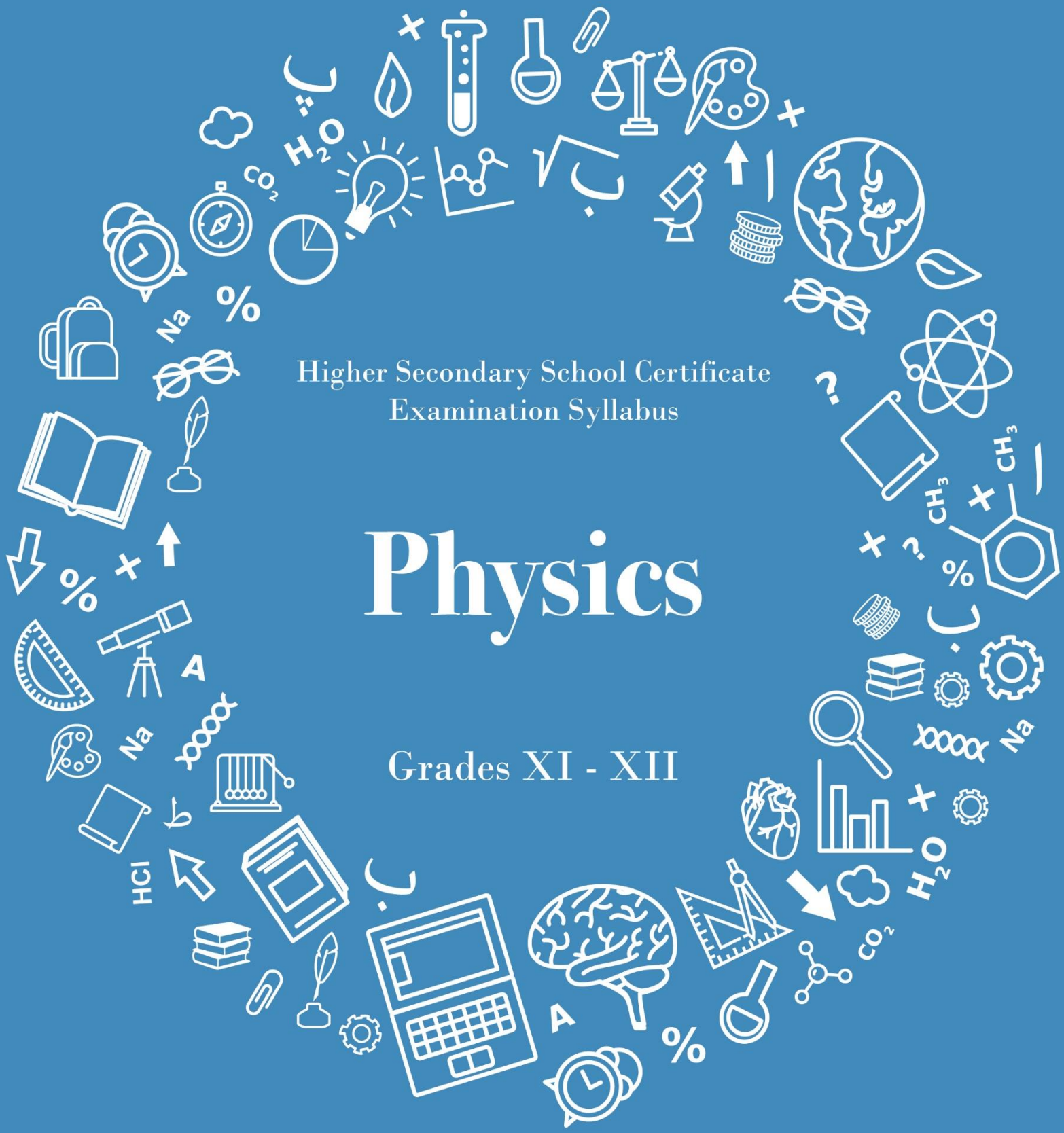
آغا خان یونیورسٹی ایگزامینیشن بورڈ

AGA KHAN UNIVERSITY EXAMINATION BOARD



Higher Secondary School Certificate
Examination Syllabus

Physics

Grades XI - XII

(Based on New National Curriculum 2022-2023)

