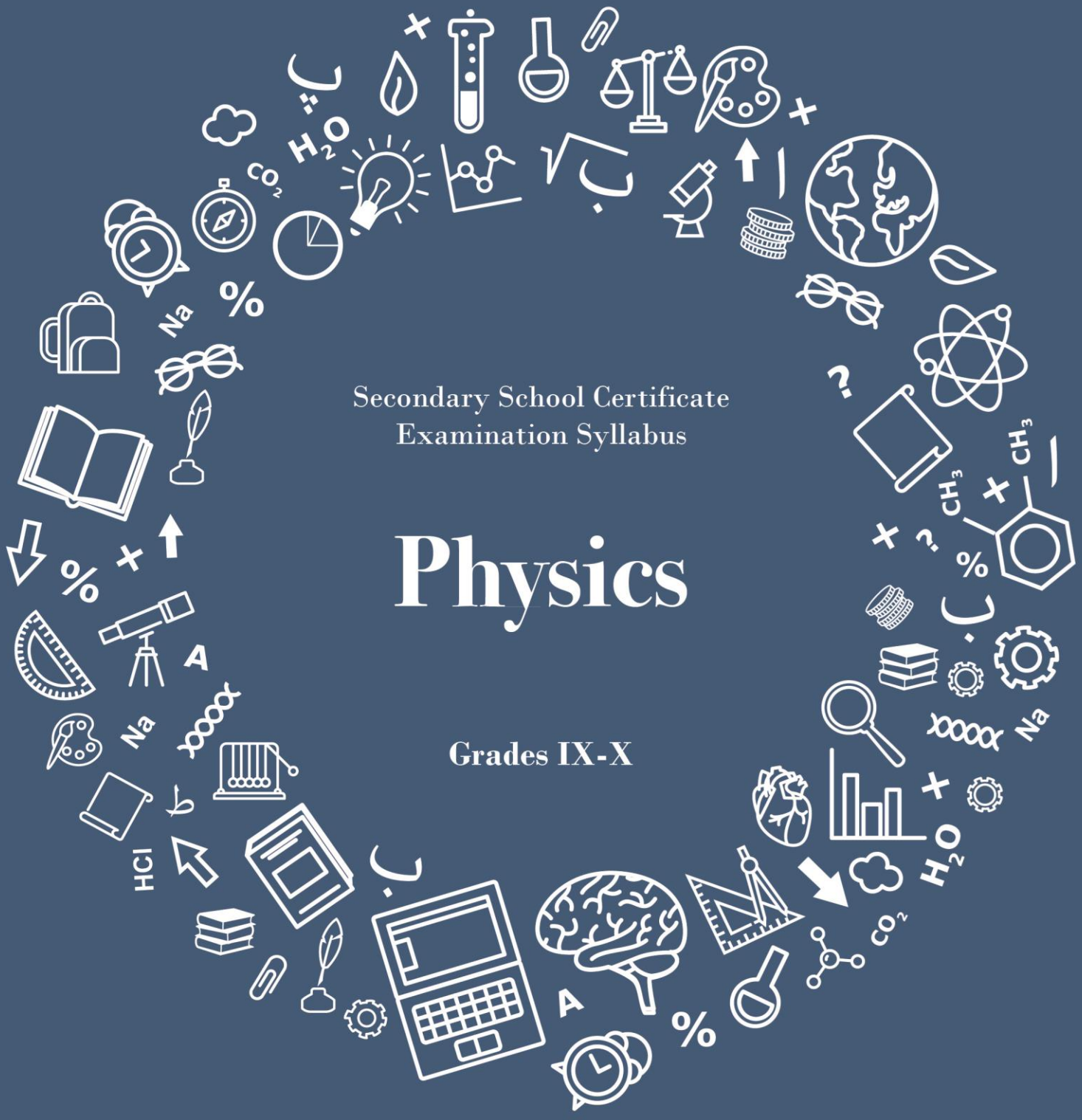
آغا خان یونیورسٹی ایگزامینیشن بورڈ

AGA KHAN UNIVERSITY EXAMINATION BOARD



Secondary School Certificate
Examination Syllabus

Physics

Grades IX-X

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

PHYSICS

GRADES IX-X

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

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 a fundamental branch of experimental sciences as it studies 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

