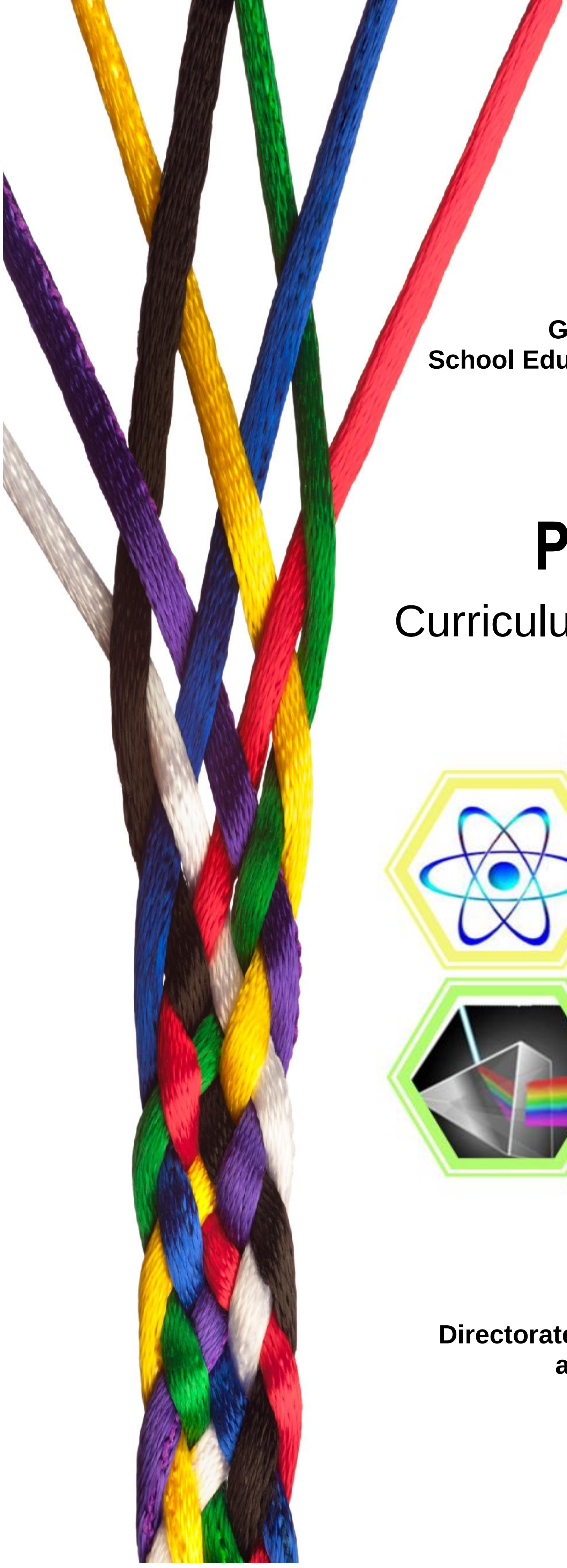
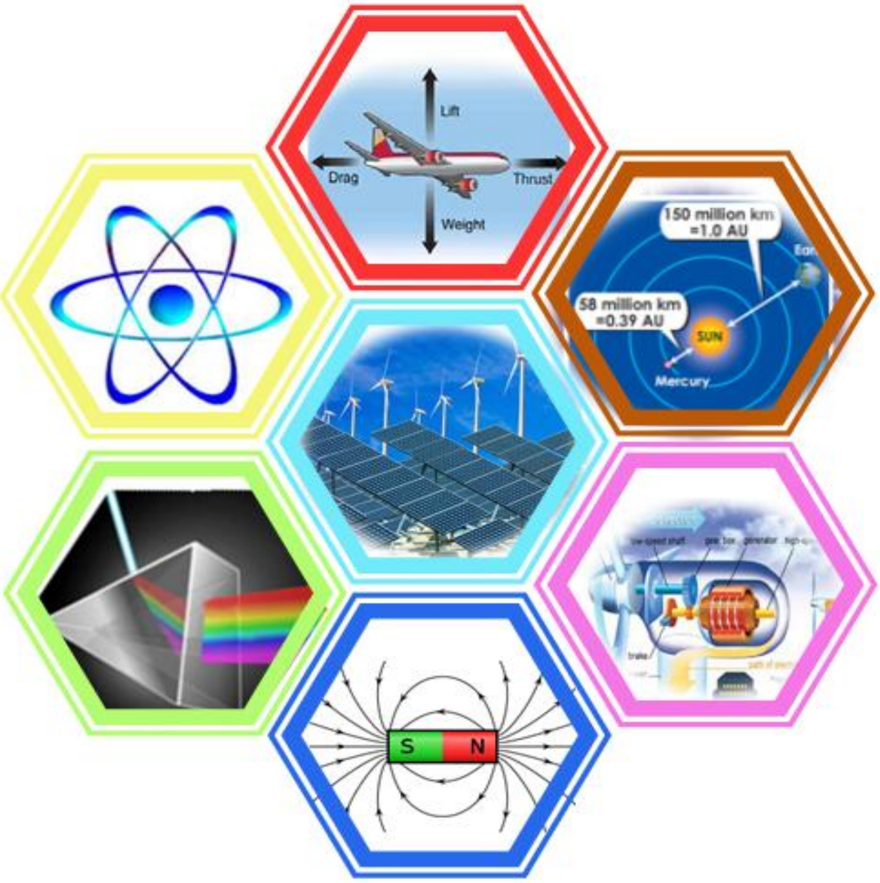


Government of Sindh
School Education & Literacy Department

PHYSICS

Curriculum for Grades IX – X



Directorate of Curriculum, Assessment
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2018

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Government of Sindh

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PHYSICS

Curriculum for Grades IX – X

Table of Contents

PART – I INTRODUCTION

The secondary school education is crucial and challenging, being a transition level from general science to discipline based curriculum. At this 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. Hence, there is a need to provide the learners with sufficient conceptual background of physics which would eventually make them competent to meet the challenges of academic and pre-professional courses after the secondary level.

RATIONALE

The present effort of revising and updating the physics curriculum is an exercise based on the feedback received on the curriculum and course material in vogue, expansion of frontiers of physics knowledge, a paradigm shift due to emerging trends of teaching - learning process towards interactive and participative approach, making a student an active and independent learner.

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 the 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 eliminating overlapping of concepts within the discipline of physics or with other disciplines making room for contemporary core topics and emerging curricular areas. 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 given to promote process-Investigation Skills/ Laboratory work, problem-solving abilities and application of concepts, useful in real life situations for making physics learning more relevant, meaningful and stimulating.

CURRICULUM DEVELOPMENT STRATAGEM

Formation of Curriculum Development Team comprising of Experts from diverse areas of education such as Subject Specialists of training college, higher secondary schools, Provincial Institute of Teacher Education (PITE), technical person from Directorate of Curriculum, Assessment and Research, Sindh Jamshoro, College and University Teachers.

1. Consultative meeting with students / working teachers, professors to get feedback and comments on existing curriculum.
2. The need assessment by critically reviewing of current curriculum, extensive field survey to seek feedback/ comments from students, teachers and other stakeholders. Analysis of feedback received by Sindh Textbook Board and Directorate of curriculum Research and Assessment, Jamshoro Sindh.
3. Downloading of 18 international curriculum documents from the internet/websites.
4. Study of foreign curricula for comparison and guidelines.

5. Determination of philosophy of curriculum design, aims and objectives, standards and benchmarks.
6. Drafting of core syllabus: The structure, units, contents, learning outcomes with time frame and weighting including identification of investigations / practical and demonstrations, assessment objectives and pattern.
7. Drafting suggestions on the other components of curriculum such as

   (a) Instructions for writing teaching-learning materials/ textbooks,
   (b) Concept mapping
   (c) Teaching strategies and methodology
   (d) Teachers training

8. Identification of salient features of Physics Curriculum for Sindh.

NEED ASSESSMENT

The necessity to revise and update physics curriculum is based on the aspirations of our Government and the people visualizing a vibrant and responsive curriculum comparable with international standards. A curriculum which can meet the challenges of the era of knowledge driven economies as well as grooming the younger generation into dynamic, responsible and productive citizens of this technological world. The feedback received in the Sindh Textbook Board during the last few years on the curriculum and course material in vogue is another factor supporting the same cause. In addition to that an extensive field survey for the purpose of need assessment was carried out to seek comments and suggestions on physics curriculum from the students, teachers and other stakeholders.

Data about the modern trends in the process of curriculum revision, the world over, were downloaded and analyzed. Newspaper articles, columns and reports were also collected to ensure a reflexive involvement of stakeholders. The committee identified the following focusing areas:

1. Elimination of vertical overlapping within the discipline and horizontal overlapping with other disciplines.
2. Linkage to be established horizontally with other disciplines and vertically within the discipline.
3. Modern trends and development to be incorporated.
4. Relevance of concepts with students own experience, observations and environment.
5. Identification of re-sequencing of some concepts.
6. Provision of conducive environment for enjoyable and thrilling learning experiences.
7. Stimulating students curiosity and sense of wonder.
8. Developing, observing, measuring, performing and recording Investigation Skills/ Laboratory work in a context that enables

students to experience the joy of doing physics.

9. Emphasis on real life applications of concepts and problem-solving techniques.

10. More emphasis on in-depth understanding of a concept rather than breadth.

Need has been realized to restructure the curriculum in the light of above study reports/feedback so that the thinking abilities and Investigation Skills/ Laboratory work becomes the vehicle for acquiring scientific knowledge, investigating and problem-solving techniques.