Student Learning Outcomes of AKU-EB HSSC Physics Syllabus

Part I (Grade XI)

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level[1]		
				R	U	A and beyond
1.	**Physical Quantities and Measurement**	Students should be able to:				
	1.1 Physical Quantities	1.1.1	discuss that all physical quantities consist of a numerical magnitude and a unit;			E
		1.1.2	determine appropriate values of physical quantities;			A
		1.1.3	identify the SI base quantities and their units;		*	
		1.1.4	discuss derived units as products or quotients of the SI base units;			E
		1.1.5	use SI base units to check the homogeneity of physical equations;			A
	1.2 Dimensions	1.2.1	describe the concept of dimensions;		*	
		1.2.2	discuss various physical quantities in terms of their dimensions;			E
		1.2.3	show the homogeneity of physical equations by using dimensions;			A
		1.2.4	derive the formula for physical quantities by using dimensions;			A
	1.3 Precision and Accuracy	1.3.1	differentiate between precision and accuracy;		*	
		1.3.2	analyse the accuracy and precision of data collected using different measuring instruments;			An

[1]R = Remember, U = Understand, A = Apply and beyond [Apply (A), Analyse (An), Evaluate (E), Create (C)]

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level		
				R	U	A and beyond
1.4	Significant Figures and Uncertainty	1.4.1	solve word problems related to uncertainty in derived quantity with correct number of significant figures;			A
		1.4.2	justify that all measurements contain uncertainty.			E

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level		
				R	U	A and beyond
2.	**Scalars and Vectors**	Students should be able to:				
2.1	Introduction to Vectors	2.1.1	differentiate between scalar and vector quantities;		*	
2.2	Addition of Vectors by Rectangular Component Method	2.2.1 2.2.2 2.2.3	analyse a vector into its rectangular components; explain the sum of vectors using perpendicular components; calculate the resultant of two vectors by rectangular component method;		 * 	An A
2.3	Scalar Product of Two Vectors	2.3.1 2.3.2 2.3.3	define scalar product of two vectors; exemplify scalar product of two vectors in terms of angle between them; describe properties of scalar product of two vectors;	* 	 * *	
2.4	Vector Product of Two Vectors	2.4.1 2.4.2 2.4.3	define vector product of two vectors; exemplify vector product of two vectors in terms of angle between them; describe properties of vector product of two vectors.	*	 * *	

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level		
				R	U	A and beyond
3.	**Motion in One Dimension**	Students should be able to:				
3.1	Equations of Motion	3.1.1	derive equations of motion for a body moving with a uniform acceleration in a straight line;			A
		3.1.2	solve word problems related to uniformly accelerated motion including free fall using appropriate equations;			A
3.2	Law of Conservation of Momentum	3.2.1	describe law of conservation of linear momentum;		*	
		3.2.2	exemplify the law of conservation of momentum in: a. karate chops to break a pile of bricks, b. car crashes, c. ball and bat, d. motion under thrust of a rocket in a straight line;		*	
		3.2.3	define elastic and inelastic collision;	*		
		3.2.4	apply law of conservation of momentum to study the special cases of elastic collision between two bodies in one dimension;			A
		3.2.5	apply law of conservation of momentum in one and two dimensions in solving word problems;			A
3.3	Work	3.3.1	describe work as the dot product of force and displacement;		*	
		3.3.2	deduce the work done from the force displacement graphs;			E
3.4	Conservative and Non-Conservative Fields	3.4.1	differentiate between conservative and non-conservative field;		*	
3.5	Work-Energy Theorem	3.5.1	deduce the work-energy theorem in non-resistive and resistive medium;			E
		3.5.2	solve word problems related to the work-energy theorem.			A

