Objectives for Material to be Learned from Unit 1

By the end of this unit, students should be able to:

1.1 (Continuing objective) Relate concepts of classical mechanics to "everyday" situations and discuss various applications of the concepts to practical problems in various fields of science, medicine and engineering.

1.2 (Lab objective) Know how to determine the uncertainty in a calculated quantity due to the uncertainty in a measurement; how to combine uncertainties due to independent measurements; how to report results with the correct number of significant figures and units. Understand how to interpret uncertainties when comparing two experimental results or when comparing an experimental result to a theoretical prediction.

1.3 Know the definitions of displacement, instantaneous velocity, instantaneous speed, and instantaneous acceleration. Use these concepts in problems involving moving objects.

1.4 Use graphical methods to relate graphs of position, velocity, and acceleration for one-dimensional motion.

1.5 Describe vector quantities using: a) magnitude and direction, b) rectangular components, and c) unit vectors. Be able to convert from one description to another.

1.6 Draw a sketch showing the addition of vectors. Calculate the vector sum quantitatively using the method of components.

1.7 Given an object's path in space (in unit vector notation or a diagram) in two or three dimensions, determine its velocity and acceleration at various locations and times.

1.8 Analyze uniform circular motion by relating period, velocity, radius, and acceleration, including the directional properties of velocity and acceleration.

1.9 Given several forces acting on a single object, use Newton's Second Law to determine the object's acceleration; or given the motion, determine an unknown force.

1.10 Given a physical situation, apply Newton's Second and Third Laws following these steps: a) sketch the situation, b) identify the forces, c) draw free-body (force) diagrams for each relevant object in the system (separate from original sketch), d) write Newton's Second Law for x-, y- and z- components for each mass (each component is a separate equation), and e) solve for unknowns.

1.11 Solve problems involving weight forces, normal forces, tensions, spring forces, friction forces, and drag forces.

1.12 Given the initial position and velocity of an object acted on by a force in one dimension, use the numerical iteration method to calculate the position and velocity several time increments later.

1.13 From a given constant force and the straight-line motion of an object, calculate the work done on the object by that force.

1.14 Determine the work done during one-dimensional motion from a force-vs-displacement graph, or by integration of $F(x)$.

1.15 Apply the work-kinetic energy theorem to a moving object subject to one or more forces.

1.16 Understand the definition of power, and be able to relate power, work, and time.

1.17 Describe the types of forces with which a potential energy may be associated. From a given one-dimensional potential energy, find the associated force (and vice-versa).

1.18 Given a graph of an object's potential energy versus position, determine the direction and approximate magnitude of the associated force. For an object with a constant mechanical energy, determine the object's kinetic energy, turning points, and points of equilibrium.

1.19 State and recognize the conditions under which conservation of mechanical energy applies.

1.20 Relate the change in mechanical energy to the work done by non-conservative forces, using these steps: a) make sketches of the system, b) write down an expression for the mechanical energy of the system, including a term for each type of energy that may change, c) evaluate the expression for the "Before" situation and again for the "After" situation, and d) use $E_{\text{before}} + W_{\text{nc}} = E_{\text{after}}$, and solve for unknowns.