.2.5 Explain the formation of stationary waves using graphical method 12.2.6 Define the terms, node and antinodes. 12.2.7 Describe modes of vibration of strings. 12.2.8 Describe formation of stationary waves in vibrating air columns.	**U** **U** **U** **U** **U** **K** **U** **U**
12.3. Doppler Effect of Sound	12.3.1 Explain the observed change in frequency of a mechanical wave coming from a moving object as it approaches and moves away 12.3.2 Recall the applications of Doppler Effect such as radar, sonar, astronomy, satellite, and radar speed traps. 12.3.3 Outline some cardiac problems that can be detected through the use of the Doppler's effect.	**U** **K** **K**

UNIT-13 PHYSICAL OPTICS STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
13.1. Nature of Light	13.1.1 Understand electromagnetic spectrum (ranging from radio waves to γ-rays). 13.1.2 Recall that light is a part of a continuous spectrum of electromagnetic waves	**U** **K**
13.2. Wave Fronts	13.2.1 Describe the concept of wave fronts and its types	K
13.3. Huygen's Principle	**13.3.1** State Huygens's Principle and use it to construct wave front after a time interval	K
13.4. Interference of Light	13.4.1 State the necessary conditions to observe interference of light. 13.4.2 Describe Young's double slit experiment and the evidence it provides to support the wave theory of light. 13.4.3 Use the equations of constructive and destructive interference to determine the position of bright and dark fringes also determine the fringe spacing. 13.4.4 Explain color pattern due to interference in thin films. 13.4.5 Describe interference pattern produced by Newton rings **13.4.6** Describe the parts and working of Michelson Interferometer and its uses.	**K** **U** **A** **K** **U** **K**
13.5. Diffraction	13.5.1 Explain diffraction and identify that interference occurs between waves that have been diffracted. 13.5.2 Describe that diffraction of light is evidence that light behaves like waves. 13.5.3 Describe and explain diffraction at a narrow slit. 13.5.4 Describe the use of a diffraction grating to determine the wavelength of light and carry out calculations using $d\sin\theta=n\lambda$. 13.5.5 Describe the phenomena of diffraction of X-rays through crystals. 13.5.6 Measure the slit separation/ grating element 'd' of a diffraction grating by using the known wavelength of laser light.	**U** **K** **U** **U** **U** **A**

UNIT-14 COMMUNICATION STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
14.1. Communication Channels	14.1.1 describe how the information may be carried by a number of different channels, including wire-pairs, coaxial cables, radio and microwave links, optic fibers and Satellites	**K**
	14.1.2 Describe relative merits of channels of communication	**K**
14.2. Modulation	14.2.1 Describe that the information can be transmitted by radio waves	**K**
	14.2.2 Understand the term modulation and be able to distinguish between amplitude modulation (AM) and frequency modulation (FM)	**A**
	14.2.3 Define the term bandwidth	**K**
	14.2.4 Demonstrate an awareness of the relative advantages of AM and FM transmissions	**K**
14.3. Digital Communication	14.3.1 Understand the advantages of the transmission of data in digital form, compared with the transmission of data in analogue form	**A**
	14.3.2 understand that the digital transmission of speech or music involves analogue-to-digital conversion (ADC) before transmission and digital-to-analogue conversion (DAC) after reception	**U**

PHYSICS GRADE – XII

- SECTIONS
- UNITS
- STUDENTS LEARNING OUTCOMES

LIST OF SECTIONS GRADE – XII

SECTION	UNITS
THERMAL PHYSICS	15. Molecular Theory of Gases 16. First Law of Thermodynamics 17. Second Law of Thermodynamics
MAGNETISM	18. Magnetic Fields 19. Electromagnetic Induction 20. AC Circuits
ELECTRONICS	21. Physics of Solids 22. Solid State Electronics 23. Digital Electronic
MODERN PHYSICS	24. Relativity 25. Quantum Physics 26. Atomic Physics 27. Nuclear Physics 28. Particle Physics

SECTION NO. 05 THERMAL PHYSICS

UNIT-15 MOLECULAR THEORY OF GASES STUDENTS LEARNING OUTCOMES			
Contents	**Students should be able to**		**Cognitive level**
15.1. Temperature	15.1.1	Recall concept of temperature	**K**
	15.1.2	Solve problems using scales of temperature and their conversion	**A**
	15.1.3	Explain triple point of water	**U**
15.2. Gas Laws	15.2.1	State general gas law	**K**
	15.2.2	Derive gas laws (Boyle's law, Charle's law and Avogadro's law)	**U**
	15.2.3	Solve problems using gas laws	**A**
15.3. Kinetic Theory of Gases (KTG)	15.3.1	State the basic postulates of KTG	**K**
	15.3.2	Describe the molecular movement causes the pressure exerted by gas and derive pressure equation	**U**
	15.3.3	Describe the relation between kinetic energy of molecules and temperature	**U**
	15.3.4	Solve problems using relation between kinetic energy and temperature	**A**

UNIT-16 FIRST LAW OF THERMODYNAMICS STUDENTS LEARNING OUTCOMES			
Contents	**Students should be able to**		**Cognitive level**
16.1. Heat and Work	16.1.1	Describe that heat flow and work are two forms of energy transfer between systems and calculate heat being transferred.	**U**
16.2. Internal Energy	16.2.1	Relate rise in temperature of a system increases its internal energy.	**U**
	16.2.2	Explain that internal energy is determined by the state of the system and that it can be expressed as the sum of the random distribution of kinetic and potential energies associated with the molecules of the system.	**U**
16.3. First Law of Thermodynamics and its Applications	16.3.1	Define thermodynamics and various terms associated with it.	**K**
	16.3.2	Calculate work done by a thermodynamic system during a volume change.	**U**
	16.3.3	Describe the first law of thermodynamics expressed in terms of the change in internal energy, the heating of the system	**U**

	and work done on the system. 16.3.4 Explain that first law of thermodynamics expresses the conservation of energy. 16.3.5 Describe the applications of first law of thermodynamics with the help of equations and graphs 16.3.6 Solve the problems using the equations of first law of thermodynamics	**K** **A** **A**
16.4. Molar Specific Heat	16.4.1 Define the terms specific heat and molar specific heats of a gas. 16.4.2 Apply first law of thermodynamics to derive Cp – Cv = R. 16.4.3 Solve the problems using equations of specific heat	**K** **A** **A**

UNIT-17 SECOND LAW OF THERMODYNAMICS STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
17.1. Second Law of Thermodynamics	17.1.1 State and explain second law of thermodynamics.	**U**
17.2. Heat Engines	17.2.1 State the working principle of heat engine. 17.2.2 Describe the concept of reversible and irreversible processes. 17.2.3 Describe the working of petrol engine and diesel engine.	**U** **U** **K**
17.3. Carnot Cycle	17.3.1 Explain the working principle of Carnot's engine 17.3.2 Explain that the efficiency of a Carnot engine is independent of the nature of the working substance and depends on the temperatures of hot and cold reservoirs. 17.3.3 Solve problems to find out the efficiency of heat engine	**U** **U** **A**
17.4. Refrigerator	17.4.1 Describe that refrigerator is a heat engine operating in reverse as that of an ideal heat engine and find its efficiency 17.4.2 Solve problems to find out the efficiency of a refrigerator	**U** **A**
17.5. Entropy	17.5.1 Describe that change in entropy is positive when heat is added and negative when heat is removed from the system. 17.5.2 Explain that increase in entropy means degradation of energy. 17.5.3 Show that energy is degraded during all-natural processes.	**U** **U** **K**

	17.5.4 Identify that system tend to become less orderly over time. 17.5.5 Solve problems using the equation of entropy	**A** **A**

SECTION NO. 06 MAGNETISM

UNIT-18 MAGNETIC FIELDS STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
18.1. Magnetic Field of Current–carrying Conductor	18.1.1 Describe that a magnetic field is an example of a field of force produced either by current-carrying conductors or by permanent magnets 18.1.2 Describe and sketch field lines pattern due to a long straight wire	**U** **U**
18.2. Magnetic Force on a Current-carrying Conductor	18.2.1 Describe the factors affecting the force on a current carrying conductor in a magnetic field. 18.2.2 Solve problems using the equation F=BILsinΘ, with directions as interpreted by Fleming's left-hand rule	**U** **A**
18.3. Magnetic Flux Density	18.3.1 Define magnetic flux density and the Tesla 18.3.2 Understand how the force on a current-carrying conductor can be used to measure the flux density of a magnetic field using a current balance 18.3.3 Describe the concept of magnetic flux (Ø) as scalar product of magnetic field (B) and area (A) using the relation $Ø_B = B.A$ 18.3.4 Solve the problems using $Ø_B = B.A$	**K** **U** **U** **A**
18.4. Ampere's Law and its Applications	18.4.1 State and explain Amperes law 18.4.2 Explain solenoid and toroid Solve problems to obtain Magnetic flux density of solenoid and toroid by amperes law $B = \mu_o I/2\pi r$ and $B = \mu_o NI$	**U** **A**
18.5. Force on a Moving Charged Particle in a Uniform Magnetic Field	18.5.1 Explain that a force acts on a charged particle in a uniform magnetic field. 18.5.2 Solve problems using $F = qvB\sin\Theta$ 18.5.3 Describe a method to measure the e/m of an electron by applying magnetic field and electric field on a beam of electrons. 18.5.4 Describe the motion of electrons in an electric field and magnetic field using a Cathode Ray tube. 18.5.5 Solve problems using related equations	**U** **A** **U** **U** **A**
18.6. Torque on a Current Carrying Coil	18.6.1 Understand the turning effect on a current carrying coil in a magnetic field 18.6.2 Derivation and use of $\tau = BANI$.	**U** **A**

in a Magnetic Field		
18.7. Electro-mechanical Instruments	18.7.1 Describe the construction and working of Galvanometer and Its conversion into Voltmeter, Ammeter and Avometer 18.7.2 Solve problems using $R_x = \left(\frac{V}{I_g}\right) - R_g$ $R_s = \left(\frac{I_g}{I - I_g}\right) R_g$	**U/A** **A**