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level		
				R	U	A and beyond
4. Motion in Two Dimensions		Students should be able to:				
4.1	Projectile	4.1.1	explain projectile motion;		*	
		4.1.2	derive the relation for: a. time of flight, b. maximum height, c. horizontal range of a projectile, d. maximum horizontal range of a projectile;			A
		4.1.3	solve word problems related to the given relations (a, b, c and d);			A
		4.1.4	predict qualitatively the effect of air resistance on the motion of a projectile;			E
4.2	Angular Motion	4.2.1	describe angular displacement, angular velocity and angular acceleration;		*	
		4.2.2	derive the relationship between linear and angular displacement, velocity and acceleration;			A
		4.2.3	solve word problems related to the rotational motion;			A
4.3	Centripetal Force and Centripetal Acceleration	4.3.1	define centripetal force and centripetal acceleration;	*		
		4.3.2	derive centripetal acceleration when speed is uniform;			A
		4.3.3	justify that a centrifuge is used to separate materials using centripetal force;			E
		4.3.4	explain that the objects in orbiting satellites appear to be weightless;		*	
		4.3.5	describe that artificial gravity is created to counter weightlessness;		*	

Topics and Sub-Topics		Student Learning Outcomes	Cognitive level		
			R	U	A and beyond
4.4 Moment of Inertia	4.4.1	explain moment of inertia and its SI unit with dimension;		*	
	4.4.2	compare the moment of inertia in rod, ring, disc and sphere;		*	
	4.4.3	derive relationship between torque, moment of inertia and angular acceleration;			A
	4.4.4	solve word problems related to the given relationships;			A
4.5 Angular Momentum	4.5.1	explain angular momentum and its SI unit with dimension;		*	
	4.5.2	solve word problems related to angular momentum;			A
	4.5.3	explain the law of conservation of angular momentum;		*	
	4.5.4	illustrate the applications of conservation of angular momentum in: a. flywheels to store rotational energy, b. gyroscopes in navigation system, c. ice skaters to adjust their angular velocity.			A

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level		
				R	U	A and beyond
5.	**Deformation in Solids**	Students should be able to:				
5.1	Types of Solids	5.1.1	distinguish between the structures of crystalline, amorphous and polymeric solids;		*	
5.2	Deformation in Solids	5.2.1	describe the deformation of solids in one dimension;		*	
5.3	Tensile and Plastic Deformation	5.3.1	describe terms elastic deformation, plastic deformation and elastic limit;		*	
5.4	Stress, Strain and Young Modulus	5.4.1 5.4.2 5.4.3 5.4.4	define stress, strain and Young modulus; interpret force extension graph for a deformed material; solve word problems related to Young modulus; use daily life objects to explain stress, strain and Young modulus;	*		E A FA[2]
5.5	Elastic Potential Energy of Materials	5.5.1	determine the elastic potential energy of a material by using $E = \frac{1}{2}Fx = \frac{1}{2}kx^2$.			A

[2]FA= Formative Assessment, not to be assessed under examination conditions

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level		
				R	U	A and beyond
6.	**Fluids Dynamics**	Students should be able to:				
	6.1 Floating Objects	6.1.1	describe upthrust;		*	
		6.1.2	solve word problems using $Upthrust = \rho gV$;			A
		6.1.3	state the principle of floatation in terms of upthrust;	*		
		6.1.4	state Archimedes' principle of floatation;	*		
		6.1.5	justify that ships are engineered to float in the sea;			E
	6.2 Streamline and Turbulent Flow	6.2.1	define the following terms: a. streamline flow (laminar flow), b. turbulent flow, c. incompressible flow;	*		
		6.2.2	state the conditions required for turbulent flow;	*		
	6.3 Equation of Continuity	6.3.1	derive the equation of continuity;			A
		6.3.2	explain that squeezing one end of a rubber pipe results in increase in flow velocity at the other end;		*	
		6.3.3	solve word problems related to the equation of continuity;			A
	6.4 Bernoulli's Equation	6.4.1	derive Bernoulli's equation;			A
		6.4.2	justify that the difference in pressure can arise from different rates of flow of a fluid;			E
		6.4.3	explain Bernoulli effect in the following cases: a. atomizer, b. swing of ball, c. the lift of golf ball (the magnus effect), d. venturi duct;		*	