COMPARATIVE STUDIES WITH INTERNATIONAL CURRICULA

The Physics Curriculum Team carried out comparative studies of Physics Curriculum in vogue with the following international curricula before initiating drafting of Physics Curriculum for Schools in Sindh:

1 Cambridge Examination Syllabus for 2020-2021

2 Physics GCE O Level 2017-19, University of Cambridge International Examinations (CIE), U.K.

3 Physics A/AS Level 2007 syllabus of Cambridge University, England.

4 Tanzania Certificate of School Education Physics Syllabus 2010 onwards

5 Singapore-Cambridge GCE Ordinary Level examination 2017

6 Physics Syllabus, Malta

7 Physics Curriculum Secondary Level, Hong Kong

8 NBSE Physics Curriculum of India for classes IX-X

9 Grades Nine through twelve – Physics, California State Board of Education, U.S.A.

10 Physics Curriculum Guidelines of Ontario, Canada

11 South Australia Certificate of Education Physics Curriculum 2006

12 New South Wales Australia Physics Curriculum 2002

The following international curriculum documents were also downloaded and consulted before initiating work on the draft curriculum:

1 National Science Curriculum Standards, The Institute for the Promotion of Teach

2 NEBRASKA Science Standards Grades K-12

3 Star Science Standards, Nebraska Department of Education

4 Physics Secondary School Curriculum, State of Utah

5 Michigan State Board of Education Standards and draft Benchmarks (summer 2000)

6 Sequoia Union High School District Physics Curriculum Guide (U.S.A.)

7 Mississippi Science Framework 2001 U.S.A.

8 Science Curriculum Reforms in U.S.A.

9 Coal city High School Physics Curriculum, U.S.A.

10 San Ramon Valley Unified School District 2002 Physics Curriculum Grades 9-12, U.S.A.

PART-II CONTENTS

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 the physics course at secondary school level are to enable student to:

1. develop interest, motivation and sense of achievement in the study of physics
2. develop the ability to describe and explain concepts, principles, systems, processes and applications related to physics.
3. develop the thinking process, imagination, ability to solve problems, data management, investigating and communication skills.
4. develop an attitude of responsible citizenship, including respect for the environment and commitment to the wise use of resources.
5. recognize the usefulness and limitations of scientific method and the interaction between science, technology and society

SYLLABUS DESIGN

The syllabus is designed to emphasize less on purely factual material, but a much greater emphasis on the understanding and application of physics concepts and principles. This approach has been adopted in recognition of the need for students to develop Investigation Skills/ Laboratory work that will be of long term value in an increasingly technological world.

The syllabus framework is based on the **standards** and **benchmarks** framed by Provincial Curriculum Council. It comprises of seven main themes/sections. Each section is further divided into “units” showing their conceptual linkages.

In order to specify the syllabus as precisely as possible and also to emphasize the importance of higher order abilities and Investigation Skills/ Laboratory work 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 "**Investigation Skills/ Laboratory work**" measuring, observing, manipulating, recording and interpreting /analyzing, predicting and **communicating abilities/ Investigation Skills** are expected to be developed through related **investigations, activities and practical work**.

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

STANDARDS, BENCHMARKS AND LEARNING OUTCOMES

In the 21st century, students will remain the most important natural resource to ensuring the continual improvement and ultimate progress of humankind. It is critical that all involved in education prepare students to meet the challenges of a constantly changing global society. It is time to call for a raising in the expectations of student learning.

Preparing students for success in the new millennium and beyond, calls for increasing rigor and relevance in the curriculum. In adult roles, individuals are expected to work with others in a team setting, have an acquired knowledge base, be able to extend and refine knowledge, be able to construct new knowledge and applications and have a habit of self-assessing their assimilation of each dimension in their everyday decision-making process.

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, communication, reasoning, and investigating that characterize a subject area. Standards may emphasize interdisciplinary themes as well as concepts in the core academic subjects.

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. Our benchmarks are split into 5 developmental levels:

- Kachi to Grade 3
- Grade 4 to Grade 5
- Grade 6 to Grade 8
- Grade 9 to Grade 10
- 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. Within this document the Learning Outcomes are presented under three subheadings:

☼ Understanding
☼ Skills including laboratory work
☼ Science, Technology and Society connections

The Standards and the accompanying Benchmarks will assist in the development of comprehensive curriculum, foster diversity in establishing high quality Learning Outcomes, and provide an accountability tool to individuals involved in the education market place. These provide a common denominator to determine how well students are performing and will assure that all students are measured on the same knowledge and skills using the same method of assessment.

PHYSICS STANDARDS AND BENCHMARKS FOR GRADES IX-XII

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.

(A) Constructing New Scientific Knowledge

Scientifically literate students are learners as well as user of knowledge. They ask question about the world that can be answered by using scientific knowledge and techniques. They can also develop solutions to problems that they encounter or questions they ask. They can remember key points and use sources of information to reconstruct previously learnt knowledge, rather than try to remember every detail of what they learnt.

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 led to new developments in science and technology.

(B) Reflecting on scientific knowledge

Scientifically literate students can show an appreciation for scientific knowledge and the patterns that reveal in the world; this often involves seeing connections among different areas of knowledge. They may be able to take a historical and cultural perspective on concepts and theories or to discuss relationships among science, technology and society.

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.

(C) Using scientific knowledge

Scientifically literate students can use their knowledge to understand the world around them and to guide their actions. Important type of activities that use scientific knowledge include description and explanation of real world objects, systems or events; prediction of future events or observations; and the design of systems or courses of action that enable people to adopt to and modify the world around them.

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.

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.

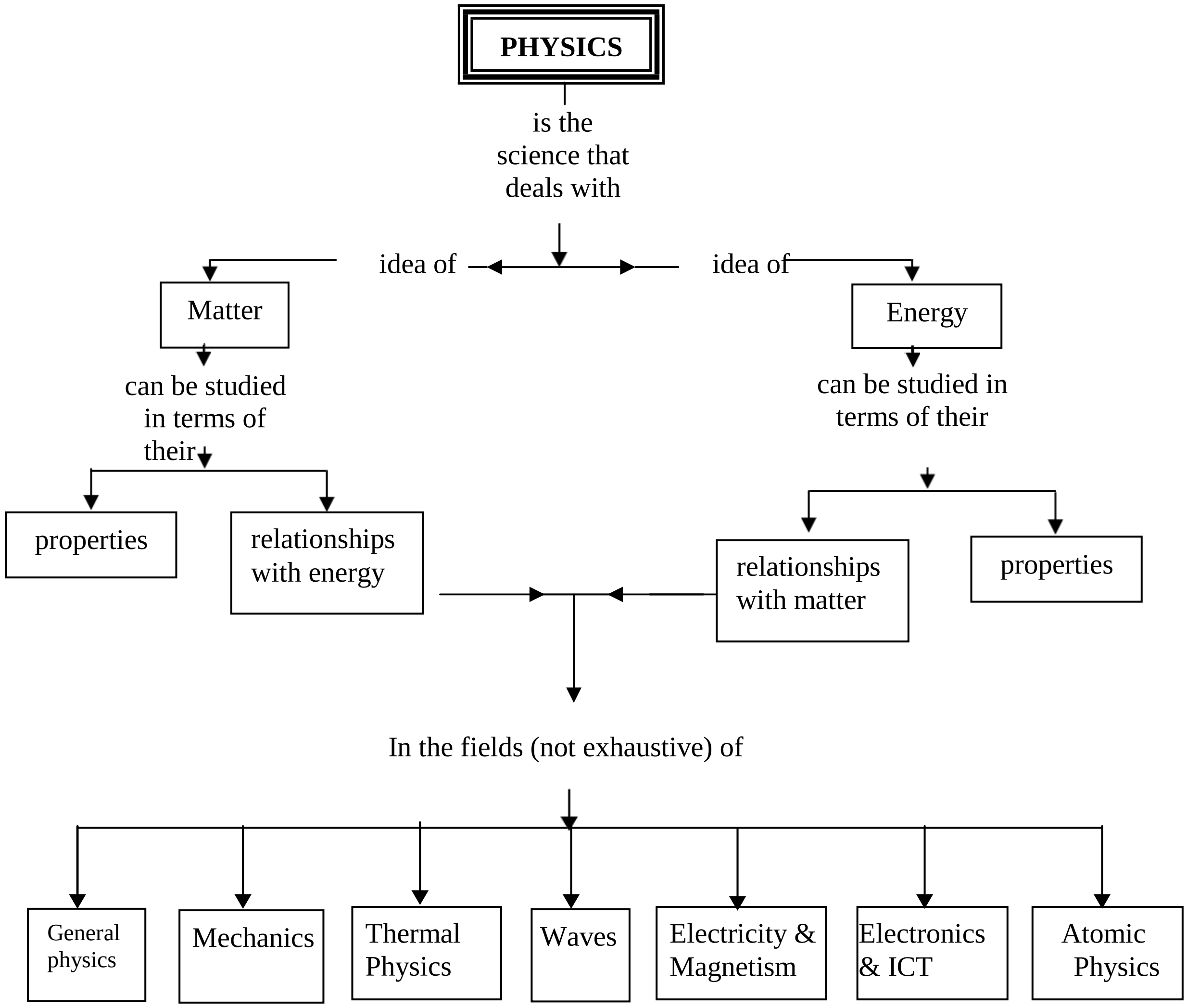
BENCHMARKS

Standard Code	Benchmarks Secondary Level	Benchmarks Higher Secondary Level
	At the end of the course, the students will:	**At the end of the course, the students will:**
1.1	Generate scientific questions about the world based on observation.	Ask questions that can be investigated empirically.
1.2	Develop solutions to problems through reasoning, observation, and investigations.	Develop solutions to problems through reasoning, observation, and investigations.
1.3	Design and conduct scientific investigations	Design and conduct scientific investigations.
1.4	Use tools and equipment appropriate to scientific investigations.	Recognize and explain the limitations of measuring devices.
1.5.	Use metric measurement devices to provide consistency in an investigation.	Gather and synthesize information from books and other sources of information.
1.6	Use sources of information in support of scientific investigations.	–
1.7	Write and follow procedures in the form of step-by-step instructions, formulae, flow diagrams, and sketches.	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.
2.1	Evaluate the strengths and weaknesses of claims, argument or data.	Justify plans or explanations on a theoretical or empirical basis.
2.2.	Describe limitations in personal knowledge.	Describe some general limitations of scientific knowledge.
2.3	Show how common themes of science, mathematics, and technology apply in real-world contexts.	Show how common themes of science, mathematics, and technology apply in real world contexts.
2.4	–	Discuss the historical development of the key scientific concepts and principles.

