LEARNING – TEACHING GUIDELINES FOR STUDENTS AND TEACHERS

This set of instructional objectives has been compiled to show the level of achievement that is expected of an average pupil on completing the study of specific parts of the syllabus. It aims at assisting the teachers in their selection of course materials, learning activities and instructional methods. It can serve as the learning guidelines for the pupils and the basis of an evaluation program.

In stating the specific objectives there are two groups of terms having very similar meaning. The first group is on achievement in recalling facts, which include 'define', describe', and state. **Define** refers to a rather formal definition of terms which involves their fundamental concept. **'Describe'** refers to the recall of phenomena or processes, **'State'** is used when the objective requires the recall of only some aspects of a phenomenon or a process; it limits the scope of teaching.

The second group is on achievement relating to science experiments. This group includes **'design'**, **'perform'**, **'demonstrate'**. **'Design' an experiment** would be used when there are more than one acceptable ways of doing it. Pupils are expected to be able to set up the experiment by applying what they have previously learned. These experiments may require the taking of quantitative data or long term observation. **'Perform' an experiment,** would be used when the objective emphasizes on the demonstration of experimental skill; the detail of the experiment could be found in the teachers' notes or textbooks. **'Demonstrate' a phenomenon** by simple experiments is used when the objective emphasizes on the result of the experiment and the experimental skill involved is very simple, such as passing some gas into a solution **'Describe' an experiment** is used when pupils are expected to know, in principle, how the experiment could be carried out and the expected result.

1. Measurements

The students will be able to:

- Know the impact of advances in Physics on society
- Understand that all physical quantities consist of a numerical magnitude and a unit.
- Recall the following base quantities and their units; mass (kg) length (m), time (s) current (A), temperature (K), luminous intensity (Cd) and amount of substance (mol).

- Describe and use of basic units, derived units, and supplementary units.
- Understand and use of scientific notation.
- Use the standard prefixes and their symbols to indicate decimal sub-multiples or multiples of both base and derived units.
- Understand and use the conventions of indicating units as set out in the SI units.
- Understand the distinctions between systematic errors (including zero errors) and random errors.
- Understand and sue significant figures.
- Understand the distinction between precision and accuracy.
- Assess the uncertainty in a derived quantity by simple addition of actual, fractional or percentage uncertainties.
- Quote answers with correct scientific notation, number of significant figures and units in all numerical and practical work.
- Use dimensionality and base units to check the homogeneity of physical equations.
- Derive formulae in simple cases using dimensions.

2. Vectors and Equilibrium

- Understand and use rectangular coordinate system.
- Understand the idea of unit vector, null vector and position vector.
- Know the rule of vector addition.
- Represent a vector as two perpendicular components (rectangular components)
- Know vector addition using rectangular components.
- Understand multiplication of vectors (scalar and vector product) and solve problems.
- Define the moment of force or the torque.
- Appreciate the use of the moment of force or torque.
- Show an understanding that when there is no resultant force and no resultant torque, a system is in equilibrium.
- Appreciate the applications of the principle of moments.
- Apply the knowledge gained to solve problems on statics.

3. Motion and Force

- Understand displacement from its definition and illustration.
- Understand velocity, average velocity and instantaneous velocity.

- Understand acceleration, average acceleration and instantaneous acceleration.
- Understand the significance of area under velocity-time graph as distance traveled.
- Recall and use equations which represent uniformly accelerated motion in a straight line including falling in a uniform gravitational field without air resistance
- Recall Newton's Laws of motion.
- Describe Newton's second laws of motion as rate of change of momentum.
- Know impulse as a product of impulsive force and time.
- Describe law of conservation of momentum.
- Use of law of conservation of momentum in simple applications including elastic collision between two bodies in one dimension.
- Describe the force produced due to flow of water.
- Understand the process of rocket propulsion (simple treatment).
- Know and describe projectile motion in a non-resistive medium.
- Derive time of flight, maximum height and horizontal range of projectile motion.
- Appreciate the motion of ballistic missiles as projectile motion.