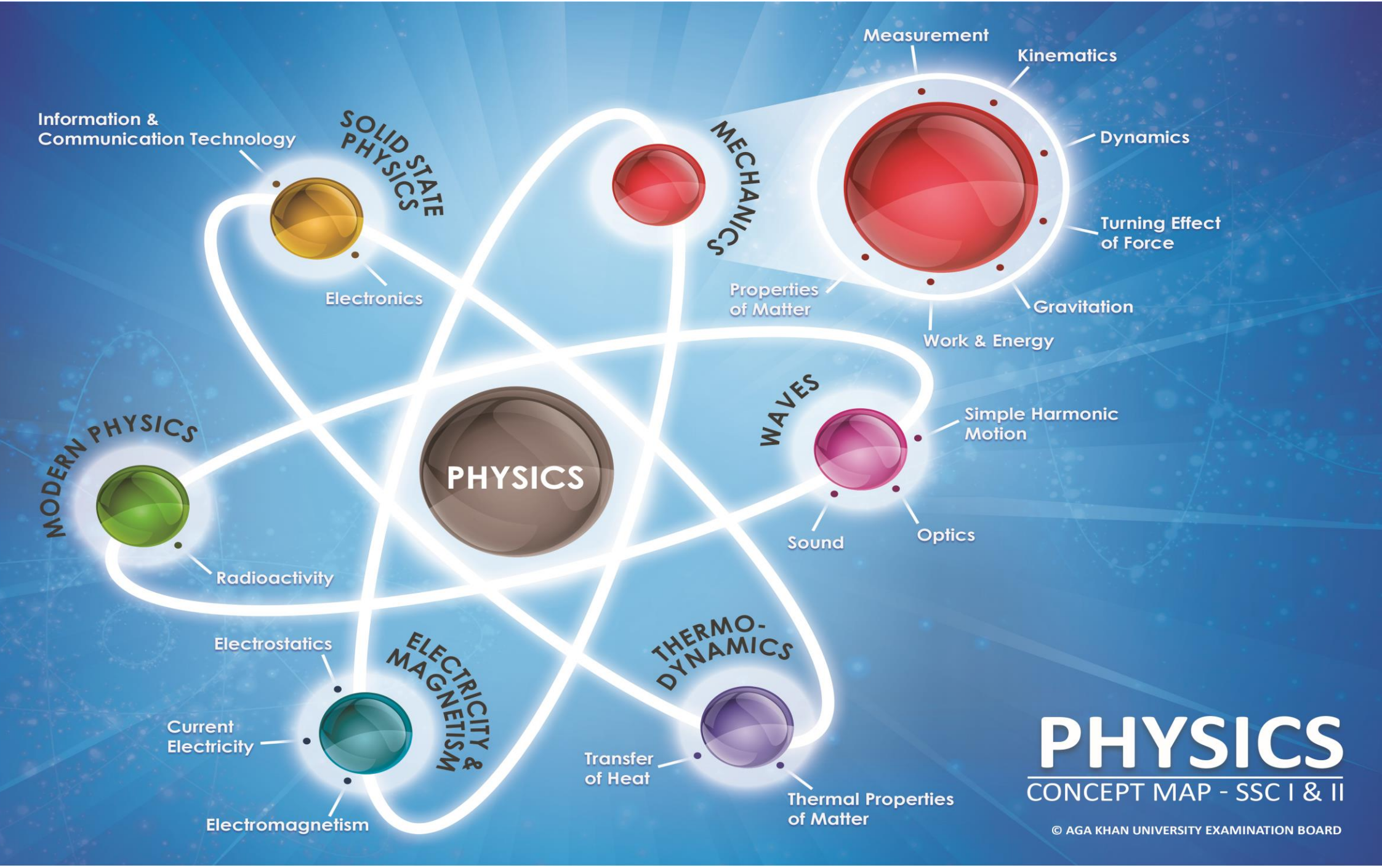
And many other related fields.

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 achieved. And finally, the exam specification guides regarding what will be expected in the examination.

What is the concept map telling you?

Nuclear Physics positively influences our daily lives through advances in technology, health, and energy production. The Concept Map of SSC Physics is influenced by this important branch of Physics. Physics itself has been represented as the nucleus at the centre. Themes (topic-clusters) have been represented as different electrons which revolve around the nucleus, thus completing the 'atom' of physics. The sub-themes (individual topics) have been represented through the presence of electron clouds, thus showing their interconnectedness.


PHYSICS
MECHANICS
Measurement
Kinematics
Dynamics
Turning Effect of Force
Gravitation
Work & Energy
Properties of Matter
SOLID STATE PHYSICS
Information & Communication Technology
Electronics
WAVES
Simple Harmonic Motion
Optics
Sound
MODERN PHYSICS
Radioactivity
ELECTRICITY & MAGNETISM
Electrostatics
Current Electricity
Electromagnetism
THERMO-DYNAMICS
Transfer of Heat
Thermal Properties of Matter
PHYSICS
CONCEPT MAP - SSC I & II
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Student Learning Outcomes of AKU- EB SSC Physics Syllabus

Part I (Grade IX)

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels[1]		
				K	U	A
1. Physical Quantities and Measurement		Students should be able to:				
1.1	Introduction	1.1.1	describe the importance of physics in science, technology and society;		*	
1.2	Physical Quantities	1.2.1	explain science is based on physical quantities with examples;		*	
1.3	International System of Units	1.3.1	differentiate between base and derived physical quantities;		*	
		1.3.2	list the seven units of International System (SI) along with their symbols and physical quantities; (standard definitions of SI units are not required)	*		
		1.3.3	explain the significance of International System (SI);		CA[2]	
1.4	Prefixes (Multiples and Sub-multiples)	1.4.1	convert the prefixes and their symbols to indicate multiple and sub-multiple for base and derived units;			*
1.5	Standard Form/ Scientific Notation	1.5.1	calculate scientific notation in measurements;			*

[1] K = Knowledge, U = Understanding, A = Application and other higher-order cognitive skills
[2] CA = Classroom Activity, not to be assessed under examination conditions.

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
1.6	Measuring Instruments • Meter rule • Stopwatch • Screw gauge • Vernier callipers • Physical balance • Measuring cylinder	1.6.1 1.6.2 1.6.3	identify the measuring instruments; describe the working of measuring instruments; determine the least count (LC) of the measuring instruments;		* *	 *
1.7	Significant Figures	1.7.1 1.7.2 1.7.3	describe significant figures; discuss the need of using significant figures for recording and stating results; apply the rules for rounding a number to given number of significant figures to solve problems.		* *	 *