2.5	Describe the advantages and risks of new technologies	Explain the social and economical advantages and risks of new technology.
2.6	Develop an awareness and sensitivity to the natural world.	Develop an awareness and sensitivity to the natural world.
2.7	Recognize the contributions made in science by cultures and individuals of diverse backgrounds.	Describe the historical, political and social factors affecting developments in science.
3.1	Understand inquiry principles and process of 1st hand investigation in Physics.	Appreciate the ways in which models, theories and laws in physics have been tested and validated
3.2	Describe applications of physics which affect society or the environment.	Assess the impacts of applications of physics on society and the environment.
3.3	Select and use appropriate equipment for investigation plan.	Justify the appropriateness of a particular investigation plan.
3.4	Identify methods, collecting and recording data, and also organizing and analyzing data.	Identify ways in which accuracy and reliability could be improved in investigations.
3.5	Use appropriate terminology and reporting styles to communicate information and understanding in physics.	Use terminology and report styles appropriately and successfully to communicate information.
3.6	Draw valid conclusions from gathered data and information.	Assess the validity of conclusions from gathered data and information.
4.1	Describe the forces acting on an object which causes changes in its motion.	Explain events in terms of Newton's laws and law of conservation of momentum.
4.2	Describe the effects of energy transfers and energy transformations.	Explain the effects of energy transfers and energy transformations.
4.3	Describe modular model of matter and its understanding to explain various concepts related the behaviour of matter.	Explain mechanical, electrical and magnetic properties of solids and their significance.
4.4	Demonstrate an understanding of the principles related to fluid statics and appreciate their use in hydraulic systems.	Demonstrate an understanding of the principles related to fluid dynamics and their applications.

4.5	Investigate and explain heat transfers by conduction, conversion and radiation and their consequences.	Explain that heat flow and work are two forms of energy transfers between systems and their significance.
4.6	Explain wave motions in terms of energy sources and the oscillations produced.	Understand wave properties, analyze wave interactions and explain the effects of those interactions.
4.7	Show understanding of geometrical optics by experimenting and exploring reflection and refraction of light and make use of them in spherical mirrors and lenses.	Demonstrate an understanding of wave model of light as e.m waves and describe how it explains diffraction patterns, interference and polarization.
4.8	Describe the relationship between force and potential energy in gravitational and electrical fields.	Explain the effects of electric, magnetic and gravitational fields.
4.9	Show understanding of electric current and potential difference and calculate electric energy consumption of appliances and demonstrate safety measures in home circuitry.	Demonstrate and understand the properties, physical quantities, principles and laws related to electricity and magnetism and make use of them.
4.10	Investigate and state basic properties of some electronic and communication components and make basic electronic circuit and make use of it.	Investigate and explain basic properties of semi-conductor devices (diodes and transistors) and make electronic circuits and make use of them.
4.11	Describe and explain the structure of atom and atomic nucleus, origin of radioactivity, its uses and hazards.	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.

Concept Map of Physics IX – X



LIST OF SECTIONS & UNITS IX-X

PART-I		
Section-1	**General Physics**	1. Physical quantities and measurement
Section-2	**Newtonian Mechanics**	2. Kinematics 3. Dynamics 4. Turning effect of forces 5. Forces and matter 6. Gravitation 7. Properties of matter
Section-3	**Energy and Thermal Physics**	8. Energy sources And Transfer of Energy 9. Thermal Properties of Matter
PART II		
Section-4	**Waves**	10. General wave properties 11. Sound 12. Electromagnetic Spectrum 13. Geometrical optics
Section-5	**Electricity and Magnetism**	14. Electrostatics 15. Current electricity 16. Electromagnetism
Section-6	**Electronics and Communication**	17. Introductory Electronics 18. Information and communication technology
Section-7	**Atomic Physics**	19. Atomic Structure 20. Nuclear Structure

PART-I STUDENTS' LEARNING OUTCOMES (SLOs)

- ⇨ **Section -01 General Physics**
- ⇨ **Section 02 Newtonian Mechanics**
- ⇨ **Section 03 Energy and thermal Physics**

Section -01 General Physics

Unit - 01 Physical Quantities and Measurements Student Learning Outcomes		
Contents	**students should be able to:**	**Cognitive level**
1.1 Introduction to physics	1.1.1 Describe the crucial role of Physics in Science, Technology and Society 1.1.2 List with brief description of various branches of physics	K K
1.2 Measuring instruments	1.2.1 To choose a proper instrument (meter rule, Vernier calipers, screw gauge, physical balance stop watch, measuring cylinder) for the measurement of length, diameter, mass, time and volume in daily life activities.	A
1.3 Prefixes	1.3.1 Interconvert the prefixes and their symbols to indicate multiple and sub-multiple for both base and derived units	U
1.4 Standard form / scientific notation	1.4.1 Write the answer in scientific notation in measurements and calculations	A
1.5 Density	1.5.1 Define term density with SI unit 1.5.2 To determine density of solids and liquids	K A
1.6 Significant figures	1.6.1 Describe the need using significant figures for recording and stating results in the laboratory	U

Section 02 Newtonian Mechanics

Unit - 02 Kinematics

Student Learning Outcomes

Contents	students should be able to:	Cognitive level
2.1 Rest and motion	2.1.1 Describe using examples how objects can be at rest and in motion simultaneously.	K
2.2 Types of motion	2.2.1 Identify different types of motion i.e., translatory, (linear, random, and circular); rotatory and vibratory motions and distinguish among them.	U
2.3 Describing motion	2.3.1 Define with examples distance, displacement, speed, velocity and acceleration (with units) 2.3.2 Differentiate with examples between distance and displacement, speed and velocity	K U
2.4 Scalars and vectors	2.4.1 Differentiate with examples between scalar and vector quantities 2.4.2 represent vector quantities by drawing	U U
2.5 Graphical analysis of motion	2.5.1 Plot and interpret distance-time graph and speed-time graph 2.5.2 Determine and interpret the slope of distance-time and speed-time graph 2.5.3 Determine from the shape of the graph, the state of a body (i) at rest (ii)moving with constant speed (iii) moving with variable speed 2.5.4 Calculate the area under speed-time graph to determine the distance traveled by the moving body.	U, A A U A
2.6 Equations of motion	2.6.1 Solve problems related to uniformly accelerated motion using appropriate equations 2.6.2 To rearrange the equation according to the requirement of the problem	A A
2.7 Motion due to gravity	2.7.1 Solve problems related to freely falling bodies using 10 m/s^2 as the acceleration due to gravity.	A

Unit - 3 Dynamics

Student Learning Outcomes

Contents	students should be able to:	Cognitive level
3.1 Momentum	3.1.1 Define momentum with SI unit 3.1.2 Calculating momentum using equation p = mV 3.1.3 Solve problem using the equation Force = change in momentum / change in time 3.1.4 Identify the safety devices (such as packaging of fragile objects, the action of crumple zones and seatbelts) utilized to reduce the effects of changing momentum.	K A A U
3.2 Newton's laws of motion	3.2.1 State Newton's laws of motion 3.2.2 Distinguish between mass and weight 3.2.3 Solve problem using F = ma, and w = mg	K U A
3.3 Friction	3.3.1 Define friction 3.3.2 Explain the effect of friction on the motion of a vehicle in the context of tyre surface, road conditions including skidding, braking force 3.3.3 Identify the relationship between load and friction by sliding a trolley carrying different load with the help of a spring balance on different surfaces 3.3.4 Demonstrate that rolling friction is much lesser than sliding friction	K U U U

Unit - 4 Turning effect of forces

Student Learning Outcomes

Contents	students should be able to:	Cognitive level
4.1 Force on bodies	4.1.1 Define like and unlike parallel forces	K
4.2 Addition of forces	4.2.1 State head to tail rule of vector addition of forces/vectors	K
4.3 Resolution of forces	4.3.1 Describe how a force is resolved into its perpendicular components 4.3.2 Determine the magnitude and direction of a force from its perpendicular components.	U A
4.4 Moment of force	4.4.1 Define moment of force or torque as moment = force x perpendicular distance from pivot to the line of action of force. 4.4.2 Explain the turning effect of force by relating it to everyday life. 4.4.3 Illustrate by describing a practical application of moment of force in the working of bottle opener, spanner, door/windows handles etc.	K U A
4.5 Principle of moments	4.5.1 State the principle of moments 4.5.2 Verify the princi1ple of moments by using a metre rod balanced on a wedge	K A
4.6 Centre of mass	4.6.1 Define the Centre of mass and Centre of gravity of a body 4.6.2 Determine the position of Centre of mass/gravity of regularly and irregularly shaped objects	K A
4.7 Couple	4.7.1 Define couple as a pair of forces tending to produce rotation. 4.7.2 Prove that the couple has the same moments about all points 4.7.3 Demonstrate the role of couple in the steering wheels and bicycle pedals	K A A
4.8 Equilibrium	4.8.1 Define equilibrium and classify its types by quoting examples from everyday life. 4.8.2 State the two conditions for equilibrium of a body 4.8.3 Solve problems on simple balanced systems when bodies are supported by one pivot only 4.8.4 Describe the states of equilibrium and classify them with common examples	K K A K

