PHYS 0111 Learning Objectives

Module 1. You should be able to: mathematically describe molecular diffusion; apply the ideal gas model to find pressure, temperature, volume, or number of moles; find the average molecular speed for a gas at a known temperature.

Module 2. You should be able to: identify a thermodynamic system; calculate the work done by an ideal gas during various thermal processes; understand the relation between heat and work; apply the first law of thermodynamics; calculate the efficiency of heat engines; apply the second law of thermodynamics in the context of heat engines.

Module 3. You should be able to: explain the microscopic origin of charge; distinguish conductors from insulators; apply conservation of charge; calculate the mutual force between two stationary charges; visualize an electric field from a stationary charge distribution with field lines; calculate the net electric field from multiple point charges; apply the relation between electric force and field.

Module 4. You should be able to: calculate the work needed to assemble a set of charges; apply the concept of electric potential energy; calculate the electric potential from a set of point charges; qualitatively apply the concept of capacitance; calculate the capacitance of a parallel-plate capacitor; calculate energy in an electric field.

Module 5. You should be able to: understand the microscopic origin of current; read a current-voltage characteristic; calculate the resistance of a conductor; calculate the equivalent resistance of multiple resistors either in series or in parallel; explain electromotive force; find currents in circuits of batteries and resistors; calculate electric power; calculate the equivalent capacitance of multiple capacitors either in series or in parallel; mathematically describe the charging and discharging of a capacitor.

Module 6. Upon mastering this material, you should be able to: describe the interaction between permanent magnets; visualize magnetic field with field lines; calculate the magnetic force on a moving charge; calculate the magnetic force on a wire; explain the fundamental differences between electric force and magnetic force; calculate the torque developed by an electric motor; calculate the mutual force between two long current-carrying wires.

Module 7. You should be able to: calculate the flux of a magnetic field; explain electromagnetic induction; calculate the induced electromotive force due to a changing magnetic flux; apply Lenz's law for sense of current; describe the operation of an electric generator; calculate the self-inductance of a solenoid; calculate energy in a magnetic field; predict the voltage or current at either end of a transformer.

Module 8. You should be able to: mathematically describe an oscillating voltage and derive root-mean-square power; explain electric-mechanical analogies; describe the oscillation of charges in an inductor-capacitor circuit; describe a resonance process; calculate the resonant frequency of an inductor-capacitor circuit.

Module 9. You should be able to: explain the fundamentals of Maxwell's unified theory of electromagnetism; describe the generation of an electromagnetic wave in empty space; relate the speed of an electromagnetic wave with its properties; calculate the intensity of a traveling electromagnetic wave; describe the process of polarization; calculate the effect of polarizing sheets on a traveling electromagnetic wave.

Module 10. You should be able to: explain the behavior of an electromagnetic wave at an interface between materials; correctly use basic geometric optics jargon (rays, fronts); apply the law of reflection; find the image formed by a plane mirror; find the object, distance, or focus of a spherical mirror; explain limitations of spherical mirrors.

Module 11. You should be able to: relate the index of refraction with the speed of an electromagnetic wave; qualitatively apply the concept of critical angle; explain total internal reflection; find different color paths in the case of dispersion; find the object, distance, or focus of a converging lens; find the object, distance, or focus of a diverging lens; qualitatively explain imaging by the human eye.

Module 12. Upon mastering this material, you should be able to: mathematically describe a traveling electromagnetic wave; apply the conditions for interference of two electromagnetic waves; explain the interference pattern produced by a double slit; explain the diffraction of light past an opening; calculate the size of the central bright fringe for a diffraction pattern; apply Rayleigh's criterion of resolution.

Module 13. You should be able to: explain the evidence for particle-like behavior of light; explain the evidence for wave-like behavior of particles; calculate the de Broglie wavelength of a particle; describe photoelectric effect; explain Einstein's hypothesis about quanta; find metal work function or maximum kinetic energy of emitted electrons in photoelectric effect.