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
2. Kinematics		Students should be able to:				
2.1	Rest and Motion	2.1.1	define rest and motion;	*		
		2.1.2	describe using examples how objects can be at rest and in motion;		*	
2.2	Types of Motion (Translatory, Rotatory, Vibratory)	2.2.1	describe different types of motion, i.e. translatory, rotatory and vibratory motion;		*	
		2.2.2	distinguish among the different types of motions;		*	
2.3	Terms Associated with Motion, (Distance and Displacement, Speed and Velocity and Acceleration)	2.3.1	define the terms speed, velocity and acceleration;	*		
		2.3.2	differentiate between distance and displacement, speed and velocity;		*	
2.4	Scalars and Vectors	2.4.1	define scalar and vector quantities;	*		
		2.4.2	differentiate between scalar and vector quantities using examples;		*	
2.5	Forces on Bodies	2.5.1	define like and unlike parallel forces;	*		
2.6	Addition of Forces	2.6.1	describe ‘head to tail’ rule of vector addition of forces/ vectors;		*	
2.7	Resolution of Forces	2.7.1	describe the resolution of force into its perpendicular components;		*	
		2.7.2	determine the magnitude and direction of a force from its perpendicular components;			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
2.8	Graphical Analysis of Motion, (Distance-Time Graph and Speed-Time Graph)	2.8.1	draw vector quantities using graphs;			*
		2.8.2	plot and interpret distance-time graph and speed-time graph;			*
		2.8.3	determine and interpret the slope/ gradient of distance-time and speed-time graph;			*
		2.8.4	determine from the shape of the graph, the state of a body a. at rest, b. moving with constant speed, c. moving with variable speed;			*
		2.8.5	calculate the area under speed-time graph of uniformly accelerated objects to determine the distance covered by the objects;			*
		2.8.6	recognise why the area under the speed-time graph of uniformly accelerated objects is equal to the distance covered by the objects;			CA
2.9	Equations of Motion $S = vt$ $v_f = v_i + at$ $S = v_i t + \frac{1}{2}at^2$ $v_f^2 - v_i^2 = 2aS$	2.9.1	derive equations of motion for a body moving with a uniform acceleration in a straight line;			*
		2.9.2	solve word problems related to uniformly accelerated motion using appropriate equations;			*
2.10	Motion due to Gravity	2.10.1	solve word problems related to freely falling bodies.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
3. Dynamics		Students should be able to:				
	3.1 Force	3.1.1	describe the concept of force with its S.I. unit;		*	
		3.1.2	differentiate among different kind of forces like gravitational force, drag force (push, pull), force of friction, electrostatic force and magnetic force;		*	
		3.1.3	analyse the concept of different kind of forces through examples from daily life;			*
	3.2 Momentum	3.2.1	define momentum;	*		
		3.2.2	explain the relationship between force and momentum;		*	
		3.2.3	solve word problems related to force and momentum;			*
		3.2.4	state the law of conservation of momentum;	*		
		3.2.5	differentiate between elastic and inelastic collision;		*	
		3.2.6	apply the principle of conservation of momentum in the elastic collision of two objects;			*
		3.2.7	determine the velocity after collision of two objects having the same and different masses using the law of conservation of momentum;			*
		3.2.8	explain safety features include seat belts, air bags and crumple zones in vehicles by using the concept of momentum;		*	
	3.3 Newton's Laws of Motion	3.3.1	describe balanced and unbalanced forces;		*	
		3.3.2	state Newton's laws of motion and inertia;	*		
		3.3.3	distinguish between mass and weight;		*	
		3.3.4	solve word problems related to the concept of mass and weight;			*
		3.3.5	derive the expressions for the tension and acceleration in a string during motion of bodies connected by a string and passing over frictionless pulley;			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
		3.3.6	discuss the effect on the passengers on a vehicle in terms of force and inertia, when a vehicle a. starts moving suddenly, b. stops moving suddenly, c. turns a corner to the left suddenly;		*	
3.4	Friction	3.4.1	explain the importance of friction for the motion of a vehicle in the context of type of surface, road conditions including skidding and braking force;		*	
		3.4.2	describe that rolling friction is much lesser than sliding friction;		*	
		3.4.3	list various methods to reduce friction;	*		
3.5	Uniform Circular Motion	3.5.1	define centripetal force;	*		
		3.5.2	explain that motion in a curved path is due to a perpendicular force on a body that changes direction of motion but not speed;		*	
		3.5.3	calculate centripetal force for a body moving in a circle.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
4. Turning Effect of Forces		Students should be able to:				
4.1	Moment of Force	4.1.1	describe moment of force or torque as moment = force × perpendicular distance from pivot to the line of action of force;		*	
		4.1.2	explain the turning effect of force by relating it to everyday life;		*	
4.2	Principle of Moments	4.2.1	state the principle of moments;	*		
		4.2.2	solve word problems related to the principle of moments;			*
4.3	Centre of Gravity	4.3.1	define centre of gravity of a body in a uniform gravitational field;	*		
4.4	Couple	4.4.1	define couple as a pair of forces tending to produce rotation;	*		
		4.4.2	explain that the couple has the same moments about all points;		*	
4.5	Equilibrium	4.5.1	define equilibrium;	*		
		4.5.2	classify types of equilibrium by quoting examples from everyday life;		*	
		4.5.3	state conditions of equilibrium;	*		
		4.5.4	explain different conditions of equilibrium with examples;		*	
		4.5.5	solve word problems on simple balanced systems when bodies are supported by one pivot only;			*
		4.5.6	describe the states of equilibrium and classify them with common examples;		*	
4.6	Stability	4.6.1	explain effects of position of the centre of gravity on the stability of simple objects.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
5. Gravitation		Students should be able to:				
5.1	Law of Gravitation	5.1.1	state Newton's law of gravitation;	*		
		5.1.2	explain that the gravitational forces are consistent with Newton's third law;		*	
		5.1.3	explain gravitational field as an example of field of force;		*	
		5.1.4	define weight as the force on an object due to a gravitational field;	*		
		5.1.5	solve word problems using Newton's law of gravitation;			*
5.2	Measurement of Mass of Earth	5.2.1	calculate the mass of Earth by using the law of gravitation;			*
5.3	Variation of 'g' with Altitude	5.3.1	explain that value of acceleration due to gravity 'g' decreases with altitude from the surface of the Earth;		*	
5.4	Motion of Artificial Satellites	5.4.1	discuss the importance of Newton's law of gravitation in understanding the motion of satellites;		*	
5.5	Earth and Space	5.5.1	explain planets have moons and they orbit around them;		*	
		5.5.2	explain how the gravitational force causes a. the planets to orbit the sun, b. the moon and artificial satellites to orbit the Earth, c. comets to orbit the sun;		*	
		5.5.3	explain that a universe is a large collection of billions of galaxies and is expanding continuously;		*	
		5.5.4	explain that the orbit of a comet differs from that of a planet.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
6. Work and Energy		Students should be able to:				
6.1	Work	6.1.1	define work and state its SI unit;	*		
		6.1.2	solve word problems on workdone;			*
6.2	Forms of Energy	6.2.1	define energy, kinetic energy (KE) and potential energy (PE) and state its SI unit of energy;	*		
		6.2.2	derive the formulae of kinetic energy and potential energy;			*
		6.2.3	solve word problems on kinetic and potential energy;			*
6.3	Kinetic Energy and Potential Energy	6.3.1	describe forms of energy stored in various objects at different positions and states;		*	
6.4	Major Sources of Energy	6.4.1	state law of conservation of energy;	*		
		6.4.2	describe the processes by which energy is converted from one form to another with reference to a. fossil fuel energy, b. hydroelectric generation, c. solar energy, d. nuclear energy, e. geothermal energy, f. wind energy, g. biomass energy;		*	
		6.4.3	state three basic concepts of mass energy equation $E = mc^2$;	*		
		6.4.4	describe the process of electricity generation by drawing a block diagram of the process from fossil fuel input to electricity output;		*	
		6.4.5	list the environmental issues associated with power generation;	*		

