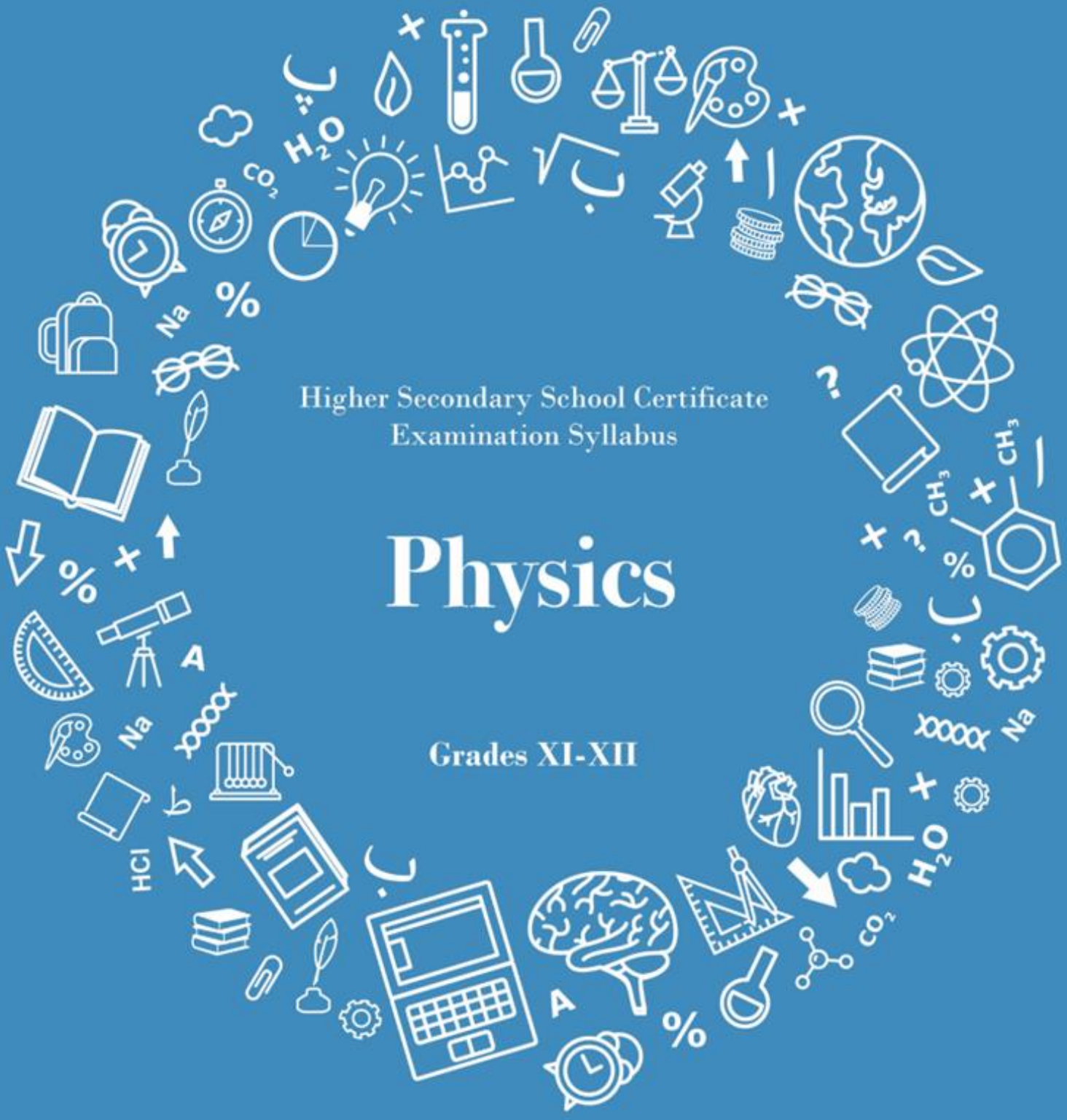
آغا خان یونیورسٹی ایگزامینیشن بورڈ

AGA KHAN UNIVERSITY EXAMINATION BOARD



Higher Secondary School Certificate
Examination Syllabus

Physics

Grades XI-XII

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Block - C, IED - PDC, 1-5/B-VII
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Higher Secondary School Certificate Examination Syllabus

PHYSICS

GRADES XI-XII

This syllabus will be examined in both Annual and Re-sit Examination sessions from Annual Examinations 2023

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For queries and feedback

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Preface

Established in 2002 through the Pakistan government's ordinance, the Aga Khan University Examination Board (AKU-EB) is country's first private autonomous qualification awarding body for secondary (SSC) and higher secondary (HSSC) school certifications. Its vision is to be a model of excellence and innovation in education in Pakistan and the developing world.

AKU-EB achieves its vision by developing examination syllabi which inculcate conceptual thinking and higher order learning and are aligned with National/ trans-provincial curricula and international standards. AKU-EB revises its syllabi periodically to support the needs of students, teachers and examiners.

The aims of the syllabus review of SSC and HSSC are to:

- Ensure continued compatibility with the goals of the trans-provincial curricula of Pakistan.
- Review the content for inclusion of new knowledge and deletion of obsolete knowledge.
- Review the content for clarity and relevance as per the changing needs of students, teachers and examiners.
- Enhance and strengthen continuation and progression of content both within and across grades IX - XII (SCC and HSSC).
- Ensure the readiness of students for higher education.

During the syllabus review, the needs of all the stakeholders were identified through a needs-assessment survey. Students and teachers of AKU-EB affiliated schools from across Pakistan participated in the survey. Thereafter, a revision panel, which consisted of examiners, teachers of affiliated and non-affiliated schools, teacher trainers and university academicians, reviewed and revised the syllabus following a planned, meticulous and standardised syllabi review process.

The syllabus is organised into topics and subtopics. Each subtopic is further divided into achievable student learning outcomes (SLOs). The SLOs of the cognitive domain are each assigned a cognitive level on which they have to be achieved. These cognitive levels are 'knowledge', 'understanding' and 'application', the latter also including other higher order skills. This is followed by the Exam Specification which gives clear guidance about the weightage of each topic and how the syllabus will be assessed.

The development of the revised syllabus has been made possible by the creativity and relentless hard work of Curriculum and Examination Development unit and the constant support provided by all the other units of AKU-EB. We are particularly thankful to Dr Sohail Qureshi for his very useful feedback on revising the syllabus review process, to Dr Naveed Yousuf for his continued guidance and support throughout the syllabus revision process and to Raabia Hirani for leading the syllabi revision. We are also thankful to all the students and teachers who took part in the needs-assessment survey and to the principals of AKU-EB affiliated schools who made this endeavour possible by facilitating and encouraging their teachers to be a part of the survey and the syllabus revision panel.

With your support and collective hard work, AKU-EB has been able to take the necessary steps to ensure effective implementation of the best international and trans-provincial standards through this syllabus. We are confident that this syllabus will continue to provide the support that is needed by students to progress to the next level of education and we wish the very best to our students and teachers in implementing this syllabus.

Dr Shehzad Jeeva
Chief Executive Officer (CEO), Aga Khan University Examination Board
Associate Professor of Practice, Faculty of Arts and Sciences, Aga Khan University

Understanding of AKU-EB Syllabi

1. The AKU-EB syllabi guide the students, teachers, parents and other stakeholders regarding the topics that will be taught and examined in each grade (IX, X, XI and XII). In each syllabus document, the content progresses from simple to complex, thereby, facilitating a gradual, conceptual learning of the content.

2. The topics of the syllabi are divided into subtopics and **student learning outcomes (SLOs)**. The subtopics and the SLOs define the depth and the breadth at which each topic will be taught, learnt and examined. The syllabi also provide enabling SLOs where needed to scaffold student learning.

