Secondary Education Curriculum

2076

Physics

Grades: 11 and 12 **Subject code: Phy. 101 (Grade 11), Phy. 102 (Grade 12)**

Credit hrs: 5 **Working hrs: 160**

1. Introduction

This curriculum presumes that the students joining grade 11 and 12 science stream come with diverse aspirations, some may continue to higher level studies in specific areas of science, others may join technical and vocational areas or even other streams. The curriculum is designed to provide students with general understanding of the fundamental scientific laws and principles that govern the scientific phenomena in the world. It focuses to develop scientific knowledge, skill competences and attitudes required at secondary level (grade 11-12) irrespective of what they do beyond this level, as envisioned by national goals. Understanding of scientific concepts and their application, in day to day context as well as the process of obtaining new knowledge through holistic approach of learning in the spirit of national qualification framework is emphasized in the curriculum.

In particular, this curriculum aims to provide sufficient knowledge and understanding of science for all learners to become confident citizens in the technological world. It helps the students to recognize the usefulness and limitations of laws and principles of physics and use them in solving problems encountered in their daily lives along a sound foundation for students who wish to study physics or related professional or vocational courses in higher education. It also helps to develop science related attitudes such as a concern for safety and efficiency, concern for accuracy and precision, objectivity, a spirit of enquiry, inventiveness, appreciation of ethno-science, and willingness to use technology for effective communication. It also promotes awareness of the principles and laws of science that are often the result of cumulative efforts and their studies and applications are subject to economic and technological limitations and social, cultural and ethical perceptions/acceptance.

The curriculum prepared in accordance with National Curriculum Framework is structured for two academic years in such a way that it incorporates the level-wise competencies, grade-wise leaning outcomes, scope and sequence of contents, suggested practical/project activities, learning facilitation process and assessment strategies so as to enhance the learning on the subject systematically.

2. Level-wise competencies

In completion of this course, students are expected to demonstrate the following competencies:

1. relate the phenomena and processes of the world around them to the knowledge and understanding of physical laws, principles and theories and describe them using appropriate scientific vocabulary, terminology and conventions
2. use scientific instruments, apparatus and methods to collect, evaluate and communicate information accurately and precisely
3. design simple experiment to develop relations among physical quantities,
4. carryout simple scientific research on issues related to physics and
5. construct simple models to illustrate physical concepts

6. use the knowledge of physics to promote care for the environment, indigenous knowledge, social values and ethics

3. Grade wise learning Outcomes

Grade 11	Grade 12
Content Area: Mechanics	
1. Physical Quantities 1.1 Demonstrate the meaning, importance and applications of precision in the measurements 1.2 Understand the meaning and importance of significant figures in measurements 1.3 Explain the meaning of dimensions of a physical quantity 1.4 Workout the dimensions of derived physical quantities applicable to this syllabus 1.5 Apply dimensional analysis method to check the homogeneity of physical equations	**1. Rotational dynamics** 1.1 Recall equations of angular motion and compare them with equations of linear motion 1.2 Derive the expression for rotational kinetic energy 1.3 Describe the term moment of inertia and radius of gyration 1.4 Find the moment of inertia of thin uniform rod rotating about its center and its one end 1.5 Establish the relation between torque and angular acceleration of a rigid body 1.6 Describe the work and power in rotational motion with expression 1.7 Define angular momentum and prove the principle of conservation of angular momentum 1.8 Solve numerical problems and conceptual questions regarding the rotational dynamics
2. Vectors 2.1 Distinguish between scalar and vector quantities 2.2 Add or subtract coplanar vectors by drawing scale diagram (vector triangle, parallelogram or polygon method) 2.3 Understand the meaning and importance of unit vectors 2.4 Represent a vector as two perpendicular components 2.5 Resolve co-planer vectors using component method	**2. Periodic motion** 2.1 Define simple harmonic motion and state its equation. 2.2 Derive the expressions for energy in simple harmonic motion 2.3 Derive the expression for period for vertical oscillation of a mass suspended from coiled spring 2.4 Describe angular simple harmonic motion and find its period 2.5 Derive expression for period of simple pendulum

2.6 Describe scalar and vector products 2.7 Understand the meaning and applications of scalar and vector product with examples 2.8 Solve related problems.	2.6 Explain the damped oscillation 2.7 Describe forced oscillation and resonance with suitable examples 2.8 Solve the numerical problems and conceptual questions regarding the periodic motion
3. Kinematics 3.1 Define displacement, instantaneous velocity and acceleration with relevant examples 3.2 Explain and use the concept of relative velocity 3.3 Draw displacement-time and velocity-time graph to represent motion, and determine velocity from the gradient of displacement-time graph, acceleration from the gradient of velocity-time graph and displacement from the area under a velocity-time graph 3.4 Establish equations for a uniformly accelerated motion in a straight line from graphical representation of such motion and use them to solve related numerical problems 3.5 Write the equations of motion under the action of gravity and solve numerical problem related to it 3.6 Understand projectile motion as motion due to a uniform velocity in one direction and a uniform acceleration in a perpendicular direction, derive the equations for various physical quantities (maximum height, time of flight, time taken to reach maximum height, horizontal range, resultant velocity) and use them to solve mathematical problems related to projectile motion	**3. Fluid statics** 3.1 State and explain Archimedes principle and Pascal's law 3.2 Define up-thrust, pressure in fluid, buoyancy, center of buoyancy and meta center 3.3 State and use the law of floatation, 3.4 Describe surface tension and explain its principle 3.5 Establish the relation between surface energy and surface tension 3.6 Define angle of contact and capillarity with examples 3.7 State the Newton's Formula for viscosity of a liquid and define coefficient of viscosity 3.8 Differentiate between laminar and turbulent flow & describe Reynolds number 3.9 Recall and use the Poiseuille's formula 3.10 State Stoke's law and use it to determine the coefficient of viscosity of given liquid 3.11 Explain equation of continuity and its application 3.12 Recall the Bernoulli's equation and explain its uses 3.13 Solve the numerical problems and conceptual questions regarding the fluid statics
4. Dynamics: 4.1 Define linear momentum, impulse, and establish the relation between them	-

4.2 Define and use force as rate of change of momentum 4.3 State and prove the principle of conservation of linear momentum using Newton's second and Newton's third of motion 4.4 Define and apply moment of a force and torque of a couple 4.5 State and apply the principle of moments 4.6 State and apply the conditions necessary for a particle to be in equilibrium 4.7 State and explain the laws of solid friction 4.8 Show the coefficient of friction is equal to the tangent of angle of repose and use the concept to solve problems. 4.9 Solve the numerical problem and conceptual question on dynamics	
5. Work, energy and power: 5.1 Explain work done by a constant force and a variable force 5.2 State and prove work-energy theorem 5.3 Distinguish between kinetic energy and potential energy and establish their formulae 5.4 State and prove the principle of conservation of energy 5.5 Differentiate between conservative and non-conservative force 5.6 Differentiate between elastic and inelastic collision and hence explain the elastic collision in one dimension 5.7 Solve the numerical problems and conceptual questions regarding work, energy, power and collision	-
6. Circular motion 6.1 Define angular displacement, angular velocity and angular acceleration 6.2 Establish the relation between angular and linear velocity & acceleration 6.3 Define centripetal force	-