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
		6.4.6	differentiate between non-renewable and renewable energy sources with examples of each;		*	
		6.4.7	explain conversion of energy in a. a filament lamp, b. a power station, c. a vehicle travelling at a constant speed on a level road;		*	
6.5	Efficiency	6.5.1	define efficiency of a working system;	*		
		6.5.2	calculate the efficiency of an energy conversion using the formula: *Efficiency* (%) = *energy converted into the required form / total energy input;*			*
		6.5.3	explain why a system cannot have an efficiency of 100%;		*	
6.6	Power	6.6.1	define power and write its formula;	*		
		6.6.2	solve word problems on the concept of power;			*
		6.6.3	define unit of power in SI system;	*		
		6.6.4	convert unit of power “watt” into “horse power”.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
7. Properties of Matter		Students should be able to:				
7.1	Kinetic Molecular Model of Matter	7.1.1	explain kinetic molecular model of matter (solid, liquid and gas forms);		*	
		7.1.2	describe plasma as the fourth state of matter;		*	
7.2	Density	7.2.1	define the term 'density';	*		
		7.2.2	compare the densities of three states of matter (solids, liquids and gases forms);		*	
7.3	Pressure	7.3.1	define the term pressure as a force acting normally on unit area;	*		
		7.3.2	explain that pressure varies with force and area with the help of everyday examples;		*	
7.4	Atmospheric Pressure	7.4.1	explain atmospheric pressure;		*	
		7.4.2	describe the use of the height of a liquid column to measure the atmospheric pressure;		*	
		7.4.3	describe that atmospheric pressure decreases with the increase in height above the earth's surface;		*	
		7.4.4	explain that changes in atmospheric pressure in a region may indicate a change in the weather;		*	
7.5	Pressure in Liquids	7.5.1	state Pascal's law;	*		
		7.5.2	explain the relation for pressure beneath a liquid surface to depth and to density, i.e. $P=\rho gh$;		*	
		7.5.3	apply and demonstrate the use of Pascal's law;			*
		7.5.4	solve word problems on the concept of pressure beneath a liquid to depth and to density;			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
		7.5.5 7.5.6	explain Archimedes principle; determine the density of an irregular object using Archimedes principle;		*	*
7.6	Upthrust	7.6.1	explain the significance of upthrust exerted by a liquid on a body;		*	
7.7	Principle of Floatation	7.7.1	state the principle of floatation in terms of upthrust;	*		
7.8	Elasticity	7.8.1 7.8.2	define elasticity; explain that a force may produce change in size and shape of a body;	*	*	
7.9	Stress, Strain and Young's Modulus	7.9.1 7.9.2 7.9.3	define the terms stress, strain and Young's modulus; state Hooke's law; explain elastic limit using Hooke's law.	* *	* 	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
8. Thermal Properties of Matter		Students should be able to:				
8.1	Temperature and Heat	8.1.1	differentiate between heat and temperature;		*	
8.2	Thermometer	8.2.1	list basic thermometric properties of materials (mercury and alcohol) to construct a thermometer;	*		
		8.2.2	convert temperature from one scale to another (Fahrenheit, Celsius and Kelvin scales);			*
		8.2.3	describe the rise in temperature of a body in terms of an increase in its internal energy;		*	
		8.2.4	describe the advantages and disadvantages of liquid in glass thermometer and thermo-couple thermometer;		*	
8.3	Specific Heat Capacity	8.3.1	describe the terms heat capacity and specific heat capacity;		*	
		8.3.2	solve word problems on the concept of specific heat capacity;			*
8.4	Latent Heat of Fusion	8.4.1	describe heat of fusion and heat of vapourisation;		*	
8.5	Latent Heat of Vapourisation	8.5.1	determine heat of fusion and heat of vapourisation of ice and water respectively by sketching temperature-time graph;			*
		8.5.2	solve word problems related to the formula of the latent heat of fusion and vapourisation;			*
8.6	Evaporation	8.6.1	explain the process of evaporation;		*	
		8.6.2	differentiate between boiling and evaporation;		*	
		8.6.3	explain how evaporation causes cooling;		*	
		8.6.4	describe factors which influence surface evaporation;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
8.7 Thermal Expansion	8.7.1	describe thermal expansion of solids in terms of a. linear expansion, b. volumetric expansion;			*	
	8.7.2	explain the thermal expansion of liquids on the a. real expansion, b. apparent expansion.			*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
9. Transfer of Heat		Students should be able to:				
9.1	Processes of Heat Transfer	9.1.1	describe thermal energy as the change in the internal energy of a body;		*	
		9.1.2	explain in terms of molecules and electrons how heat transfer occurs in solids;		*	
		9.1.3	define the term 'thermal conductivity';	*		
		9.1.4	describe the factors affecting the transfer of heat through solid conductors;		*	
		9.1.5	solve word problems based on thermal conductivity of solid conductors;			*
		9.1.6	describe good and bad conductors of heat with examples;		*	
		9.1.7	describe the uses of good and bad conductors;		*	
9.2	Conduction	9.2.1	explain that insulation reduces energy transfer by conduction;		*	
9.3	Convection	9.3.1	explain the convection currents in fluids due to difference in density;		*	
		9.3.2	mention some examples of heat transfer by convection in everyday life;	*		
9.4	Radiation	9.4.1	describe radiation as the emission or transmission of energy;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
9.5	Consequences and Everyday Application of Heat Transfer	9.5.1	explain rate of energy transfer is affected by a. colour and texture of the surface, b. surface temperature, c. surface area;		*	
		9.5.2	describe greenhouse effect on the bases of heat radiation emitted by the sun.		*	