4. Work, Power and Energy

- Understand the concept of work in terms of the product of a force and displacement in the direction of the force
- Understand and derive the formula Work = wd = mgh for work done in a gravitational field near earth's surface.
- Know that work can be calculated from area under the force – displacement graph.
- Define power as the product of force and velocity.
- Relate power to work done and time taken using appropriate examples.
- Quote examples of power from every day life.
- Explain the two types of mechanical energy.
- Understand the work energy principle.
- Drive an expression for absolute potential energy.
- Define escape velocity.
- Understand that in a resistive medium loss of potential energy of a body is equal to gain in kinetic energy of the body plus work done by the body against friction.
- Give examples of conventional sources of energy including
  i. Tidal energy
  ii. Energy from Waves

iii. Solar energy
iv. Energy from Biomass
v. Energy from waste products
vi. Geo thermal energy

5. Circular Motion

- Describe angular motion.
- Define angular displacement, angular velocity and angular acceleration.
- Define radian and convert an angle from radian measure to degree and vice versa.
- Use the equation S = r Θ to convert linear velocity to angular displacement.
- Use the equation $V = r\omega$ to convert linear velocity to angular velocity.
- Describe qualitatively motion in a curved path due to a perpendicular force and understand the centripetal acceleration in case of uniform motion in a circle.
- Derive the equation $a = r\omega = V^2/r$ and $Fc = m\omega r$ and $m V^2/r$
- Understand the concept of angular momentum.
- Describe examples of conservation of angular momentum
- Understand and describe moment of inertia of a body.
- Know moment of inertia of various bodies. Understand and express rotational kinetic energy of a disc and a hoop on an inclined plane. Know and describe the motion of artificial satellites.
- Express that the objects in satellite appear to be weightless.
- Know about a gravity free system.
- Understand that how and why artificial gravity is produced
- Understand geo-stationary orbits and orbital velocity of satellites
- Know communication satellite and their applications
- Describe Einstein's view of gravitation.

6. Fluid Dynamics

- Understand the viscous forces in a fluid cause a retarding force on an object moving through it.
- Describe an experiment based on the measurement of terminal velocity to determine the viscosity of a liquid.
- Understand how the magnitude of the viscous force in fluid flow depends on the velocity gradient and on the viscosity of the fluid.

- Use dimensional analysis to confirm the form of the equation $F = 6 \pi \eta r V$ (Stoke's law) for the drag force under laminar conditions in a viscous fluid.
- Use Stoke's law to derive an expression for terminal velocity of spherical body falling through a viscous fluid under laminar conditions.
- Understand the terms steady (laminar, streamline) flow, incompressible flow, non viscous flow as applied to the motion of an ideal fluid.
- Understand how the velocity vector of a particle in an ideal fluid in motion is related to the stream line associated with that particle.
- Understand how steam lines can be used to define a tube of flow.
- Appreciate that a sufficiently high velocity, the flow of viscous fluid undergoes a transition from laminar to turbulent conditions.
- Appreciate that the equation of continuity AV = Constant for the flow of an ideal and incompressible fluid.
- Appreciate that the equation of continuity is a form of the principle of conservation of mass.
- Understand that the pressure difference can arise from different rates of flow of a fluid (Bernoulli effect)
- Derive Bernoulli equation in form $P_1 + \frac{1}{2} \rho v_1^2 = P_2 + \frac{1}{2} \rho v_2^2$ for the case of horizontal tube of flow.
- Explain how Bernoulli effect is applied in the filter pump, in the Venturi meter, in atomizers, in the flow of air over an aerofoil and in blood physics.
- Appreciate that the majority of practical examples of fluid flow and resistance to motion in fluids involve turbulent rather than luminar conditions.
- Give qualitative explanations in terms of turbulence and Bernoulli effect for the swing of a spinning cricket ball and the lift of a spinning golf ball and on an aeroplane.

7. Oscillations

- Investigate the motion of an oscillator using experimental, analytical and graphical methods.
- Understand and describe that when an object moves in a circle the motion of its projection on the diameter of the circle is simple harmonic.
- Show that the motion of mass attached to a spring is simple harmonic

- Know that the motion of simple pendulum is simple harmonic and calculate its time period.
- Understand and use the terms amplitude, time period, frequency, angular frequency and phase difference.
- Express time period in terms of both frequency and angular frequency.
- Know and use of solutions in the form of x = x Cos **ω t or y = y Sin ω t**
- Describe the interchange between kinetic and potential energy during SHM.
- Describe practical examples of free and forced oscillations.
- Understand and express frequency response of ear.
- Describe practical examples of damped oscillations with particular reference to the effects of the degree of damping and the importance of critical damping in cases such as car suspension system (shock absorbers).