3. Each SLO starts with an achievable and assessable **command word** such as describe, relate, evaluate, etc. The purpose of the command words is to direct the attention of teachers and students to specific tasks that the students are expected to undertake in the course of their studies. The examination questions are framed using the same command words or their connotations to elicit evidence of these competencies in students' responses.

4. The topics of the syllabi are grouped into themes derived from the National/ trans-provincial curricula. The connection between various themes and topics is highlighted in the '**concept map**' provided at the beginning of each syllabus. This ensures that students begin to understand the interconnectedness of knowledge, learn conceptually and think critically.

5. The SLOs are classified under three **cognitive levels**: knowledge (K), understanding (U) and application and other higher order skills (A) for effective planning during teaching and learning. Furthermore, it will help to derive multiple choice questions (MCQs), constructed response questions (CRQs) and extended response questions (ERQs) on a rational basis from the subject syllabi.

6. By focusing on the achievement of the SLOs, these syllabi aim to counter the culture of rote memorisation as the preferred method of examination preparation. While suggesting relevant, locally available textbooks for achieving these outcomes, AKU-EB recommends that teachers and students use multiple teaching and learning resources for achieving these outcomes.

7. The syllabi follow a uniform layout for all subjects to make them easier for students and teachers to follow. They act as a bridge between students, teachers and assessment specialists by providing a common framework of student learning outcomes and **exam specifications**.

8. On the whole, the AKU-EB syllabi for Secondary School Certificate (SSC) provide a framework that helps students to acquire conceptual understanding and learn to critically engage with it. This lays a solid foundation for HSSC and beyond.

Subject Rationale of AKU-EB Physics

What will you learn in AKU-EB Physics?

Physics is the most fundamental branch of experimental sciences, as it explains everything from the very smallest particles of matter, i.e. quarks and leptons, to the vast distances between millions and billions of galaxies and the milky ways. Through a systematic study of the smallest and the largest phenomena, and everything in between, which has been discovered to-date regarding matter and energy, it opens doors for exploring the yet unknown realms.

As Physics is based on theoretical and as well as a practical approach, therefore, learners in this subject have opportunities to design, construct, investigate, collect and interpret purposeful data, analyse the findings and communicate results. These investigations of the learners in this subject can be inside or outside laboratory.

It provides a combination of content, methodology and cognitive skills which enhances the students' abilities to think conceptually and critically and solve real-life problems.

Where will it take you?

After studying AKU-EB Physics, students will be able to pursue the following career fields:

- Electronic Engineering
- Civil Engineering
- Electrical Engineering
- Petroleum Engineering
- Renewable Energy Researcher
- Medical Physics
- Geophysics
- Astrophysics
- Mechanical Engineering
- Software Engineering
- Automobile Engineering
- Textile Engineering

And many other related fields.

How to approach the syllabus?

The concept map of the syllabus gives an overview of the entire syllabus. The topics and the student learning outcomes (SLOs) guide regarding the details about what has to be achieve. And finally, the exam specification guides regarding what will be expected in the examination.

What is the concept map telling you?

The electromagnetic spectrum is an important part of Modern Physics. It provides us information about different forms of electromagnetic rays. The electromagnetic spectrum consists of Radiowaves, Microwaves, Infrared, Visible light, Ultraviolet, X-Rays, gamma rays and Cosmic rays. The AKU-EB HSSC Physics concept map represents the different themes (topic-clusters) of Physics as various forms of electromagnetic rays. Different ranges show the close linkage among different themes and sub-themes (individual topics) of Physics.

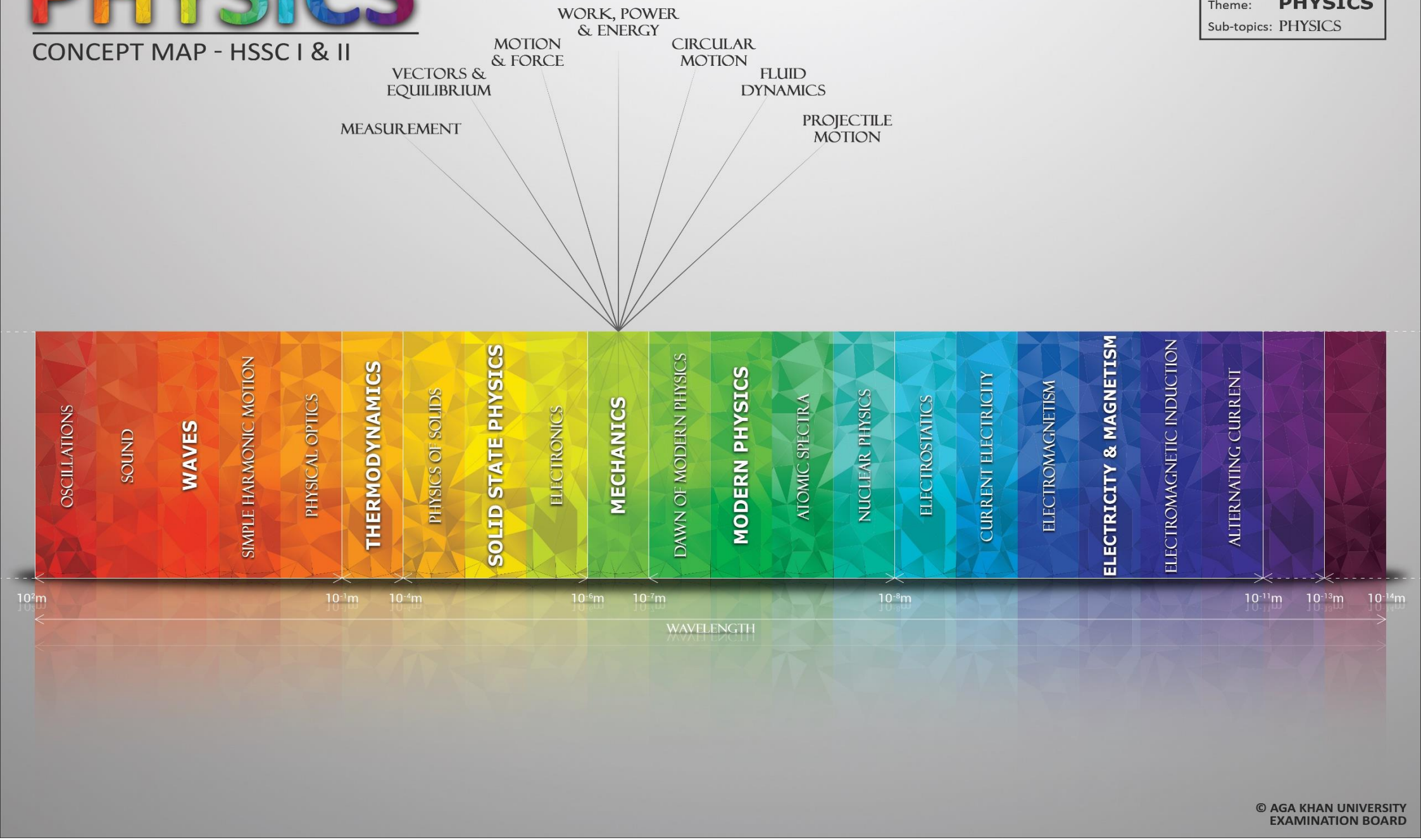
PHYSICS

CONCEPT MAP - HSSC I & II

Map Key

Theme: **PHYSICS**

Sub-topics: PHYSICS



Student Learning Outcomes of AKU-EB HSSC Physics Syllabus

Part I (Grade XI)