Part II (Grade X)

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
10. Simple Harmonic Motion and Waves		Students should be able to:				
10.1	Simple Harmonic Motion (SHM)	10.1.1	define oscillatory motion, periodic motion, time period, frequency and amplitude;	*		
		10.1.2	explain SHM with simple pendulum, ball and bowl examples;		*	
		10.1.3	state the conditions necessary for an object to oscillate with SHM;	*		
		10.1.4	draw forces acting on a displaced pendulum;			*
		10.1.5	solve word problems related to time period of a simple pendulum;			*
		10.1.6	describe that damping progressively reduces the amplitude of oscillation;		*	
10.2	Waves, their Nature and Types	10.2.1	describe wave motion as illustrated by vibrations in rope, slinky spring and by experiments with water waves;		*	
		10.2.2	describe that waves are means of energy transfer without transfer of matter;		*	
		10.2.3	distinguish between mechanical and electromagnetic waves;		*	
		10.2.4	identify transverse and longitudinal waves in mechanical media;	*		
10.3	Properties of Waves	10.3.1	describe properties of waves such as reflection, refraction and diffraction with the help of ripple tank;		*	

Topics and Sub-topics	Student Learning Outcomes		Cognitive levels		
			K	U	A
	Students should be able to:				
10.4 Characteristics of Waves	10.4.1	define the terms: a. speed (v), b. frequency (f), c. wavelength (λ), d. time period (T), e. amplitude, f. crest, g. trough, h. wave cycle, i. compression and rarefaction;	*		
	10.4.2	derive equation V=f λ;			*
	10.4.3	solve word problems by applying the relation f = 1/T and V= f λ.			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
11. Sound		Students should be able to:				
11.1	Sound Waves	11.1.1	explain production of sound waves;		*	
		11.1.2	describe the longitudinal nature of sound waves;		*	
11.2	Characteristics of Sound	11.2.1	define the terms pitch, loudness and quality of sound;	*		
		11.2.2	describe the effect of change in amplitude on loudness and the effect of change in frequency on pitch of sound;		*	
		11.2.3	define intensity and state its SI unit;	*		
		11.2.4	describe intensity level of sound and mention its unit;		*	
		11.2.5	solve word problems related to the intensity level of sound;			*
11.3	Noise Pollution	11.3.1	describe nuisance as annoying individuals by the persons, things, conditions or practices;		*	
		11.3.2	describe how reflection of sound produce echo;		*	
		11.3.3	describe the importance of acoustic protection;		*	
11.4	Audible Frequency Range	11.4.1	describe audible frequency range;		*	
		11.4.2	describe the uses of ultrasound.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
12. Geometrical Optics		Students should be able to:				
12.1	Reflection of Light	12.1.1	describe with reference to the reflection of light the following terms: a. normal, b. angle of incidence, c. angle of reflection;		*	
		12.1.2	state laws of reflection of light;	*		
12.2	Image Location by Spherical Mirror Equation	12.2.1	solve word problems related to the image location by spherical mirrors using mirror formula;			*
12.3	Refraction of Light	12.3.1	describe with reference to the refraction of light the following terms: a. angle of incidence, b. angle of refraction;		*	
		12.3.2	state laws of refraction of light;	*		
		12.3.3	demonstrate the passage of light ray through parallel-sided transparent material (glass slab);			*
		12.3.4	solve word problems by using the given formulae: a. sin ∠i / sin ∠r, b. speed of light in vacuum / speed of light in the given medium, c. real depth / apparent depth;			*
		12.3.5	demonstrate the passage of light through a glass prism;			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
12.4	Total Internal Reflection	12.4.1	define total internal reflection;	*		
		12.4.2	state the conditions necessary for total internal reflection;	*		
		12.4.3	describe the use of total internal reflection in light propagation;		*	
		12.4.4	describe the relation between critical angle and refractive index;		*	
		12.4.5	solve word problems related to the critical angle and refractive index;			*
12.5	Image Location by Lens Equation	12.5.1	demonstrate that light is refracted through lenses;			*
		12.5.2	draw images by placing objects at different positions in front of convex and concave lens;			*
		12.5.3	solve word problems related to the image location by lenses using lens formula;			*
12.6	Magnifying Power and Resolving Power	12.6.1	define power of a lens and state its unit;	*		
		12.6.2	define the terms resolving power of lens and magnifying power of lens;	*		