6.4 Derive the expression for centripetal acceleration and use it to solve problems related to centripetal force 6.5 Describe the motion in vertical circle, motion of vehicles on banked surface 6.6 Derive the period for conical pendulum 6.7 Solve the numerical problem and conceptual question on circular motion	
7. Gravitation 7.1 Explain Newton's law of gravitation 7.2 Define gravitational field strength 7.3 Define and derive formula of gravitational potential and gravitational potential energy 7.4 Describe the variation in value of 'g' due to altitude and depth 7.5 Define center of mass and center of gravity 7.6 Derive the formula for orbital velocity and time period of satellite 7.7 Define escape velocity and derive the expression of escape velocity 7.8 Find the potential and kinetic energy of the satellite 7.9 Define geostationary satellite and state the necessary conditions for it 7.10 Describe briefly the working principle of Global Position -System (GPS) 7.11 Solve the numerical problems and conceptual questions regarding related to the gravitation	-
8. Elasticity 8.1 State and explain Hooke's law 8.2 Define the terms stress, strain, elasticity and plasticity 8.3 Define the types of elastic modulus such as young modulus, bulk modulus and shear modulus 8.4 Define Poisson's ratio 8.5 Derive the expression for energy stored in	-

a stretched wire 8.6 Solve the numerical problems and conceptual questions regarding elasticity	
Content Area: Heat and thermodynamics	
9. Heat and temperature 9.1 Explain the molecular concept of thermal energy, heat and temperature, and cause and direction of heat flow 9.2 Explain the meaning of thermal equilibrium and Zeroth law of thermodynamics. 9.3 Explain thermal equilibrium as a working principle of mercury thermometer.	**4. First Law of Thermodynamics** 4.1 Clarify the concept of thermodynamic system. 4.2 Explain the meaning of work done by the system and work done on the system, and describe how work done by gas during expansion can be calculated from indicator (P – V) diagram. 4.3 Explain the concept of latent heat and internal energy. 4.4 State and explain first law of thermodynamics - increase of internal energy (dU) = heat into the system (dQ) + work done on the system (PdV) realizing its limitations and necessity of second law of thermodynamics. 4.5 Define and explain two specific heat capacities of gas appreciating the relation Cp – Cv = R and cp – cv = r. 4.6 Explain various thermodynamic process (isothermal, isobaric, isochoric and adiabatic) with good concept of their P – V diagram. 4.7 Derive adiabatic equation $PV\gamma$ = constant. 4.8 Derive expression for work done during isothermal and adiabatic process. 4.9 Give concept of reversible and irreversible process with examples. 4.10 Solve mathematical problems related to first law of thermodynamics and thermodynamic process.
10. Thermal Expansion 10.1 Explain some examples and applications of thermal expansion, and	**5. Second Law of Thermodynamics** 5.1 State and explain second law of thermodynamics (Kelvin's and

demonstrate it with simple experiments. 10.2 Explain linear, superficial, cubical expansion and define their corresponding coefficients with physical meaning. 10.3 Establish a relation between coefficients of thermal expansion. 10.4 Describe Pullinger's method to determine coefficient of linear expansion. 10.5 Explain force set up due to expansion and contraction. 10.6 Explain differential expansion and its applications. 10.7 Explain the variation of density with temperature. 10.8 Explain real and apparent expansion of liquid appreciating the relation $\gamma r = \gamma g + \gamma a$. 10.9 Describe Dulong and Petit's experiment to determine absolute expansivity of liquid. 10.10 Solve mathematical problems related to thermal expansion.	Clausius's statement). 5.2 Compare second and first law of thermodynamics considering indication of direction of flow of heat. 5.3 Explain heat engine as a device to convert heat energy into mechanical energy appreciating that its efficiency is less than 100%. 5.4 Discuss Carnot's cycle with the concept of P – V diagram and calculate the work done of each step and corresponding efficiency. 5.5 Describe internal combustion engines, Otto engine and diesel engine with the help of P – V diagram to compare their efficiencies. 5.6 Explain refrigerator as heat engine working in reverse direction 5.7 Introduce entropy as a measure of disorder appreciating its roles in thermodynamic process. 5.8 Solve mathematical problems related to heat engine.
11. Quantity of Heat 11.1 Define heat capacity and specific heat capacity and explain application of high specific heat capacity of water and low specific heat capacity of cooking oil and massage oil 11.2 Describe Newton's law of cooling with some suitable daily life examples. 11.3 Explain the principle of calorimetry and describe any one standard process of determining specific heat capacity of a solid 11.4 Explain the meaning of latent heat of substance appreciating the graph between heat and temperature and define specific latent heat of fusion and vaporization. 11.5 Describe any one standard method of	-

measurement of specific latent heat of fusion and explain briefly the effect of external pressure on boiling and melting point. 11.6 Distinguish evaporation and boiling. 11.7 Define triple point. 11.8 Solve mathematical problems related to heat	
12. Rate of heat flow 12.1 Explain the transfer of heat by conduction, convection and radiation with examples and state their applications in daily life. 12.2 Define temperature gradient and relate it with rate of heat transfer along a conductor. 12.3 Define coefficient of thermal conductivity and describe Searl's method for its determination. 12.4 Relate coefficient of reflection (r), coefficient of transmission (t) and coefficient of absorption (r + a + t = 1). 12.5 Explain ideal radiator (e= 1, a =1) and black body radiation. 12.6 State and explain Stefan's law of black body radiation using terms; emissive power and emissivity. 12.7 Describe idea to estimate apparent temperature of sun. 12.8 Solve mathematical problems related to thermal conduction and black body radiations.	-
13. Ideal gas 13.1 Relate pressure coefficient and volume coefficient of gas using Charles's law and Boyle's law. 13.2 Define absolute zero temperature with the support of P - V, V- T graph. 13.3 Combine Charles's law and Boyle's law to obtain ideal gas equation. 13.4 Explain molecules, inter molecular	-

forces, moles and Avogadro's number. 13.5 Explain the assumptions of kinetic – molecular model of an ideal gas. 13.6 Derive expression for pressure exerted by gas due to collisions with wall of the container appreciating the use of Newton's law of motion. 13.7 Explain the root mean square speed of gas and its relationship with temperature and molecular mass. 13.8 Relate the pressure and kinetic energy. 13.9 Calculate the average translational kinetic energy of gas for 1 molecule and Avogadro's number of molecules. 13.10 Solve mathematical problems related ideal gas.	
Content Area : Wave and Optics	
14. Reflection at curved mirrors 14.1 State the relation between object distance, image distance and focal length of curved mirrors 14.2 State the relation between object size and image size 14.3 Know the difference between the real and virtual image in geometrical optics 14.4 Calculate the focal length of curved mirrors and its applications	**6. Wave motion** 6.1 Define and understand progressive wave 6.2 Write progressive wave in mathematical form 6.3 Discuss the condition under which stationary waves can be formed 6.4 Write stationary wave in mathematical form 6.5 Calculate frequency, amplitude, velocity, time period, etc of progressive wave 6.6 Find expression for stationary wave using two progressive waves
15. Refraction at plane surfaces 15.1 Recall the laws of refraction 15.2 Understand the meaning of lateral shift 15.3 Understand the meaning of refractive index of a medium 15.4 Calculate refractive index of a medium using angle of incidence and angle of refraction	**7. Mechanical waves** 7.1 Calculate Speed of wave motion 7.2 Understand and write expression for the Velocity of sound in solid and liquid 7.3 Describe Velocity of sound in gas 7.4 Describe Laplace correction 7.5 Formulate the effect of temperature, pressure, humidity on velocity of sound