UNIT-19 ELECTROMAGNETIC INDUCTION STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
19.1. Faraday's Law	19.1.1 Describe the production of electricity by magnetism. 19.1.2 Explain that induced emf's can be generated in two ways. (i) by relative movement (the generator effect). (ii) by changing a magnetic field (the transformer effect). 19.1.3 Infer the factors affecting the magnitude of the induced emf. 19.1.4 State Faraday's law of electromagnetic induction. 19.1.5 Account for Lenz's law to predict the direction of an induced current and relate to the principle of conservation of energy. 19.1.6 Apply Faraday's law of electromagnetic induction and Lenz's law to solve problems	**U** **U** **U** **K** **U** **A**
19.2. Eddy Currents	19.2.1 Explain the production of eddy currents and identify their magnetic and heating effects. 19.2.2 Explain the need for laminated iron cores in electric motors, generators and transformers	**U** **K**
19.3. Self-Induction	19.3.1 Define Self Induction and its unit 19.3.2 How an inductor is used to store electric potential energy? 19.3.3 Derive energy produced in Self Induction is $E = ½ Li^2$	**K** **K** **A**

19.4. Mutual Inductance	19.4.1 Explain Mutual Inductance (M) and its unit henry. 19.4.2 Describe the construction of a transformer and explain how it works. 19.4.3 Identify the relationship between the ratio of the number of turns in the primary and secondary coils and the ratio of primary to secondary voltages. 19.4.4 Recall that how step up and step-down transformers can be used to ensure efficient transfer of electricity along cables. 19.4.5 Describe the use of step-down and step-up transformers for the electric supply from power station to houses and electric appliances at home. 19.4.6 Solve problems using $\frac{N_S}{N_p}=\frac{V_S}{V_p}$	**U** **U** **A** **K** **K** **A**
19.5. Motional emf and A.C. Generator	19.5.1 Define motional emf 19.5.2 Compute the potential difference across ends of a given rod or wire moving through a magnetic field 19.5.3 Explain construction and working of an AC generator 19.5.4 Identify the factors affecting induced EMF of an AC generator 19.5.5 Solve problems using **$\xi=\xi_0$ Sin2πft**	**K** **U** **U** **U** **U**
19.6. A.C. Motor and Back emf	19.6.1 Describe the main features of an A.C motor and the role of each feature. 19.6.2 Explain the production of back emf in electric motors.	**U** **U**

UNIT-20 AC CIRCUITS
STUDENTS LEARNING OUTCOMES

Contents	Students should be able to	Cognitive level
20.1. Alternating Current	20.1.1 Define the terms time period, frequency, instantaneous peak value and root mean square value of an alternating current and voltage. 20.1.2 Represent a sinusoidal alternating current or voltage by an equation of the form $x = x_o \sin \omega t$. 20.1.3 Describe the phase of A.C and how phase lags and leads in A.C Circuits.	**K** **A** **U**

20.2. AC through Resistor	20.2.1 Explain the flow of A.C through Resistors 20.2.2 Calculate the resistance of resistors 20.2.3 Construct phasor diagrams and carry out calculations on circuits including resistive components	**U** **U** **A**
20.3. AC through Capacitor	20.3.1 Explain the flow of A.C through capacitors 20.3.2 Calculate the reactance of capacitors 20.3.3 Construct phasor diagrams and carry out calculations on circuits including reactive components	**U** **A** **A**
20.4. AC through Inductor	20.4.1 Explain Ac through inductors. 20.4.2 Identify inductors as important components of A.C circuits termed as chokes 20.4.3 Construct phasor diagrams and carry out calculations on circuits including inductive components	**U** **K** **A**
20.5. RLC Circuits	20.5.1 Describe impedance as vector summation of resistances and reactance 20.5.2 Construct phasor diagrams and carry out calculations on circuits including resistive reactive and inductive components in series and parallel. 20.5.3 Solve the problems using the formulae of A.C Power. 20.5.4 Explain resonance in an A.C circuit and carry out calculations using the resonant frequency formulae. 20.5.5 Describe that maximum power is transferred when the impedances of source and load match to each other. 20.5.6 Illustrate the principle of metal detectors used for security checks. 20.5.7 State the principle of electro-cardiograph in medical diagnostic. 20.5.8 Describe the importance of oscillator circuit as broadcaster of radio waves. 20.5.9 Describe the principle of resonance in tuning circuits of a radio. 20.5.10 Solve problems using Equations of RC, RL, LC, RLC circuits in series and parallel $\mathbf{Z_{RC}} = \sqrt{\boldsymbol{R^2} + \frac{1}{(\omega \boldsymbol{c})^2}}$ $\mathbf{Z_{RL}} = \sqrt{\boldsymbol{R^2} + (\omega \boldsymbol{L})^2}$ $\mathbf{f_R} = \frac{1}{2\pi\sqrt{LC}}$	**U** **A** **A** **U** **U** **K** **K** **U** **U** **A**

SECTION NO. 07 ELECTRONICS

UNIT- 21 PHYSICS OF SOLIDS STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
21.1. Classification of Solids	21.1.1 Distinguish between the structure of crystalline, glassy, amorphous and polymeric solids. 21.1.2 Describe that deformation in solids is caused by a force and that in one dimension; the deformation can be tensile or compressive.	**U** **U**
21.2. Mechanical Properties of Solids	21.2.1 Define and use the terms Young's modulus, bulk modulus and shear modulus. 21.2.2 Demonstrate the force-extension graphs for typical ductile, brittle and polymeric materials. 21.2.3 Become familiar ultimate tensile stress, elastic deformation and plastic deformation of a material.	**K** **U** **K**
21.3. Electrical Properties of Solids	21.3.1 Describe the idea about energy bands in solids. 21.3.2 Classify insulators, conductors, and semiconductors on the basis of energy bands. 21.3.3 Become familiar with the behavior of superconductors and their potential uses. 21.3.4 Describe the applications of superconductors in magnetic resonance imaging (MRI), magnetic levitation trains, powerful but small electric motors and faster computer chips.	**U** **U** **K** **U**
21.4. Magnetic Properties of Solids	21.4.1 Distinguish between dia, para and Ferro magnetic materials. 21.4.2 Describe the concepts of magnetic domains in a material. 21.4.3 Explain the Curie point. 21.4.4 Classify hard and soft ferromagnetic substances. 21.4.5 Describe hysteresis loss. 21.4.6 Synthesis from hysteresis loop how magnetic field strength varies with magnetizing current. 21.4.7 Identify the importance of hysteresis loop to select materials for their use to make them temporary magnets or permanent magnets.	**U** **U** **K** **K** **U** **U** **A**

UNIT-22 SOLID STATE ELECTRONICS STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
22.1. P and N type Substance	22.1.1. Intrinsic (pure) and doped semiconductors 22.1.2. How the n-type and p-type semiconductors are produced 22.1.3. Explain the concept of holes and electrons in semiconductors.	**K** **K** **U**
22.2. PN Junction	22.2.1 Explain how electrons and holes flow across a junction. 22.2.2 Describe a PN junction(diode) 22.2.3 Discuss its forward and reverse biasing 22.2.4 Describe the I-V characteristic curves of PN junction 22.2.5 Define rectification and describe the use of diodes for half and full wave rectifications. 22.2.6 Describe the function and use of LED, Photodiode and Photo voltaic cell.	**K** **U** **U** **A** **U** **U**
22.3. Transistor and Its Characteristics	22.3.1 Distinguish between PNP & NPN transistors. 22.3.2 Describe the operations of transistors 22.3.3 Deduce current equation and apply it to solve problems on transistors. 22.3.4 Apply operation principles of the transistor including I-V characteristics and biasing methods 22.3.5 Explain the use of transistors as a switch and an amplifier (common-emitter, 22.3.6 Explain common-base and common collector configurations)	**K** **U** **U** **A** **U** **U**
22.4. OP amplifier	22.4.1 Describe the properties of an ideal operational amplifier, 22.4.2 Express operational amplifier as a comparator 22.4.3 Understand the effects of negative feedback on the gain of an operational amplifier 22.4.4 Draw the circuit diagrams for both the inverting and the non inverting amplifier for single signal input 22.4.5 Understand the virtual earth approximation and derive an 22.4.6 Express for the gain of inverting amplifiers 22.4.7 Recall and use expressions for the voltage gain of inverting and of non-inverting amplifiers	**U** **U** **A** **U** **U** **U** **K**

UNIT-23 DIGITAL ELECTRONICS STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
23.1 Digital Signal Levels	23.1.1 Explain signal levels employed in digital electronics or circuits are 'high' (for example, +5 volts) and 'low' (for example, 0 volts) 23.1.2 Describe the 'high' and 'low' states are referred to as '1' and '0' for open and close circuit respectively	**U** **U**
23.2 Logic Gates	23.2.1 Recall electronic symbols of the logic gates AND, OR, NOT, NOR, NAND, XOR 23.2.2 Use logic gates (AND, OR, NOT, NOR, NAND, XOR, combinations) and their truth tables for 2, 3 and 4 inputs 23.2.3 Identify the behavior of a 2 inputs AND gate and a 2 inputs OR gate with simple circuit using 2 switches, a lamp and a battery	**K** **U** **A**

SECTION NO. 08 MODERN PHYSICS

UNIT-24 RELATIVITY STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
24.1 Frame of References	24.1.1 Describe Relative Motion with suitable examples (same and opposite direction) 24.1.2 Distinguish between inertial and non-inertial frames of reference 24.1.3 Predict the motion of an object relative to a different frame of reference e.g. dropping a ball in a moving vehicle observed from the vehicle and by a person standing on the side walk.	**U** **K** **A**
24.2 Special Theory of Relativity	24.2.1 Analyze and evaluate the evidence confirming or denying Einstein's two postulates 24.2.2 Identify that if c is constant then space and time become relative. 24.2.3 Explain qualitatively and quantitatively the consequence of special relativity in relation to the relativity of simultaneity length contraction time dilation mass increase the equivalence between mass and energy 24.2.4 Discuss the limitation on the maximum velocity of a particle imposed by special relativity 24.2.5 Explain the implications of mass increase, time dilation and length contraction for space travel. 24.2.6 Identify the role of special theory of relativity in global positioning, NAVSTAR system. 24.2.7 Solve problems using □=$t_0/\sqrt{1-\mathrm{V}^2/\mathrm{C}^2}$ and l=$l_0\sqrt{1-\mathrm{V}^2/\mathrm{C}^2}$ m=$m_0/\sqrt{1-\mathrm{V}^2/\mathrm{C}^2}$ $E=mc^2$	**A** **K** **U** **U** **U** **K** **A**
24.3 General Relativity	25.3.1 Describe the general relativity 25.3.2 Understand gravity as space time continuum	**U** **U**

UNIT-25 QUANTUM PHYSICS STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
25.1 Quantum Theory of Radiation	25.1.1 Describe the concept of black body radiation. 25.1.2 Describe how energy is distributed over the wavelength range for several values of source temperature.	**U** **U**