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
12.7	Compound Microscope	12.7.1	define least distance of distinct vision;	*		
		12.7.2	describe the working and uses of simple microscope;		*	
		12.7.3	draw a ray diagram of a simple microscope;			*
		12.7.4	determine the formula of the magnifying power of a simple microscope;			*
		12.7.5	describe the working and uses of compound microscope;		*	
		12.7.6	draw a ray diagram of a compound microscope and mention its magnifying power;			*
12.8	Telescope	12.8.1	describe the working and uses of telescope;		*	
		12.8.2	draw a ray diagram of a telescope and mention its magnifying power;			*
12.9	Defects in Human Eye	12.9.1	state the short-sightedness and long-sightedness;	*		
		12.9.2	draw ray diagrams to show the formation of images in the eye of an individual with a. normal vision, b. short-sightedness, c. long-sightedness;			*
		12.9.3	describe the correction of short-sightedness and long-sightedness using concave and convex lenses.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
13. Electrostatics		Students should be able to:				
13.1	Electric Charge	13.1.1	describe by using simple experiments to show the production and detection of electric charge;		*	
		13.1.2	discuss the potential dangers of electrostatic charges;		*	
13.2	Electrostatic Induction	13.2.1	describe electrostatic charging by induction;		*	
		13.2.2	state that there are positive and negative charges in nature;	*		
13.3	Electroscope	13.3.1	describe the construction and working principle of electroscope;		*	
13.4	Coulomb's Law	13.4.1	explain Coulomb's law;		*	
		13.4.2	solve word problems related to the electrostatic charges by using Coulomb's law;			*
13.5	Electric Field and its Intensity	13.5.1	define electric field and electric field intensity;	*		
		13.5.2	draw electric field lines for an isolated positive and negative point charges;			*
13.6	Electrostatic Potential	13.6.1	describe the concept of electrostatic potential;		*	
		13.6.2	define the unit 'volt';	*		
		13.6.3	describe potential difference;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
13.7	Applications of Electrostatic	13.7.1	describe a situation in which static electricity is dangerous;		*	
		13.7.2	discuss the precautions taken to ensure the safe discharge of static electricity;		*	
		13.7.3	describe the application of electrostatics in ink-jet printer and photocopier;		*	
13.8	Capacitors and Capacitance	13.8.1	describe a capacitor;		*	
		13.8.2	define capacitance and state its SI unit;	*		
		13.8.3	derive the formula for the effective/ equivalent capacitance of a number of capacitors connected in series and in parallel;			*
		13.8.4	apply the concept of the effective/ equivalent capacitance of a number of capacitors connected in series and in parallel to solve related word problems;			*
13.9	Different Types of Capacitors	13.9.1	differentiate between a fixed and a variable capacitor.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
14. Current Electricity		Students should be able to:				
14.1	Electric Current	14.1.1	define electric current;	*		
		14.1.2	differentiate between conventional and non-conventional (electronic) current;		*	
14.2	Potential Difference and Electromotive Force (e.m.f.)	14.2.1	differentiate between potential difference and electromotive force;		*	
		14.2.2	investigate the potential difference across a circuit components and mention its SI unit;			*
14.3	Ohm's Law	14.3.1	describe Ohm's law and its limitations;		*	
		14.3.2	define resistance and its SI unit;	*		
		14.3.3	describe the factors affecting the resistance of a metallic conductor;		*	
		14.3.4	distinguish between conductors and insulators;		*	
14.4	Electric Circuits	14.4.1	define electrical circuits;	*		
		14.4.2	describe the characteristics of series and parallel combinations of resistors;			*
		14.4.3	derive the effective/ equivalent resistance of a number of resistors connected in series and in parallel;			*
		14.4.4	solve word problems related to simple series and parallel combinations of resistors;			*
14.5	The I-V Characteristics for Ohmic and Non-Ohmic Conductor	14.5.1	draw and interpret the I-V characteristics graph for a metallic conductor, a filament lamp and a thermistor;			*

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
14.6	Electrical Power and Joule's Law	14.6.1	describe electrical power;		*	
		14.6.2	describe that energy is dissipated in a resistor and explain Joule's law;		*	
		14.6.3	apply the equation $E=IVt = I^2Rt = V^2 t / R$ to solve word problems;			*
		14.6.4	calculate the cost of energy when given the cost per kWh;			*
		14.6.5	distinguish between alternating current (AC) and direct current (DC);		*	
14.7	Uses of Circuit Components	14.7.1	identify circuit components and describe their uses in daily life; (switches, batteries, fuses, variable resistors, capacitors)		*	
14.8	Measuring Instruments (Galvanometer, Ammeter, Voltmeter)	14.8.1	describe the use of electrical measuring devices; (galvanometer, ammeter and voltmeter)		*	
		14.8.2	demonstrate the behaviour of light bulbs in series and parallel circuit such as, for celebration lights;			*
14.9	Alternating Current (AC)	14.9.1	state the functions of live, neutral and earth wires in the domestic main power supply;	*		
		14.9.2	explain why domestic (AC) supplies are connected in parallel series;		*	
14.10	Safety Measures	14.10.1	describe hazards of electricity; (damage insulation, overheating of cables, damp condition)		*	
		14.10.2	explain the use of safety measures in household electricity. (fuse, circuit breaker, earth wire)		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
15. Electromagnetism		Students should be able to:				
15.1	Magnetic Effect of a Steady Current	15.1.1	demonstrate that an electric current in a conductor produces a magnetic field around it;			*
15.2	Force on a Current Carrying Conductor in a Magnetic Field	15.2.1	describe that a force acts on a current carrying conductor placed in a magnetic field;		*	
15.3	Turning Effect on a Current Carrying Coil in a Magnetic Field	15.3.1	describe that a current carrying coil in a magnetic field experiences a torque with the help of Fleming's left hand rule;		*	
15.4	Direct Current (DC) Motor	15.4.1	relate the turning effect off a coil to the action of a DC motor;		*	
15.5	Electromagnetic Induction	15.5.1	describe an experiment to show that a changing magnetic field can induce e.m.f. in a circuit;		*	
		15.5.2	describe factors affecting the magnitude of an induced e.m.f.;		*	
		15.5.3	describe the direction of an induced e.m.f. opposes the change causing it;		*	
15.6	Alternating Current (AC) Generator	15.6.1	describe a simple form of AC generator;		*	
15.7	Induction	15.7.1	describe self-induction and state its units;		*	
		15.7.2	describe mutual-induction and state its units;		*	
15.8	Transformer	15.8.1	explain that a transformer works on the principle of mutual induction between two coils;		*	
		15.8.2	describe the purpose of transformers in AC circuits.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
16. Introductory Electronics		Students should be able to:				
16.1	Thermionic Emission	16.1.1	explain the process of thermionic emission emitted from a filament;		*	
16.2	Electron Gun and Cathode Rays	16.2.1	describe the simple construction and use of an electron gun as a source of electron beam;		*	
16.3	Deflection of Electron by Electric Field	16.3.1	describe the effect of electric field on an electron beam;		*	
16.4	Deflection of Electron by Magnetic Field	16.4.1	describe the effect of magnetic field on an electron beam;		*	
16.5	Cathode Rays Oscilloscope (CRO)	16.5.1	describe the basic principle of CRO and make a list of its uses;		*	
16.6	Introduction to Electronics	16.6.1	explain the importance of electronics;		*	
16.7	Analogue and Digital Electronics	16.7.1	differentiate between analogue and digital electronics;		*	
		16.7.2	describe that digital signals can carry more information;		*	
		16.7.3	state the basic operations of digital electronics;	*		
16.8	Logic Gates	16.8.1	identify and draw the symbols for the logic gates; (NOT, OR, AND, NOR and NAND)			*
		16.8.2	state the action of the logic gates in truth table form with two inputs;	*		
		16.8.3	describe the simple uses of logic gates.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
17. Information and Communication Technology		Students should be able to:				
17.1	Components of Information Technology (IT)	17.1.1	describe information technology (IT) and the components of information technology; (hardware, software, data, procedure and people)		*	
17.2	Flow of Information	17.2.1	describe the transmission of; a. electric signals through wires, b. radiowaves through air, c. light signals through optical fibres;		*	
17.3	Communication Technology	17.3.1	describe uses of fax machine, cell phone, photo phone and computer;		*	
		17.3.2	state the purpose of using e-mails and internet;	*		
17.4	Storing Information	17.4.1	describe the use of information storage devices such as audio cassettes, video cassettes, hard discs, floppy discs, compact discs and flash drive;		*	
17.5	Handling Information	17.5.1	identify the functions of word processing, data managing, monitoring and controlling.		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
18. Radioactivity		Students should be able to:				
18.1	Atom and Atomic Nucleus	18.1.1	describe Rutherford's nuclear model;		*	
		18.1.2	describe the composition of the nucleus of an atom in terms of protons and neutrons;		*	
		18.1.3	explain that the number of protons in a nucleus distinguishes one element from the other;		*	
		18.1.4	show various nuclides by using the symbol of proton number (Z), nucleon number (A) and the nuclide notation (X);		*	
18.2	Natural Radioactivity	18.2.1	explain that some nuclei are unstable;		*	
		18.2.2	describe the three types of radiation (α, β and γ);		*	
		18.2.3	state, for radioactive emissions a. their nature, b. their relative ionizing effects, c. their relative penetrating abilities;	*		
		18.2.4	explain that an element may change into another element when radioactivity occurs;		*	
18.3	Natural Transmutations	18.3.1	show changes in the composition of the nucleus by symbolic equations when alpha or beta particles are emitted;		*	
18.4	Background Radiation	18.4.1	describe that radioactive emissions occur randomly over space and time;		*	
		18.4.2	explain the existence of background radiation and its sources;		*	