4.9 Stability	4.9.1 Explain effect of the position of the Centre of mass on the stability of simple objects 4.9.2 Demonstrate through a balancing toy, racing car etc. that the stability of an object can be improved by lowering the Centre of mass and increasing the base area of the objects	U U

Unit - 5 Forces and Matter

Student Learning Outcomes

Contents	students should be able to:	Cognitive level
5.1 Forces acting on solids	5.1.1 Using forces to change the shape and size of the body	U
5.2 Stretching springs	5.2.1 Carry out experiment to produce extension against load graph 5.2.2 Interpret extension against load graph	U A
5.3 Hook's law	5.3.1 Define Hook's law 5.3.2 Calculate extension in spring and spring constant using formula F = kx	K A
5.4 Pressure	5.4.1 Define and explain pressure 5.4.2 To understand the factors that affects the pressure 5.4.3 To calculate the pressure using formula P = F/A 5.4.4 To understand hydraulic machines	K U A U

Unit - 6 Gravitation

Student Learning Outcomes

Contents	students should be able to:		Cognitive level
6.1 Law of Gravitation	6.1.1	State Newton's law of gravitation	K
	6.1.2	Explain that the gravitational forces are consistent with Newton's third law.	U
	6.1.3	Explain gravitational field as an example of field of force.	U
	6.1.4	Solve problems using Newton's law of gravitation	A
6.2 Weight	6.2.1	Define weight (as the force on an object due to a gravitational field.)	K
6.3 Measurement of mass of earth	6.3.1	Calculate the mass of earth by using law of gravitation	A
6.4 Artificial satellites	6.4.1	Discuss the importance of Newton's law of gravitation in understanding the motion of satellites	U
	6.4.2	Describe how artificial satellites keep on moving around the earth due to gravitational force	U

Unit - 7 Energy sources and transfer of energy

Student Learning Outcomes

Contents	Students should be able to:	Cognitive level
7.1 Work	7.1.1 Define work and its SI unit. 7.1.2 Calculate work done using equation Work = force x distance moved in the direction of force	K A
7.2 Energy forms	7.2.1 Define kinetic energy and potential energy 7.2.2 Use Kinetic Energy Ek = ½ mv2 and potential energy E_p = mgh to solve problems.	K A
7.3 Conversion of energy	7.3.1 Describe the processes by which energy is converted from one form to another with reference to fossil fuel energy, hydroelectric generation, solar energy, nuclear energy, geothermal energy, wind energy, biomass energy and tidal energy.	U
7.4 Renewable and nonrenewable energy sources	7.4.1 Differentiate energy sources as non-renewable and renewable energy sources with examples of each.	U
7.5 Efficiency	7.5.1 Define efficiency of a working system and calculate the efficiency of an energy conversion using the formula efficiency = energy converted into the required form / total energy input 7.5.2 Explain why a system cannot have an efficiency of 100%.	K U
7.6 Power	7.6.1 Define power and calculate power from the formula Power = work done / time taken 7.6.2 Define the unit of power "watt" in SI and its conversion with horse power	K, A K,A

Section 03 Energy and thermal Physics

Unit - 8 Properties of Matter Student Learning Outcomes		
Contents	**Students should be able to:**	**Cognitive level**
8.1 Kinetic molecular model of matter	8.1.1 Describe States of matter 8.1.2 State kinetic molecular model of matter	U K
8.2 Forces and kinetic theory	8.2.1 Explain the kinetic model in terms of forces b/w particles	U
8.3 Gases and the kinetic theory	8.3.1 Explain the behavior of gases 8.3.2 Calculate changes in pressure and volume	U A

Unit - 9 Thermal Properties of Matter

Student Learning Outcomes

Contents	students should be able to:	Cognitive level
9.1 Heat and temperature	9.1.1 Differentiate b/w heat and temperature	U
9.2 Specific heat capacity	9.2.1 Define the terms heat capacity and specific heat capacity with SI unit 9.2.2 Describe one everyday effect due to relatively large specific heat of water	K K
9.3 Heat of fusion and heat of vaporization	9.3.1 Describe heat of fusion and heat of vaporization (as energy transfer without a change of temperature for change of state) 9.3.2 Describe experiments to determine heat of fusion and heat of vaporization of ice and water respectively by sketching temperature-time graph on heating ice.	K A
9.4 Evaporation process	9.4.1 Explain the process of evaporation and the difference between boiling and evaporation. 9.4.2 Explain that evaporation causes cooling 9.4.3 List the factors which influence surface evaporation	U U A
9.5 Thermal expansion	9.5.1 Define thermal expansion 9.5.2 Describe qualitatively the thermal expansion of solids (linear and volumetric expansion) 9.5.3 List and explain some of the everyday applications and consequences of thermal expansion 9.5.4 Explain the thermal expansion of liquids (real and apparent expansion)	K U A U

PART-II

- ⇨ **Section 04 Waves**
- ⇨ **Section 5 Electricity and Magnetism**
- ⇨ **Section 6 Electronics and Communication**
- ⇨ **Section 7 Atomic Physics**

Section 04 Waves

Unit - 10 General wave properties **Student Learning Outcomes**		
Contents	**students should be able to:**	**Cognitive level**
10.1 Waves and nature of waves	10.1.1 Describe wave motion as illustrated by vibrations in rope, slinky spring and by experiments with water waves 10.1.2 Identify transverse and longitudinal waves in mechanical media, slinky and springs 10.1.3 Describe that waves are means of energy transfer without transfer of matter 10.1.4 Distinguish between mechanical and electromagnetic waves	K U K U
10.2Properties of Waves	10.2.1 Describe properties of waves such as reflection, refraction and diffraction with the help of ripple tank 10.2.2 Define the terms speed (v), frequency (f), wavelength (λ), time period (T), amplitude, crest, trough, cycle, wave front, compression and rarefaction 10.2.3 Solve problems by applying the relation $f = 1/T$ and $v = f\lambda$	U K A
10.3Simple Harmonic Motion (SHM)	10.3.1 State the conditions necessary for an object to oscillate with SHM	K
10.4Simple pendulum	10.4.1 Explain SHM with simple pendulum, ball and bowl examples. 10.4.2 Draw forces acting on a displaced pendulum 10.4.3 Solve problems by using the formula $T = 2\pi\sqrt{l/g}$ for simple pendulum	U U A
10.5Damped Oscillation	10.5.1 Understand that damping progressively reduces the amplitude of oscillation	U

Unit - 11 Sound

Student Learning Outcomes

Contents	**Students should be able to:**	**Cognitive level**
11.1 Sound waves	11.1.1 Describe the production of sound by vibrating sources. 11.1.2 Describe the longitudinal nature of sound waves and describe compression and rarefaction. 11.1.3 Explain why a medium is required in order to transmit sound waves and describe an experiment to demonstrate this.	K K U
11.2 Speed of sound	11.2.1 Describe a direct method for the determination of the speed of sound in air and make the necessary calculation. 11.2.2 State the order of magnitude of the speeds of sound in air, liquids and solids. 11.2.3 Describe the factors which affects the speed of sound (temperature, humidity etc.)	A K U
11.3 Seeing sounds	11.3.1 Describe how the shape of a sound wave as demonstrated by an oscilloscope is affected by the quality (timbre) of the sound wave	K
11.4 Noise pollution	11.4.1 Explain that noise is a nuisance.	U
11.5 Ultrasound	11.5.1 Define ultrasound. 11.5.2 Describe how the reflection of sound may produce an echo. 11.5.3 Describe how ultrasound techniques are used in medical and industry.	K U K

Unit - 12 Electromagnetic spectrum Student Learning Outcomes		
Contents	**Students should be able to:**	**Cognitive level**
12.1 Dispersion of light	12.1.1 Describe the dispersion of light as illustrated by the action on light of a glass prism. 12.1.2 State the colours of the spectrum and explain how the colours are related to frequency/wavelength. 12.1.3 Describe the behavior of light when passing through water droplets. 12.1.4 State that all electromagnetic waves travel with the same high speed in air and state the magnitude of that speed.	U U K K
12.2 Characteristics of electromagnetic waves	12.2.1 Describe the main components of the electromagnetic spectrum.	K
12.3 Uses of electromagnetic waves	12.3.1 Discuss the role of the following: (i) radio waves – radio and television communications, (ii) microwaves – satellite television and telephone, (iii) infra-red – household electrical appliances, television controllers and intruder alarms, (iv) light – optical fibers in medical uses and telephone, (v) ultra-violet – sunbeds, fluorescent tubes and sterilization, (vi) X -rays – hospital use in medical imaging and killing cancerous cells, and engineering applications such as detecting cracks in metal, (vii) gamma rays – medical treatment in killing cancerous cells, and engineering applications such as detecting cracks in metal	U