	25.1.3 Describe the Planck's hypothesis that radiation emitted and absorbed by the walls of a black body cavity is quantized. 25.1.4 Elaborate the particle nature of electromagnetic radiation 25.1.5 Solve problems using $E = \frac{hc}{\lambda}$	**U** **U** **U**
25.2 Photoelectric Effect	25.2.1 Describe the phenomenon of photoelectric effect 25.2.2 Explain Photoelectric Effect on the basis of quantum theory 25.2.3 Solve problems using $hf - \varphi = \frac{1}{2}mv^2$ 25.2.4 Identify data sources, gather, process and present information to summarize the use of the photoelectric effect in solar cells & photocells	**U** **U** **U** **K**
25.3 Compton Effect	25.3.1 Explain the particle model of light in terms of photons with particular energy and frequency. 25.3.2 Describe Compton effect qualitatively 25.3.3 Solve problems using $\Delta\lambda = \frac{h}{m_0 c}(1 - \cos\theta)$	**U** **U** **U**
25.4 Pair Production	25.4.1 Explain the process of pair production on the basis of conservation Laws	**U**
25.5 Annihilation of Matter	25.5.1 Describe conservation laws in the annihilation of matter.	**U**
25.6 Wave nature of particles	25.6.1 Describe the impact of de Broglie's proposal that any kind of particle has both wave and particle properties. 25.6.2 Describe the confirmation of de Broglie's proposal by Davisson and Germer experiment in which the diffraction of electrons by the surface layers of a crystal lattice was observed. 25.6.3 Explain how the very short wavelength of electrons, and the ability to use electrons and magnetic fields to focus them, allows electron microscope to achieve very high resolution. 25.6.4 Search and describe the role of electron microscope to study the micro structures and properties of matter.	**U** **U** **U** **K**
25.7 Uncertainty Principle	25.7.1 Describe uncertainty principle	**K**

UNIT-26 ATOMIC PHYSICS STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
26.1 Atomic Spectra	26.1.1 Describe and explain the origin of different types of optical spectra.	**U**
	26.1.2 Show an understanding of the existence of discrete electron energy levels in isolated atoms (e.g. atomic hydrogen) and deduce how this leads to spectral lines.	**U**
	26.1.3 Explain how the uniqueness of the spectra of elements can be used to identify an element.	**K**
26.2 Bohr Model	26.2.1 Describe Bohr's postulates of Hydrogen atom	**U**
	26.2.2 Derive an expression for quantized radii;	**A**
	26.2.3 Explain hydrogen atom in terms of energy levels on the basis of Bohr Model	**A**
	26.2.4 Determine the ionization energy and various excitation energies of an atom using energy level diagram	**U**
	26.2.5 Illustrate the significance of the hydrogen spectrum in the development of Bohr's model of the atom.	**A**
	26.2.6 Derive $1/\lambda = R_H [1/p2 - 1/n2]$.	**A**
	26.2.7 Solve problems using $1/\lambda = R_H [1/p^2 - 1/n^2]$.	**A**
26.3 X-Rays	26.3.1 Describe inner shell transitions	**U**
	26.3.2 Explain production and characteristics of X-rays based on inner shell transition;	**U**
	26.3.3 Describe properties and uses of X-rays	**K**
26.4 LASER	26.4.1 Explain the terms spontaneous emission, stimulated emission, meta stable states, population inversion and laser action.	**U**
	26.4.2 Describe the structure and purpose of the main components of a He-Ne gas laser.	**U**
	26.4.3 Identify the useful properties of laser light and give some examples of their uses.	**U**
	26.4.4 Identify the measures requirement for safe handling of lasers.	**K**

UNIT-27 NUCLEAR PHYSICS STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
27.1 Isotopes	27.1.1 Recall the composition of atomic nuclei	**K**
	27.1.2 Describe isotopes in detail	**U**
	27.1.3 Explain that an element can exist in various isotopic forms each with a different number of	**U**

	neutrons. 27.1.4 Explain the use of mass spectrograph to demonstrate the existence of isotopes and to measure their relative abundance.	**U**
27.2 Radioactive Decay	27.2.1 Explain the process of radioactive decay 27.2.2 State law of radioactive decay 27.2.3 Identify the spontaneous and random nature of nuclear decay. 27.2.4 Define the terms activity and decay constant and recall and 27.2.5 Solve problems using $A = \lambda N$ 27.2.6 Infer and sketch the exponential nature of radioactive decay 27.2.7 Describe the term half life and solve problems using the equation $\lambda=0.693/T_{1/2}$.	**U** **K** **U** **K** **A** **A** **U/A**
27.3 Mass Defect and Binding Energy	27.3.1 Define the terms unified mass scale, mass defect and calculate binding energy using Einstein's equation 27.3.2 Illustrate graphically the variation of binding energy per nucleon with the mass number.	**U** **A**
27.4 Nuclear Reactions	27.4.1 Determine the release of energy from different nuclear reactions. 27.4.2 Explain that atomic number and mass number conserve in nuclear reactions. 27.4.3 Describe energy and mass conservation in simple reactions and in radioactive decay. 27.4.4 Describe the phenomena of nuclear fission and fusion. 27.4.5 Describe the fission chain reaction 27.4.6 Describe the function of various components of a nuclear reactor. 27.4.7 Explain the basic principle of nuclear reactor. 27.4.8 Describe how the conditions in the interiors of the Sun and other stars allow nuclear fusion to take place and hence, how nuclear fusion is their main energy conversion process.	**U** **U** **U** **U** **U** **U** **K** **K**
27.5 Radiation Exposure	27.5.1 Show awareness about nuclear radiation exposure and biological effects of radiation. 27.5.2 Describe the term dosimetry. 27.5.3 Describe the use of radiations for medical diagnosis and therapy. 27.5.4 Explain the importance of limiting exposure to ionizing radiation. 27.5.5 Describe the examples of the use of radioactive tracers in medical diagnosis, agriculture and industry.	**K** **K** **U** **U** **U**

UNIT-28 PARTICLE PHYSICS STUDENTS LEARNING OUTCOMES		
Contents	**Students should be able to**	**Cognitive level**
28.1 The Standard Model	29.1.1. Describe the fundamental forces of nature and their field particles 29.1.2. Describe the key features and components of the standard model of matter including hadrons, leptons and quarks.	**U** **U**
28.2 Radiation Detectors	28.2.1 Describe the working principal, construction and use of Wilson Cloud Chambers **28.2.2** Describe the working principal, construction and use of GM counter	**U** **U**

PRACTICAL AND PROJECT WORK

Practical task, project work and experiments are carried out with expected to develop among the learners following skills:

A. Planning

B. Implementing and

C. Interpreting and concluding

Students are required to carry out practical work as an integral part of the course. They are advised to maintain a laboratory record book in which they record their practical work, the experimental arrangements used, the observations made and the analysis of these observations. Particular attention should be placed on the following:

1. Techniques

(i) Reading to the maximum accuracy of linear and angular scales; use of Vernier scales, timing by stopwatch or stop clock.

(ii) Accurate focusing and location of images.

(iii) Connecting up and checking electrical circuits from a circuit diagram, drawing a circuit diagram for a given simple circuit, already connected up.

(iv) Recognize hazards and adopt safety measures and respond to safety precautions.

(2) Information Handling

(i) Display of results in tabular and graphical form.

(ii) Translate information between graphical, numerical, algebraic and verbal forms.

(iii) Accurate plotting with suitable choice of scales.

(iv) Determine the slope, intercept and intersection for linear graph.

(v) Choose, by inspection, a straight line which will serve as the best straight line through a set of data points presented graphically.

(vi) Recall standard line form $y = mx + c$ and rearrange relationships into linear form where appropriate.

(vii) Understand and use of area below a curve where the area has physical significance.

Note: Use of centimetre graph be made compulsory.

(3) Procedures

(i) Making rough preliminary measurements and calculations where appropriate, e.g. assess the best range for accurate measurements, use an instrument of appropriate resolution, cooperate with other effectively describing the pattern of results and draw a valued conclusion.

(ii) Careful recording of all actual measurements made.

(4) Order of Accuracy

(i) Random and system errors.

(ii) Meaning of absolute and relative (or percentage) error.

(iii) Estimates of maximum error in simple cases.

(iv) Common-sense appreciation of orders of accuracy of common measurements (not merely of scale readings) and ability to quote results to a number of significant figures reasonably in keeping with their estimated accuracy.

(5) Error Estimates

(i) Rules for combination of maximum errors in the simple case; $x \pm y$, xy, x/y, x^n.

PRACTICAL EXPERIMENTS FOR GRADE-XI

1- Measure length and diameter of a solid cylinder and hence estimate its volume quoting proper number of significant figures using Vernier calipers.

2- Measure the diameters of a few ball bearings of different sizes using Screw Gauge and estimate their volumes. Mention the uncertainty in each result.

3- Determine the radius of curvature of convex lens and a concave lens using a spherometer

4- Verify the two conditions of equilibrium using a suspended meter rod.

5- Investigate the value of 'g' by free fall method using electronic timer.

6- Investigate the downward force, along an inclined plane, acting on a roller due to gravity and study its relationship with the angle of inclination by plotting graph between force and $\sin\theta$.

7- Verify that the time period of the simple pendulum is directly proportional to the square root of its length and hence find the value of 'g' from the graph.

8- Determine the value of 'g' by vibrating a metal lamina suspending from different points.

9- Determine the wavelength of sound in air using stationary waves and to calculate the speed of sound using resonance tube.

10- Determine the wavelength of light by using a diffraction grating and spectrometer

11- Determine the relation between current and capacitance when different capacitors are used in AC circuit using different series and parallel combinations of capacitors.

12- Determine time constant by charging and discharging a capacitor through a resistor.

13- Determine resistance of wire by slide Wire Bridge.

14- Determine resistance of voltmeter by drawing graph between R and I/V.

15- Determine internal resistance of a cell using potentiometer.

16- Determine emf of a cell using potentiometer.

17- Determine the emf and internal resistance of a cell by plotting V against I graph.

18- Investigate the relationship between current passing through a tungsten filament lamp and the potential applied across it.

19- Convert a galvanometer into voltmeter of range 0 – 3 V.

20- Observe the line spectrum of mercury with diffraction grating and spectrometer to determine the wavelength of several different lines, and hence, draw a conclusion about the width of visible spectrum.