15.5 Learn the relation between the refractive indices 15.6 Know the meaning of total internal reflection and the condition for it 15.7 Understand critical angle and learn the applications of total internal reflection 15.8 Explain the working principle of optical fiber	and their physical meaning 7.6 Solve numerical problems related to velocity of sound in the given medium and condition
16. Refraction through prisms: 16.1 Understand minimum deviation condition 16.2 Discuss relation between angle of prism, angle of minimum deviation and refractive index 16.3 Use above relations to find the values of refractive index of the prism 16.4 Understand deviation in small angle prism and learn its importance in real life	**8. Wave in pipes and strings** 8.1 Understand the formation of stationery waves in closed and open pipes 8.2 Define and understand harmonics and overtones 8.3 Discuss harmonics and overtones in closed and open organ pipes 8.4 Understand end correction in pipes 8.5 State and use the formula for velocity of transverse waves along a stretched string 8.6 Understand Vibration of string and overtones 8.7 Know the laws of vibration of fixed string.
17. Lenses 17.1 State properties of Spherical lenses 17.2 State the relation between object distance, image distance and focal length of a convex lens 17.3 Define visual angle and angular magnification 17.4 Derive Lens maker's formula and use it to find focal length	**9. Acoustic phenomena:** 9.1 Describe sound waves as pressure waves in a medium 9.2 Characterize the sound using its intensity, loudness, quality and pitch 9.3 Discuss Doppler's effect 9.4 Apply Doppler effect in realistic case where source and observers are in relative motion.
18. Dispersion 18.1 Understand pure spectrum 18.2 Learn the meaning of dispersive power 18.3 Discuss chromatic and spherical aberration 18.4 Discuss achromatism in lens and its applications	**10. Nature and propagation of Light:** 10.1 Use Huygen's principle to explain reflection and refraction of light

-	**11. Interference** 11.1 Explain the Phenomenon of Interferences 11.2 Understand the meaning of coherent sources 11.3 Describe Young's double slit experiment and obtain the expression fro nth order maxima
-	**12. Diffraction** 12.1 Describe diffraction at a single slit 12.2 Understand diffraction pattern of image and derive the expression for the position of nth order minima 12.3 Explain diffraction through transmission/diffraction grating and use the formula d sinqn = nl for maxima 12.4 Explain resolving power of optical instruments
-	**13. Polarization** 13.1 Describe phenomenon of polarization 13.2 Explain how polarization of light explains the transverse nature of light 13.3 State and use Brewster's law 13.4 Show the understanding of construction, working principle and uses of Potentiometer for comparing emfs and measuring internal resistance of cells
Content Area: Electricity and Magnetism	
19. Electric charges 19.1 Understand the concept of electric charge and charge carriers 19.2 Understand the process of charging by friction and use the concept to explain related day to day observations 19.3 Understand that, for any point outside a spherical conductor, the charge on the sphere may be considered to act as a point charge at its centre	**14. Electrical circuits:** 14.1 Understand Kirchhoff's law as well as use it to calculate unknown parameters in electrical circuits 14.2 Describe the circuit diagram and working of Wheatstone bridge circuit and understand its importance in real situation 14.3 Describe Meter bridge and understand it

19.4 State Coulomb's law 19.5 Recall and use $F = \frac{Qq}{4\pi\varepsilon_o r^2}$ for the force between two point charges in free space or air 19.6 Compute the magnitude and direction of the net force acting at a point due to multiple charges	14.4 Know construction, working and importance of Potentiometer 14.5 Understand the concept of super conductors 14.6 Know the meaning of perfect conductors and distinguish it from superconductor 14.7 Learn the technique to convert galvanometer into voltmeter and ammeter
20. Electric field: 20.1 Describe an electric field as a region in which an electric charge experiences a force 20.2 Define electric field strength as force per unit positive charge acting on a stationary point charge 20.3 Calculate forces on charges in uniform electric fields of known strength 20.4 Use $E = \frac{Q}{4\pi\varepsilon_o r^2}$ strength of a point charge in free space or air 20.5 Illustrate graphically the changes in electric field strength with respect distance from a point charge 20.6 Represent an electric field by means of field lines 20.7 Describe the effect of a uniform electric field on the motion of charged particles 20.8 Understand the concept of electric flux of a surface 20.9 State Gauss law and apply it for a field of a charged sphere and for line charge 20.10 Understand that uniform field exists between charged parallel plates and sketch the field lines	**15. Thermoelectric effects:** 15.1 Explain Seebeck effect and its application in Thermocouples 15.2 Show understanding of the construction and working principle of thermocouple as a temperature measuring device 15.3 Explain Peltier effect 15.4 Understand the construction and working of Thermopile
21. Potential, potential difference and potential energy 21.1 Define potential at a point as the work done per unit positive charge in bringing a small test charge from infinity to the point	**16. Magnetic field:** 16.1 Show understanding of the concept of magnetic field lines and magnetic flux and sketch magnetic field lines around a straight current carrying conductor and long solenoid

21.2 Use electron volt as a unit of electric potential energy 21.3 Recall and use $V = \frac{Q}{4\pi\varepsilon_o r}$ for the potential in the field of a point charge 21.4 Illustrate graphically the variation in potential along a straight line from the source charge and understand that the field strength of the field at a point is equal to the negative of potential gradient at that point 21.5 Understand the concept of equipotential lines and surfaces and relate it to potential difference between two points 21.6 Recall and use $E = \frac{\Delta V}{\Delta x}$ to calculate the field strength of the uniform field between charged parallel plates in terms of potential difference and separation	16.2 Explain Oersted's experiment, its outcome and limitations 16.3 Discuss force on moving charge in uniform magnetic field 16.4 Discuss force on a current carrying conductor placed in uniform magnetic field 16.5 Describe force and Torque on rectangular coil placed in uniform magnetic field 16.6 Describe moving coil galvanometer and know its applications 16.7 Explain Hall effect and derive the expression VH=BI/ntq where t is thickness 16.8 Use Hall probe to measure flux density of a uniform magnetic field 16.9 State Biot and Savart law and know its application on (i) a circular coil (ii) a long straight conductor (iii) a long solenoid 16.10 State Ampere's law and know its applications to (i) a long straight conductor (ii) a straight solenoid (ii) a toroidal solenoid 16.11 Discuss force between two parallel conductors carrying current- definition of ampere
22. Capacitor **22.1 capacitance and capacitor** a. Show understanding of the uses of capacitors in simple electrical circuits b. Define capacitance as the ratio of the change in an electric charge in a system to the corresponding change in its electric potential and associate it to the ability of a system to store charge c. Use $C = \frac{Q}{V}$ d. Relate capacitance to the gradient of potential-charge graph	**17. Magnetic properties of materials:** 17.1 Define relative permeability and relative susceptibility of a magnetic material 17.2 Discuss relationship between relative permeability and susceptibility 17.3 Discuss Hysteresis of ferromagnetism 17.4 Understand Dia,-para- and ferro-magnetic materials