Topics and Sub-topics		Student Learning Outcomes		Cognitive levels		
				K	U	A
		Students should be able to:				
18.5	Half-Life	18.5.1 18.5.2	explain the meaning of half-life of a radioactive material; calculate the half-life of radioactive elements and draw graphs showing decay curves of these elements;		* 	 *
18.6	Radio Isotopes	18.6.1 18.6.2	describe radio isotopes and their uses; describe the process of carbon dating to estimate the age of ancient objects;		* *	
18.7	Fission and Fusion	18.7.1	describe the processes and practical applications of fission and fusion;		*	
18.8	Hazards of Radioactivity and Safety Measures	18.8.1	describe the hazards of radioactive materials.		*	

Scheme of Assessment

Grade IX

Table 1: Number of Student Learning Outcomes by Cognitive Level

Topic No.	Topics	No. of Sub-topics	SLOs			Total
			K	U	A	
1.	Physical Quantities and Measurement	7	1	8	4	13
2.	Kinematics	10	4	7	10	21
3.	Dynamics	5	5	11	7	23
4.	Turning Effect of Forces	6	5	7	2	14
5.	Gravitation	5	2	8	2	12
6.	Work and Energy	6	8	6	6	20
7.	Properties of Matter	9	7	13	3	23
8.	Thermal Properties of Matter	7	1	11	4	16
9.	Transfer of Heat	5	2	10	1	13
	Total	**60**	**35**	**81**	**39**	**155**
	Percentage		**23**	**52**	**25**	**100**

Table 2: Exam Specifications

Topic No.	Topics	Marks Distribution			Total Marks
		MCQs	CRQs	ERQs	
1.	Physical Quantities and Measurement	4	Total 2 Marks (1 CRQ)		6
2.	Kinematics	5		6 Marks Choose any ONE from TWO	16
3.	Dynamics	5			
4.	Turning Effect of Forces	4	Total 3 Marks (1 CRQ)		7
5.	Gravitation	4	Total 2 Marks (1 CRQ)		6
6.	Work and Energy	5		6 Marks Choose any ONE from TWO	16
7.	Properties of Matter	5			
8.	Thermal Properties of Matter	4	Total 3 Marks (1 CRQ)		7
9.	Transfer of Heat	4	Total 3 Marks (1 CRQ)		7
	Total	**40**	**13**	**12**	**65**
	Practical*				**10**
	Total				**75**

Grade X

Table 3: Number of Student Learning Outcomes by Cognitive Level

Topic No.	Topics	No. of Sub-topics	SLOs			Total
			K	U	A	
10.	Simple Harmonic Motion and Waves	4	4	6	4	14
11.	Sound	4	2	9	1	12
12.	Geometrical Optics	9	8	8	13	29
13.	Electrostatics	9	4	12	4	20
14.	Current Electricity	10	4	13	8	25
15.	Electromagnetism	8	0	11	1	12
16.	Introductory Electronics	8	2	9	1	12
17.	Information and Communication Technology	5	1	5	0	6
18.	Radioactivity	8	1	15	1	17
	Total	**65**	**26**	**88**	**33**	**147**
	Percentage		**17**	**60**	**23**	**100**

Table 4: Exam Specifications

Topic No.	Topics	Marks Distribution			Total Marks
		MCQs	CRQs	ERQs	
10.	Simple Harmonic Motion and Waves	4		6 Marks Choose any ONE from TWO	14
11.	Sound	4			
12.	Geometrical Optics	5	Total 3 Marks (1 CRQ)		8
13.	Electrostatics	4		6 Marks Choose any ONE from TWO	14
14.	Current Electricity	4			
15.	Electromagnetism	5	Total 3 Marks (1 CRQ)		8
16.	Introductory Electronics	5	Total 2 Marks (1 CRQ)		7
17.	Information and Communication Technology	4	Total 2 Marks (1 CRQ)		6
18.	Radioactivity	5	Total 3 Marks (1 CRQ)		8
	Total	**MCQs 40**	**CRQs 13**	**ERQs 12**	**65**
	Practical*				**10**
	Total				**75**

- 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 grades IX and X respectively. This will serve as a guide in the construction of the examination paper. It also indicates that more emphasis has been given to the Understanding (52% in IX and 60% in X), Application and higher order skills (25% in IX and 23% in X) to discourage rote memorisation. Tables 1 and 3, however, do not translate directly into marks.