APPARATUS & EQUIPMENT FOR GRADE-XI

1. Vernier Calipers, solid cylinder.
2. Micrometer screw gauge, ball bearings of different sizes.
3. Spherometer, a convex lens and a concave lens
4. Metre rod, wedge, two stands, set of slotted weights, two spring balances.
5. Free fall apparatus, steel ball, electronic timer with power supply, plumb line and metre rod.
6. Variable inclined plane fitted with pulley, roller, weights, pan, stopwatch
7. Simple pendulum, stopwatch, stand, thread, cork, Vernier calipers.
8. Metal lamina, iron stand, stopwatch.
9. Resonance apparatus, two tuning forks of known frequency, thermometer, plumb line, Vernier calipers, cork or rubber pad, two set squares, beaker and water.
10. 1mW He-Ne laser source, diffraction grating, drawing board, a white screen, meter rod.
11. Galvanometer, power supply or battery, large value capacitor, key, stopwatch.
12. Slide wire bridge, resistance box, unknown resistance, galvanometer, rheostat, cell, tapping key, connecting wires and sand paper.
13. Voltmeter, resistance box, two keys, sand paper, connecting wires and graph paper.
14. Voltmeter, power supply or battery, large value capacitor, key, stopwatch and slide wire bridge
15. Potentiometer, battery, ammeter, resistance box, rheostat, two keys, galvanometer, given cell, shunt wire, sand paper and connecting wires.
16. Potentiometer, battery, tow-way key, rheostat, ammeter, key, shunt, wire, galvanometer, sand paper and connecting wires.
17. Power supply or battery, voltmeter, ammeter, rheostat or resistance box or assorted resistors.
18. 36W, 12 volt car bulb, bulb holder, 12 volt battery, high resistance rheostat, voltmeter, ammeter, key, sand paper and connecting wires.
19. Galvanometer, ammeter, standard voltmeter, accumulator, resistance box, plug key, rheostat, sand paper and connecting wires.
20. Mercury lamp, spectrometer, diffraction grating

PLANNING, ANALYSIS AND EVALUATION FOR XII

Planning

Defining the problem

Candidates should be able to:

- identify the independent variable in the experiment
- identify the dependent variable in the experiment
- identify the variables that are to be kept constant.

Methods of data collection

Candidates should be able to:

- describe the method to be used to vary the independent variable
- describe how the independent and dependent variables are to be measured
- describe how other variables are to be kept constant
- describe, with the aid of a clear labelled diagram, the arrangement of apparatus for the experiment and the procedures to be followed.

Method of analysis

Candidates should be able to:

- describe how the data should be used in order to reach a conclusion, including details of derived quantities to be calculated and graphs to be drawn as appropriate.

Data analysis

Candidates should be able to:

- rearrange expressions into the forms $y = mx + c$, $y = ax^n$ and $y = ae^{(kx)}$.
- plot a graph of y against x and use the graph to find the constants m and c in an equation of the form $y = mx + c$
- plot a graph of log y against log x and use the graph to find the constants a and n in an equation of the form $y = ax^n$

- plot a graph of ln y against x and use the graph to find the constants a and k in an equation of the form $y = ae^{(kx)}$.
- decide what derived quantities to calculate from raw data in order to enable an appropriate graph to be plotted.
- calculate other quantities from their raw data
- use the correct number of significant figures for these calculated quantities following the conventions required for Paper 3. Where logarithms are required, units should be shown with the quantity whose logarithm is being taken, e.g. ln (d / cm). The logarithm itself does not have a unit.

Table of Results

Candidates should be able to:

- complete a table of results.

Graph

Candidates should be able to:

- plot a graph following the conventions.
- show error bars, in both directions where appropriate, for each point on the graph
- draw a straight line of best fit and a straight worst acceptable line through the points on the graph when the trend on the graph is linear.
- draw a curved trend line and a tangent to the curve where appropriate. The worst acceptable line should be either the steepest possible line or the shallowest possible line that passes through the error bars of all the data points. It should be distinguished from the line of best fit either by being drawn as a broken line or by being clearly labeled.

Conclusion

Candidates should be able to:

- determine the gradient and y-intercept of a straight-line graph or tangent to a curve
- derive expressions that equate to the gradient or the y-intercept of their straight lines of best fit
- draw the required conclusions from these expressions.

Treatment of Uncertainties

Candidates should be able to:

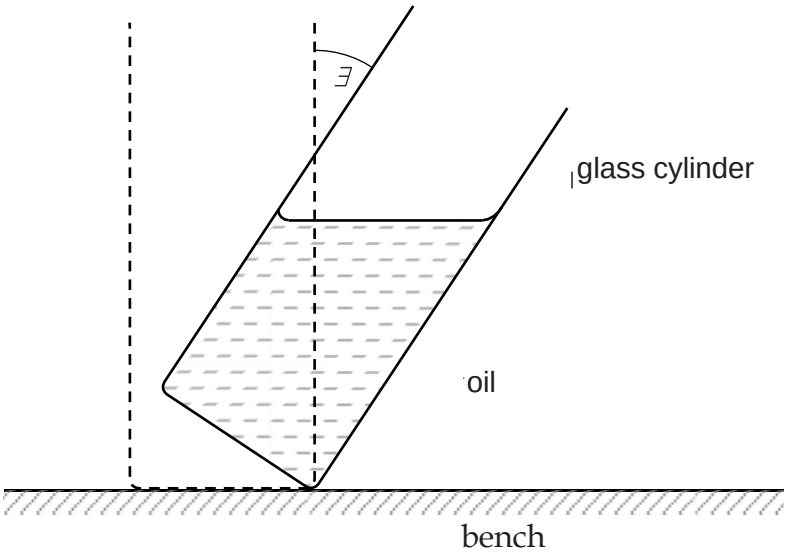
- convert absolute uncertainty estimates into fractional or percentage uncertainty estimates and vice versa
- show uncertainty estimates, in absolute terms, beside every value in a table of results
- calculate uncertainty estimates in derived quantities
- show uncertainty estimates as error bars on a graph
- estimate the absolute uncertainty in the gradient of a graph by recalling that absolute uncertainty = gradient of line of best fit – gradient of worst acceptable line
- estimate the absolute uncertainty in the *y*-intercept of a graph by recalling that absolute uncertainty = *y*-intercept of line of best fit – *y*-intercept of worst acceptable line
- express a quantity as a value, an uncertainty estimates and a unit.

Defining the problem	Methods of data collection	Method of analysis	Safety considerations	Additional detail

Examples related to Planning Analysis and evaluation
(Sample questions taken as example from Cambridge A level examination)

Example-1

A student is investigating the angle at which a glass cylinder containing oil topples, as shown in Fig.



A cylinder containing a mass m of oil can be tilted through a maximum angle ϕ from the vertical before it topples.

It is suggested that the relationship between m and ϕ is $\frac{1}{tan\emptyset} = \frac{am}{\rho d^3} + b$

where d is the diameter of the cylinder, ρ is the density of the oil and a and b are constants.

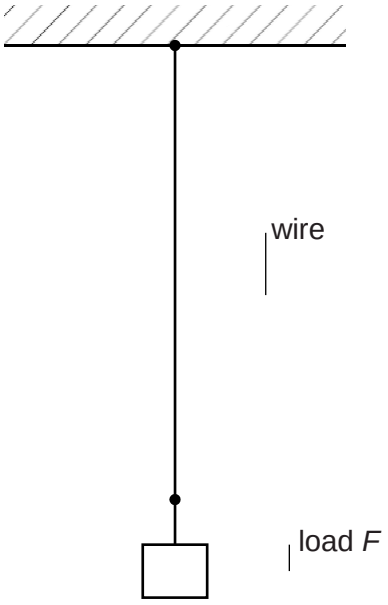
Design a laboratory experiment to test the relationship between ϕ and m.
Explain how your results could be used to determine values for a and b. You should draw a diagram, on page 3, showing the arrangement of your equipment. In your account you should pay particular attention to;

(a) the procedure to be followed,
(b) the measurements to be taken,
(c) the control of variables,
(d) the analysis of the data,
(e) the safety precautions to be taken.

Example -2

A student is investigating how the extension of a loaded wire depends on the diameter of the wire.

The apparatus is set up as shown in Fig.



A load F is applied to the wire and the extension e is measured.

The experiment is repeated for wires of the same material and same initial length L but different diameter d.

It is suggested that e and d are related by the equation $e = \frac{4LF}{\pi E d^2}$

where E is a constant.

(a) A graph is plotted of e on the y-axis against $\frac{1}{d^2}$ on the x-axis.

Determine an expression for the gradient.

(b) Values of d and e are given in Fig

d / 10^{-3} m	e / 10^{-3} m	
0.28 ± 0.02	11.3	
0.32 ± 0.02	8.6	
0.38 ± 0.02	6.0	
0.46 ± 0.02	4.1	
0.56 ± 0.02	2.7	
0.72 ± 0.02	1.7	

Calculate and record values of $\frac{1}{d^2}$ 0^6 m^{-2} in fig

Include the absolute uncertainties in $\frac{1}{d^2}$

(c) **(i)** Plot a graph of e / 10^{-3} m against $\frac{1}{d^2}$ 10^6 m^{-2}.

Include error bars for $\frac{1}{d^2}$

(ii) Draw the straight line of best fit and a worst acceptable straight line on your graph. Both lines should be clearly labeled.

(iii) Determine the gradient of the line of best fit. Include the absolute uncertainty in your answer.

(d) **(i)** Using your answers to **(a)** and **(c) (iii)**, determine the value of E. Include an appropriate unit.

Data: L = 2.50 ± 0.01 m and F = 19.0 ± 0.5 N.

OBJECTIVES OF ASSESSMENT

The objectives of the examination are to assess students for the following abilities, skills and attitudes:

Knowledge and Understanding
Students should be able to:

- Recognize and use physics terms and concepts accurately.
- Explain phenomena, laws and models.
- Show awareness of instruments and apparatus including techniques of operation and aspects of safety.

Application
Students should be able to:

- Apply knowledge including principles of physics to everyday and unfamiliar/ novel situations.
- Apply knowledge including principles of physics to selected phenomena and applications.
- Apply knowledge including principles of physics in problem solving and experimental investigation using quantitative, numerical, theoretical and practical techniques.

Analysis
Students should be able to:

- Discriminate between relevant and irrelevant information.
- Interpret the recorded data.
- Use information to identify pattern, draw inferences and conclusions.
- Critically analyze information
- Analyze and synthesize information for the purpose of identifying problems for inquiry and solving the problems using a variety of skills.