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels[1]		
				K	U	A
1.	**Measurement**	Students should be able to:				
1.1	Scope of Physics	1.1.1	describe the importance of physics in space technology, nano-technology, aero-dynamics, medical physics, thermodynamics and solid state physics;		*	
1.2	International System (SI) Units	1.2.1	define the following: a. SI base units, b. derived units, c. supplementary units;	*		
		1.2.2	identify the components of SLO 1.2.1 (a, b and c) for the various measurements;		*	
		1.2.3	show the derived units as products or quotients of the base units;			*
1.3	Errors and Uncertainty	1.3.1	differentiate between systematic and random errors;		*	
		1.3.2	solve word problems related to the uncertainty in the derived quantity;			*
1.4	Precision and Accuracy	1.4.1	define precision and accuracy;	*		
		1.4.2	differentiate between precision and accuracy;		*	
1.5	Significant Figures	1.5.1	solve word problems using scientific notations and with correct number of significant figures;			*
		1.5.2	recognise that the least count (LC) of an instrument is the smallest measurable value of that instrument;		*	

[1] K = Knowledge, U = Understanding, A = Application and other higher-order cognitive skills

Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
1.6	Dimensions	1.6.1	describe the concept of dimensions using mass, length and time;		*	
		1.6.2	show the homogeneity of physical equations by using dimensions and basic units;			*
		1.6.3	derive formula for physical quantities by using dimensions.			*

Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
2.	**Vectors and Equilibrium**	Students should be able to:				
2.1	Cartesian Coordinate System	2.1.1	describe the Cartesian coordinate system in two and three dimension systems;		*	
2.2	Addition of Vectors by Head to Tail Rule	2.2.1 2.2.2 2.2.3	explain the sum of vectors using head to tail rule; define resultant, negative, unit, null, position and equal vectors; analyse a vector into its rectangular components;	* 	* 	 *
2.3	Addition of Vectors by Rectangular Component Method	2.3.1	explain the sum of vectors using perpendicular components;		*	
2.4	Scalar Product of Two Vectors	2.4.1 2.4.2 2.4.3	define scalar product of two vectors; exemplify the scalar product of two vectors in terms of angle between them; describe properties of scalar product of two vectors;	*	 * *	
2.5	Vector Product of Two Vectors	2.5.1 2.5.2 2.5.3	define vector product of two vectors; exemplify vector product of two vectors in terms of angle between them; describe properties of vector product;	*	 * *	
2.6	Torque	2.6.1 2.6.2	describe torque as a vector product of $\vec{r} \times \vec{F}$; discuss applications of torque;		* *	
2.7	Equilibrium of Forces	2.7.1 2.7.2	define equilibrium and its types; describe first and second conditions of equilibrium with the help of examples from daily life.	*	 *	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
3.	**Motion and Force**	Students should be able to:				
3.1	Displacement	3.1.1	define displacement;	*		
3.2	Velocity	3.2.1	define velocity, average velocity and instantaneous velocity;	*		
		3.2.2	define acceleration, average acceleration and instantaneous acceleration;	*		
		3.2.3	interpret velocity-time graph for constant direction;			*
		3.2.4	calculate area under velocity-time graph;			*
		3.2.5	analyse the significance of area under velocity-time graph;			*
3.3	Acceleration	3.3.1	explain the equations of motion a. for uniformly accelerated bodies in a straight line, b. in uniform gravitational field in a non-resistive medium;		*	
3.4	Laws of Motion	3.4.1	describe Newton's laws of motion;		*	
3.5	Force, Momentum and Impulse	3.5.1	relate the rate of change of momentum with Newton's 2nd law of motion;		*	
		3.5.2	infer impulse as product of impulsive force and time;			*
		3.5.3	describe law of conservation of momentum;		*	
		3.5.4	apply law of conservation of momentum and study the special cases of elastic collision between two bodies in one dimension;			*
		3.5.5	describe the force produced due to flow of water;		*	
		3.5.6	apply the law of conservation of momentum to study explosive forces;			*
		3.5.7	explain interaction of forces during rocket propulsion;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive levels		
			K	U	A
	Students should be able to:				
3.6 Projectile	3.6.1	define the following: a. projectile, b. projectile motion, c. trajectory of projectile;	*		
	3.6.2	describe projectile motion in non-resistive medium;		*	
	3.6.3	derive the relation for a. time of flight, b. maximum height, c. horizontal range of a projectile;			*
	3.6.4	solve word problems related to the above relations (a, b and c);			*
	3.6.5	exemplify projectile motion through the motion of ballistic missiles.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
4.	**Work, Power and Energy**	Students should be able to:				
	4.1 Work	4.1.1	define work as the cross-product of force and displacement;	*		
		4.1.2	describe work when force and displacement are acting at an angle (θ);		*	
		4.1.3	list different units of work done;	*		
		4.1.4	distinguish between positive, negative and zero work done with examples;		*	
		4.1.5	describe work done by variable and constant forces;		*	
	4.2 Work Done in a Gravitational Field	4.2.1	explain the work done in a gravitational field;		*	
	4.3 Power	4.3.1	define power as the rate of doing work;	*		
		4.3.2	list different units of power;	*		
		4.3.3	derive the formula of power in terms of force and velocity and use it in solving word problems;			*
	4.4 Energy	4.4.1	define energy;	*		
		4.4.2	list different units of energy;	*		
		4.4.3	differentiate between potential and kinetic energy;		*	
	4.5 Work-Energy Relation	4.5.1	deduce the relationship between energy and work a. when friction is present, b. when friction is not present;			*
	4.6 Absolute Gravitational Energy	4.6.1	analyse the absolute gravitational energy;			*
		4.6.2	derive an expression for absolute potential energy (PE);			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
4.7	Escape Velocity	4.7.1 4.7.2 4.7.3	describe the concept of escape velocity; derive the formula for escape velocity; calculate escape velocity for the Moon and the Earth when mass and radius of the bodies are given and use this formula for solving word problems;		* 	 * *
4.8	Conservation of Energy	4.8.1 4.8.2	explain the law of conservation of energy; derive potential energy and kinetic energy in a resistive medium;		*	*
4.9	Types of Energy Sources	4.9.1 4.9.2	list the types of conventional and non-conventional energy sources; describe the uses of energy in different fields.	*	 *	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
5.	**Circular Motion**	Students should be able to:				
5.1	Angular Motion	5.1.1	define angular displacement, angular velocity and angular acceleration;	*		
		5.1.2	discuss the relation between linear and angular displacement, velocity and acceleration;		*	
5.2	Centripetal Force and Centripetal Acceleration	5.2.1	define centripetal force and centripetal acceleration;	*		
		5.2.2	derive centripetal acceleration when speed is uniform;			*
		5.2.3	relate centripetal acceleration with angular velocity;		*	
5.3	Moment of Inertia	5.3.1	define moment of inertia and state its SI unit with dimension;	*		
5.4	Angular Momentum	5.4.1	define angular momentum and state its SI unit with dimension;	*		
		5.4.2	explain the law of conservation of angular momentum;		*	
5.5	Rotational Kinetic Energy	5.5.1	define rotational kinetic energy;	*		
		5.5.2	derive an expression for rotational kinetic energy and use this expression for solving word problems;			*
5.6	Artificial Satellites and Weightlessness	5.6.1	describe reasons for weightlessness in artificial satellites;		*	
		5.6.2	relate free fall motion with orbital motion of satellites;		*	
		5.6.3	classify different types of satellites;		*	
		5.6.4	define geostationary orbits;	*		
		5.6.5	derive an expression for geostationary altitudes and solve problems based on this expression;			*
		5.6.6	explain how artificial gravity can be produced when a satellite revolves around the Earth;		*	
5.7	Orbital Velocity	5.7.1	define orbital velocity;	*		
		5.7.2	derive a relation for orbital velocity and use this relation for solving word problems.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
6.	**Fluid Dynamics**	Students should be able to:				
6.1	Streamline and Turbulent Flow	6.1.1	define the following terms: a. streamline flow, b. turbulent flow;	*		
		6.1.2	state the conditions required for turbulent flow;	*		
6.2	Equation of Continuity	6.2.1	derive the equation of continuity;			*
		6.2.2	describe the motion of a rocket using the equation of continuity;		*	
		6.2.3	solve word problems related to the equation of continuity;			*
6.3	Bernoulli's Equation	6.3.1	derive Bernoulli's equation;			*
		6.3.2	apply Bernoulli effect in the flow of air over an aerofoil, venturi meter and atomizers;			*
		6.3.3	solve word problems using Bernoulli's equation;			*
6.4	Viscous Fluids and Fluid Friction	6.4.1	define the following terms: a. viscous fluids, b. non-viscous fluids;	*		
		6.4.2	describe that viscous force in a fluid causes a retarding force on an object moving through it;		*	
		6.4.3	define fluid friction;	*		