Unit - 13 Geometrical Optics

Student Learning Outcomes

Contents	Students should be able to:		Cognitive level
13.1Reflection of light	13.1.1	Describe the terms used in reflection including normal, angle of incidence, angle of reflection and state laws of reflection	U
13.2 Image location by spherical mirror equation	13.2.1	Solve problems of image location by spherical mirrors by using mirror formula.	A
	13.2.2	Describe the use of spherical mirrors for safe driving, blind turns on hilly roads, dentist mirror.	U
13.3 Refraction of light	13.3.1	Define the terminology for the angle of incidence i and angle of refraction r and describe the passage of light through parallel-sided transparent material.	K
	13.3.2	Solve problems by using the equation sin i /sin r = n (refractive index)	A
13.4 Total internal reflection	13.4.1	State the conditions for total internal reflection	K
	13.4.2	Describe how total internal reflection is used in light propagation through optical-fibres	U
	13.4.3	Describe the use of optical fibres in telecommunications and medical field and state the advantages of their use.	K
13.5 Refraction through a prism	12.5.1	Describe the passage of light through a glass prism.	U
13.6 Image location by lens equation	13.6.1	Describe how light is refracted through lenses.	U
	13.6.2	Define power of a lens and its unit.	K
	13.6.3	Solve problems of image location by lenses using lens formula.	A
	13.6.4	Describe the use of a single lens as a magnifying glass and in a camera, projector and photographic enlarger and draw ray diagrams to show how each forms an image.	K
13.7 Magnifying power and	13.7.1	Define the terms resolving power and magnifying power of lens.	K

resolving power		
13.8 Compound microscope	13.8.1 Draw ray diagram of simple microscope and mention its magnifying power. 13.8.2 Draw ray diagram of compound microscope and mention its magnifying power. 13.8.3 Describe the exploration of the world of microorganism by using microscopes and of distant celestial bodies by telescopes	U U K
13.9Telescope	13.9.1 Draw ray diagram of a telescope and mention its magnifying power 13.9.2 Describe the correction of short-sight and long-sight 13.9.3 Describe the use of lenses/ contact lenses for rectifying vision defects of the human eye.	U U U
13.10 Defects in vision	13.10.1 Draw ray diagrams to show the formation of images in the normal eye, a short- sighted eye and a long-sighted eye	U

Section 5 Electricity and Magnetism

Unit - 14 Electrostatics

Student Learning Outcomes

Contents	Students should be able to:	Cognitive level
14.1 Electric charge	14.1.1 Describe simple experiments to show the production and detection of electric charge 14.1.2 Demonstrate the existence of different kind of charges.	K U
14.2 Electrostatic induction	14.2.1 Describe experiments to show electrostatic charging by induction.	K
14.3 Electroscope	14.3.1 State that there are positive and negative charges. 14.3.2 Describe the construction and working principle of electroscope. 14.3.3 Detect the type of charge on a body using an electroscope. 14.3.4 Demonstrate that like charges repel each other and unlike charges attract each other using an electroscope.	K K A A
14.4 Coulomb's law	14.4.1 State Coulomb's law. 14.4.2 Solve problems on electrostatic charges by using Formula F=kq1q2/r2	K A
14.5 Electric field and its intensity	14.5.1 Define electric field and electric field intensity. 14.5.2 Sketch the electric field lines for an isolated +ve and –ve point charges. 14.5.3 Solve problems using equation $E=F/q^0$	K U A
14.6 Electrostatic potential	14.6.1 Describe the concept of electrostatic potential. 14.6.2 Define the unit "volt". 14.6.3 Describe potential difference as energy transfer per unit charge. 14.6.4 Describe one situation in which static electricity is dangerous and the precautions taken to ensure that static electricity is discharged safely	U K U K

14.7 Applications of electrostatic	14.7.1 Describe the use of electrostatic charging (e.g. spraying of paint and dust extraction).	U
14.8 Capacitors and capacitance	14.8.1 Describe that the capacitor is charge storing device. 14.8.2 Define capacitance and its unit. 14.8.3 Explain importance of effective capacitance of a number of capacitors connected in series and in parallel. 14.8.4 Apply the formula for the effective capacitance of a number of capacitors connected in series and in parallel to solve related problems	U K U A
14.9 Different types of capacitors	14.9.1 List the use of capacitors in various electrical appliances.	A

Unit - 15 Current Electricity

Student Learning Outcomes

Contents	Students should be able to:	Cognitive level
15.1 Electric current	15.1.1 Define electric current. 15.1.2 Describe the concept of conventional current	K U
15.2 Potential difference and emf	15.2.1 Understand the potential difference across a circuit component and name its unit	U
15.3 Ohm's law	15.3.1 Describe Ohm's law and its limitations	U
15.4 Resistance	15.4.1 Define resistance and its unit. 15.4.2 Explain the under lying principles in the working of volume controls of radio and T.V	K U
15.5 Series and parallel combinations	15.5.1 Calculate the effective resistance of a number of resistances connected in series and also in parallel.	A
15.6 The I-V characteristics for ohmic and non ohmic conductors	15.6.1 Describe the factors affecting the resistances of a metallic conductor 15.6.2 Distinguish between conductors and insulators 15.6.3 Sketch and interpret the V-I characteristics graph for a metallic conductor, a filament lamp and a thermistor	U U A
15.7 Electrical power and Joule's law	15.7.1 Describe how energy is dissipated in a resistance and explain Joule's law. 15.7.2 Apply the equation E=I.Vt = I2Rt = V2 t/R to solve numerical problem. 15.7.3 Calculate the cost of energy when given the cost per kWh.	U A A
15.8 Use of circuit components	15.8.1 Identify circuit components such as switches, resistors batteries transducers, LDRs, Thermistors and capacitors, Relays and diodes, LEDs. 15.8.2 Identify the symbols of circuit components and colour codes on resistors 15.8.3 Construct simple series (single path) and parallel circuits (multiple paths). 15.8.4 State the functions of the live, neutral and earth wires in the domestic main supply. 15.8.5 Predict the behavior of light bulbs in series and	U U U K A

	parallel circuit such as for celebration lights.	
15.9 Measuring instruments (voltmeter, galvanometer, ammeter)	15.9.1 Describe the use of electrical measuring devices like galvanometer, ammeter and voltmeter (construction and working principles not required).	A
5.10 Alternating current A.C	15.10.1Explain Alternating Current AC	U
5.11 Safety Measures	15.11.1 Describe hazards of electricity (damage insulation, overheating of cables, damp conditions). 15.11.2 Explain the use of safety measures in household electricity, (fuse, circuit breaker, earth wire). 15.11.3 Describe the damages of an electric shock from appliances on the human body.	U U K

Unit - 16 Electromagnetism

Student Learning Outcomes

Contents	students should be able to:	Cognitive level
16.1 Magnetic effect of a steady current	16.1.1 Explain by describing an experiment that an electric current in a conductor produces a magnetic field around it. 16.1.2 Define Magnetic field 16.1.3 Sketch the lines of magnetic force	U
16.2 Force on a current carrying conductor in a magnetic field	16.2.1 Describe that a force acts on a current carrying conductor placed in a magnetic field as long as the conductor is not parallel to the magnetic field	U
16.3 Turning effect on a current carrying coil in a magnetic field	16.3.1 State that a current carrying coil in a magnetic field experiences a torque.	K
16.4 D.C motor	16.4.1 Relate the turning effect on a coil to the action of a D.C. motor	A
16.5 Electromagnetic induction	16.5.1 Describe an experiment to show that a changing magnetic field can induce e.m.f. in a circuit. 16.5.2 List factors affecting the magnitude of an induced e.m.f. 16.5.3 Explain that the direction of an induced e.m.f opposes the change causing it and relate this phenomenon to conservation of energy	U A U
16.6 A.C generator	16.6.1 Describe a simple form of A.C generator.	U
16.7 Mutual Induction	16.7.1 Describe mutual induction and state its units	K
16.8 Transformer	16.8.1 Identify that a transformer works on the principle of mutual induction between two coils 16.8.2 Describe the purpose of transformers in A.C circuits 16.8.3 Identify the role of transformers in power transmission from power station to your house. 16.8.4 List the use of transformer (step – up and step-down) for various purposes in your home	U U U A

Section 06 Electronics and Communication

Unit - 17 Introductory Electronics

Student Learning Outcomes

Contents	Students should be able to:	Cognitive level
17.1 Introduction to electronics	17.1.1 Identify by quoting examples that the modern world is the world of digital electronics. 17.1.2 Identify that the computers are the forefront of electronic technology. 17.1.3 Realize that electronics is shifting from low-tech electrical appliances to high-tech electronic appliances 17.1.4 Differentiate between analogue and digital electronics.	U U U U
17.2 Thermionic emission	17.2.1 Explain the process of thermionic emission emitted from a filament.	U
17.3 Electron gun and cathode rays	17.3.1 Describe the simple construction and use of an electron gun as a source of electron beam.	U
17.4 Deflection of electron by electric field	17.4.1 Describe the effect of electric field on an electron beam.	U
17.5 Deflection of electron by magnetic field	17.5.1 Describe the effect of magnetic field on an electron beam.	U
17.6 Cathode rays oscilloscope (CRO)	17.6.1 Describe the basic principle of CRO and make a list of its uses.	U
17.7 Analogue and digital electronics	17.7.1 State the basic operations of digital electronics.	K
17.8 Logic gates	17.8.1 Identify and draw the symbols for the logic gates (NOT, OR, AND, NOR and NAND). 17.8.2 State the action of the logic gates in truth table form. 17.8.3 Describe the simple uses of logic gates.	U K A

Unit - 18 Information and Communication Technology ICT

Student Learning Outcomes

Contents	**Students should be able to:**		**Cognitive level**
18.1 Components of ICT	18.1.1 18.1.2	Describe the components of information technology. Analyze and describe the energy transformations that occur in cell phone photo phone and fax machine	U U
18.2 Flow of Information	18.2.1	Explain briefly the transmission of electric signals through wires radio waves through air light signals through optical fibres	U
18.3 Communication Technology	18.3.1 18.3.2	Describe function and use of fax machine, cell phone, photo phone and computer. Make a list of the use of E-mail and internet.	U U
18.4 Storing information	18.4.1	Describe the use of information storage devices such as audio cassettes, video cassettes, hard discs, floppy, compact discs and flash drive.	U
18.5 Handling information	18.5.1	Identify the functions of word processing, data managing, monitoring and controlling	U