Evaluation
Students should be able to:

- Evaluate information and hypothesis
- Draw valid conclusions from physics data
- Make predictions and put forward hypothesis
- Evaluate the result of an experiment

Communication
Students should be able to:

- Locate, select and present information in an organized and logical sequence from a variety of sources
- Identify and express ideas in physics clearly and concisely.
- Translate information from one form to another.
- Compile, organize and interpret data, using appropriate formats and treatment, including tables, flow charts, graphs and diagrams.
- Discuss issues relating to the social, economical, environmental and technological implications of physics

Experimental skills and investigations
Students should be able to:

- Become acquainted with basic instruments and measuring techniques and acquire the ability to select method, plan experiment, use material safely and effectively.
- Make observation and measurements with due regard for precision, accuracy and units.
- Understand the effect of uncertainty in a measurement on the final result.
- Interpret and evaluate observations and experimental data.
- Present and translate experimental data graphically.
- Analyze and interpret information and observations obtained in scientific and practical work. Identify patterns and trends and draw valid conclusions.

Attitudes
Students should acquire:

- An appreciation of the role of experimental work in the field of science.
- Concern for accuracy and precisions in investigations and practical work.
- Inquisitiveness and interest in their study of physics.

LIST OF APPARATUS & EQUIPMENT FOR GRADE-XII

FOR A GROUP 40 STUDENTS

	Apparatus/ Equipment	Quantity
1.	Gravesend's Apparatus or Vector Table	10
2.	Hanger	10
3.	Slotted Weights	10
4.	Solid Cylinder	10
5.	Plane Mirror Strip	24
6.	Metre rod	20
7.	Protractor	20
8.	Metallic bob	10
9.	Set square	10
10.	Ticker tape	5
11.	Power supply (AC & DC)	10
12.	Electric stop clock	5
13.	Frequency meter	5
14.	Electromagnet	5
15.	Two-way switch	5
16.	Vernier Calipers	10
17.	Cork	1 pkt
18.	Stand with clamp	10
19.	Stopwatch	10
20.	Thread	5 spools
21.	Helical spring	20
22.	Slotted weights with hanger	20 sets
23.	Trolley	10
24.	Smooth plane wooden surface with adjustable screws	5
25.	Trolley weight (1 kg) set	10
26.	Ticker-timer	5
27.	Plasticine	5 pkt
28.	Resonance tube	10
29.	Glycerine	5 litre
30.	Steel ball bearings of different sizes	1 pkt

31.	Bar magnet	10
32.	Half kg. Slotted masses	5 sets
33.	Fly wheel	5 sets
34.	Meld's apparatus	5
35.	Rubber pad	10
36.	Tuning forks (480 & 512 Hz)	10
37.	Electric oscillator	10 each
38.	Sonometer	5
39.	Tubes (one sliding into other)	10
40.	Thermometer	10
41.	Iron stand with clamp	10
42.	Spectrometer	20
43.	He-Ne- gas laser	10
44.	CRO	5
45.	Microphone	5
46.	Diffraction grating	10
47.	Measuring tape	5
48.	Electric calorimeter	10
49.	Rheostat (low resistance)	10
50.	Rheostat (high resistance)	10
51.	Ammeter – (0-3A)	10
52.	Voltmeter (0-15V)	10
53.	Half degree thermometer	10
54.	Physical balance	4
55.	Weight box	4
56.	Meter bridge	10
57.	Galvanometer	10
58.	Dry cell	5 pkt
59.	Resistance box (high resistance)	10
60.	Resistance box (low resistance)	10
61.	Resistance box (fractional)	10
62.	Jockey	10
63.	Keys	10
64.	Thermistor	10

65.	Beaker (250, 500 cc)	10 each
66.	Screw gauge	10
67.	Potentiometer	10
68.	Car bulb with holder	10
69.	12 Volts Battery	2
70.	Plotting compass	12
71.	Capacitors (1 μ F - 8 μ F)	10 sets
72.	Two-way key	10
73.	Auto transformer	10
74.	Semiconductor diode	20
75.	Milli ammeter	10
76.	Micro ammeter	10
77.	NPN transistor	20
78.	Photo cell	10
79.	Wooden box	10
80.	Lamp	10
81.	Step-down transformer	10
82.	AC voltmeter	6
83.	Multimeter (digital)	6
84.	GM tube	2
85.	Scaler Unit	2
86.	Inclined plane with changeable inclination	6
87.	Steel Roller	6
88.	Metal Lamina	10
89.	Printing Screen Pieces (Used)	10
90.	Dice	150
91.	GM Point Tube	5
92.	Set of LEDs of different colours fitted on board	5
93.	Mercury Lamp	5
94.	Spherometer	10

ESTIMATED TIME ALLOCATION FOR GRADE-XI

PHYSICS XI

Sections	Units included	Weightage%	Period	Practical Work
General Physics	1. Physics and measurements	11	17	
Mechanics	2. Kinematics 3. Dynamics 4. Rotational and Circular Motion 5. Work, Energy and power 6. Fluid Statics 7. Fluid Dynamics	5 6 8 10 4 6	8 9 11 15 5 9	
Electricity	8. Electric Fields 9. Capacitors 10. D.C Circuits	11 3 10	16 5 15	
Waves and communications	11. Oscillations 12. Acoustics 13. Physical optics 14. Communication	7 8 8 4	11 11 12 6	

PHYSICS XII

Sections	Units included	Weightage%	Period	Practical
Thermal Physics	1. Molecular theory of gases 2. First law of thermodynamics 3. Second law of thermodynamics	5 5 6	7 8 10	
Magnetism	4. Magnetic Fields 5. Electromagnetic induction 6. A.C circuits	9 11 10	13 16 15	
Electronics	7. Physics of Solids 8. Solid State Electronics 9. Digital Electronics	7 10 2	11 15 3	
Modern Physics	10. Relativity 11. Quantum Physics 12. Atomic Physics 13. Nuclear Physics 14. Particle Physics	5 9 8 11 2	7 13 12 17 3	

GLOSSARY

Terms Used in Learning Outcomes/Assessment

It is hoped that the glossary will prove helpful to candidates as a guide, although it is not exhaustive. The glossary has been deliberately kept brief not only with respect to the number of terms included but also to the descriptions of their meanings. Candidates should appreciate that the meaning of a term must depend in part on its context. They should also note that the number of marks allocated for any part of a question is a guide to the depth of treatment required for the answer.

Define (the term(s) ...) is intended literally. Only a formal statement or equivalent paraphrase, such as the defining equation with symbols identified, being required.

What is meant by ... normally implies that a definition should be given, together with some relevant comment on the significance or context of the term(s) concerned, especially where two or more terms are included in the question. The amount of supplementary comment intended should be interpreted in the light of the indicated mark value.

Explain may imply reasoning or some reference to theory, depending on the context.

State implies a concise answer with little or no supporting argument, e.g. a numerical answer that can be obtained 'by inspection'.

List requires a number of points with no elaboration. Where a given number of points is specified, this should not be exceeded.

Describe requires candidates to state in words (using diagrams where appropriate) the main points of the topic. It is often used with reference either to particular phenomena or to particular experiments. In the former instance, the term usually implies that the answer should include reference to (visual) observations associated with the phenomena. The amount of description intended should be interpreted in the light of the indicated mark value.

Discuss requires candidates to give a critical account of the points involved in the topic.

Deduce/Predict implies that candidates are not expected to produce the required answer by recall but by making a logical connection between other pieces of information. Such information may be wholly given in the question or may depend on answers extracted in an earlier part of the question.

Suggest is used in two main contexts. It may either imply that there is no unique answer or that candidates are expected to apply their general knowledge to a 'novel' situation, one that formally may not be 'in the syllabus'.

Calculate is used when a numerical answer is required. In general, working should be shown.

Measure implies that the quantity concerned can be directly obtained from a suitable measuring instrument, e.g. length, using a rule, or angle, using a protractor.

Determine often implies that the quantity concerned cannot be measured directly but is obtained by calculation, substituting measured or known values of other quantities into a standard formula, e.g. the Young's modulus, relative molecular mass.

Show is used where a candidate is expected to derive a given result. It is important that the terms being used by candidates are stated explicitly and that all stages in the derivation are stated clearly.

Estimate implies a reasoned order of magnitude statement or calculation of the quantity concerned. Candidates should make such simplifying assumptions as may be necessary about points of principle and about the values of quantities not otherwise included in the question.

Sketch, when applied to graph work, implies that the shape and/or position of the curve need only be qualitatively correct. However, candidates should be aware that, depending on the context, some quantitative aspects may be looked for, e.g. passing through the origin, having an intercept, asymptote or discontinuity at a particular value. On a sketch graph, it is essential that candidates clearly indicate what is being plotted on each axis.

Sketch, when applied to diagrams, implies that a simple, freehand drawing is acceptable: nevertheless, care should be taken over proportions and the clear exposition of important details.

Compare requires candidates to provide both similarities and differences between things or concepts.

Acknowledgement: Extracted from Physics A/AS Level 2019 syllabus of Cambridge University, England

The purpose of assessment is to measure the extent to which students have achieved the learning outcomes of the programme based on these curriculum statements.
An external examination is recommended at the end of each year. The syllabus division is suggested as shown below:

The Examination

The theory examination is suggested to consist of two parts each containing a wide variety of types of questions. Together the paper should be designed to examine the candidates' under standing of the whole syllabus and should test the following range of abilities.

Knowledge of Physics	15%
Understanding and problem solving in Physics	40%
Analyzing, synthesizing and evaluation	25%
Communicating knowledge of Physics	20%

Paper - I (XI Physics Theory) **Half an hour 20%**	**Section I (20 Marks)** 20 compulsory objective questions. This may include MCQ of various types to evaluate abilities and skills as detailed in Assessment objectives From knowledge understanding and application
Paper - I **2½ hour Section-II** **CRQs 40%** **Section-III** **ERQs 20%**	This paper should consist of two sections. **Section II (40 Marks)** Student should attempt all questions Section II should contain at least eight constructed response questions **(CRQs)** to provide entire syllabus coverage and may **consist of variable marks** value to be answered in the space provided in the answer Booklet **Section III (20 Marks)** Section III should contain at least two extended response questions (ERQs) including numerical problems which may have a choice
Paper- II (XI Physics Practical Test (2 hours) 20%	This paper requires candidates to carry out practical work in timed conditions. The practical examination will consist of two experiments drawn from different areas of physics to test the experimental and investigating skills given in Assessment objectives
Paper - III (XII Physics Theory) **Half an hour 20%**	**Section I (20 Marks)** 20 compulsory objective questions. This may include MCQ of various types to evaluate abilities and skills as detailed in Assessment objectives From knowledge understanding and application

Paper – III (XII Physics Theory) **2½ hour Section-II** **CRQs 40%** **Section-III** **ERQs 20%**	This paper should consist of two sections. **Section II (40 Marks)** Student should attempt all questions Section II should contain at least eight constructed response questions **(CRQs)** to provide entire syllabus coverage and may **consist of variable marks** value to be answered in the space provided in the answer Booklet **Section III (20 Marks)** Section III should contain at least two extended response questions (ERQs) including numerical problems which may have a choice
Paper- IV (XII Physics Planning, Analysis and Evaluation (2 hours) 20%	This paper requires candidates to carry out two questions of equal mark value based on the practical skills of planning, analysis and evaluation. The context of the questions may be outside the syllabus content, but candidates will be assessed on their practical Skills of planning, analysis and evaluation rather than their knowledge of theory. Candidates will answer both questions.