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
6.5	Fluid Friction and Terminal Velocity	6.5.1	define terminal velocity;	*		
		6.5.2	describe the factors on which terminal velocity depends;		*	
		6.5.3	state Stoke's law;	*		
		6.5.4	derive an expression for terminal velocity of spherical body falling through viscous fluids by using Stoke's law;			*
		6.5.5	apply dimensional analysis to confirm the form of the Stoke's law.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
7.	**Oscillations**	Students should be able to:				
7.1	Simple Harmonic Motion (SHM)	7.1.1	derive an expression for acceleration of a body vibrating under elastic restoring force;			*
7.2	Uniform Circular Motion and SHM	7.2.1 7.2.2	discuss SHM in uniform circular motion; derive expression for instantaneous displacement, velocity and acceleration in terms of (ω);		*	 *
7.3	Phase Angle	7.3.1	define phase angle;	*		
7.4	A Horizontal Mass-Spring System	7.4.1	derive an expression for instantaneous velocity in case of horizontal mass-spring system;			*
7.5	Simple Pendulum	7.5.1 7.5.2 7.5.3	show the motion of a simple pendulum is SHM; derive an expression for the time period of a simple pendulum; solve word problems using the expression for the time period of a simple pendulum;			* * *
7.6	Energy Conservation in SHM	7.6.1	relate potential energy (PE) and kinetic energy (KE) with total energy for a body oscillating with SHM;		*	
7.7	Free and Forced Oscillation	7.7.1	exemplify free and forced oscillation;		*	
7.8	Resonance	7.8.1	exemplify resonance;		*	
7.9	Damped Oscillations	7.9.1 7.9.2	explain damped oscillation; list different applications of damped oscillation.	 *	*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
8.	**Waves**	Students should be able to:				
	8.1 Wave Motion	8.1.1	describe periodic waves;		*	
		8.1.2	exemplify the propagation of waves;		*	
		8.1.3	define progressive waves;	*		
		8.1.4	explain energy transfer through a progressive wave;		*	
		8.1.5	differentiate between transverse and longitudinal waves;		*	
		8.1.6	solve word problems using $V = f\lambda$;			*
	8.2 Speed of Sound	8.2.1	relate the speed of sound with the properties of the medium in which it propagates;		*	
		8.2.2	describe Newton's formula for the speed of sound;		*	
		8.2.3	discuss Laplace's correction to Newton's formula;		*	
		8.2.4	explain the effects of pressure, density and temperature on the speed of sound in air;		*	
		8.2.5	show the expression $V = V_o + 0.61\ t$;			*
	8.3 Superposition of Waves	8.3.1	state the principle of superposition of two waves;	*		
		8.3.2	describe the phenomenon of interference of sound waves;		*	
		8.3.3	explain the formation of beats using diagrams;		*	
	8.4 Stationary Waves	8.4.1	describe the formation of stationary waves using graphs;		*	
		8.4.2	define the terms nodes and antinodes;	*		
		8.4.3	describe the formation of stationary waves in a string;		*	
		8.4.4	classify the harmonic overtones in a string;		*	
		8.4.5	identify the formation of stationary waves in a vibrating air column;		*	
		8.4.6	solve word problems using $L = n\lambda / 2$;			*

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
8.5	Doppler's Effect	8.5.1	define Doppler's effect;	*		
		8.5.2	derive the relation between the original frequency of source of sound and the apparent frequency detected by the listener in following conditions: i. When the source is at rest and the listener is moving towards or away from the source. ii. When the listener is at rest and the source is moving towards or away from the listener. iii. Both source and listener are moving towards each other. iv. Both source and listener are moving away from each other;			*
		8.5.3	solve word problems using the above relations;			*
		8.5.4	explain the application of Doppler's effect in electromagnetic waves;		*	
		8.5.5	apply Doppler's effect to understand the working of radar, sonar, satellites and red and blue shifts.			*

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
9.	**Physical Optics**	Students should be able to:				
	9.1 Nature of Light	9.1.1	discuss different points of view about nature of light;		*	
		9.1.2	discuss the concept of wave-front;		*	
		9.1.3	describe Huygen's principle;		*	
		9.1.4	relate linear superposition of light with Huygen's principle;		*	
	9.2 Interference of Light	9.2.1	describe coherent sources of light;		*	
		9.2.2	define interference of light;	*		
		9.2.3	state conditions necessary for the interference of light;	*		
		9.2.4	explain Young's double slit experiment;		*	
		9.2.5	derive relation for fringe spacing and use the relation in solving word problems;			*
	9.3 Interference in Thin Films	9.3.1	describe basic concept of interference in thin films;		*	
	9.4 Newton's Ring	9.4.1	exemplify the formation of Newton's rings;		*	
	9.5 Michelson's Interferometer	9.5.1	describe the working and uses of Michelson's interferometer;		*	
	9.6 Diffraction of Light	9.6.1	define diffraction of light;	*		
		9.6.2	describe diffraction of light by diffraction grating;		*	
		9.6.3	describe diffraction in a narrow slit;		*	

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
9.7	Bragg's Law	9.7.1	define Bragg's law;	*		
		9.7.2	describe X-rays diffraction through crystals;		*	
		9.7.3	describe the applications of X-rays diffraction in medical physics;		*	
		9.7.4	derive the equation $2\,d\,\sin\theta = m\,\lambda$ and use this equation for solving word problems;			*
9.8	Polarisation	9.8.1	describe unpolarised and polarised light;		*	
		9.8.2	explain polarisation with reference to transverse waves;		*	
		9.8.3	explain the production of polarisation by a polaroid;		*	
		9.8.4	describe the applications of polarisation in daily life.		*	

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
10. Thermodynamics		Students should be able to:				
10.1	Kinetic Theory of Gases	10.1.1	state basic postulates of kinetic theory of gases;	*		
		10.1.2	calculate pressure on a gas molecule inside a gas container;			*
		10.1.3	interpret temperature in terms of kinetic energy;			*
10.2	Gas Laws	10.2.1	derive Boyle's and Charles's law with the help of kinetic theory of gases;			*
10.3	Internal Energy	10.3.1	explain that internal energy is function of 'state' and is independent of paths;		*	
10.4	Work and Heat	10.4.1	describe the forms of energy transfer between systems, i.e. heat flow and work done;		*	
		10.4.2	explain work in terms of change in volume;		*	
		10.4.3	solve word problems related to the work done in thermodynamics system during a volume change;			*
10.5	Thermodynamics	10.5.1	define the 'thermodynamics' and 'thermal equilibrium';	*		
		10.5.2	explain the 1st law of thermodynamics;		*	
		10.5.3	apply the 1st law of thermodynamics in (a) isothermal, (b) adiabatic, (c) isobaric, (d) isochoric processes;			*
		10.5.4	calculate on the basis of the 1st law of thermodynamics a. change in internal energy, b. work done on the system, c. work done by the system;			*
		10.5.5	explain the 1st law of thermodynamics in terms of conservation of energy;		*	

