

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.