- There will be two examinations, one at the end of grade IX and one at the end of grade X.

- In each grade, the theory paper will be of 3 hours and will consist of two parts: paper I and paper II.

- Paper I theory will consist of 40 compulsory, multiple choice items. These questions will involve four response options.

- Paper II theory will carry 25 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 10 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 IX

S. No.	SLO No.	PRACTICAL ACTIVITIES	APPARATUS
		Topic 1: Physical Quantities and Measurement	
1.	1.6.2	To calculate the area of cross section of a solid cylinder by measuring diameter with Vernier callipers.	Vernier callipers, solid cylinder.
2.	1.6.2	To measure the thickness of a metal strip or diametre of a wire using a screw gauge.	Screw gauge, wire or metal strip.
		Topic 2: Kinematics	
3.	2.6.1	To find the weight of an unknown object using vector addition of forces.	Gravesand's apparatus, slotted weights with hangers, plane mirror strips, plumb line, thread.
4.	2.8.3	To find the acceleration of a ball rolling down an angle-iron by drawing a graph between distance (2S) and time (t^2).	Angle iron, iron ball, iron stand, stopwatch, set square.
5.	2.8.4	To study the relationship between load and extension of a helical spring with the help of a graph.	Helical spring with stand, pan, weight box, metre rod.
6.	2.10.1	To find the value of acceleration due to gravity "g" using the free fall method.	Free fall apparatus, pendulum bob, thread, candle, piece of chalk, plumb line.

S. No.	SLO No.	PRACTICAL ACTIVITIES	APPARATUS
		Topic 3: Dynamics	
7.	3.3.5	To find the tension in strings by balancing a metre rod on the iron stands.	Two iron stands, two spring balance, metre rod, wedge, slotted weight with hangers, thread.
		Topic 4: Turning Effect of Forces	
8.	4.2.2	To find the weight of an unknown object using the principle of moments.	Metre rod, weight box, thread, wooden wedge.
9.	4.5.5	To verify the principle of moments using a metre rod balanced on a wedge.	Metre rod, weight box, thread, wooden wedge.
		Topic 7: Properties of Matter	
10.	7.5.6	To find the density of an insoluble object which is heavier than water using Archimedes principle.	Physical/ digital balance, weight box, beaker, thread, small wooden bench, thermometer, water.
		Topic 8: Thermal Properties of Matter	
11.	8.3.2	To find the specific heat by the method of mixture using polystyrene cups. (used as container of negligible heat capacity).	Polystyrene cup with lid and stirrer, hypsometer, burner, thermometer, Physical/ digital balance, weight box, water.
12.	8.5.1	To draw a graph between temperature (^{o}C) against time (minutes) for the conversion of ice into water and then steam as a result of slow heating.	Thermometer, beaker, spirit lamp, sand, ice, stop watch, burner.

Grade X

S. No.	SLO No.	PRACTICAL ACTIVITIES	APPARATUS
		Topic 10: Simple Harmonic Motion and Waves	
1.	10.1.5	To study the effect of the change in the length of a simple pendulum on its time period and hence calculate the value of acceleration due to gravity "g".	A metallic bob with a hook, stop watch, cork, Vernier callipers, thread, iron stand, metre rod, piece of chalk.
2.	10.1.5	To prove that time period of a simple pendulum is independent of (i) mass of the pendulum and (ii) amplitude of the vibration.	Different metallic bobs with a hook, stop watch, cork, Vernier callipers, thread, iron stand, metre rod, piece of chalk.
		Topic 12: Geometrical Optics	
3.	12.3.3	To verify the laws of refraction of light using a glass slab.	Glass slab, drawing pins, common pins, drawing board, white paper.
4.	12.3.5	To trace the path of a ray of light through glass a prism and measure the angle of deviation.	Glass prism, drawing board, common pins, drawing pins, white paper, metre rod.
5.	12.2.1	To find the refractive index of water using concave mirror.	Concave mirror, sharp pointed bright needle, stand, metre rod, set square, knitting needle, two wooden blocks.
6.	12.5.3	To find the focal length of a convex lens by the parallax method using two pins.	Convex lens, knitting needles, convex lens holder, needle stands, optical bench.

S. No.	SLO No.	PRACTICAL ACTIVITIES	APPARATUS
		Topic 14: Current Electricity	
7.	14.3.1	To verify Ohm's law using a wire as a conductor.	Voltmetre, ammetre, battery, connecting wires, resistance, rheostat.
8.	14.4.2	To study resistance in a series circuit.	Two resistances, voltmetre, ammetre, key, battery, connecting wires, sand paper.
9.	14.4.2	To study resistance in a parallel circuit.	Two resistances, voltmetre, ammeter, key, battery, connecting wires, sand paper.
10.	14.8.1	To find the resistance of a galvanometre by the half deflection method.	Galvanometre, high resistance box, fractional resistance box, two key plugs, cell (1.5 V), connecting wires.
		Topic 15: Electromagnetism	
11.	15.1.1	To trace the magnetic field lines created due to a current carrying circular coil.	Circular coil of insulated copper fitted in a board, white paper plain sheet (A-4 size), scissors, compass needle, battery, key plug, rheostat, connecting wires.
12.	16.8.1	To verify the truth tables of the OR and the AND gates.	DC power supply, OR gate (7432), AND gate (7408), LED indicator module, two key plugs, connecting wires.

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