8. Waves

- Recall the generation and propagation of waves.
- Describe the nature of the motions in transverse and longitudinal waves.
- Understand and use the terms wave length, frequency and velocity of wave.
- Understand and use the equation $v = f \lambda$
- Understand and describe Newton's formula of velocity of sound.
- Know Laplace correction in Newton's formula of velocity of sound for air.
- Derive the formula $v_t = v_0 + 0.61t$
- Recognize and describe the factors on which speed of sound in air depends.
- Explain and use the principle of superposition.
- Understand the terms interference and beats.
- Describe the phenomena of interference and beats giving examples of sound waves.
- Understand and describe reflection of sound waves.
- Describe experiments which demonstrate stationary waves for stretched strings and vibrating air columns.
- Explain the formation of a stationary wave using a graphical method.
- Understand the terms node and anti-node.
- Understand and describe modes of vibration of strings.
- Understand and describe Doppler's effect and its causes.
- Recognize the application of Doppler's effect such as radar, sonar, astronomy, satellite and radar speed traps.

9. Physical Optics

- Understand the concept of wave front.
- State Huygen's principle
- Use Huygen's principle to explain linear propagation, reflection and refraction of light.
- Understand interference of light.
- Describe Young's double slit experiment and the evidence it provided to support wave theory of light. $\text{Sin}\,\Theta = n\,\lambda/d$ and $\text{Sin}\,\Theta = (\frac{n-1}{2})\,\lambda/d = y/L$
- Use the equation $\text{Sin}\,\Theta = n\,\lambda/d$ and $\text{Sin}\,\Theta = (\frac{n-1}{2})\,\lambda/d = y/L$ to solve any one variable given the others.
- Describe the formation of Newton's rings.
- Recognize and express colour patterns in thin films.
- Understand the working of Michelsorn interferometer and its uses.
- Explain the meaning of the term 'diffraction'.
- Use the mathematical equations that describe diffraction at a single slit.
- Derive the equation for angular position of first minimum.
- Derive the equation $d\,\text{Sin}\,\Theta = m\,\lambda$
- Derive Bragg's equation $2d\,\text{Sin}\,\Theta = m\,\lambda$
- Carry out calculations using the diffraction grating formula.
- Describe the phenomena of diffraction of X-rays through crystals.
- Appreciate the use of diffraction of X-rays by crystals.
- Understand polarization as a phenomenon associated with transverse waves.
- Recognize and express that polarization is produced by a Polaroid.
- Understand the effect of rotation of Polaroid on Polarization.
- Understand how plane polarized light is produced and detected.

10. Optical Instruments

- Recognize the term of least distance of distinct vision.
- State the terms magnifying power and resolving power
- Derive expression for magnifying power and resolving power of simple microscope, compound microscope and astronomical telescope.
- Understand the working of spectrometer.

- Describe to find the speed of light by Michelson rotating mirror method.
- Know and appreciate the principles of optical fibre.
- Identify the types of optical fibre.
- Appreciate the applications of optical fibre.

11. Heat and Thermodynamics

- State the basic postulates of Kinetic theory of gases.
- Explain how molecular movement causes the pressure exerted by a gas and derive the equation P =2/3 N < ½ m v^2 >, where N is the number of molecules per unit volume of the gas.
- Compare P = 2/3 N < ½ m v^2 > with PV = nRT and hence deduce that the average translational kinetic energy of a molecule is proportional to temperature.
- Derive gas laws on the basis of kinetic theory.
- Describe that the internal energy of an ideal gas in due to the kinetic energy of its molecules.
- Understand and use the terms work and heat in thermodynamics.
- Understand isothermal and adiabatic processes.
- Know about the molar specific heats of gas.
- Apply first law of thermodynamics to derive Cp – Cv = R
- Explain second law of thermodynamics and its meaning in terms of entropy.
- Understand the concept of reversible and irreversible cycle.
- Understand the term heat engine.
- Understand and describe Carnot theorem.
- Know the thermodynamic scale of temperature.
- Describe the working / function of petrol and diesel engines.
- Explain the term entropy.
- Know that change in entropy $\Delta S = \Delta Q/T$
- Appreciate environmental crisis as an entropy crisis.