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
10.6	Specific and Molar Specific Heat of Gases	10.6.1 10.6.2 10.6.3	define the terms specific heat and molar specific heat; explain $C_p > C_v$ show that $C_p - C_v = R$ by using 1st law of thermodynamics;	*	*	*
10.7	Reversible and Irreversible Process	10.7.1	compare reversible and irreversible reactions;		*	
10.8	Second Law of Thermodynamics	10.8.1	explain the 2nd law of thermodynamics using schematic diagram;		*	
10.9	Carnot Engine	10.9.1 10.9.2 10.9.3	describe heat engine with reference to the 2nd law of thermodynamics; explain the working principle of Carnot engine with its four processes with PV diagram; derive the formula for efficiency of Carnot engine and use it in solving word problems;		* *	*
10.10	Refrigerator	10.10.1 10.10.2	describe refrigerator as a reverse of heat engine; derive expression for the coefficient of performance of a refrigerator;		*	*
10.11	Entropy	10.11.1 10.11.2 10.11.3 10.11.4	explain 'entropy'; describe positive and negative entropy; explain that increase in entropy is an evidence of increase in temperature of a system; discuss environmental crisis as an entropy crisis.		* * *	

Part II (Grade XII)

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
11. Electrostatics		Students should be able to:				
11.1	Electrostatics	11.1.1	describe charge and types of charge;		*	
11.2	Coulomb's Law	11.2.1	explain Coulomb's law for static charges;		*	
		11.2.2	describe the effect of medium on Coulomb's force;		*	
		11.2.3	discuss the working of ink-jet printer and photocopier with reference to electrostatic;		*	
11.3	Electric Field and Electric Intensity	11.3.1	define electric intensity;	*		
		11.3.2	derive an expression for the magnitude of electric field of a distance or from a point charge "q" and use the expression in solving word problems;			*
		11.3.3	compare electric field lines formed when a. same charges are brought together, b. opposite charges are brought together;		*	
		11.3.4	describe the concept of electric dipole;		*	
11.4	Electric Flux	11.4.1	explain electric flux;		*	
11.5	Gauss's Law with its Applications	11.5.1	explain Gauss's law;		*	
		11.5.2	apply Gauss's law to find the electric field intensity produced a. due to a hollow charged spherical, b. due to an infinite sheet of charge, c. between two opposite charged parallel plates;			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
11.6	Electric Potential	11.6.1	describe electric potential at a point as work done in bringing a unit charge from infinity to that point;		*	
		11.6.2	state unit of electric potential;	*		
		11.6.3	describe electric field as potential gradient;		*	
		11.6.4	derive an expression for electric potential at a point due to a point charge;			*
		11.6.5	define electron volt (eV);	*		
		11.6.6	explain Millikan's method to measure the charge on an electron;		*	
11.7	Capacitor	11.7.1	evaluate capacitance of parallel plate capacitors in terms of area, distance and permittivity of free space;			*
		11.7.2	calculate capacitance of different capacitors in series and in parallel using formulae;			*
		11.7.3	describe the effects of resistance in charging and discharging of capacitors with the help of *q-t* graph;		*	
		11.7.4	describe time constant;		*	
		11.7.5	describe that the product of *RC* has the same unit as time $\tau = RC$;		*	
11.8	Energy Stored in a Capacitor	11.8.1	prove that energy stored in a capacitor is $W = ½ QV$ and $W = ½ CV^2$;			*
		11.8.2	explain polarisation of dielectric of a capacitor.		*	

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
12.	**Current Electricity**	Students should be able to:				
12.1	Current Electricity	12.1.1	define electric current;	*		
		12.1.2	describe the flow of current in a conductor;		*	
		12.1.3	distinguish between conventional and non-conventional current;		*	
12.2	Resistance	12.2.1	define resistance and conductance;	*		
		12.2.2	define voltage;	*		
		12.2.3	state Ohm's law;	*		
		12.2.4	explain factors affecting resistance;		*	
		12.2.5	explain non-ohmic relationship between current and voltage for semi-conductor diode and a filament lamp;		*	
12.3	Resistivity and Conductivity	12.3.1	define resistivity;	*		
		12.3.2	define conductivity;	*		
		12.3.3	differentiate between resistivity and conductivity;		*	
		12.3.4	derive a relation between resistance and resistivity;			*
		12.3.5	describe the relationship between temperature and resistance;		*	
		12.3.6	calculate the value of carbon resistance by using colour codes;			*
12.4	Internal Resistance	12.4.1	define electromotive force (e.m.f.);	*		
		12.4.2	derive a relationship between e.m.f. and potential difference (PD) with the help of formula;			*
		12.4.3	discuss examples of effect of internal resistance on external circuit in terms of current and voltage;		*	
		12.4.4	define electric power;	*		
		12.4.5	calculate the formula of power in terms of current (I), voltage (V) and resistance (R);			*

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
		12.4.6	calculate the power dissipation due to the internal resistance of a circuit;			*
12.5	Kirchoff's Laws	12.5.1 12.5.2 12.5.3	explain Kirchoff's laws; explain conservation of charge in a circuit with the help of Kirchoff's 1st law; explain conservation of energy in a circuit with the help of Kirchoff's 2nd law;		* * *	
12.6	Potential Divider	12.6.1 12.6.2 12.6.3	exemplify potential divider; explain the construction and working of a rheostat with the help of a diagram; explain the functions of a rheostat as a potential divider;		* * *	
12.7	Balanced Potential	12.7.1 12.7.2 12.7.3 12.7.4 12.7.5	describe Wheatstone bridge with the help of a diagram; calculate the unknown resistance by using a Whetstone bridge; describe potentiometre with the help of diagram; describe the measurement and comparison of e.m.f. by using potentiometre; explain the accuracy of potentiometre for e.m.f.'s measurement and comparison.		* * * *	 *

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
13.	**Electromagnetism**	Students should be able to:				
	13.1 Current Carrying Conductor in a Magnetic Field	13.1.1	describe magnetic field due to current in a straight wire;		*	
		13.1.2	describe the direction of magnetic field produced by a current carrying conductor;		*	
		13.1.3	compare strong and weak magnetic fields;		*	
		13.1.4	derive an expression for force, i.e. $F = ILB\sin\theta$ and use this equation for solving word problems;			*
		13.1.5	describe magnetic flux and magnetic flux density and solve problems using $\phi = \vec{B}.\vec{A}$;		*	
		13.1.6	describe factors governing field produced by long straight wire;		*	
		13.1.7	explain Ampere's law;		*	
		13.1.8	discuss applications of Ampere's law in a. straight current carrying wire, b. solenoid;		*	
	13.2 Force on a Moving Charged Particle	13.2.1	derive an equation for force on a moving charge in a uniform magnetic field and beam of particles and use this equation for solving word problems;			*
		13.2.2	calculate e/m value by using beam of charged particles in a uniform magnetic field;			*
	13.3 Cathode Rays Oscilloscope (CRO)	13.3.1	describe basic principle and uses of CRO;		*	

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
13.4	Current Carrying Rectangular Coils in a Uniform Magnetic Field	13.4.1	derive an expression of torque due to a couple acting on a coil and use this expression for solving word problems;			*
		13.4.2	define sensitivity of a galvanometre;	*		
13.5	Electrical Instruments	13.5.1	explain the principle, construction and working of a. galvanometer, b. voltmeter, c. ammeter, d. AVO meter, e. analogue digital multimetre (DMM);		*	
		13.5.2	explain different types of galvanometer;		*	
		13.5.3	list the important steps to change a galvanometre into voltmetre and ammetre.	*		
		13.5.4	differentiate between analogue and digital multimetre.		*	