22.2 Parallel plate capacitor a. Derive $C = \frac{\varepsilon_o A}{d}$, using Gauss law and $C = \frac{Q}{V}$, for parallel plate capacitor b. Explain the effect on the capacitance of parallel plate capacitor of changing the surface area and separation of the plates c. Explain the effect of a dielectric in a parallel plate capacitor in **22.3 Combination of capacitors** a. Derive formula for combined capacitance for capacitors in series combinations b. Solve problems related to capacitors in series combinations c. Derive formula for combined capacitance for capacitors in parallel combinations d. Solve problems related to capacitors in parallel combinations **22.4 Energy stored in a charged capacitor** a. Deduce, from the area under the potential-charge graph, the equations $E = \frac{1}{2}QV$ and hence $E = \frac{1}{2}CV^2$ for the average electrical energy of charged capacitor **22.5 Effect of dielectric** b. Show understanding of a dielectric as a material that polarizes when subjected to electric field c. Explain the effect of inserting dielectric between the plates of a parallel plate capacitor on its capacitance	
23. DC Circuits **23.1 Electric Currents; Drift velocity and its relation with current** a. Understand the concept that potential difference between two points in a	**18. Electromagnetic Induction:** 18.1 State and show understanding of Faraday's law of electromagnetic induction 18.2 State and show understanding of

conductor makes the charge carriers drift

b. Define electric current as the rate of flow of positive charge, $Q = It$

c. Derive, using $Q=It$ and the definition of average drift velocity, the expression $I=nAvq$ where n is the number density of free charge carriers

23.2 Ohm's law Ohm's law; Electrical Resistance: resistivity and conductivity

a. Define and apply electric resistance as the ratio of potential difference to current

b. Define *ohm* , *resistivity* and *conductivity*

c. Use $R = \rho l$ /A for a conductor

d. Explain, using $R = \rho l$ /A, how changes in dimensions of a conducting wire works as a variable resistor

e. Show an understanding of the structure of strain gauge (pressure sensor) and relate change in pressure to change in in resistance of the gauge

f. Show an understanding of change of resistance with light intensity of a light-dependent resistor (the light sensor)

g. Show an understanding of change of resistance of *n-type* thermistor to change in temperature (electronic temperature sensor)

23.3 Current-voltage relations: ohmic and non-ohmic

a. Sketch and discuss the I–V characteristics of a metallic conductor at constant temperature, a semiconductor diode and a filament lamp d) state Ohm's law

b. State Ohm's law and identify ohmic and non-ohmic resistors

Lenz's law

18.3 Discuss construction and working of A.C. generators

18.4 Define eddy currents, explain how they arise and give a few examples where eddy currents are useful and where they are nuisance

18.5 Describe self-inductance and mutual inductance and understand their uses

18.6 State the expression for energy stored in an inductor and use it wherever needed

18.7 Discuss the construction, working principle and importance of transformer

18.8 Discuss the sources of energy loss in practical transformer

19. Alternating Currents:

19.1 Understand peak and rms value of AC current and voltage

19.2 Discuss AC through a resistor, a capacitor and an inductor

19.3 Understand Phasor diagram in RC and RL circuits

19.4 Discuss series circuits containing combination of resistance, capacitance and inductance

19.5 Describe series resonance condition and know its applications

19.6 Understand the meaning of quality factor

19.7 Discuss power in AC circuits and know the term power factor

23.4 Resistances in series and parallel a. Derive, using laws of conservation of charge and conservation of energy, a formula for the combined resistance of two or more resistors in parallel b. Solve problems using the formula for the combined resistance of two or more resistors in series c. Derive, using laws of conservation of charge and conservation of energy, a formula for the combined resistance of two or more resistors in parallel d. Solve problems using the formula for the combined resistance of two or more resistors in series and parallel to solve simple circuit problems **23.5 Potential divider** a. Understand the principle of a potential divider circuit as a source of variable p.d. and use it in simple circuits b. Explain the use of sensors (thermistors, light-dependent resistors and strain gauges) in potential divider circuit as a source of potential difference that is dependent on temperature, illumination and strain respectively **23.6 Electromotive force of a source, internal resistance** a. Define electromotive force (e.m.f.) in terms of the energy transferred by a source in driving unit charge round a complete circuit b. Distinguish between e.m.f. and potential difference (p.d.) in terms of energy considerations c. Understand the effects of the internal resistance of a source of e.m.f. on the terminal potential difference **23.7 Work and power in electrical circuit** *a.* Derive from the definition of V and I, the relation $P=IV$ for power in	

electric circuit *b.* Use $P=IV$ *c.* Derive $P=I^2R$ for power dissipated in a resistor of resistance R and use the formula for solving the problems of heating effects of electric current	
Content Area: Modern Physics	
24. Nuclear physics 24.1 Explain how nucleus was discovered 24.2 Convey the meaning of mass number, atomic number 24.3 Calculate the expression of nuclear density 24.4 Explain the existence of different isotopes of the same element 24.5 Describe main theme of Einstein's mass energy relation and state the relation 24.6 Explain the meaning of mass defect and cause of it 24.7 Describe the terms creation and annihilation 24.8 Derive the relation of binding energy and binding energy per unit nucleon of different nuclei 24.9 Plot a graph between BE per nucleon and mass number of different nuclei 24.10 Define nuclear fusion and fission and explain the mechanism of energy release 24.11 Solve numerical problems related to nuclear physics	**20. Electrons** 20.1 Describe Millikan's oil drop experiment and explain how it suggests quantization of charge 20.2 Describe the motion of electrons in electric and magnetic fields and derive appropriate mathematical expressions 20.3 Describe J.J Thomson's experiment with suitable diagrams to explain the discovery of electron and its characters 20.4 Solve numerical problems related to above topics
25. Solids 25.1 Distinguish between energy level and energy band along with the formation of energy band in solids 25.2 Differentiate metals, semiconductors, and conductors on the basis of energy band 25.3 Explain the meaning of intrinsic and	**21. Photons** 21.1 Describe quantum nature of radiation 21.2 Explain properties of photons 21.3 Describe work function and photoelectric effect 21.4 Derive Einstein's photoelectric

extrinsic semiconductors with examples 25.4 Explain how p and n type semiconductors are formed 25.5 Interpret unit related conceptual questions clearly	equation 21.5 Describe Millikan's experiment for the verification of Einstein's photoelectric equation and calculate Planck's constant 21.6 Solve some related problems
26. Recent Trends in Physics 26.1 Explain elementary particles and antiparticles 26.2 Classify the particles with examples 26.3 Name different quarks with their charges and symbols 26.4 Write quark combination of few mesons and baryons particles 26.5 Describe leptons with examples 26.6 Explain Big Bang and Hubble's law and justify the expansion of the universe 26.7 Briefly describe dark matter, black hole and gravitational wave	**22. Semiconductor devices** 22.1 Describe the formation of PN junction and semiconductor diode 22.2 Plot forward and reverse characteristics of semiconductor diode including the concept of Zener diode 22.3 Define rectifier 22.4 Describe full wave rectification using semiconductor diodes 22.5 Define logic gates and explain operation of different logic gates OR, AND, NOT, NAND and NOR gates with their symbol , Boolean algebra and truth table
-	**23. Quantization of energy** 23.1 Write the postulates of Bohr's model 23.2 Derive the expression of radius of nth orbit, velocity of electron in nth orbit and total energy of electron in nth orbit of H-atom 23.3 Obtain the expression of wavelength of a spectral line 23.4 Obtain mathematical expressions different spectral series of H-atom 23.5 Differentiate excitation and ionization potentials 23.6 Explain emission and absorption spectra 23.7 Describe de Broglie hypothesis 23.8 Define x-rays 23.9 Describe modern Coolidge tube method for the production of x-rays with quality and quantity 23.10 Illustrate different properties of x-rays

	along with their applications 23.11 Solve numerical problems related to quantization of energy
-	**24. Radioactivity and nuclear reaction** 24.1 Explain the meaning of Radioactivity – natural and artificial 24.2 Differentiate types of radiations coming from radioactive sources – alpha, beta particles and gamma rays and state their properties 24.3 Explain radioactive disintegration law 24.4 Obtain the expressions of half-life, decay constant and mean life 24.5 Explain the working of Geiger-Muller Tube 24.6 Analyze some medical uses and health hazard of nuclear radiation 24.7 Work out some related numerical problems **24.8** Reason conceptual questions
-	**25. Recent trends in physics** **25.1 Seismology** a. Briefly explain the origin of earthquakes b. Explain different types of surface waves: Rayleigh and Love waves c. Explain different types of internal waves: S and P-waves d. Give brief introduction to the wave patterns of Gorkha Earthquake 2015 **25.2** Demonstrate basic ideas on a. Gravitational Wave b. Nanotechnology c. Higgs Boson

