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. Electrostatics

- Understand and describe Coulomb's law in the form $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$ for the force between two point charges in free space and air.
- Describe that a charge has a field of force around it.
- Represent and sketch electric field by means of field lines.
- Understand fields of like and unlike charges.

- Calculate electric field strength of the uniform field between charged parallel plates in terms of potential difference and separation.
- Appreciate the principle of inkjet printers and photostat copier as an application of electrostatic phenomena.
- Explain the electric intensity in a free space and in other media.
- Describe and derive the value of electric charge by Millikan's method.
- State and prove Gauss's Law.
- Appreciate the applications of Gauss's Law.
- Explain electric potential at a point in terms of work done in bringing a unit positive charge from infinity to that point.
- Relate electric field strength and potential gradient.
- Find expression for potential at a point due to a point charge.
- Define electron volt (eV).
- Recognize the analogy between quantitative aspects of electric and gravitational forces in case of inverse square law.
- Calculate the capacitance of parallel plate capacitor.
- Recognize the effect of dielectric on the capacitance of parallel plate capacitor.
- Understand and describe electric polarization of dielectric.
- Know the process of charging and discharging of a capacitor through a resistance.
- Calculate the time constant and find energy expression of a charged capacitor.

2. Current Electricity

- Understand the concept of steady current
- Describe some sources of current
- Recognize effects of currents.
- Understand and describe Ohm's law.
- Sketch and explain the current –voltage characteristics of (a metallic conductor at constant temperature, diode and filament lamp)
- Understand resistivity and explain its dependence upon temperature.
- Understand and elaborate conductance and conductivity of conductor.
- Calculate problem relating the variation of resistance with temperature for one dimensional current flow.
- Describe the characteristics of thermistor.
- Know the value of resistance by reading colour code on it.

- Use the energy considerations to distinguish between e.m.f and p.d.
- Understand the internal resistance of sources and its consequences for external circuits.
- Describe the conditions for maximum power transfer.
- Know and use the application of Kirchhoff's first law as conservation of charge.
- Know and use the application of Kirchhoff's second law as conservation of energy.
- Know the working and use of rheostat in the potential divider circuit.
- Describe the function of Wheatstone Bridge to measure the unknown resistance.
- Describe the function of potentiometer to measure and compare potentials without drawing any current from the circuit.

3. Electromagnetism

- Appreciate that a force might act on a current carrying conductor placed in a magnetic field.
- Define magnetic flux density and the Tesla.
- Derive and use the equation F = ILB Sin Θ with directions.
- Understand how the force on a current carrying conductor can be used to measure the magnetic flux density of a magnetic field using a current balance.
- Describe and sketch flux patterns due to a long straight wire.
- Define magnetic flux and the Weber.
- Derive and use the relation $\phi = \vec{B}.\vec{A}$
- Understand and describe Ampere's circuital law
- Appreciate the use of Ampere's circuital law to find magnetic flux density inside a solenoid.
- Appreciate that there acts a force on a charged particle moving in a uniform magnetic field.
- Understand and describe method to measure e/m.
- Know the basic principle of Cathode ray oscilloscope (CRO).
- Appreciate the use of CRO.
- Derive the expression of torque due to couple acting on a coil.
- Know the principle, construction and working of a galvanometer.
- Know how a galvanometer is converted into a Voltmeter and an Ammeter.
- Describe Avometer/Multimeter.
- Read through analogue scale and digital display on electrical meters.

4. Electromagnetic Induction

- Recall that a change magnetic flux through a circuit causes an e.m.f. to be induced in the circuit.
- Know that the induced e.m.f. lasts as long as the magnetic flux keep changing.
- Use Faraday's law of electromagnetic induction to determine the magnitude of induced e.m.f.
- Apply Lenz's law to determine the direction of induced e.m.f.
- Recognize self and mutual induction.
- Define mutual inductance and self inductance.
- Define Henry
- Know and use the formula $E = \frac{1}{2} LI^2$.
- Calculate the energy stored in an inductor.
- Describe the principle, construction and operation of an AC generator and DC generator.
- Describe the principle construction and operation of DC motor.
- Recognize back e.m.f in motors and back motor effect in generators.
- Describe the structure and principle of operation of transformer.
- Use $\frac{N_s}{N_p} = \frac{V_s}{V_p}$ and $V_sI_s = V_pI_p$ for an ideal transformer.
- Apply transformer equation to solve the problem.
- Understand and describe eddy current, use of laminated core and Hystersis loss.

5. Alternating Current

- Understand and describe time period, frequency, the peak and root mean square values of an alternating current and voltage.
- Know and use the relationship for the sinosidal case.
- Understand the flow of A. C. through resistor, capacitors and inductors.
- Understand how phase lags and leads in the circuit.
- Apply the knowledge to calculate reactance of capacitors and inductors.
- Describe impedance as vector summation of resistance.
- Know and use the formulae of A.C. Power to solve the problems.
- Understand the function of resonant circuits.
- Appreciate the principle of metal detectors used for security checks.