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
14.	**Electromagnetic Induction**	Students should be able to:				
	14.1 Law of Electromagnetic Induction	14.1.1	describe electromagnetic induction;		*	
		14.1.2	explain Faraday's law of electromagnetic induction;		*	
		14.1.3	apply Lenz's law to determine the direction of induced e.m.f.;			*
	14.2 Inductance	14.2.1	distinguish between inductance and induction;		*	
		14.2.2	explain self and mutual induction with formula and units;		*	
	14.3 Energy Stored in an Inductor	14.3.1	derive the formula $E = \frac{1}{2} L I^2$;			*
		14.3.2	show that the energy is stored in an inductor;			*
	14.4 Simple Alternating Current (AC) Generator, Direct Current (DC) Generator and Direct Current (DC) Motor	14.4.1	describe principle, construction and working of an AC and DC generator;		*	
		14.4.2	differentiate between AC and DC generators;		*	
		14.4.3	discuss the effects of back e.m.f. in motor and back motor effects in generator;		*	
	14.5 Transformer	14.5.1	describe the principle, construction and working of a transformer;		*	
		14.5.2	differentiate between 'step-up' and 'step-down' transformer;		*	
		14.5.3	list the uses of step-up and step-down transformers in daily life;	*		
		14.5.4	derive $\frac{N_s}{N_p} = \frac{V_s}{V_p}$ and $V_s I_s = V_p I_p$ for an ideal transformer and use it for solving word problems;			*
		14.5.5	describe the simple energy losses due to eddy current and hysteresis.		*	

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
15.	**Alternating Current**	Students should be able to:				
15.1	Root Mean Square Value (rms)	15.1.1	describe sinusoidal waves;		*	
		15.1.2	define alternating current and alternating voltage;	*		
		15.1.3	describe the following terms: a. time period, b. frequency, c. peak value;		*	
		15.1.4	calculate the rms value of alternate current and alternate voltage;			*
15.2	Alternating Current (AC) Circuits	15.2.1	explain the flow of AC through resister, capacitor and inductor;		*	
		15.2.2	explain 'phase lag' and 'phase lead' in a circuit through a vector diagram;		*	
15.3	Impedance	15.3.1	derive the expression of impedance as vector summation of resistance in series (R-C and R-L) circuits;			*
15.4	Three Phase AC supply	15.4.1	describe three phase AC supply;		*	
15.5	Electromagnetic Waves	15.5.1	explain electromagnetic waves and spectrum (ranging from radio waves to gamma rays);		*	
		15.5.2	describe production, transmission and receptions of electromagnetic (EM) waves;		*	
		15.5.3	describe the amplitude modulation (AM) and frequency modulation (FM).		*	

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
16.	**Physics of Solids**	Students should be able to:				
	16.1 Classification of Solids	16.1.1	define lattice and unit cell of crystalline solids;	*		
		16.1.2	distinguish among the structures of crystalline, amorphous and polymeric solids;		*	
	16.2 Mechanical Properties of Solids	16.2.1	differentiate between elastic and plastic deformations in solids;		*	
		16.2.2	define tensile compression stress;	*		
		16.2.3	define Young's modulus, shear modulus and bulk modulus;	*		
		16.2.4	derive the formulae of Young's modulus, shear modulus and bulk modulus;			*
		16.2.5	define elastic limit and yield strength;	*		
		16.2.6	deduce the strain energy in a deformed material from an area under the force and extension graph;			*
	16.3 Electric Properties of Solids	16.3.1	define conductors, insulators and semiconductors;	*		
		16.3.2	describe energy bands in solids;		*	
		16.3.3	describe energy gaps in insulators and, intrinsic and extrinsic semiconductors;		*	
	16.4 Super Conductors	16.4.1	describe the behaviour of super conductors and their potential uses;		*	
	16.5 Magnetic Properties of Solids	16.5.1	state domain theory of magnetism;	*		
		16.5.2	describe diamagnetic, paramagnetic and ferromagnetic solids;		*	
		16.5.3	describe ferromagnets as a special case of paramagnets, magnetic dipoles and domains;		*	
		16.5.4	define the following terms: a. curie point, b. soft and hard magnetic substances.	*		

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
17.	**Electronics**	Students should be able to:				
	17.1 Electronics	17.1.1	define electronics;	*		
	17.2 Semiconductor Devices	17.2.1	differentiate between conductors and insulators;		*	
		17.2.2	describe semiconductors materials;		*	
		17.2.3	differentiate between p-type and n-type semiconductors with the help of diagrams;		*	
		17.2.4	describe p-n junction and p-n junction diode with labelled diagrams;		*	
		17.2.5	describe forward and reverse bias;		*	
		17.2.6	describe direct current;		*	
		17.2.7	define rectification;	*		
		17.2.8	describe half and full wave rectification;		*	
		17.2.9	describe the function and uses of light-emitting diodes (LEDs) and photodiodes;		*	
		17.2.10	define transistor;	*		
		17.2.11	distinguish between PNP and NPN transistor;		*	
		17.2.12	deduce current equation and its application;			*
	17.3 Operational Amplifier	17.3.1	define operational amplifier;	*		
		17.3.2	describe operational amplifier as an inverting and non-inverting amplifier;		*	
		17.3.3	explain the uses of transistor as a switch and as an amplifier;		*	
	17.4 Digital System	17.4.1	describe logic gates;		*	
		17.4.2	explain functions of logic gates with the help of truth table with two inputs;		*	
		17.4.3	relate different logic gates and their control function.		*	

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
18.	**Dawn of Modern Physics**	Students should be able to:				
	18.1 Special Theory of Relativity	18.1.1	distinguish between inertial and non-inertial frames of reference;		*	
		18.1.2	explain postulates of special theory of relativity;		*	
		18.1.3	describe if the speed of light (c) is constant then space and time become relative;		*	
		18.1.4	describe the consequences of special theory of relativity;		*	
		18.1.5	explain the amplification of a. mass increase, b. time dilation, c. length contraction for speed travel;		*	
	18.2 Quantum Theory	18.2.1	discuss the blackbody radiations using wavelength-energy graph;		*	
		18.2.2	describe laws governing blackbody radiations and their drawbacks;		*	
		18.2.3	explain Planck's assumption for the existence of blackbody;		*	
		18.2.4	describe that the radiations emitted and absorbed by blackbody is quantised;		*	
		18.2.5	discuss photon as an electromagnetic radiation;		*	
	18.3 Photoelectric Effect	18.3.1	describe photoelectric effect;		*	
		18.3.2	explain different features of photoelectric effect using a graph;		*	
		18.3.3	derive Einstein's photoelectric equation;			*
		18.3.4	define a photocell;	*		
		18.3.5	list the uses of photocell;	*		

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
18.4	Compton's Effect	18.4.1	describe the Compton's effect;		*	
		18.4.2	compare the phenomenon of pair production and pair annihilation;		*	
18.5	Dual Nature of Light	18.5.1	describe particle nature of light;		*	
		18.5.2	discuss the wave nature of light;		*	
		18.5.3	state de-Broglie's hypothesis;	*		
		18.5.4	explain that every particle has wave nature as well as particle nature with the reference to de-Broglie's hypothesis;		*	
		18.5.5	describe Davison and Germer experiment;		*	
		18.5.6	state the uncertainty principle;	*		
		18.5.7	explain the uncertainty principle with the help of an experiment.		*	