4. Scope and Sequence of Contents

Grade 11		Grade 12	
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Content Area: Mechanics			
1. Physical Quantities **1.1.** Precision and significant figures. Dimensions and uses of dimensional analysis.	**3**	**1. Rotational dynamics** 1.1 Equation of angular motion, Relation between linear and angular kinematics 1.2 Kinetic energy of rotation of rigid body 1.3 Moment of inertia; Radius of gyration 1.4 Moment of inertia of a uniform rod 1.5 Torque and angular acceleration for a rigid body 1.6 Work and power in rotational motion 1.7 Angular momentum, conservation of angular momentum.	**7**
2. Vectors 2.1. Triangle, parallelogram and polygon laws of vectors 2.2. Resolution of vectors; Unit vectors 2.3. Scalar and vector products.	**4**	2. **Periodic motion** 2.1 Equation of simple harmonic motion (SHM) 2.2 Energy in SHM 2.3 Application of SHM: vertical oscillation of mass suspended from coiled spring 2.4 Angular SHM, simple pendulum 2.5 Oscillatory motion: Damped oscillation, Forced oscillation and resonance.	**6**
3. Kinematics 3.1 Instantaneous velocity and acceleration	**5**	**3. Fluid statics** 3.1 Fluid statics: Pressure in a fluid; Buoyancy 3.2 Surface tension: Theory of	**9**

3.2 Relative velocity 3.3 Equation of motion (graphical treatment) 3.4 Motion of a freely falling body 3.5 Projectile motion and its applications.		surface tension; Surface energy 3.3 Angle of contact, capillarity and its applications 3.4 Fluid Dynamics: Newton's formula for viscosity in a liquid; Coefficient of viscosity 3.5 Poiseuille's formula and its application 3.6 Stokes law and its applications 3.7 Equation of continuity and its applications 3.8 Bernoulli's equation and its applications.	
4. Dynamics 4.1 Linear momentum, Impulse 4.2 Conservation of linear momentum 4.3 Application of Newton's laws 4.4 Moment, torque and equilibrium 4.5 Solid friction: Laws of solid friction and their verifications.	**6**	-	
5. Work, energy and power 5.1 Work done by a constant force and a variable force 5.2 Power 5.3 Work-energy theorem; Kinetic and potential energy 5.4 Conservation of Energy 5.5 Conservative and non-conservative forces 5.6 Elastic and inelastic collisions.	**6**	-	
6. Circular Motion 6.1 Angular displacement, velocity and acceleration 6.2 Relation between angular and linear velocity and acceleration 6.3 Centripetal acceleration 6.4 Centripetal force	**6**	-	

6.7 Conical pendulum 6.8 Motion in a vertical circle 6.9 Applications of banking.			
7. Gravitation 7.1 Newton's law of gravitation 7.2 Gravitational field strength 7.3 Gravitational potential; Gravitational potential energy 7.4 Variation in value of 'g' due to altitude and depth 7.5 Centre of mass and center of gravity 7.6 Motion of a satellite: Orbital velocity and time period of the satellite 7.7 Escape velocity 7.8 Potential and kinetic energy of the satellite 7.9 Geostationary satellite 7.10 GPS	**10**	-	
8. Elasticity 8.1 Hooke's law: Force constant 8.2 Stress; Strain; Elasticity and plasticity 8.3 Elastic modulus: Young modulus, bulk modulus, shear modulus 8.4 Poisson's ratio 8.5 Elastic potential energy.	**5**	-	
Content Area: Heat and Thermodynamics			
9. Heat and Temperature 9.1 Molecular concept of thermal energy, heat and temperature, and cause and direction of heat flow 9.2 Meaning of thermal equilibrium and Zeroth law of thermodynamics. 9.3 Thermal equilibrium as a working principle of mercury thermometer.	**3**	**4. First Law of Thermodynamics** 4.1 Thermodynamic systems 4.2 Work done during volume change 4.3 Heat and work; Internal energy and First law of thermodynamics 4.4 Thermodynamic processes: Adiabatic, isochoric, isothermal	**6**

10. Thermal Expansion 10.1 Linear expansion and its measurement 10.2 Cubical expansion, superficial expansion and its relation with linear expansion 10.3 Liquid Expansion: Absolute and apparent 10.4 Dulong and Petit method of determining expansivity of liquid	**4**	and isobaric 4.5 Heat capacities of an ideal gas at constant pressure and volume and relation between them 4.6 Isothermal and Adiabatic processes for an ideal gas.	
11. Quantity of Heat 11.1 Newton's law of cooling 11.2 Measurement of specific heat capacity of solids and liquids 11.3 Change of phases: Latent heat 11.4 Specific latent heat of fusion and vaporization 11.5 Measurement of specific latent heat of fusion and vaporization 11.6 Triple point	**6**	**5. Second Law of Thermodynamics** 5.1 Thermodynamic systems and direction of thermodynamic processes 5.2 Second law of thermodynamics 5.3 Heat engines 5.4 Internal combustion engines: Otto cycle, Diesel cycle; Carnot cycle 5.5 Refrigerator 5.6 Entropy and disorder (introduction only)	**6**
12. Rate of heat flow 12.1 Conduction: Thermal conductivity and measurement 12.2 Convection 12.3 Radiation: Ideal radiator 12.4 Black- body radiation 12.5 Stefan – Boltzmann law.	**5**	-	
13. Ideal gas 13.1 Ideal gas equation 13.2 Molecular properties of matter 13.3 Kinetic-molecular model of an ideal gas 13.4 Derivation of pressure exerted by gas, 13.5 Average translational kinetic	**8**	-	

energy of gas molecule 13.6 Boltzmann constant, root mean square speed 13.7 Heat capacities: gases and solids.			
Content Area: Waves & Optics			
14. Reflection at curved mirror 14.1 Real and Virtual images. 14.2 Mirror formula	**2**	**6. Wave motion** 6.1 Progressive waves 6.2 Mathematical description of a wave 6.3 Stationary waves	**2**
15. Refraction at plane surfaces 15.1 Laws of refraction: Refractive index 15.2 Relation between refractive indices 15.3 Lateral shift 15.4 Total internal reflection.	**4**	**7. Mechanical waves** 7.1 Speed of wave motion; Velocity of sound in solid and liquid 7.2 Velocity of sound in gas 7.3 Laplace's correction 7.4 Effect of temperature, pressure, humidity on velocity of sound.	**4**
16. Refraction through prisms 16.1 Minimum deviation condition 16.2 Relation between Angle of prism, minimum deviation and refractive index 16.3 Deviation in small angle prism.	**3**	**8. Wave in pipes and strings** 8.1 Stationary waves in closed and open pipes 8.2 Harmonics and overtones in closed and open organ pipes 8.3 End correction in pipes 8.4 Velocity of transverse waves along a stretched string 8.5 Vibration of string and overtones 8.6 Laws of vibration of fixed string.	**4**
17. Lenses 17.1 Spherical lenses, angular magnification 17.2 Lens maker's formula 17.3 Power of a lens	**3**	**9. Acoustic phenomena** 9.1 Sound waves: Pressure amplitude 9.2 Characteristics of sound: Intensity; loudness, quality and pitch 9.3 Doppler's effect.	**5**
18. Dispersion 18.1 Pure spectrum and dispersive	**3**	**10. Nature and propagation of light**	**3**