ASSESSMENT METHODS

1. The **selected response -** students select the answer to a question from two or more given choices. Such items are easy to develop. Their short response time allows more information to be assessed in a short time. However, since answer choices are provided, students can guess the correct answer without knowing the material. Scoring is quick and objective, since the teacher need only check if the single correct or best answer was identified for each item.

2. A **constructed response** format requires students to create or produce their own answer in response to a question or task. This allows teachers to gain insight into students' thinking and creative processes, and to assess higher order thinking. However, such items are time-consuming to answer and score. Although they eliminate guesswork, scoring is more subjective and thus clear criteria are necessary to maintain validity.

Essay Items may have students construct restricted-responses that limit the length, content and nature of the answer; or extended-responses that allow greater freedom in response.
Performance assessments require students to construct a more extensive response to a well-defined task, often involving real-world application of knowledge and skills.

GUIDELINES FOR AUTHORS

An important dimension of curriculum is the translation of learning experiences or contents at the proper cognitive level of the target students. It is highly technical and delicate task to assist both teachers and students in learning and transmission of the life experiences. The concept to be introduced be explained informally before providing the formal definition or statement along with tangible examples from real life situation. The solved examples and the exercises should cover the whole range of variety of questions and their applications in the everyday life, science and technology. Keeping this strategy in view, the author should observe the following guidelines while writing the textbooks.

1. Learning objectives expected to be achieved in each chapter should be prominently stated at the beginning of the chapter.
2. Headings and sub headings should be clearly indicated.
3. Key words, terms and definitions should be highlighted in the text.
4. Concepts, application and relationships should be developed from concrete to abstract or simple to complex. Provide transition from previous information covered and new information presented.
5. The intended level and scope of treatment of each content/concept is defined by the desired learning outcomes identifying learning abilities, Investigation Skills/ Laboratory work and relevance with science, technology and society (STS). The intended learning outcomes mentioned under STS should preferably be developed through novel questions or numerical problems on real life situations.
6. The language used in the text should be concise and simple, consisting of short sentences using active tone and should be understandable to the students independently.
7. Ensure gender equity, textual matter urban/rural oriented and relevant to daily life.
8. The text should be supported with art i.e. illustrations and photographs possibly in colour which should be clear, properly labelled and captioned to make the substance interesting and stimulating.
9. Concepts, information and examples should match the sequence and content of learning outcomes.
10. The text should be free from material repugnant to Islamic and Pakistani Ideology.
11. Examples and applications from local environment should be preferred.
12. SI units and terminology should be used all over in the text. However, conversion tables with other units can be given as additional information. Uniformity be maintained in symbolic representation of physical quantities and values of constants throughout in the text and in numerical problems.
13. Answers to the numerical problems should be quoted in scientific notation with correct number of significant figures and units.
14. Solved numerical examples and end of chapter numerical problems should be based on variety of situations in novel manner and be related to local environment, culture and real-life situations.
15. Boxed "Tid bits", "interesting information", "do you know", and "point of ponder" may be given to highlight additional information along with the description of

concepts particularly related to STS connection through inquiry process.

16. Interesting sidelights such as case studies, discoveries, related technologies etc. may be given in the form of "boxed essays".
17. Tables, flow charts/diagrams and concept maps may be given wherever appropriate.
18. Reference of the experiments given in the practical manual should be made with the related topics given in the text.
19. Coherent and precise summary should be given at the end of each Unit.
20. MCQS and Structured Questions should be given at the end of each Unit. They should test not only knowledge but particularly the higher abilities such as understanding, handling information, analyzing, application of ideas and solving problems and relevant Investigation Skills/ Laboratory work and processes.
21. Self-Assessment Questions should be given at the end of each content of unit.
22. All questions should be very appropriately and clearly worded/constructed to test varying abilities and Investigation Skills on the basis of Bloom's taxonomy.
23. The amount of information to be covered by the must match the number of hours of instructional time.
24. A comprehensive glossary of terms and index should be given at the end of the book.
25. The teachers guide and workbooks should also be developed alongwith textbook which should include suitable strategies that a teacher can adopt for teaching a particular topic and should contain instructions how to explain a topic and how to show relevant demonstration.
26. A practical manual for the students should also be written to support practical work.

TEACHING METHODOLOGIES AND STRATEGIES

Effective and efficient delivery of knowledge is the main objective. There is a need to bring a paradigm shift in the process of teaching and learning by adopting the most modern teaching tools and techniques. The directive model is to be gradually replaced by the interactive and participative model, making a student an active learner. In addition to classroom lecturers, seminars, workshops, tutorials, study circles, presentations, case studies, investigating and mini projects and other similar techniques can be combined to achieve the objectives.

Be informed that physics should not be taken as a collection of facts, and teaching of Physics should not emphasize memorization of formal statements by rote, mechanical solution of problems by formulate or carrying out routine measurements by following given detailed instructions.

To present physics in a lively, exciting and intelligible way, emphasis should be placed on teaching for understanding by organized investigation, learning and discussion. A good demonstration can be used to stimulate learning. It is intended that consideration of everyday industrial and technological applications should pervade the course. Social, economic and environmental issues should also be considered where appropriate.

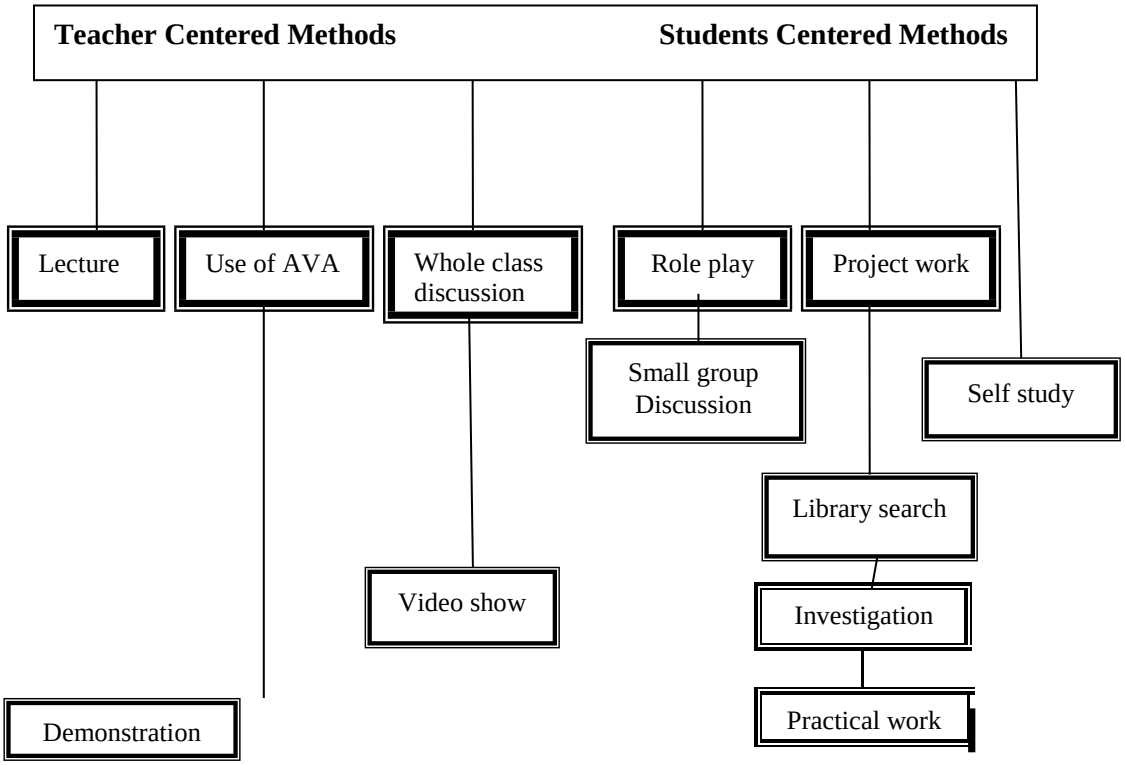
Quantitative treatment is a feature of physics. However, teacher must keep the emphasis on the understanding of the physical interpretation of theoretical formulate and experimental data.

An investigation approach to practical work is essential. Individual student project promotes creativity and demonstrate the students mastery of scientific principles involved. Independent use of apparatus by the students develop manipulative skills. The development of psychomotor skills such as correctly manipulating various instruments is an important objective of physics course.

Practical work is essential for students to gain personal experience of physics through doing and finding out. Another important objective of science teaching is to develop attitude of thinking in students. Teachers are encouraged to design their lessons in such a way that suitable questions and activities are incorporated in order to develop various types and levels of thinking in students, including analysis, evaluation, critical thinking and creative thinking.

Teachers capable in content areas may opt the teaching strategy that matches with psychology of the students. The strategy like posing problems, discussion, investigations, and solving the problems with the involvement of the students may provide an ample opportunity in conceptual clearance of a content.

Generally speaking, student centered and interactive approaches are useful in providing suitable learning experiences for stimulating and developing higher level thinking and are highly recommended. Teachers may consider to adopt a variety of strategies from the following spectrum which ranges from very teacher-centred methods to very students centred methods.



Spectrum of Teaching Methods

Teachers should choose appropriate teaching methods in accordance with the topic/skill to be taught as well as the interest and abilities of their students. The following are some factors to be considered when deciding on the teaching method for a particular topic.

- Learning objectives to be achieved
- Ability of student;
- Subject matter;
- Availability of resources; and
- Amount of time available

Role of E-media: Knowledge and technology needs to be shared freely on electronic media. It is time to look to the potential of ICT and digital technology beyond just the traditional technological sense.