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level		
				R	U	A and beyond
6.5	Viscous Fluids and Fluid Friction	6.5.1	define the following terms: a. viscous fluids, b. non-viscous fluids;	*		
		6.5.2	describe that viscous force in a fluid causes a retarding force on an object moving through it;		*	
		6.5.3	explain that real fluids are viscous fluids;		*	
		6.5.4	describe the following terms: a. fluid friction, b. super fluidity;		*	
		6.5.5	use different liquids in the surroundings to explain fluid friction and super fluidity.			FA

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level		
				R	U	A and beyond
7.	**Oscillations**	Students should be able to:				
7.1	Simple Harmonic Motion (S.H.M.)	7.1.1	define periodic and non-periodic oscillation;	*		
		7.1.2	describe Simple Harmonic Motion (S.H.M.);		*	
7.2	Uniform Circular Motion and S.H.M.	7.2.1	define the following terms in the context of oscillations: a. displacement, b. amplitude, c. period, d. frequency, e. angular frequency, f. phase difference;	*		
		7.2.2	relate S.H.M. with uniform circular motion;		*	
		7.2.3	derive expression for instantaneous displacement, velocity and acceleration in terms of angular velocity (ω);			A
		7.2.4	solve word problems related to the SLO # 7.2.3;			A
		7.2.5	analyse graphical representations of the variations of displacement, velocity and acceleration with time for simple harmonic motion;			An
7.3	Mass-Spring System	7.3.1	explain that the motion of a body under elastic restoring force is S.H.M.;		*	
		7.3.2	derive an expression for the time period of a mass-spring system;			A
		7.3.3	solve word problems using the expression for the time period of a mass-spring system;			A

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level		
				R	U	A and beyond
7.4	Simple Pendulum	7.4.1 7.4.2 7.4.3	explain that the motion of a simple pendulum is S.H.M.; 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;		* 	 A A
7.5	Energy Conservation in S.H.M.	7.5.1 7.5.2 7.5.3	derive an expression to show that energy is conserved in mass-spring system executing S.H.M.; solve word problems related to given expression; analyse the interchange between kinetic and potential energy during simple harmonic motion;			A A An
7.6	Free and Forced Oscillation	7.6.1	exemplify free and forced oscillation;		*	
7.7	Resonance	7.7.1 7.7.2	define resonance; describe applications and consequences of resonance in real life;	*	 *	
7.8	Damped Oscillations	7.8.1 7.8.2 7.8.3	explain damped oscillation; list different applications of damped oscillation; illustrate displacement-time graphs to show light, critical and heavy damping.	 *	*	 A

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level		
				R	U	A and beyond
8.	**Waves**	Students should be able to:				
8.1	Wave Motion	8.1.1	define progressive waves;	*		
		8.1.2	explain energy transfer through a progressive wave;		*	
		8.1.3	solve word problems using *intensity = power/ area* and *intensity* $\propto$ *(amplitude)*^{2} for a progressive wave;			A
		8.1.4	solve word problems using $V = f\lambda$;			FA
8.2	Transverse and Longitudinal Waves	8.2.1	differentiate between transverse and longitudinal waves;			FA
		8.2.2	analyse graphical representations of transverse and longitudinal waves;			FA
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	calculate the phase difference between two waves;			A
		8.3.4	explain the formation of beats using diagrams;		*	
8.4	Stationary Waves	8.4.1	define the terms nodes and antinodes;	*		
		8.4.2	describe the formation of stationary waves in a string and air column;		*	
		8.4.3	solve word problems related to stationary waves;			A

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level		
				R	U	A and beyond
8.5	Doppler's Effect	8.5.1	describe 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: a. when the source is at rest and the listener is moving towards or away from the source, b. when the listener is at rest and the source is moving towards or away from the listener, c. when both source and listener are moving towards each other, d. when both source and listener are moving away from each other;			A
		8.5.3	solve word problems using the above relations mentioned in the SLO # 8.5.2;			A
		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;			A
8.6	Waves in Modern World	8.6.1	use of waves in modern world for: a. medical purposes, b. digital transmission, c. storage of information, d. monitoring earthquake and tsunami.			FA