power 18.2 Chromatic and spherical aberration 18.3 Achromatism and its applications		10.1 Huygen's principle 10.2 Reflection and Refraction according to wave theory	
-		**11. Interference** 11.1 Phenomenon of Interferences: Coherent sources 11.2 Young's double slit experiment.	**2**
-		**12. Diffraction** 12.1 Diffraction from a single slit 12.2 Diffraction pattern of image; Diffraction grating 12.3 Resolving power of optical instruments.	**3**
-		**13. Polarization** 13.1 Phenomenon of polarization 13.2 Brewster's law; transverse nature of light 13.3 Polaroid.	**3**
Content Area: Electricity & Magnetism			
19. Electric Charges 19.1 Electric charges 19.2 Charging by induction 19.3 Coulomb's law- Force between two point charges 19.4 Force between multiple electric charges.	**3**	**14. Electrical circuits** 14.1 Kirchhoff's law 14.2 Wheatstone bridge circuit; Meter bridge 14.3 Potentiometer: Comparison of e.m.f., measurement of internal resistances of a cell 14.4 Super conductors; Perfect conductors 14.5 Conversion of galvanometer into voltmeter and ammeter; Ohmmeter 14.6 Joule's law	**6**
20. Electric field 20.1 Electric field due to point charges; Field lines	**3**	**15. Thermoelectric effects:** 15.1 Seebeck effect; Thermocouples 15.2 Peltier effect: Variation of	**3**

20.2 Gauss Law: Electric Flux 20.3 Application of Gauss law: Field of a charge sphere, line charge, charged plane conductor		thermoelectric e.m.f. with temperature; Thermopile	
21. Potential, potential difference and potential energy 21.1 Potential difference, Potential due to a point, Charge, potential energy, electron volt 21.2 Equipotential lines and surfaces 21.3 Potential gradient	**4**	**16. Magnetic field** 16.1 Magnetic field lines and magnetic flux; Oersted's experiment 16.2 Force on moving charge; Force on a conductor 16.3 Force and Torque on rectangular coil, Moving coil galvanometer 16.4 Hall effect 16.5 Magnetic field of a moving charge 16.6 Biot and Savart law and its application to (i) a circular coil (ii) a long straight conductor (iii) a long solenoid 16.7 Ampere's law and its applications to (i) a long straight conductor (ii) a straight solenoid (ii) a toroidal solenoid 16.8 Force between two parallel conductors carrying current- definition of ampere	**9**
22. Capacitor 22.1 Capacitance and capacitor 22.2 Parallel plate capacitor 22.3 Combination of capacitors 22.4 Energy of charged capacitor 22.5 Effect of a dielectric Polarization and displacement.	**7**	**17. Magnetic properties of materials:** 17.1 Magnetic field lines and magnetic flux 17.2 Flux density in magnetic material; Relative permeability; Susceptibility 17.3 Hysteresis 17.4 Dia,-para- and ferro-magnetic	**5**

		materials.	
23. DC Circuits 23.1 Electric Currents; Drift velocity and its relation with current 23.2 Ohm's law; Electrical Resistance; Resistivity; Conductivity 23.3 Current-voltage relations; Ohmic and Non-Ohmic resistance 23.4 Resistances in series and parallel, 23.5 Potential divider 23.6 Electromotive force of a source, internal resistance 23.7 Work and power in electrical circuits	**10**	**18. Electromagnetic Induction:** 18.1 Faraday's laws; Induced electric fields 18.2 Lenz's law, Motional electromotive force 18.3 A.C. generators; Eddy currents 18.4 Self-inductance and mutual inductance 18.5 Energy stored in an inductor 18.6 Transformer.	**6**
-		**19. Alternating Currents** 19.1 Peak and rms value of AC current and voltage 19.2 AC through a resistor, a capacitor and an inductor 19.3 Phasor diagram 19.4 Series circuits containing combination of resistance, capacitance and inductance 19.5 Series resonance, quality factor 19.6 Power in AC circuits: power factor	**6**
Content Area : Modern Physics			
24. Nuclear physics 24.1 Nucleus: Discovery of nucleus 24.2 Nuclear density; Mass number; Atomic number 24.3 Atomic mass; Isotopes 24.4 Einstein's mass-energy relation 24.5 Mass Defect, packing fraction, BE per nucleon 24.6 Creation and annihilation	**6**	**20. Electrons** 20.1 Milikan's oil drop experiment, 20.2 Motion of electron beam in electric and magnetic fields 20.3 Thomson's experiment to determine specific charge of electrons	**4**

24.7 Nuclear fission and fusion, energy released			
25. Solids 25.1 Energy bands in solids (*qualitative ideas*) 25.2 Difference between metals, insulators and semi-conductors using band theory 25.3 Intrinsic and extrinsic semi-conductors	**3**	**21. Photons** 21.1 Quantum nature of radiation 21.2 Einstein's photoelectric equation; Stopping potential 21.3 Measurement of Plank's constant	**3**
26. Recent Trends in physics *26.1 Particle physics:* Particles and antiparticles, Quarks (baryons and meson) and leptons (neutrinos) *26.2 Universe:* Big Bang and Hubble law: expansion of the Universe, Dark matter, Black Hole and gravitational wave	**6**	**22. Semiconductor devices** 22.1 P-N Junction 22.2 Semiconductor diode: Characteristics in forward and reverse bias 22.3 Full wave rectification 22.4 Logic gates; NOT, OR, AND, NAND and NOR.	**6**
-		**23. Quantization of energy** 23.1 Bohr's theory of hydrogen atom 23.2 Spectral series; Excitation and ionization potentials 23.3 Energy level; Emission and absorption spectra 23.4 De Broglie Theory; Duality 23.5 Uncertainly principle 23.6 X-rays: Nature and production; uses 23.7 X-rays diffraction, Bragg's law.	**8**
-		**24. Radioactivity and nuclear reaction** 24.1 Alpha-particles; Beta-particles, Gamma rays 24.2 Laws of radioactive disintegration 24.3 Half-life, mean-life and decay	**6**

		constant 24.4 Geiger-Muller Tube 24.5 Carbon dating 24.6 Medical use of nuclear radiation and possible health hazard.	
-		**25. Recent trends in physics** *Seismology:* 25.1 Surface waves: Rayleigh and Love waves Internal waves: S and P-waves Wave patterns of Gorkha Earthquake 2015 25.2 Gravitational Wave Nanotechnology Higgs Boson	**6**
	128		**128**

5. Practical Courses **[32 Hours]**

The practical work that students do during their course is aimed at providing them learning opportunities to accomplish competency number 2 and 3 of the syllabus as well as reinforcing their learning of the theoretical subject content. This part of the syllabus focuses more on skill building than knowledge building. Students must be aware of the importance of precision, accuracy, significant figures, range and errors while collecting, processing, analyzing and communicating data. Likewise, graphical method of analysis and drawing conclusion should be encouraged wherever possible.