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
19.	**Atomic Spectra**	Students should be able to:				
	19.1 Atomic Spectra, Spectrum of Hydrogen, Bohr's model of Hydrogen Atom	19.1.1	describe the origin of different types of optical spectra;		*	
		19.1.2	analyse the experimental facts of hydrogen spectrum;			*
		19.1.3	describe Bohr's atomic model of hydrogen atom;		*	
		19.1.4	explain hydrogen spectrum in terms of energy levels;		*	
		19.1.5	derive an expression for quantized radii;			*
		19.1.6	prove $1/\lambda = R_H\left[\frac{1}{p^2}-\frac{1}{n^2}\right]$;			*
		19.1.7	solve word problems related to the SLO 19.1.6;			*
	19.2 Emission Spectrum	19.2.1	deduce spectral lines through discrete electron energy level;			*
	19.3 Excitation and Ionization Potential	19.3.1	define excitation potential and ionisation potential;	*		
		19.3.2	determine ion energy and excitation energy levels of an atom using an energy level diagram;			*
	19.4 Inner Shell Transition and Characteristics	19.4.1	describe inner shell transitions;		*	
		19.4.2	explain production and characteristics of X-rays based on inner shell transition;		*	
		19.4.3	explain the production, properties and uses of X-rays;		*	
	19.5 Lasers	19.5.1	describe the following terms: a. spontaneous emission, b. stimulated emission, c. meta-stable state, d. population inversion,` e. laser action;		*	
		19.5.2	describe the structure and functions of main components of He-Ne laser gas.		*	

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
20.	**Nuclear Physics**	Students should be able to:				
	20.1 Composition of Atomic Model	20.1.1	describe a simple model of an atom to include electrons, protons and neutrons;		*	
	20.2 Atomic Number, Mass Number, Isotopes and Isobars	20.2.1	define the following terms: a. atomic number, b. mass number, c. isotopes, d. isobars;	*		
		20.2.2	determine number of protons, neutrons and nucleons for the specification of nucleus in the form ${}^{A}_{Z}X$;			*
	20.3 Mass Spectrograph	20.3.1	describe the principle, construction and working of mass spectrograph;		*	
	20.4 Mass Defect and Binding Energy	20.4.1	define the following terms: a. mass defect, b. binding energy;	*		
		20.4.2	identify (graphically) variation of binding energy per nucleon using mass number;		*	
	20.5 Radioactivity	20.5.1	define the term 'radioactivity';	*		
		20.5.2	list the properties of α, β and γ radiations;	*		
	20.6 Law of Radioactive Decay	20.6.1	explain the process of radioactive decay;		*	
		20.6.2	describe α, β and γ decay with balanced equations;		*	
		20.6.3	define half-life of a radioactive element;	*		
		20.6.4	derive an equation for first and second half-life from the decay of radioactive element;			*

Topics and Sub-Topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
20.7	Detection of Ionizing Radiation	20.7.1 20.7.2	describe the effect of α, β particles and γ rays on matter; analyse the nature of radiations emitted from a radioactive particle by using Wilson cloud chamber, Geiger-Muller (G.M.) counter and solid state detector;		*	*
20.8	Nuclear Fission and Fusion	20.8.1	differentiate between nuclear fission and fusion;		*	
20.9	Nuclear Reactor	20.9.1 20.9.2	explain the working principle of a nuclear reactor; list the various types of nuclear reactor;	*	*	
20.10	Nuclear Radiations and Exposure	20.10.1	discuss the biological effects due to exposure of nuclear radiations;		*	
20.11	Medical Physics	20.11.1 20.11.2	describe uses of radiations for medical diagnosis and therapy; describe importance of limiting exposure to ionising radiations;		* *	
20.12	Basic Forces of Nature	20.12.1	describe basic forces of nature;		*	
20.13	Building Blocks of Nature	20.13.1	describe the modern view of the building blocks of matter based on hadrons, leptons and quarks.		*	

Scheme of Assessment

Grade XI

Table 1: Number of Student Learning Outcomes by Cognitive level

Topic No.	Topics	No. of Sub-topics	SLOs			Total
			K	U	A	
1.	Measurement	6	2	6	5	13
2.	Vectors and Equilibrium	7	4	10	1	15
3.	Motion and Force	6	4	8	8	20
4.	Work, Power and Energy	9	7	8	7	22
5.	Circular Motion	7	7	7	4	18
6.	Fluid Dynamics	5	6	3	7	16
7.	Oscillations	9	2	5	6	13
8.	Waves	5	4	15	6	25
9.	Physical Optics	8	4	17	2	23
10.	Thermodynamics	11	3	15	9	27
	Total	**73**	**43**	**94**	**55**	**192**
	Percentage		**22**	**49**	**29**	**100**

Table 2: Exam Specifications

Topic No.	Topics	Marks Distribution			Total Marks
		MCQs	CRQs	ERQs	
1.	Measurement	4	Total 3 Marks (1 CRQ)		7
2.	Vectors and Equilibrium	5	Total 2 Marks (1 CRQ)		7
3.	Motion and Force	5	Total 3 Marks (1 CRQ)		8
4.	Work, Power and Energy	6		7 Marks Choose any ONE from TWO	13
5.	Circular Motion	5	Total 2 Marks (1 CRQ)		7
6.	Fluid Dynamics	5	Total 3 Marks (1 CRQ)		8
7.	Oscillations	4	Total 2 Marks (1 CRQ)		6
8.	Waves	6	Total 3 Marks (1 CRQ)		9
9.	Physical Optics	4	Total 3 Marks (1 CRQ)		7
10.	Thermodynamics	6		7 Marks Choose any ONE from TWO	13
	Total	**50**	**21**	**14**	**85**
	Practical*				**15**
	Total				**100**

Grade XII

Table 3: Number of Student Learning Outcomes by Cognitive level

Topic No.	Topics	No. of Sub-topics	SLOs			Total
			K	U	A	
11.	Electrostatics	8	3	15	6	24
12.	Current Electricity	7	8	17	6	31
13.	Electromagnetism	5	2	11	4	17
14.	Electromagnetic Induction	5	1	10	4	15
15.	Alternating Current	5	1	8	2	11
16.	Physics of Solids	5	7	7	2	16
17.	Electronics	4	4	14	1	19
18.	Dawn of the Modern Physics	5	4	19	1	24
19.	Atomic Spectra	5	1	8	6	15
20.	Nuclear Physics	13	6	13	3	22
	Total	**62**	**37**	**122**	**35**	**194**
	Percentage		**19**	**63**	**18**	**100**

Table 4: Exam Specifications

Topic No.	Topics	Marks Distribution			Total Marks
		MCQs	CRQs	ERQs	
11.	Electrostatics	6	Total 3 Marks (1 CRQ)		9
12.	Current Electricity	5		7 Marks Choose any ONE from TWO	12
13.	Electromagnetism	5	Total 3 Marks (1 CRQ)		8
14.	Electromagnetic Induction	4	Total 3 Marks (1 CRQ)		7
15.	Alternating Current	4	Total 2 Marks (1 CRQ)		6
16.	Physics of Solids	5	Total 2 Marks (1 CRQ)		7
17.	Electronics	5	Total 3 Marks (1 CRQ)		8
18.	Dawn of the Modern Physics	5		7 Marks Choose any ONE from TWO	12
19.	Atomic Spectra	5	Total 2 Marks (1 CRQ)		7
20.	Nuclear Physics	6	Total 3 Marks (1 CRQ)		9
	Total	**50**	**21**	**14**	**85**
	Practical*				**15**
	Total				**100**

- Multiple Choice Question (MCQ) requires candidates to choose one best/ correct answer from four options for each question. Each MCQ carries ONE mark.
- Constructed Response Question (CRQ) requires students to respond with a short text (few phrases/ sentences), calculations or diagrams.
- Extended Response Question (ERQ) requires students to answer in a more descriptive form. The answer should be in paragraph form, with diagrams where needed, and address all parts of the question.