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level		
				R	U	A and beyond
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;			E
		9.1.2	discuss the concept of wave-front;			E
		9.1.3	describe Huygen's principle;		*	
9.2	Interference of Light	9.2.1	define coherent and monochromatic 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;			A
		9.2.6	solve word problems related to the fringe spacing;			A
9.3	Michelson's Interferometer	9.3.1	describe the construction and working of Michelson's interferometer;		*	
		9.3.2	describe qualitatively about gravitational waves;		*	
		9.3.3	state that a gravitational wave passes a body of mass creates a distortion in spacetime;	*		
		9.3.4	describe the use of interferometers in detecting gravitational waves;		*	
9.4	Diffraction of Light	9.4.1	define diffraction of light;	*		
		9.4.2	describe diffraction of light by diffraction grating;		*	
		9.4.3	describe diffraction in a narrow slit;		*	
		9.4.4	solve word problems related to diffraction of light;			A

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level		
				R	U	A and beyond
9.5	Bragg's Law	9.5.1	state Bragg's law;	*		
		9.5.2	describe diffraction of X-rays through crystals;		*	
		9.5.3	derive the equation $2\ d\ sin\ \theta = m\ \lambda$;			A
		9.5.4	solve word problems related to the given equation;			A
9.6	Polarisation	9.6.1	describe unpolarised and polarised light;		*	
		9.6.2	explain polarisation with reference to transverse waves;		*	
		9.6.3	explain polarisation by reflection;		*	
		9.6.4	explain polarisation by a polaroid;		*	
		9.6.5	state Malus's law;	*		
		9.6.6	solve word problems related to the Malus's law;			A
		9.6.7	describe the applications of polarisation in daily life.		*	

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level		
				R	U	A and beyond
10. Thermodynamics		Students should be able to:				
10.1	Heat and Temperature	10.1.1	distinguish between heat and temperature;		*	
		10.1.2	describe heat as a form of transit energy;		*	
		10.1.3	identify that regions of equal temperature are in thermal equilibrium;		*	
		10.1.4	investigate to provide evidence for the transfer of thermal energy between two bodies at different temperatures in a closed system;			FA
10.2	Fundamentals of the Ideal Gas	10.2.1	state Boyle's law and Charles's law;	*		
		10.2.2	describe that a gas obeying $PV \propto T$ is an ideal gas;		*	
10.3	Kinetic Molecular Theory of Gases	10.3.1	state basic postulates of kinetic molecular theory of gases;	*		
		10.3.2	derive relation $PV = \frac{1}{3} Nm < v^2 >$;			A
		10.3.3	calculate the root-mean-square speed of an ideal gas;			A
		10.3.4	derive the formula for the average translational kinetic energy of a gas;			A
		10.3.5	solve word problems related to given average translational kinetic energy of a gas;			A
10.4	Internal Energy and Work	10.4.1	describe internal energy of an ideal gas as the sum of their kinetic energy of molecules only;		*	
		10.4.2	explain that internal energy is function of 'state' and is independent of paths;		*	
		10.4.3	explain work done in thermodynamics;		*	
		10.4.4	differentiate between the work done by a gas and the work done on a gas;		*	

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level		
				R	U	A and beyond
10.5	First Law of Thermodynamics	10.5.1	explain the first law of thermodynamics;		*	
		10.5.2	apply the first law of thermodynamics in: a. isothermal, b. adiabatic, c. isobaric, d. isochoric processes;			A
		10.5.3	calculate the following on the basis of the first law of thermodynamics: a. change in internal energy, b. work done, c. change in heat;			A
10.6	Molar Specific Heat of Gases	10.6.1	define the terms: a. specific heat, b. molar specific heat;	*		
		10.6.2	explain $C_p > C_v$;		*	
		10.6.3	show that $C_p - C_v = R$ by using first law of thermodynamics;			A
10.7	Reversible and Irreversible Process	10.7.1	describe the concept of reversible and irreversible processes;		*	
10.8	Second Law of Thermodynamics	10.8.1	explain the second law of thermodynamics using schematic diagram;		*	