Students should

1. learn to use metre rule for measuring length, Vernier-calipers for measuring small thicknesses, internal and external diameters of cylindrical objects and depths of holes, spherometer for measuring radius of curvature of spherical surfaces and micrometer screw-gauge for measuring diameter of small spherical or cylindrical objects and very small thicknesses, traveling microscope with Vernier scale for measuring small distances, top-pan balance for measuring small masses, stop watch for measuring time interval, laboratory thermometer for measuring temperature, protractor for measuring angle), ammeter and milli-ammeter for measuring electric current and voltmeter for measuring electric potential difference.
2. learn to measure precisely up to the least count of the measuring instrument-

   metre rule – 0.001m or 1 mm

   Vernier calipers - 0.1 mm

Spherometer - 0.01 mm

micrometer screw gauge - 0.01 mm

stop watch - 0.01s

laboratory thermometer - 0.5^{o}C

protractor - 1^{o}

3. learn to repeat readings and take the average value
4. learn to draw a standard table, with appropriate heading and unit for every column for storing data
5. learn to plot a graph using standard format, draw suitable trend lines, determine gradient, intercepts and area and use them to draw appropriate conclusion
6. learn to estimate and handle uncertainties.

In each academic year, students should perform 10 experiments, either listed below or designed by teacher, so that no more than three experiments come from the same unit of this syllabus.

a) Practical Activities for Grade 11

I. Mechanics

1. Verify the law of moments by graphically analyzing the relation between clockwise moment and anticlockwise moment on a half metre rule suspended at the cerntre by a string.
2. Determination of the coefficient of friction for the two surfaces by graphically analyzing how minimum force needed to set a trolley resting on plan horizontal surface to motion varies with its mass.
3. Determination of young modulus of elasticity of the material of a given wire by graphically analyzing the variation of tensile force with respect to extension produced by it.

II. Heat

4. Use of Pullinger's apparatus for the Determination of the linear expansivity of a rod.
5. Use of Regnault's apparatus to determination of the specific heat capacity of a solid by the method of mixture.
6. Determination of the thermal conductivity of a good conductor by Searle's method.

III. Geometrical Optics

7. Use of rectangular glass slab to determine the thickness of the slab by graphically analyzing how lateral shift varies with the angle of incidence.
8. Use of Travelling Microscope for the determination of the refractive index of glass slab by graphically analyzing how apparent depth varies with the real depth for glass plates of different thicknesses.
9. Determination of the focal length of a concave mirror by graphically analyzing the variation of image distance with respect to object distance.

IV. Current electricity

10. Verification of Ohm's law and determination of resistance of a thin-film resistor by graphical analysis of variation of electric current in the resistor with respect to potential difference across it.
11. Determination of resistivity of a metal wire by graphical analysis of variation of electric current through a metal wire against its length.
1. Investigation of *I-V* characteristics of a heating coil by graphically analyzing the variation of electric current though a light bulb with respect to the potential difference across it.

b) Sample project works for grade 11

1. Study the variation in the range of a jet of water with angle of projection
2. Study the factors affecting the rate of loss of heat of a liquid
3. Study the nature and size of the image formed by a convex lens using a candle and a screen.
4. Study of uses of alternative energy sources in Nepal
5. Study of energy consumption patterns in the neighborhood.
6. Study of study of electricity consumption pattern in the neighborhood.
7. Study of application of laws and principle of physics in any indigenous technology.
8. Verification of the laws of solid friction.
9. Study the temperature dependence of refractive index of different liquids using a hollow prism and laser beam.
10. Study the frequency dependence of refractive index of glass using a glass prism and white light beam.

c) Some examples of innovative works for grade 11

1. Construct a hygrometer using dry and wet bulb thermometers and use it to measure relative humidity of a given place.
2. Design and construct a system to demonstrate the phenomenon of total internal reflection (TIR) of a laser beam through a jet of water.
3. Construct a digital Newton meter using the concept of potential divider.

d) Practical Activities for Grade 12

I. Mechanics

1. Use of Simple pendulum for the determination of the value of 'g' in the laboratory by graphically analyzing the variation of period of oscillations with length of the pendulum.
2. Determination of the surface tension of water by capillary tube method by graphically analyzing the variation of by graphically analyzing the variation of height of the liquid against the diameter of capillary tube for five capillaries of different diameters dipped in water simultaneously.

3. Determination of the coefficient of viscosity of liquid by Stoke's method by graphically analyzing the variation of time taken for six metal balls of different diameters to travel the same distance in the given liquid with respect to their diameters.

II. Wave and Optics

4. Determination of the wavelength of He-Ne laser light by passing a plane diffraction grating.
5. Determination of the frequency of A.C. Mains using sonometer and graphically analyzing the variation of the ratio of resonating lengths with respect to the frequency of tuning fork using tuning forks of different frequencies.
6. Determination of velocity of sound in air at NTP using resonance tube.

III. Electricity and magnetism

7. Use of potentiometer for the
   a) Comparison of emf's of two cells
   b) Determination of the internal resistance of a cell
8. Study the variation or resistance of a thermistor with temperature.
   1. Use of deflection magnetometer to determination of the pole strength and magnetic moment of a bar magnet
   2. Determine the magnetic field strength of a bar magnet stuck on table by graphically analyzing the period of torsional motion of a freely suspended bar magnet and its distance from the near pole of the fixed magnet along its long axis.

IV. Modern Physics

11. Study the I-V characteristics of a semiconductor diode.

e) Sample project works for grade 12

1. Study the traffic noise level in your town using a sound pressure level (SPL) meter.
2. Design and construct a step-up transformer.
3. Construct a simple device to measure angle of contact of a liquid with a solid surface and also calculate the surface free energy of some hydrophobic and hydrophilic surfaces.
4. Calculate the surface free energy of some hydrophobic and hydrophilic surfaces.
5. Construct a simple DC motor using a disk type magnet and a battery.
6. Construct a model of AC generator/dynamo.
7. Construct a current balance to measure magnetic flux density of a U-shaped magnet.
8. Construction of a step down transformer attached with a full wave rectifier made from semiconductor diodes.

f) Some examples of innovative works for grade 12

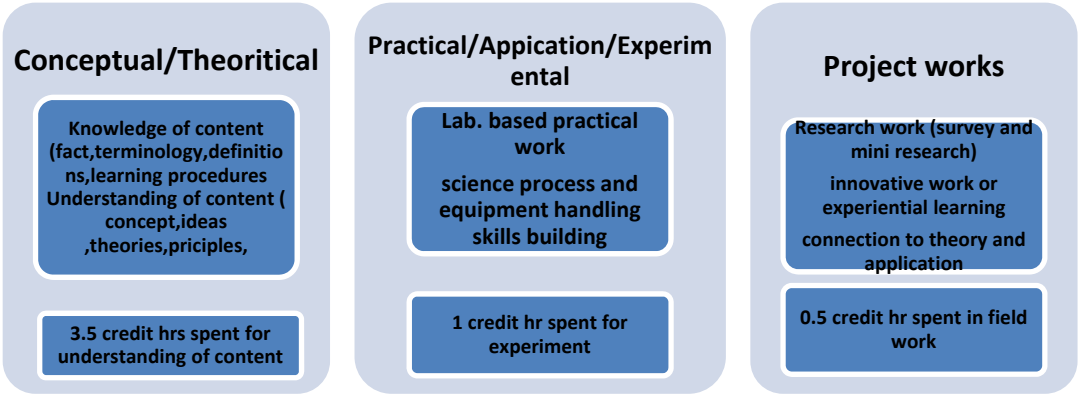
1. Construct a thermocouple thermometer and use it to investigate how temperature of a Bunsen burner flame changes with the height of the flame from the top of the burner.