- Tables 1 and 3 indicate the number and nature of SLOs in each topic in classes XI and XII. This will serve as a guide in the construction of the examination paper. It also indicates that more emphasis has been given to Understanding (49% and 63%), Application and higher order skills (29% and 18%) to discourage rote memorization. Tables 1 and 4, however, does not translate directly into marks.

- There will be two examinations, one at the end of Class XI and one at the end of Class XII.

- In each class, the theory paper will be in two parts: paper I and paper II. Both papers will be of duration of 3 hours.

- Paper I theory will consist of 50 compulsory, multiple choice items. These questions will involve four response options.

- Paper II theory will carry 35 marks and consist of a number of compulsory, structured questions and a number of extended response questions. Each extended response question will be presented in an either/or form.

- All constructed response questions will be in a booklet which will also serve as an answer script.

***Practical:**

- In each grade, practical examination will be conducted separate from the theory paper and will consist of 15 marks.
- Practical examination will be based on the list of practical activities given in the examination syllabus. Schools may design their own practical manuals based on these activities.
- Practical journal/ portfolio should be developed by students and endorsed by a figure of authority, such as a teacher or principal, and submitted at the time of the practical examination.
- It is essential for each school to equip its laboratories with chemicals, instruments, apparatus, specimens etc. according to the requirements of the practical activities. Each school will be responsible to make sure that each student is provided the opportunity to do the practical activities.

Annex A: Practical Activities

Grade XI

S. No.	SLO No.	PRACTICAL ACTIVITY	APPARATUS
		Topic 1: Measurement	
1.	1.5.2	Determine the capacity and thickness of a test tube by using Vernier callipers.	Vernier callipers, test tube.
2.	1.5.2	Measure the diametre of few ball bearings of different sizes using screw gauge and estimate their volumes.	Screw gauges, steel ball bearings.
3.	1.5.2	Determine the radius of curvature of any spherical surface by using a spherometre.	Spherometre, convex or concave lens/ mirror.
		Topic 2: Vectors and Equilibrium	
4.	2.3.1	Determine the weight of a body by vector addition of forces. (Parallelogram Method)	Gravesend's apparatus, slotted weights, thread nos., plane mirror strip.
5.	2.7.2	Verify the two conditions of equilibrium using a suspended metre rod.	Metre rod, hangers, slotted weights, stand.
		Topic 3: Motion and Force	
6.	3.3.1	Measure the free fall time of a ball using a ticker-timer and hence calculate the value of 'g'.	Ticker-tape vibrator, roll of ticker-tape, steel ball, transformer, sellotape.
7.	3.3.1	Investigate the value of acceleration due to gravity 'g' by free fall method using electronic timer.	Free fall apparatus, steel ball, electronic timer with power supply, plumb line, metre rod.

S. No.	SLO No.	PRACTICAL ACTIVITY	APPARATUS
		Topic 7: Oscillations	
8.	7.5.2	Verify that the time period of the simple pendulum is directly proportional to the square root of its length and hence find the value of acceleration due to gravity 'g' from the graph.	Simple pendulum, stopwatch, stand with clamp, thread, cork, Vernier callipers.
		Topic 8: Waves	
9.	8.4.3	Determine the frequency of AC by Melde's apparatus/ electric sonometer.	AC vibrator, step-down transformer (6V), connecting wires, thread, pulley, scale plan.
10.	8.4.3	Investigate the laws of vibration of stretched strings by sonometer or electromagnetic method. (Use copper wire instead of iron wire)	Sonometer, tuning forks of different frequencies, hanger, ½ kg weights, wires of different diametre, physical /digital/ spring balance, weight box, metre rod.
11.	8.4.5	Determine the wavelength of sound in air using stationary waves and calculate the speed of sound using resonance tube.	Resonance apparatus, two tuning forks of known frequencies, thermometer, plumb line, Vernier callipers, rubber pad, two set squares, beaker.

S. No.	SLO No.	PRACTICAL ACTIVITY	APPARATUS
12.	10.6.1	Measure the mechanical equivalent of heat by electric method.	Electrical calorimeter, 1/5°C thermometer, battery, rheostat, key, ammetre, voltmetre, connecting wires, stopwatch, physical/ digital/ spring balance, weight box.
13.	10.6.1	Determine the specific heat of water by electrical method.	Electrical calorimeter, 1/5°C thermometer, battery, rheostat, key, ammetre, voltmetre, connecting wires, stopwatch, physical/ digital/ spring balance, weight box.

Grade XII

S. No.	SLO No.	PRACTICAL ACTIVITY	APPARATUS
		Topic 11: Electrostatics	
1.	11.7.2	Determine the relation between current and capacitance when different capacitors are used in AC circuit using different series and parallel combinations of capacitors.	AC milliammetre, AC voltmetre, capacitors of different, capacitances, step-down transformre sand paper, connecting wires.
2.	11.7.4	Determine time constant by charging and discharging a capacitor through a resistor.	Galvanometre, power supply, large value capacitor, key, stopwatch.
		Topic 12: Current Electricity	
3.	12.2.4	Determine resistance of voltmetre by drawing graph between (R) and (I/V).	Voltmetre, resistance box, two keys, sand paper, connecting wires, graph paper.
4.	12.3.5	Investigate the relationship between current passing through a tungsten filament lamp and the potential applied across it.	36 W, 12 V car bulb, bulb holder, 12 V battery, high resistance rheostat, voltmetre, ammetre, key, sand paper, connecting wires.
5.	12.7.2	Determine resistance of wire by slide wire bridge.	Slide wire bridge, resistance box, unknown resistance, galvanometre, rheostat, cell, tapping key, connecting wires, sand paper.

S. No.	SLO No.	PRACTICAL ACTIVITY	APPARATUS
6.	12.7.4	Determine internal resistance of a cell using potentiometre.	Potentiometre, battery, ammetre, resistance box, rheostat, two keys, galvanometre, cell, shunt wire, sand paper, connecting wires.
7.	12.7.5	Determine electromotive force (e.m.f.) of a cell using potentiometre.	Potentiometre, battery, two way key, rheostat, ammetre, key, shunt, wire, galvanometre, sand paper, connecting wires.
		Topic 17: Electronics	
8.	17.2.4	Draw characteristics of semiconductor diode and calculate forward and reverse current resistances.	Semi-conductor diode, voltmetre, milliammetre, micro-ammetre, 500 Ω rheostat, 1 kΩ resistor, 3 V battery, sand paper, connecting wires.
9.	17.2.11	Study the characteristics of an NPN transistor.	NPN transistor, DC power supplies, microammetre, variable resistance of 500 Ω, 50 Ω & 10 Ω, 2.2 kΩ, milliammetre, high resistance voltmeter.
10.	17.4.1	Verify truth table for logic gates.	DC power supply, OR, AND, NOR, NAND, NOT gates, LED indicator module, two key plugs, connecting wires.

S. No.	SLO No.	PRACTICAL ACTIVITY	APPARATUS
11.	17.4.2	Make burglar alarm using NAND gate.	Two NAND gates, two resistance of 100 kΩ, electronic bell, connecting wires, power supply 5 V DC, key plugs.
12.	17.4.2	Make a fire alarm using gates.	AND, OR gates, smoke sensor, heat sensor, alarm, connecting wires, power supply, alarm bell.
		Topic 18: Dawn of Modern Physics	
13.	18.3.1	Study of the variation of electric current with intensity of light using a photocell.	Photocell, galvanometre, battery, rheostat, key, electric bulb with case, connecting wires.

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