Topics and Sub-Topics		Student Learning Outcomes		Cognitive level		
				R	U	A and beyond
10.9	Carnot Engine	10.9.1	describe heat engine with reference to the second law of thermodynamics;		*	
		10.9.2	explain the working principle of Carnot engine and its four processes with pressure-volume (PV) diagram;		*	
		10.9.3	derive the formula for efficiency of Carnot engine;			A
		10.9.4	solve word problems related to efficiency of Carnot engine;			A
		10.9.5	design an energy efficient device for daily life use;			FA
10.10	Refrigerator	10.10.1	describe refrigerator as a reverse of heat engine;		*	
		10.10.2	derive expression for the coefficient of performance of a refrigerator;			A
10.11	Entropy	10.11.1	explain 'entropy';		*	
		10.11.2	describe positive and negative entropy;		*	
		10.11.3	explain that increase in entropy is the evidence of increase in temperature of a system;		*	
		10.11.4	explain that energy is degraded during all natural processes;		*	
		10.11.5	discuss environmental crisis as an entropy crisis.			E

Topic Wise Practical Activities

Part I (Grade XI)

S. No.	Topic-Wise Practical Activities	Apparatus
	Topic 1: Physical Quantities and Measurement	
1	Determine the capacity and thickness of a test tube by using Vernier callipers.	Vernier callipers, test tube.
2	Measure the diameter of few ball bearings of different sizes using screw gauge and estimate their volumes.	Screw gauges, steel ball bearings.
3	Determine the radius of curvature of any spherical surface by using a spherometer.	Spherometer, convex or concave lens/ mirror.
	Topic 2: Scalars and Vectors	
4	Determine the weight of a body by vector addition of forces. (Parallelogram Method)	Gravesend's apparatus, slotted weights, thread nos., plane mirror strip.
	Topic 3: Motion in One Dimension	
5	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.
6	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, meter rod.
	Topic 7: Oscillations	
7	Verify that the time period of the simple pendulum is directly proportional to the square root of its length and hence, find the value of acceleration due to gravity 'g' from the graph.	Simple pendulum, stopwatch, stand with clamp, thread, cork, Vernier callipers.

S. No.	Topic-Wise Practical Activities	Apparatus
	Topic 8: Waves	
8	Determine the frequency of AC by Melde's apparatus/ electric sonometer.	AC vibrator, step-down transformer (6V), connecting wires, thread, pulley, scale plan.
9	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 diameter, physical/ digital/ spring balance, weight box, meter rod.
10	Determine the wavelength of sound in air using stationary waves and calculate the speed of sound using resonance tube.	Resonance apparatus, different tuning forks of known frequencies, thermometer, Vernier callipers, rubber pad, two set squares, beaker.
	Topic 10: Thermodynamics	
11	Determine the specific heat capacity of solid using method of mixture (Regnaults Method).	Regnaults apparatus for specific heat, thermometer, solid ball, calorimeter.
12	Determine the specific heat capacity of water by electrical method.	Electrical calorimeter, 1/5^{o}C thermometer, battery, rheostat, key, ammeter, voltmeter, connecting wires, stopwatch, physical/ digital/ spring balance, weight box.

Scheme of Assessment

Grade XI

Table 1: Exam Specifications

Topic No.	Topics	Marks Distribution			Total Marks
		MCQs	CRQs	ERQs	
1.	Physical Quantities and Measurement	2	Total 2 Marks (1 CRQ)		4
2.	Scalars and Vectors	2	Total 2 Marks (1 CRQ)		4
3.	Motion in One Dimension	6	Total 2 Marks (1 CRQ)	5 Marks Choose any ONE from TWO	13
4.	Motion in two Dimensions	7	Total 3 Marks (1 CRQ)		15
5.	Deformation in Solids	1	Total 2 Marks (1 CRQ)		3
6.	Fluids Dynamics	4	Total 2 Marks (1 CRQ)		6
7.	Oscillations	7	Total 3 Marks (1 CRQ)		10
8.	Waves	7	Total 3 Marks (1 CRQ)	5 Marks Choose any ONE from TWO	15
9.	Physical Optics	7	Total 3 Marks (1 CRQ)		15
10.	Thermodynamics	7	Total 3 Marks (1 CRQ)		10
	Total	**50**	**25**	**10**	**85**
	Practical*				**15**
	Total				**100**

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