2. Study of the status of hydroelectricity in Nepal.
3. Study of application of laws and principle of physics in any indigenous technology.
4. Verify Joule' law.
5. Investigation on Peltier effect.
6. History of space exploration
7. Study on history of nuclear power in Asia

6. Learning Facilitation Method and Process

Students should be facilitated to learn rather than just accumulation of information. Teacher plays vital role for delivering subject matters although others' role is also important. Student centered teaching-learning process is highly emphasized. Students are supposed to adopt multiple pathway of learning, such as online search, field visit, library work, laboratory work, individual and group work, research work etc. with the support of teacher. Self-study by students is highly encouraged and learning should not be confined to the scope of curriculum. Teacher should keep in mind intra and inter-disciplinary approach to teaching and learning, as opposed to compartmentalization of knowledge. Supportive role of parents/guardians in creating conducive environment for promoting the spirit of inquiry and creativity in students' learning i anticipated.

During the delivery process of science teaching in grade 11 and 12, basically following three approaches will be adopted;



a) Conceptual/Theoretical Approach

Possible theoretical methods of delivery may include the following;

- lecture
- interaction
- question answer
- demonstrations
- ICT based instructions
- cooperative learning
- group discussions (satellite learning group, peer group, small and large group)

- debate
- seminar presentation
- Journal publishing
- daily assignment

b) Practical/Application/Experimental approach

Practical work is the integral part of the learning science. The process of lab based practical work comprises as;

- familiarity with objective of practical work
- familiarity with materials, chemicals, apparatus
- familiarity with lab process (safety, working modality etc.)
- conduction of practical work (systematically following the given instruction)
- analysis, interpretation and drawing conclusion

c) Project work Approach

Project work is an integral part of the science learning. Students should be involved in project work to foster self-learning of students in the both theoretical and practical contents. Students will complete project work to have practical idea through learning by doing approach and able to connect the theory into the real world context. It is regarded as method/ process of learning rather than content itself. So use of project work method to facilitate any appropriate contents of this curriculum is highly encouraged.

In this approach student will conduct at least one **research work, or an innovative work** under the guidance of teacher, using the knowledge and skills learnt. It could include any of the followings;

(a) Mini research
(b) Survey
(c) Model construction
(d) Paper based work
(e) study of ethno-science

General process of research work embraces the following steps;

- Understanding the objective of the research
- Planning and designing
- Collecting information
- analysis and interpretation
- Reporting /communicating (presentation, via visual aids, written report, graphical etc.)

General process of innovative work embraces the following steps;

- identification of innovative task (either assigned by teacher or proposed by student)
- planning
- performing the task

- presentation of the work
- Record keeping of the work

Students are free to choose any topic listed in this curriculum or a topic suggested by teacher provided that it is within the theoretical contents of the Curriculum. However, repetition of topic should be discouraged.

Learning process matrix

Knowledge and understanding	Scientific skills and process	Values, attitudes and application to daily life
• Scientific phenomenon, facts, definition, principles, theory, concepts and new discoveries • Scientific vocabulary, glossary and terminology • Scientific tools, devises, instruments apparatus • Techniques of uses of scientific instruments with safety • Scientific and technological applications	• Basic and integrated scientific process skills <u>Process</u> • Investigation • Creative thinking • problem solving	• Responsible • Spending time for investigation

Basic Science Process Skills includes,

1. Observing: using senses to gather information about an object or event. It is description of what was actually perceived.
2. Measuring: comparing unknown physical quantity with known quantity (standard unit) of same type.
3. Inferring: formulating assumptions or possible explanations based upon observations.
4. Classifying: grouping or ordering objects or events into categories based upon characteristics or defined criteria.
5. Predicting: guessing the most likely outcome of a future event based upon a pattern of evidence.
6. Communicating: using words, symbols, or graphics to describe an object, action or event.

Integrated Science Process Skills includes,

1. Formulating hypotheses: determination of the proposed solutions or expected outcomes for experiments. These proposed solutions to a problem must be testable.
2. Identifying of variables: Identification of the changeable factors (independent and dependent variables) that can affect an experiment.
3. Defining variables operationally: explaining how to measure a variable in an experiment.

4. Describing relationships between variables**:** explaining relationships between variables in an experiment such as between the independent and dependent variables.
5. Designing investigations: designing an experiment by identifying materials and describing appropriate steps in a procedure to test a hypothesis.
6. Experimenting: carrying out an experiment by carefully following directions of the procedure so the results can be verified by repeating the procedure several times.
7. Acquiring data: collecting qualitative and quantitative data as observations and measurements.
8. Organizing data in tables and graphs: presenting collected data in tables and graphs.
9. Analyzing investigations and their data: interpreting data, identifying errors, evaluating the hypothesis, formulating conclusions, and recommending further testing where necessary.
10. Understanding cause and effect relationships: understanding what caused what to happen and why.
11. Formulating models: recognizing patterns in data and making comparisons to familiar objects or ideas.

7. Student Assessment

Evaluation is an integral part of learning process. Both formative and summative modes of evaluation are emphasized. Formative evaluation will be conducted so as to provide regular feedback for students, teachers and parents/guardians about how student learning is. Class tests, unit tests, oral question-answer, home assignment etc. are some ways of formative evaluation.

There will be separate evaluation of theoretical and practical learning. Summative evaluation embraces theoretical examination, practical examination and evaluation of research work or innovative work.

(a) Internal Evaluation

Out of 100 full marks Internal evaluation covers 25 marks. Internal evaluation consists of Practical work (16 marks), (b) Marks from trimester examinations (6 marks), and (c) Classroom participation (3 marks)

- **Practical Activities**

Practical work and project work should be based on list of activities mentioned in this curriculum or designed by the teacher. Mark distribution for practical work and project work will be as follows:

S. N.	Criteria	Elaboration of criteria	Marks
1.	Laboratory experiment	Correctness of apparatus setup/preparation	2
		Observation/Experimentation	2
		Tabulation	1
		Data processing and Analysis	1
		Conclusion (Value of constants or prediction with	1

		justification)	
		Handling of errors/precaution	1
2.	Viva-voce	Understanding of objective of the experiment	1
		Skills of the handling of apparatus in use	1
		Overall impression	1
3.	Practical work records and attendance	Records (number and quality)	2
4	Project work	Reports (background, objective, methodology, finding, conclusion	2
		Presentation	1
		Total	**16**

Note: (i) Practical examination will be conducted in the presence of internal and external supervisors. Evaluation of laboratory experiment will focus both the product of work and skills competencies of student in using apparatus.

(ii) Project work assessment is the internal assessment of reports and presentation of their project works either individually or group basis. In case of group presentation, every member of the group should submit a short reflection on the presented report in their own language. Records of project works must be attested by external supervisor.

- **Marks from trimester examinations**

Total of 6 marks; 3 marks from each trimester.

- **Classroom participation (3 marks)**

Classroom participation includes attendance (1) and participation in learning (2).

(b) External Evaluation

Out of 100 marks theoretical evaluation covers 75 marks. The tool for external evaluation of theoretical learning will be a written examination. Questions for the external examination will be based on the specification grid developed by Curriculum Development Centre. Examination question paper will be developed using various levels of revised Bloom's taxonomy including remembering level, understanding level, application level and higher ability (such as analyzing, evaluating, creating).