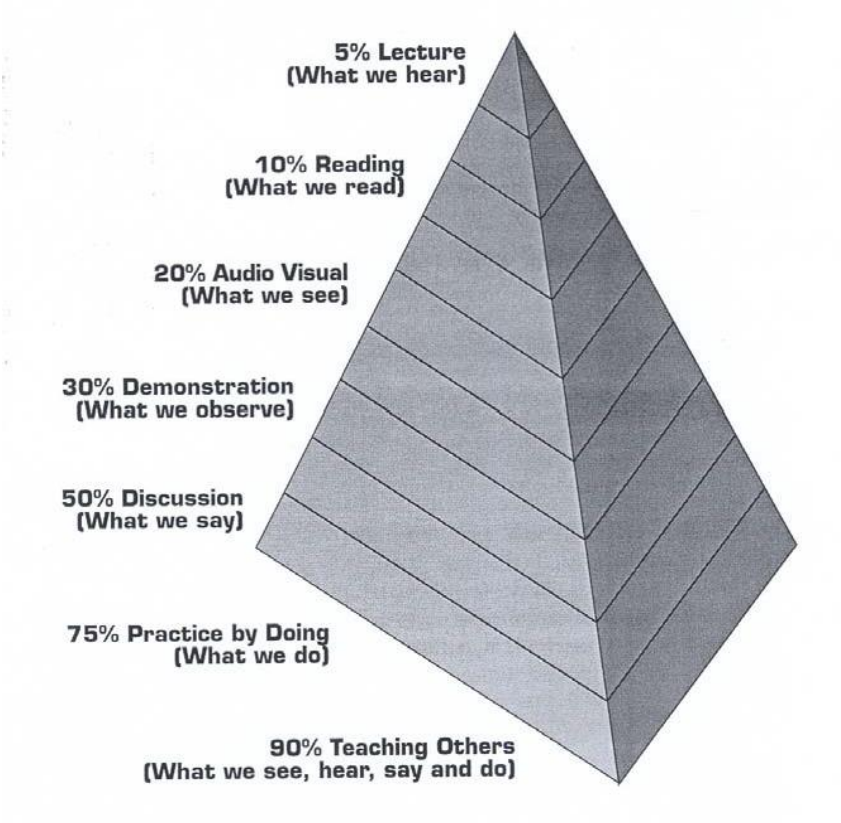
TEACHING / INSTRUCTIONAL STRATEGIES

Evidence from most Pakistani classrooms indicate that teaching and learning follows what Freire (1970) calls "The banking concept of education" in which teachers "transmit" textbook facts to students who are expected to memorize and regurgitate these facts in examinations. This practice has become so ingrained because teachers have themselves, as students, learned in this way, have been trained in this way, and have

found that the methods of lecture and recitation (teacher asks questions and student answers) are a good way of teaching the large number of students in their classrooms and assessing students ability to memorize textbook facts to ensure they do well in examinations.

There are many reasons for using instructional strategies other than lecture and recitation. First, research shows that students learn very little (5%) when taught through the lecture method. However, as their active intellectual engagement in the learning process increases they retain more of their learning. Second, living in the information age where knowledge is growing exponentially and facts are available at the click of a button students need to learn "how to learn". Third, many instructional strategies besides facilitating students' academic learning also aid development of a number of skills and values and promote their psychological health preparing them for the varied roles they will play in today's society. Finally, in any class of students there will be a range of interests, abilities and styles learning. Varying the teaching strategies will address these differences allowing all children to learn.

The Learning Pyramid: Outcomes for Traditional Learning Methodology vs. Outcomes for Active / Experiential Learning Methodology



This section begins with the lecture methods as teachers are most familiar with and suggests ways to encourage students' participation in a lecture to improve learning.

EFFECTIVE LECTURING STRATEGY

A lecture is method in which, the teacher transmits ideas, concepts and information to the students. A lecture allows teachers to transmit knowledge and explain key concepts in a limited time to a large group of students. The lack of active intellectual engagement by students could make the lecture boring so that students lose interest which hinders learning. Lecturing spoon-feeds the students without developing their power of reasoning. However, if used with different activities and exercises that call for students participation, the lecture can stimulate students intellectually and facilitate learning.

Developing an effective lecture

To deliver an effective lecture, the teacher must plan it. First, the teacher should identify the purpose of the lecture. The procedure of the lecture will follow from the purpose. If the purpose is to introduce new knowledge and concepts, the teacher can structure it in the classic way. However, if the purpose is to make students aware of different approaches to a particular problem, then the problem-oriented structure can be used.

In a classic lecture structure, the teacher outlines the purpose of the lecture and the main themes/subtopics that will be covered. Each theme/subtopic is then explained with examples. At the end, the teacher summarizes each theme/subtopic and concludes the lecture. A lecture can be made more effective by the use of diagrams, photos, graphics, etc. using charts, an overhead or multimedia projector.

In a problem-oriented lecture, the teacher states the problem and then offers one positive solution followed by a discussion of the weaknesses and strengths of the solution. Then he/she continues with the second solution and discusses its strengths and weaknesses. At the end, the teacher makes some concluding remarks.

Some ways to make a lecture interactive

Posing questions

In order to keep students engaged in a lecture, ask a question at the end of each theme/subtopic. This activity requires students to quickly process and use newly presented information to answer the question or solve the problem. Following the question give time to the students to come up with the answer, call on a few students to share their answers, sum up and move on. Some students out of fear of giving an incorrect response may not answer. To increase students participation use the Think-Pair-Share strategy; students think individually, share ideas with a colleague and then with the class. Sum up responses and move on. Alternatively, use Buzz groups. Buzz groups are small groups of three to five students who discuss the question before answering. Clear instructions regarding what to do, for how long and what is expected at the end of 'buzzing' must be given. After groups 'buzz', randomly choose students from 2-3 buzz groups to share their groups' discussion points or solutions. Sum up and move on.

Inviting students' questions

Before the lecture ask students if to share questions they want answers to and tailor lecture to answer them. Encourage students to ask questions on completion of each

theme/subtopic. Students' questions can be answered by the teacher or directed to the students inviting them to answer.

Assessing students' learning from a lecture

Students' learning can be assessed by asking students to answer questions orally or fill in a 'one-minute' worksheet which asks them to write down the 2-3 most important things they learnt in the lecture. Alternatively, students' notes on a lecture can be reviewed. A few days later a test could be given to find out what students learnt.

CONDUCTING INTERACTIVE DEMONSTRATIONS

In-class demonstrations have been considered a very important part of teaching science. Demonstrations can certainly make science classes fun and entertaining, and can also stimulate students' interest and curiosity. However, despite these positive aspects of demonstrations, there is a growing body of evidence suggesting that traditional in-class demonstrations are not very effective in promoting conceptual understanding. One important factor is the lack of active participation and interaction of students during demonstrations. Recent research studies indicate that students who saw traditional demonstrations in a course fared no better than students who did not see the demonstrations. The data do suggest, however, that there is at least a small improvement in performance when students have to predict the outcome of a demonstration before seeing it. Based on these and other studies, it has become increasingly clear that some form of interactive engagement is essential to maximize the effectiveness of classroom demonstrations.

Preparation

1. Determine the purpose of the demonstration and what you want to achieve.
2. Conduct the demonstration yourself to ensure the results are as you want.
3. Prepare curricular materials or worksheets and ensure they are designed to promote student-student as well as student-teacher interaction in the classroom.
4. The problem-dissection technique is used to break a given demonstration into several conceptually linked mini-demonstrations.
5. The mini-demonstrations are presented as a sequence in a pre-determined order. Breaking down the main demonstration into smaller component demonstrations is very effective in helping students construct a deeper understanding of physical concepts through step-by-step confrontation with their alternate conceptions.
6. We utilize techniques (such as the use of flashcards, show of hands, for acquiring immediate feedback from all the students in the class).
7. Ask a question and have students predict the outcome of the demonstration by providing a response or selecting a response. They may provide or select a response before and/or after talking to their neighbours. For example, if we are exploring freely falling objects the question could be:

A one-rupee coin and five rupees coin are dropped simultaneously from the same height. Which one will hit the floor first?

A. One-rupee coin will hit the floor first.
B. Five rupees coin will hit the floor first.

C. Both hit the floor at the same time.
D. I am not sure/ I don't know.

8. Perform the demonstration
9. Once the first demonstration is complete have students complete their worksheet activities. Note: An interactive demonstration like the one described could be made up of a number of conceptually linked mini-demonstration to address important conceptual issues associated with free-fall and worksheet activities requires students to write predictions, draw motion diagrams and answer a set of multiple-choice questions.
10. Conduct a whole class discussion. Where necessary provide explanations to clarify or extend learning.

DISCUSSION

Discussion is a unique form of group interaction where students join together to address a topic or questions regarding something they need to understand, appreciate or decide. They exchange and examine different views, experiences, ideas, opinions, reactions and conclusions with one another during the discussion. There are several benefits of discussion. Students increase their knowledge of the topic; explore a diversity of views which enables them to recognize and investigate their assumptions in the light of different perspectives; develop their communicative competence, listen attentively, speak distinctly and learn the art of democratic discourse.

Conducting a discussion

Preparation for discussion

Plan carefully by reviewing the material and choosing a question or a problem on a topic, framing it as interrogative question instead of a statement or a phrase. It is important that students have some knowledge of the topic chosen for discussion. Good ways of ensuring this are; asking students to read on the topic, interview concerned individuals, and engage in observation.

Conducting the discussion

Rearrange the classroom or move to another place (lab, playground) so students can sit in a circle or semicircle as it promotes better interaction between the students. Start by presenting the question orally and in writing it on the board to enable students to read and understand the question. Give students time to think and note down ideas in response to the question. Indicate the start of the discussion by repeating the question. While students share their own views and experiences or refer to their readings write down some answers so as to track and guide the discussion. During the discussion, ask probing questions such as “Why do you think?” “Can you elaborate further?” Or draw a conclusion and raise a new but related question. Give students the opportunity to participate and contribute to the discussion.

Concluding the discussion

Conclude the discussion by summarizing all the ideas shared and identifying questions for further inquiry or discussion. Summaries should be short but accurate.

Assessing students learning from a discussion

The knowledge, skills and values developed through discussion can be assessed using different assessment strategies. Use a checklist to record the presence or absence of desired behaviours such as presentation of factual research-based information, seeking clarifications, extending a idea presented, questioning one's assumptions, listening attentively, communicating clearly and openly and respecting others. Based on data the teacher can give feedback to the students for improvement. If the purpose is to assess students' knowledge and understanding, students could be asked to write an essay on the topic or answer test questions.

INQUIRY/INVESTIGATION

Inquiry/investigation is a process of framing questions, gathering information, analyzing it and drawing conclusions. An inquiry classroom is one where students take responsibility for their learning and are required to be active participants, searching for knowledge, thinking critically and solving problems. Inquiry develops students' knowledge of the topic of investigation inquiry, skills of questioning, hypothesizing, information gathering, critical thinking and presentation. They are also disposed to engaging in inquiry, open-mindedness and continuing their learning.