Section 7 Atomic Physics

Unit - 19 Atomic Structure

Student Learning Outcomes

Contents	Students should be able to;	Cognitive level
19.1 Atom and atomic nucleus	19.1.1 Describe the structure of an atom in terms of a nucleus and electrons 19.1.2 Describe evidence for the nuclear model of the atom	K U
19.2 Protons, neutrons	19.2.1 Describe the composition of the nucleus in terms protons and neutrons	K
19.3 Elements	19.3.1 Explain that number of protons in a nucleus distinguishes one element from the other. 19.3.2 Represent various nuclides by using the symbol of proton number Z, nucleon number A and the nuclide notion X	U K
19.4 Elements and isotopes	19.4.1 Use the term isotope	A

Unit - 20 Nuclear Structure

Student Learning Outcomes

Contents	Students should be able to:	Cognitive level
20.1 Natural Radioactivity	20.1.1 Explain that some nuclei are unstable, give out radiation to get rid of excess energy and are said to be radioactive. 20.1.2 Describe that the three types of radiation are α, β & γ. 20.1.3 State, for radioactive emissions: (i)their nature (ii)their relative ionizing effects. (iii)their relative penetrating abilities	U K U
20.2 Natural transmutations	20.2.1 Explain that an element may change into another element when radioactivity occurs. 20.2.2 Represent changes in the composition of the nucleus by symbolic equation when alpha or beta particles are emitted.	U U
20.3 Background radiation	20.3.1 Describe sources of background radiations and artificial radiations. 20.3.2 Describe that radioactive emission occur randomly over space and time.	U U
20.4 Half life	20.4.1 Explain the meaning of half-life of a radioactive material. 20.4.2 Make calculation based on half-life which might involve information in tables or shown by decay curves. 20.4.3 Determine the half-life of a sample of radioactive material by using a graph of number of radioactive nuclei or activity versus time. 20.4.4 Make estimation of age of ancient objects by the process of carbon dating.	U A A A
20.5 Radio isotopes	20.5.1 Describe what are radio isotopes. What makes them useful for various applications? 20.5.2 Describe the application of radioisotopes in medical, agriculture and industrial fields.	U U
20.6 Fission and fusion	20.6.1 Describe briefly the process of fission and fusion	U
20.7 Hazards and safety measures	20.7.1 Describe how radioactive materials are handled, used, stored and disposed of, in a safe way.	U

LIST OF PRACTICAL FOR IX-X GRADES

1 To measure the area of cross section by measuring diameter of a solid cylinder with Vernier callipers.

2 To measure the volume of a solid cylinder by measuring length and diameter of a solid cylinder with Vernier callipers.

3 To measure the thickness of a metal strip or a wire by using a screw gauge.

4 To find the acceleration of a ball rolling down an angle iron by drawing a graph between 2S and T^2.

5 To find the value of “g” by free fall method.

6 Investigate the relationship between force of limiting friction and normal reaction to find the co-efficient of sliding friction between a wooden block and horizontal surface.

7 Measure the force of limiting friction by rolling a roller on a horizontal plane.

8 To determine the value of “g” by the Atwood’s machine.

9 To determine the resultant of two forces graphically using a Horizontal force table.

10 To verify the principle of moments by using a metre rod balanced on a wedge.

11 To find the tension in the strings by balancing a metre rod on the stands.

12 To find the weight of an unknown object by using vector addition of forces.

13 To find the weight of an unknown object by using principle of moments.

14 To study the effect of the length of simple pendulum on time and hence find “g” by calculation.

15 To prove that time period of a simple pendulum is independent of (i) mass of the pendulum (ii) amplitude of the vibration.

16 To study the relationship between load and extension (Helical spring) by drawing a graph.

17 To find the density of a body heavier than water by Archimedes principle.

18 To find the density of a liquid using 5 ml syringe (instead of density bottle).

19 To find the specific heat by the method of mixture using polystyrene cups (used as container of negligible heat capacity).

20 To draw a graph between temperature and time when ice is converted into water and then to steam by slow heating.

21 To measure the specific heat of fusion of ice.

22 To verify the laws of refraction by using a glass slab.

23 To find the refractive index of water by using concave mirror.

24 To determine the critical angle of glass using a semicircular slab and a light ray box/or by prism.

25 To trace the path of a ray of light through glass prism and measure the angle of deviation.

26 To find the focal length of a convex lens by parallax method.

27 To set up a microscope and telescope.

28 Verify Ohm's law (using wire as conductor).

29 To study resistors in series circuit.

30 To study resistors in parallel circuit.

31 To find the resistance of galvanometer by half deflection method.

32 To trace the magnetic field using a bar magnet.

33 To trace the magnetic field due to a current carrying circular coil.

34 To verify the truth table of OR, AND, NOT, NOR and NAND gates.

35 To make a burglar alarm/fire alarm using an appropriate gate.

Note:

1- At least 30 standard practical along with exercises are required to be performed during the two years of course of studies of grades IX-X.

2- Use of centimetre graph paper be made compulsory.

LIST OF EQUIPMENTS/ APPRATUS
REQUIRED ACCORDING TO THE PHYSICS EXPERIMENTS FOR IX-X GRADES

1. Vernier callipers, solid cylinder.
2. Screw gauge, metal strip or small solid sphere or a piece of wire.
3. Angle iron 2m long, 2 wooden stands having V-shaped top, steel ball, stopwatch, metre rod.
4. Free-fall apparatus, a metal bob, stopwatch.
5. Horizontal plane, weight box, pulley, wooden block, pan, thread, spring balance, metre rod.
6. Horizontal plane, weight box, pulley, pan, thread, ruler.
7. Atwood's machine, stopwatch, metre rod.
8. Horizontal board fixed with three pulleys, plane mirror strip, 3 sets of slotted masses of 50 g with hangers, thread, metre scale, protractor.
9. Metre rod, wooden wedge, thread, weight box.
10. Two stands, two spring balances, metre rod, thread.
11. Horizontal board fixed with three pulleys, plane mirror strip, 3 sets of slotted masses of 50 g with hangers, thread, metre scale, protractor.
12. Wedge, metre rod, slotted weights, thread, object of unknown weight.
13. Metallic bob, Vernier callipers, metre scale, stopwatch, splitted cork, stand with clamp.
14. Metallic bob, Vernier callipers, metre scale, stopwatch, splitted cork, stand with clamp.
15. Helical spring, iron stand, half metre rod, set of masses with hanger.
16. Physical balance, weight box, solid body (glass stopper), beaker, thread, small wooden bench, water, thermometer.
17. 5ml disposable syringe, liquid, water, beaker, weight box, physical balance.
18. Polystyrene cup, two thermometers, heating arrangement, metallic bob, physical balance, weight box.
19. Gas burner or spirit lamp, thermometer ($-10^{o}C$ to $110^{o}C$), iron stand, beaker, stopwatch, tripod stand, stirrer.
20. Copper calorimeter with lagging, thermometer, ice chips.
21. Rectangular glass slab, common pins, drawing pins, drawing board, geometry box, white sheet of paper.

22. Concave mirror, stand with a clamp, cork with a pin.
23. Semicircular glass block, ray box, drawing board, white paper and pins, protractor, half metre rule, pair of compasses or prism.
24. Glass prism, drawing board, white paper and drawing pins, common pins, geometry box.
25. Convex lens, two needles, three uprights, knitting needle and a metre rod.
26. Convex lens of different focal length and metre rod.
27. Voltmeter, ammeter, a piece of resistance wire, rheostat, battery, connecting wires, key.
28. Two standard resistances, voltmeter, ammeter, connecting wires, key, battery, rheostat.
29. Two standard resistances, voltmeter, ammeter, connecting wires, key, battery, rheostat.
30. Galvanometer, dry cell with box, high resistance box, low resistance box, two keys.
31. Bar magnet, drawing board, white paper and pins, magnetic compass, needle, pencil.
32. Circular coil fitted on a wooden board, compass needle, ammeter, battery, key.
33. OR gate, AND gate, NOT gate, NOR gate and NAND gate modules, power supply, LED indicator module.
34. NOT gate module, thermistor or smoke sensor, alarm system, power pack.

LIST OF APPARATUS

REQUIRED FOR A STANDARD PHYSICS LABORATORY FOR GRADES IX-X
(FOR A GROUP OF 40 STUDENTS)

Sr. No.	Apparatus/ Equipment	Quantity
1.	Vernier Callipers	12
2.	Screw gauge	12
3.	Solid cylinder	12
4.	Metallic wire	1 kg
5.	Small metallic sphere	12
6.	Angle iron 2m long with steel ball	10
7.	Wooden stands having V-shaped top	10
8.	Atwood's machine	10
9.	Stopwatch	10
10.	Free fall apparatus	10
11.	Metallic bob	10
12.	Wooden block	10
13.	Weight box with fractional weights	2
14.	Pulley	20
15.	Spring balance	20
16.	Horizontal Board fixed with three pulleys	10
17.	Pan	20
18.	Slotted weights with hangers set of 50g weights	20
19.	Slotted weights with hangers set of 20g weights	20
20.	Metre rod	20
21.	Wedge	12
22.	Plane mirror strip	24
23.	Protractor	24
24.	Inclined plane	10
25.	Steel roller with suspended pan	10
26.	Helical spring	24
27.	Iron stands with clamps	20

