Newtonian Mechanics

D. Systems of Particles, Linear Momentum *(Ch 6)*

Impulse and Momentum:

Students should understand impulse and linear momentum so they can:

- Relate mass, velocity, and linear momentum for a moving object, and calculate the total linear momentum of a system of objects. *(6.1)*
- Relate impulse to the change in linear momentum and the average force acting on an object. *(6.1)*
- Calculate the area under a force vs time graph and relate it to the change in momentum of an object. *(6.1)*

Conservation of Linear Momentum & Collisions:

Students should understand linear momentum conservation so they can:

- Identify situations in which linear momentum, or a component of the linear momentum vector, is conserved. *(6.2)*
- Apply linear momentum conservation to one-dimensional elastic and inelastic collisions and two-dimensional completely inelastic collisions. *(6.3 - 6.4)*
- Analyze collisions of particles in one or two dimensions to determine how much kinetic energy is lost in a collision. *(6.3 - 6.4)*

Equations – Systems of Particles, Linear Momentum *(Ch 6)*:

$$p = m \cdot v \qquad J = F \cdot \Delta t = \Delta p$$

E. Circular Motion and Rotation *(Ch 7 & 8)*

Uniform Circular Motion:

Students should understand the uniform circular motion of a particle so they can:

- Relate the radius of the circle and the speed or rate of revolution of the particle to the magnitude of the centripetal acceleration. *(7.4)*
- Describe the direction of the particle's velocity and acceleration at any instant during the motion. *(7.4)*
- Determine the components of the velocity and acceleration vectors at any instant, and sketch or identify graphs of these quantities. *(7.4)*

Students should be able to analyze situations in which an object moves with specified acceleration under the influence of one or more forces so they can determine the magnitude and direction of the net force, or of one of the forces that makes up the net force in situations such as the following:

- Motion in a horizontal circle (e.g. mass on a rotating merry-go-round, or car rounding a banked curve.) *(7.6 - 7.7)*
- Motion in a vertical circle (e.g. mass swinging on the end of a string, cart rolling down a curved track, rider on a Ferris wheel.) *(7.6 - 7.7)*

E. Circular Motion and Rotation *(cont)*

Torque and Rotational Statics:

Students should understand the concept of torque so they can:

- Calculate the magnitude and direction of the torque associated with a given force. *(8.1)*
- Calculate the torque on a rigid object due to gravity. *(8.1)*

Students should be able to analyze problems in statics so they can:

- State the conditions for translational and rotational equilibrium of a rigid object. *(8.2 - 8.4)*
- Apply these conditions in analyzing the equilibrium of a rigid object under the combined influence of a number of coplanar forces applied at different locations. *(8.2 - 8.4)*

Equations – Circular Motion & Rotation *(Ch 7 & 8)*:

$$a_c = \frac{v^2}{r} \qquad \tau = r \cdot F \cdot \sin\theta$$

F. Gravitation *(Ch 7)*

Newton's Law of Gravity:

Students should know Newton's Law of Universal Gravitation so they can:

- Determine the force that one spherically symmetrical mass exerts on another. *(7.8)*
- Determine the strength of the gravitational field at a specified point outside a spherically symmetrical mass. *(7.8)*

Orbits of Planets and Satellites:

Students should understand the motion of an object in circular orbit under the influence of gravitational forces so they can:

- Recognize that the motion does not depend on the object's mass, describe qualitatively how the velocity, period of revolution, and centripetal acceleration depend upon the radius of the orbit, and derive expressions for the velocity and period of revolution in such an orbit. *(7.10)*
- Derive Kepler's Third Law of planetary motion. *(7.8)*

Equations – Gravitation *(Ch 7)*:

$$F_g = -\frac{G \cdot m_1 \cdot m_2}{r^2} \qquad U_g = -\frac{G \cdot m_1 \cdot m_2}{r}$$

*** AP Course Outline information is taken from the Teacher's Guide to Advance Placement Courses in Physics, published by the College Entrance Examination Board and Educational Testing Service. ***