- Describe the three phases of A. C. supply.
- Become familiar with electromagnetic spectrum (ranging from radio waves to γ rays.)
- Know the production, transmission and reception of electromagnetic waves.

6. Physics of Solids

- Distinguish between the structure of crystalline, glassy, amorphous and polymeric solids.
- Understand the idea of lattice and unit cell.
- Appreciate that deformation is caused by a force and that, in one dimension, the deformation can be tensile or compressive.
- Define and use the terms Young's modulus, bulk modulus and shear modulus.
- Describe an experiment to determine elastic limit and yield strength.
- Distinguish between elastic and plastic deformation of a material.
- Synthesis and deduce the strain energy in a deformed material from the area under the force-extension graph.
- Describe the energy bands in solids.
- Classify insulators, conductors, semiconductors on the basis of energy bands.
- Distinguish between intrinsic and extrinsic semiconductors.
- Explain how electrons and holes flow across a junction.
- Describe superconductors.
- Distinguish between dia, para and ferro magnetic materials.
- Understand and describe the concept of magnetic domains in material.
- Know the Curie point.
- Classify hard and soft ferro magnetic substances.
- Understand Hystersis loss.
- Synthesis from Hystersis loop how magnetic field strength varies with magnetizing current.

7. Electronics

- Describe forward and reverse biasing of a PN junction.
- Understand half and full wave rectification.
- Know the uses of LED, photodiode and photo voltaic cell.
- Describe the operations of transistor.

- Know current equation and solve problems.
- Understand the use of transistors as a switch and an amplifier.
- Understand operational amplifier and its characteristics.
- Know the applications of an operational amplifier as inverting and non inverting amplifier using virtual earth concept.
- Understand the use of an operational amplifier as a comparator e.g. night switch or thermostat.
- Understand the function of each of the following logic gates: AND, NOT, OR and NAND gates and represent these functions by means of truth tables (limited to a maximum of tow inputs)
- Describe how to combine AND, NOT and OR gates, or NAND gates only, to form EX-OR and EX-NOR gates.
- Understand combinations of logic gates to perform control functions.

8. Dawn of Modern Physics

- Distinguish between inertial and non inertial frames of references.
- Describe the postulates of special theory of relativity and its results.
- Understand the NAVSTAR navigation system.
- Understand the concept of black body radiation.
- Understand and describe how energy is distributed over the wave length range for several values of source temperature.
- Know Planck's assumptions.
- Know the origin of quantum theory.
- Show an appreciation of the particular nature of electromagnetic radiation.
- Describe the phenomena of photoelectric effect.
- Explain photoelectric effect in terms of photon energy and work function energy.
- Explain the function of photocell and describe its uses.
- Describe Compton's effect.
- Explain the phenomena of pair production and pair annihilation.
- Describe De-Broglie's hypotheses of wave nature of particles.
- Describe and interpret qualitatively the evidence provided by electron diffraction for the wave nature of particles.
- Understand the working principle of electron microscope.
- Understand and describe uncertainty principle.

9. Atomic Spectra

- Know experimental facts of hydrogen spectrum.
- Describe Bohr's postulates of hydrogen atom.
- Explain hydrogen atom in terms of energy levels.
- Describe De-Broglie's interpretation of Bohr's orbits.
- Understand excitation and ionization potentials.
- Describe uncertainty regarding position of electron in the atom.
- Understand the production, properties and uses of X-rays.
- Describe the terms spontaneous emission, stimulated emission, metastable states and population inversion.
- Understand laser principle.
- Describe the He-Ne gas laser.
- Describe the application of laser including holography.

10. Nuclear Physics

- Understand the qualitative treatment of Rutherford's scattering experiment and the evidence it provides for the existence and small size of nucleus.
- Distinguish between nucleon number (mass number) and atomic number.
- Understand that an element can exist in various isotopic forms each with a different number of neutrons.
- Understand the use Mass Spectrograph to demonstrate the existence of isotopes and to measure their relative abundance.
- Understand mass defect and calculate binding energy using Einstein's equation.
- Illustrate graphically the variation of binding energy per nucleon with the mass number.
- Appreciate the spontaneous and random nature of nuclear decay.
- Explain the meaning of half life.
- Recognize and use decay law.
- Understand and describe the interaction of nuclear radiation with matter.
- Understand the use of Wilson cloud chamber, Geiger Muller counter and solid state detectors to detect the radiations.
- Appreciate that atomic number and mass number is conserved in nuclear process.

- Describe energy and mass conservation in simple reactions and in radioactive decay.
- Understand and describe the phenomena of nuclear fission and nuclear fusion.
- Explain the working principle of nuclear reactor.
- Beware of various types of nuclear reactors.
- Show an awareness about nuclear radiation exposure and biological effects of radiation.
- Describe in simple terms the use of radiations, for medical diagnosis and therapy.
- Understand qualitatively the importance of limiting exposure to ionizing radiation.
- Outline the use of trace technique to obtain diagnostic information about internal structures.
- Describe examples of the use of radioactive tracers in diagnosis.
- Describe basic forces of nature.
- Describe the modern view of the building blocks of matter based on hadrons, leptons and quarks.