28.	Physical balance	02
29.	Beaker (Assorted 250 cc, 500 cc, 1000 cc)	24
30.	Small wooden bench	10
31.	5 ml disposable syringes	20
32.	Polystyrene cups	24
33.	Thermometer – $10C^{o}$ to $110C^{o}$ with half degree mark	24
34.	Gas burner or spirit lamp	10
35.	Solid lead shots	1 kg
36.	Tripod stand	10
37.	Stirrer	10
38.	Thread	5 spools
39.	Split cork	1pkt
40.	Rubber pad	12
41.	Concave mirror with stand	12
42.	Needles with stands (Uprights)	24
43.	Kitting needle	12
44.	Rectangular glass slab	12
45.	Common pins	2 pkts
46.	Drawing board pins	2 pkts
47.	White paper	1 pkt
48.	Semi -circular glass slab	10
49.	Light ray box	10
50.	Drawing board	15
51.	Compass	15
52.	Glass prism	12
53.	Convex lens (f= 10 cm to 20 cm)	20
54.	Voltmeter (0 - 5V)	10
55.	Ammeter (0 – 3A)	10
56.	Resistance wire	1 spool
57.	Rheostat	10
58.	Connecting wires	2 kg

59.	Keys	20
60.	Standard resistances (1Ω, 2Ω, 5Ω, 10Ω)	10 each
61.	Galvanometer	10
62.	Dry cell with box	24
63.	High resistance box	12
64.	Low resistance box	12
65.	Bar magnet	12 set
66.	Circular coil (fitted on wooden board)	10
67.	Power supply	10
68.	OR gate module	10
69.	AND gate module	10
70.	NOR gate module	10
71.	NAND gate module	10
72.	NOT gate module	10
73.	LED indicator module	10
74.	Alarm system	5
75.	Smoke sensor	5
76.	Thermistor	5

Estimated Time Allocation

Estimated Time Allocation and Weighting for Various Units/Chapters
GRADES IX-X (Two years course)

Unit -	Content	Weighting in %age	Periods (Theory)	Periods (Investigation / Practical work)
		PART-I		
1.	Physical quantities and measurement	12%	13	7
2.	Kinematics	15%	15	9
3.	Dynamics	8%	8	5
4.	Turning effect of forces	19%	19	10
5.	Forces and Matter	8%	8	5
6.	Gravitation	8%	8	5
7.	Energy Sources and Transfer of Energy	13%	13	7
8.	Properties of Matter	6%	7	5
9.	Thermal properties of matter	11%	10	8
		100%	**100**	**60**
		PART-II		
10.	General Wave Properties	10%	9	6
11.	Sound	10%	9	6
12.	Electromagnetic Spectrum	5%	6	4
13.	Geometrical optics	10%	19	8
14.	Electrostatics	12%	17	6
15.	Current electricity	14%	21	6
16.	Electromagnetism	14%	15	5
17.	Introductory electronics	10%	15	6
18.	Information & communication Technology	5%	9	4
19.	Atomic Physics	5%	7	5
18.	Radioactivity	5%	13	4
		100%	**140**	**60**

OBJECTIVES OF ASSESSMENT

The Investigation Skills/ Laboratory work appropriate to physics are broadly categorized as:

- **a. Knowledge with understanding and its applications.**
- **b. Handling information and problem solving.**
- **c. Experimental Investigation Skills/ Laboratory work and investigations.**

The objectives of the examination are to assess students' abilities;

a. Knowledge, understanding and applications

The student should be able to:

1. Recall and understand the knowledge and principles of Physics set out in the syllabus.
2. Demonstrate the understanding of scientific vocabulary, terminology and units.
3. Apply the knowledge and principles of physics set out in the syllabus to explain simple phenomena or effects which are not already familiar to them.
4. Understand the application of Physics with their social, economic and environmental implications.

b. Handling information and solving problems

The students should be able to:

1. Search, select, understand and interpret scientific information from a variety of sources, including everyday experience.
2. Present and communicate scientific information in appropriate forms.
3. Translate information from one form to another.
4. Draw graphs and interpret information from them.
5. Manipulate numerical and other data.
6. Apply the knowledge and principles of physics set out in the syllabus to solve problems involving familiar or unfamiliar situation.

c. **Experimental Investigation Skills/ Laboratory work and investigation**

The student should be able to:

1. Understand the use of scientific instruments and apparatus, including techniques of operation, essential precautions and safety aspects.
2. Make and record observations, measurements and estimates with due regard to precision, accuracy and units.
3. Analyze and interpret information and result obtained in scientific investigation and practical work, identify patterns and trends, and draw valid conclusion.

ASSESSMENT METHODS

1. The **selected response (SRQ/ MCQs) -** 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 questions (CRQs)** 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.

3. **Extended response questions (ERQs)** allow greater freedom in response. An extended response item is an open-ended question that begins with some type of prompt. These questions allow students to write a response that arrives at a conclusion based on their specific knowledge of the topic.

Assessment Pattern IX-X (Physics)

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

Syllabus percentage / Weightage

PART-I		
Section 1 General Physics	Chapter 1	5%
Section 2 Newtonian Mechanics	Chapter 2-7	75 %
Section 3 Energy and thermal Physics	Chapter 8-9	20 %
PART-II		
Section 4 Waves	Chapter 10-13	40 %
Section 5 Electricity & Magnetism	Chapter 14-16	30 %
Section 6 Electronics and communication	Chapter 17-18	15%
Section 7 Atomic Physics	Chapter 19-20	15%

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 understanding of the whole syllabus and should test the following range of abilities.

Knowledge (10%) and understanding (50%)	**60%**
Higher abilities (handling information, Applications, and problem solving etc.)	**40%**

Examination pattern

Each year at the end of part-I and part-II, the students will be assessed through three examination papers. Paper-1 and paper-2 will be conducted in examination hall in single sitting. Whereas paper-3 will be conducted in physics laboratory.

Detailed description is given below:

FINAL / ANNUAL EXAMINATION (Part-I)	
Paper – 1 **Section – A 20%** (MCQs/ SRQs) Half an hour	20 compulsory objective questions. This may include MCQs / SRQs of various types to evaluate abilities and Investigation Skills as detailed in Assessment objectives (a) and (b).
Paper - 2 2½ hour **Section-B 40%** **(CRQs)**	This paper should consist of two sections. Section-B should contain eight compulsory constructed response questions (CRQs) to provide syllabus coverage and may consist of variable marks value to be answered in the space provided in the answer booklet
Section-C 25% **(ERQs)**	Section-C should contain 3 explanatory response questions (ERQs) which may include choice of attempting 2 questions. Any calculations required should be simple and direct.
Paper – 3 2 hours Practical test / alternate to practical	One practical exercise from a choice of two alternatives based to test the experimental and Investigation Skills/ Laboratory work as given in assessment objectives (c). **<u>OR</u>** Alternate to the practical will be designed for those centers where the lab facilities are not available / not well prepared. The alternate to practical paper consists of four or five questions relating to practical physics candidates will demonstrate his learning by responding to the answer on the question paper in the specified space.
Part-II **NOTE:** Part-II, Paper 1,paper 2 and paper 3 all Will have the same structure as detailed above for examination of part-I	

Note:

(i) Assessment pattern is subject to the requirement, policies, and procedures of approved government policies.

(ii) Question paper will be based on the curriculum not on a particular textbook.

(iii) Questions involving unfamiliar contexts or daily life experiences may be set to asses candidates' problem-solving and higher-order processing Investigation Skills. In answering such questions, sufficient information will be given for candidates to understand the situation or context. Candidates are expected to apply their knowledge and Investigation Skills included in the syllabus to solve the problems.

(iv) In general, SI units and terminology will be used.

(v) It is suggested that in addition to external examination, the teacher should valuate class work on completion of each lesson/unit. Four more internal school examinations during the course should be conducted which may not be of more than one-week duration each

GLOSSARY OF TERMS

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.

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

2. **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.

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

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

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

6. **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.

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

8. **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.

9. **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'.

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

11. **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.

12. **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 modulus, relative molecular mass.

13. **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.

14. **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.

15. **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.

16. **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.

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

PART-III

- ⇨ **INSTRUCTIONS AND SUGGESTIONS**
- ⇨ **GUIDELINES TO TEXTBOOK AUTHORS**
- ⇨ **CONCEPT MAPPING**
- ⇨ **TEACHING METHODOLOGIES AND STRATEGIES**
- ⇨ **THE LEARNING PYRAMID**
- ⇨ **PROFESSIONAL DEVELOPMENT OF TEACHERs**

GUIDELINES TO TEXTBOOK 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. Keeping this strategy in view, the author should observe the following guidelines while writing the textbooks.

1. Student learning outcomes (SLOs) 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.
5. Provide transition from previous information covered and new information presented. This should be achieved by providing review of the linked topics using text boxes on the right margin of the page.
6. Link with future information should be given at the end of topic in page bottom by mentioning topics along with section number.
7. A summary of every chapter should be included before the concept map.
8. Concept map for each chapter should be developed by author and will be subject to approval of review committee.
9. At the end of every chapter concept map should be given. A sample of concept map of the chapter to be provided to the author even though he/she wants to create a novel concept map then it is allowed but it is subject to the approval of review committee.
10. Assessment questions at the end of each section should be included. These questions must be simple and thought provoking.
11. At the end of each chapter questions and problems should be included section wise.
12. All questions should be very appropriately and clearly worded/constructed to test varying abilities and Investigation Skills on the basis of Bloom's taxonomy.
13. Author will also provide solutions of end of the section and end of the chapter questions that will be included in the teacher's guide.
14. The amount of information to be covered by the chapter must match the number of hours of instructional time.
15. 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.

16. 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.

17. The text should be supported with art i.e. illustrations and photographs possibly in colors which should be clear, properly labeled and captioned to make the substance interesting and stimulating.

18. Concepts, information and examples should match the sequence and content of learning outcomes.

19. Examples and applications from local environment should be preferred.

20. 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.

21. Answers to the numerical problems should be quoted in scientific notation with correct number of significant figures and units.

22. 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.

23. Interesting sidelights such as case studies, discoveries, related technologies etc. may be given in the form of "boxed essays".