Teaching students to conduct an inquiry investigation

There are two main types of inquiry: knowledge-based inquiry and problem-based inquiry/investigation. Knowledge-based inquiry enables students to enhance their knowledge and understanding of content. Problem-based inquiry/investigation encourages study of social and scientific problems. If the study could lead to social action work with students to engage in responsible action.

There are a number of steps in conducting an inquiry/investigation. Each step is described below and an example of a knowledge inquiry and scientific investigation is provided below:

1. Choose a topic and have students frame inquiry questions(s) based on the topic or plan an investigation by developing materials yourself.
2. Have students formulate a hypothesis, i.e. provide possible explanations or educated guesses in answer to the questions.

3. Help students plan the inquiry. For example:

- What is the best place to find information on the topic/What is the best way to gather data to solve the problem?
- How to allocate time?
- Whom to consult.?

4. Help students locate information/gather data.
5. Have students record information as they find it.
6. Help students evaluate their findings and draw conclusions. Students should look for relationships in the information gathered, analyze the information and try to answer of the inquiry question.
7. Have students communicate their findingsin creative ways, written, oral and visual. For example, as a poster, article, talk show, role-play, etc.

8. Encourage student to suggest possible action based on findings. Select actions that are doable. Look at possible consequences of each action. Choose the bestaction.

9. Make an action plan and carry out the action.

10. Reflect on the success/challenges of the action.

Assessing learning from an inquiry/investigation

The process as well as products of an inquiry. Investigation must be assessed through the following:

- **Observation:** Students' abilities and skills can be observed during each stage of the inquiry/investigation. For example, you can observe a student conducting an interview, looking for relevant information in the library or making a graph. Teachers can provide detailed descriptive feedback to the students on their abilities and skills observed.

PROFESSIONAL DEVELOPMENT OF TEACHERS

Physics should be visualized as a vehicle to train a child to think critically and to articulate logically. It is a subject that is closely related to our society and environment. Students need to develop an awareness of the impact and role of physics in society and the environment and the interconnections between science, technology and society to live effectively in a world that is becoming increasingly scientific and technological.

An effective and meaningful physics education can only be ensured if the teacher, the key pivot of the change, is developed enough in contents as well as methodology. A teacher who has a sound knowledge of the subject, and adapting child- centered approach can do the justice to his profession by providing meaningful learning while poor delivery may cause disappointment, disenchantment and promote rote- learning.

Pre-service and in-service training may help the teachers to become familiar with a variety of strategies for successful delivery of the curriculum. In-service training providing exposure and sharing teaching-learning experiences will indeed help in developing the teaching force. During the course of training the teachers be posed open-ended problems related to real life situations for exploiting their potential and enhancing their interest and capabilities. The major purposes of in-service training in helping the teachers are to:

a. improve teaching skills
b. be aware of new innovations and strategies
c. develop ability to conduct action research and
d. enhance capability to specialize in specific subject

The curriculum development is a continuous process in all stages of education so is the process of updating the teacher education programmes at pre- service as well as at in-service stages. Probably, the changes in teacher training require greater insight and in-depth appreciation of all other changes to make these programmes more effective. If the teacher is not fully equipped and trained to handle the new curricula, the curriculum transaction would not be appropriate and consequently, the learning in school will be inadequate. Teacher education institutions (pre-service) have to continuously update their understanding of the curriculum process as well as the demands and expectations from the community on the educational system. The training stages have to be governed by both these considerations. The teacher is, however, no longer a mere transector of curriculum in the classroom, but its developer as well. Teaching Physics is replaced by learning physics, learning by doing, activity methods, child centred approach and others efforts are to be made to link it to the individual's life and his environment. Teacher's training needs the following actions:

1. Pre-service teacher training institutions be strengthened and their curricula be revised to meet the demands of fast changing and developing world.

2. In-service training is imparted in a number of ways. Workshops, seminars and extension lectures be organized more frequently and regularly and particularly in summer vacation. In-service training includes training in contents and methodology. Practicing a tested methodology alone may not help much. Hence, content up-grading in the subject of physics has been realized as an urgent need for effective teaching of physics.

Emphasis should specifically be laid on learner- centered and activity based approaches. Laboratory practices, classroom demonstration, active participation by the students whenever possible, and field interactions should become major components of the course.

3. The performance of participants in the courses of in-service training be monitored in the field and linked with their advancement in career.

4. A resource center at the training institutions be established for a ready help to the needy teachers. With the advent of electronic technology, the print matter is now receiving a lot of support from audio visual inputs. This needs to be exploited for the in-service of teachers. Lectures/demonstrations of eminent teachers could be prepared and made available for resource centres. The whole strategy will offer an opportunity of getting to interact with the best of learning materials for professional up-lift. Aids of all sorts are meant only to help in teaching and not to act as a substitute for teaching nor to replace the teacher. Aids make teaching realistic and effective, and these aids are meant to supplement the teaching. The effectiveness of the use of aids depends upon the skill of the teacher who has to examine the necessity and suitability of the aids.

5. A question bank be prepared which may consist of question based on Bloom's Taxonomy for assessing various abilities and skills.

6. A monthly publication of a journal can support instructional methodology/demonstrations, sharing teaching-learning experiences and other curriculum issues. Students' exposure to a wide variety of articles will also serve the purpose of broadening and enriching the curriculum. Students should be encouraged independently to read and write articles, popular essays on a variety of topics so that they can develop the ability to interpret, analyse and communicate scientific information.

Physics is a way of knowing, a process for gaining knowledge and understanding of the natural world. The course is designed to produce an integrated set of Learning Outcomes for students. As described in these, students will:

- Use science process and thinking skills.
- Manifest science interests and attitudes.
- Show an understanding of important science concepts and principles.
- Communicate effectively using science language and reasoning.

Coherent:
The Course has been designed so that, wherever possible, the science ideas taught within a particular class have a logical and conceptual linkage with each other and with those of earlier classes. Efforts have also been made to select topics and skills that integrate well with one another and with other subject areas appropriate to class level. In addition, there is an upward articulation of science concepts, skills, and content. This spiraling is intended to prepare students to understand and use more complex science concepts and skills as they advance through their science learning.

Outcome Based:
In order to specify the syllabus as precisely as possible and also to emphasize the importance of higher order abilities and skills, other than recall, learning outcomes have been used throughout. The intended level and scope of treatment of a content is defined by the stated learning outcomes with easily recognizable domain of (i) recalling, (ii) understanding, (iii) applying, (iv) analyzing, (v) evaluating and (vi) creating.

Cognitively Appropriate:
The Course takes into account the psychological and social readiness of students. It builds from concrete experiences to more abstract understandings. The course resists the temptation to describe abstract concepts at inappropriate class levels; rather, it focuses on providing experiences with concepts that students can explore and understand in depth to build a foundation for future science learning.

Encourages Interactive Teaching Practices:
It is difficult to accomplish the full intent of the Course by lecturing and having students read from textbooks. The Science Course emphasizes student inquiry. Science process skills are central in each standard. Good science encourages students to gain knowledge by doing science: observing, questioning, exploring, making and testing hypotheses, comparing predictions, evaluating data, and communicating conclusions. The Course is designed to encourage instruction with students working in cooperative groups.

Comprehensive:
Due care has been taken that the syllabus is not heavy and at the same time, it is comparable to the international standards. Overlapping of concepts within the discipline and with other disciplines have been eliminated to make room for contemporary core topics and emerging curricular areas.
The course provides a comprehensive background in science by emphasizing depth rather than breadth. The course seeks to empower students rather than intimidate them with a collection of isolated and forgettable facts.
Apart from need assessment, aims, objectives, core syllabus, the curriculum document also contains:

(i) Chapter/unit wise weighting and time frame.
(ii) Assessment objectives, glossary and examination pattern.
(iii) List of standard practicals alongwith required equipment and a comprehensive list of equipment for a standard laboratory.
(iv) General Instructions to authors.
(v) Teaching strategies/methodologies.
(vi) Suggestions for professional training/ capacity building of teachers.
(vii) Implementation strategy.

Relevant:
The curriculum is harmonized with the national aspiration and needs. It is in consonance with the revised scheme of studies. The curriculum relates directly to student needs and interests. It is grounded in the natural world in which they live. The relevance and significance of concepts to students everyday life is given under the subhead "Science, Technology and Society" connections in every unit.

Character Builder:
Value for honesty, integrity, self-discipline, respect, responsibility, punctuality, cooperation, consideration, and teamwork are emphasized as an integral part of science learning. These relate to the care of living things, safety and concern for self and others, and environmental stewardship.

Effective, Flexible and Enjoyable:
Science instruction can cultivate and build on students' curiosity and sense of wonder. Effective science instruction engages students in enjoyable learning experiences. In a world of rapidly expanding knowledge and technology, all students need to gain the skills they will need to understand and function responsibly and successfully in the world. The Course provides skills in a context that enables students to experience the joy of doing science.

Encourages Thinking and Problem-Solving Based Assessment:
Student achievement of the standards and objectives in this Course is best assessed using a variety of assessment instruments. Performance tests are particularly appropriate to evaluate student mastery of science processes and problem- solving skills.

REVIEW COMMITTEE

PROVINCIAL TEXTBOOK & CURRICULUM REVIEW TEAM PHYSICS GRADE IX-XII

The following members of 'Provincial Review Committee for Physics Curriculum Grade (XI-XII) curriculum and assessment experts, working teachers and co-opted members participated in the orientation, discussions, workshops and review meeting.

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GOVERNMENT OF SINDH
SCHOOL EDUCATION & LITERACY DEPARTMENT
Karachi, dated: 20th November, 2019

NOTIFICATION

School Education & Literacy Department, Government of Sindh is pleased to notify the reviewed Curriculum for Grade XI and XII for the subjects of Sindhi, Biology, Physics, Chemistry, English Literature and Computer Science, Ethics for Grade III and IV, Computer Science for Grade IX and X developed by the Directorate of Curriculum, Assessment & Research (DCAR).

(-AHSAN ALI MAANGI-PAS)
Secretary to Government of Sindh

NO: SO (G-III) SELD/3-910/18 Karachi, Dated: 20th November, 2019

Copy is forwarded for information and necessary action:

1. The Chairman, Sindh Textbook Board, Jamshoro.
2. The Director, Directorate of Curriculum, Assessment & Research, Jamshoro
3. The Chief Program Manager, Reform Support Unit (RSU), Karachi.
4. The Chief Advisor, School Education & Literacy Department, Karachi.
5. The P.S to Secretary School Education & Literacy Department, Karachi.
6. Office Order File.

SECTION OFFICER (G-III) 20/11/2019