24. Tables, flow charts/diagrams and concept maps may be given wherever appropriate.

25. Reference of the experiments given in the practical manual should be made with the related topics given in the text.

26. Coherent and precise summary should be given at the end of each chapter.

27. A comprehensive glossary of terms and index should be given at the end of the book.

28. The teacher's guide and workbooks should also be developed along with 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.

29. A practical manual for the students should also be written to support practical work.

CONCEPT MAPPING

A particularly good way to organize information about a problem or subject is to construct a "concept map." Construction of concept maps helps us pull together information we already know about a subject and understand new information as we learn. It is versatile tool for assisting and enhancing many of the types of thinking and learning that we are required to do.

Concept mapping helps students fulfill high-quality and meaningful learning outcomes in science. Maps provide concrete visual aids to help organize information before it is learned. Students can make their own maps while they learn and examine the changes in their thinking as they construct their understanding. Maps can also be made as a type of assessment at the conclusion of lessons.

Concept maps show a definite relationship between big ideas and small ideas, thus clarifying the difference between details or specifics and the big idea or subordinate concept. This can be helpful when a teacher must decide how much emphasis to give to specific facts as compared to concepts in a lesson.

The concept maps also provide visual imagery that can help students recall information and see relationships between concepts. Concept maps show hierarchies of ideas that suggest psychologically valid sequences. These hierarchies may not match the linear sequence, or outline, that a teacher has decided to use for a presentation.

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.

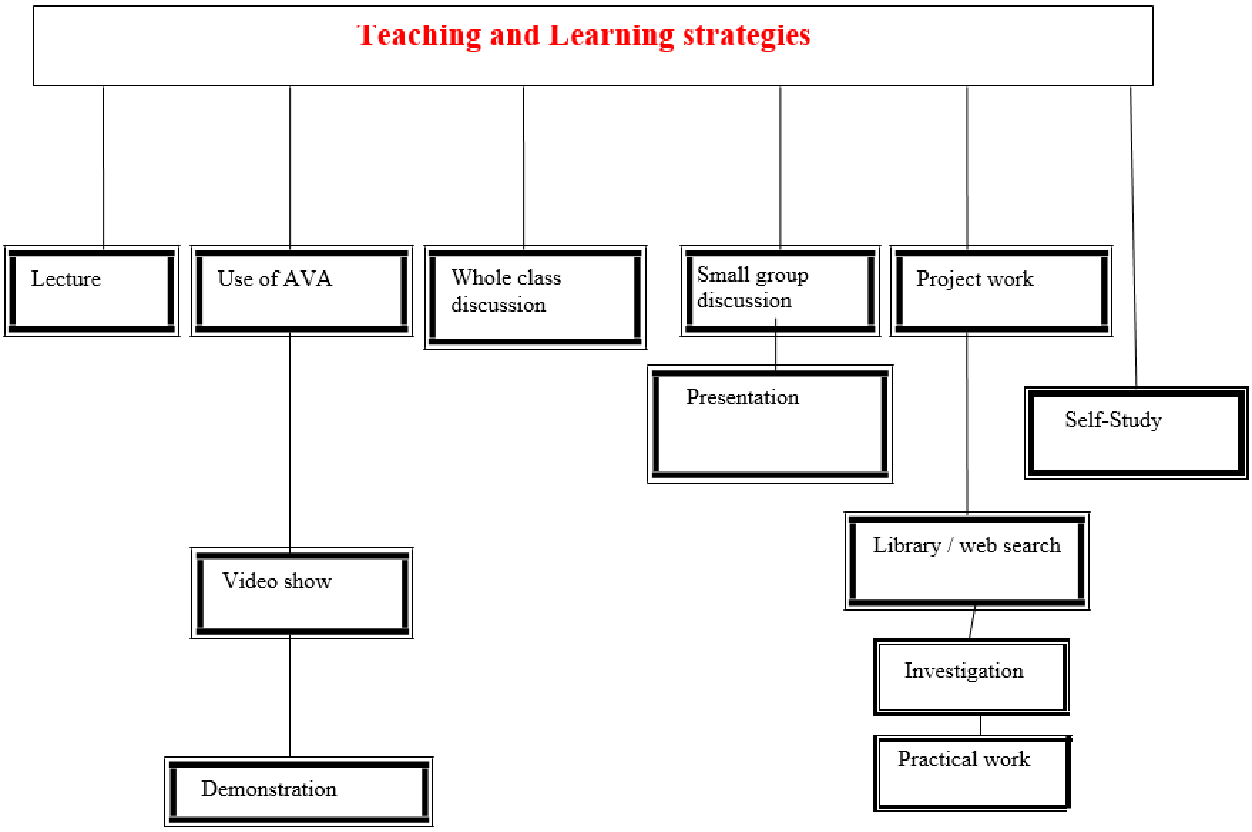
An investigation approach to practical work is essential. Individual student project promotes creativity and demonstrate the students' mastery of scientific principles involved. Independent use of apparatus by the students develop manipulative Investigation Skills. The development of psychomotor Investigation 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 centred 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 outcomes to be achieved
- Ability of student
- Subject matter
- Availability of resources; and
- Amount of time available

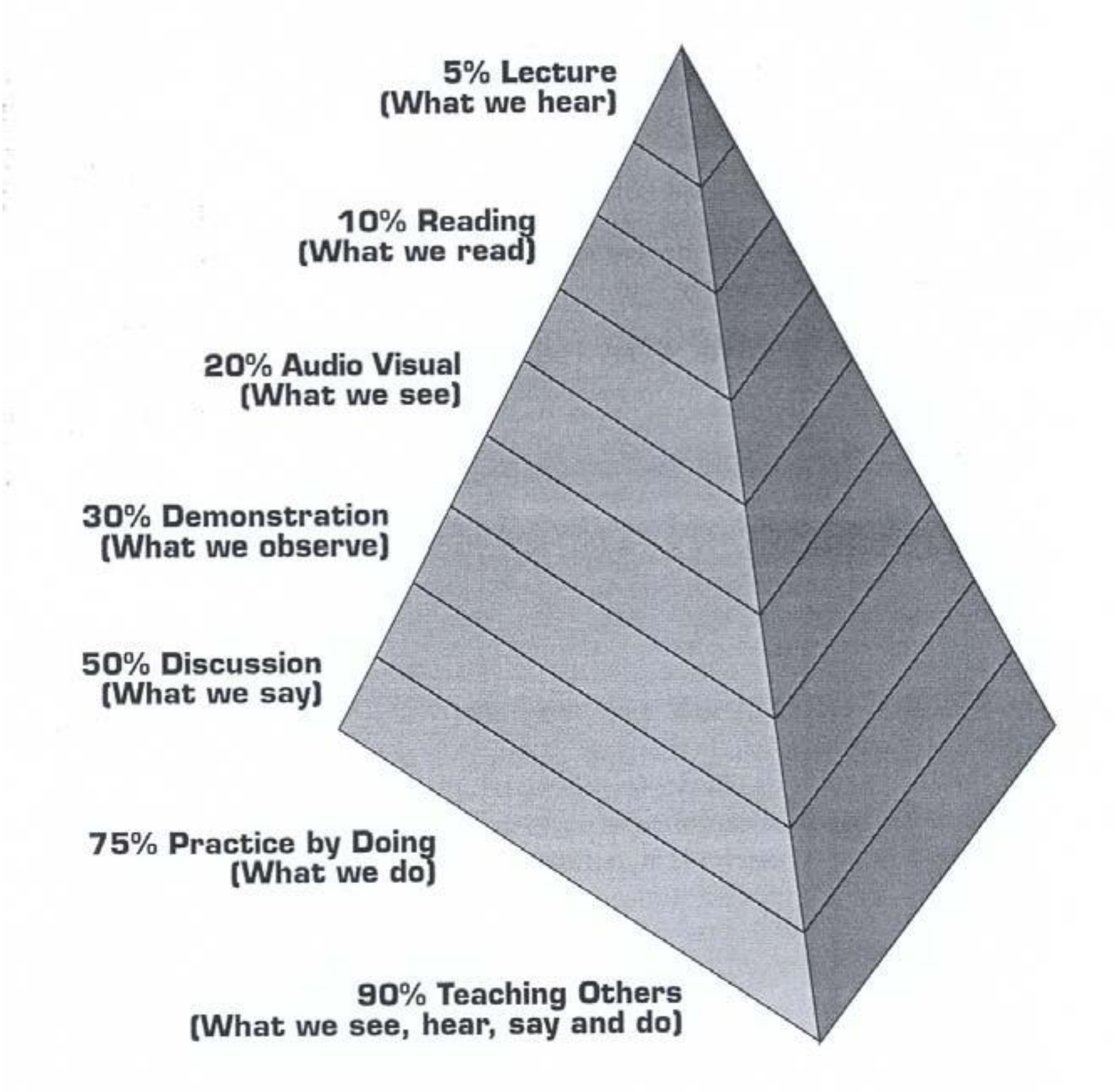
Role of E-media: knowledge and technology need to be shared freely on electronic media. It is time to look to the potential of ICT and digital technology beyond just the traditional technological sense.

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 question

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.

1. 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.

2. Perform the demonstration
3. 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.

4. 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 findings in 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 best action.
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 accessed 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 Investigation Skills/ Laboratory work
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 centers. 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 Investigation Skills/ Laboratory work.

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, analyze and communicate scientific information.

PART IV

- ⇨ **SALIENT FEATURES OFPHYSICS CURRICULUM**
- ⇨ **NATIONAL CURRICULUM DEVELOPMENT TEAM**
- ⇨ **TEAM OF ADVISORS**
- ⇨ **PHYSICS CURRICULUM & TEXTBOOK REVIEW COMMITTEE SINDH**

SALIENT FEATURES OFPHYSICS CURRICULUM

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 along with 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.

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