Unit 1: Dynamics Extension (25 hours)

Vector Analysis of Forces and Motion (15 hours)
- ☐ use vector analysis in two dimensions for systems involving two or more masses, relative motions, static equilibrium, and static torques (ACP-1)
- ☐ use vectors to represent forces and acceleration of an object when acted on by unbalanced forces (325-5)

Conservation of Momentum (5 hours)
- ☐ apply quantitatively the law of conservation of momentum to one-dimensional collisions and explosions (326-3)

Technological Implications (2 hours)
- ☐ analyze and describe examples where energy- and momentum-related technologies were developed and improved over time (115-5, 116-4)
- ☐ describe and evaluate the design of technological solutions and the way they function using principles of energy and momentum (116-6)
- ☐ explain the importance of using appropriate language and conventions when describing events related to momentum and energy (114-9)

Collisions in Two Dimensions (3 hours)
- ☐ apply quantitatively the laws of conservation of momentum to one and two dimensional collisions and explosions (326-3)
- ☐ determine in which real-life situations involving elastic and inelastic interactions the laws of conservation of momentum and energy are best used (326-4)

Unit 2: Projectiles, Circular Motion, and Universal Gravitation (25 hours)

Projectiles (8 hours)
- ☐ analyze and describe examples where technologies such as rocket launchers and skeet shooters were developed based on scientific understanding (116-4)
- ☐ analyze quantitatively the horizontal and vertical motion of a projectile (325-6)

Circular Motion (8 hours)
- ☐ describe uniform circular motion using algebraic and vector analysis (325-12)
- ☐ explain quantitatively circular motion using Newton's laws (325-13)

Simple Harmonic Motion (4 hours)
- ☐ explain qualitatively the relationship between displacement, velocity, time, and acceleration for simple harmonic motion (327-2)
- ☐ explain quantitatively the relationship between potential and kinetic energies of a mass in simple harmonic motion (327-4)

Universal Gravitation (5 hours)
- ☐ explain qualitatively Kepler's first and second laws and apply quantitatively Kepler's third law (ACP-2)
- ☐ use appropriate numeric and graphic analysis to explain and apply the law of universal gravitation to orbital rotations (215-2)

Unit 3: Fields (30 hours)

Magnetic, Electric, and Gravitational Fields (5 hours)

- ☐ describe magnetic, electric and gravitational fields as regions of space that affect mass and charge (328-1)
- ☐ describe magnetic, electric, and gravitational fields by illustrating the source and direction of the lines of force (328-2)
- ☐ describe electric fields in terms of like & unlike charges, and magnetic fields in terms of poles (328-3)
  - draw the magnetic field around one or more bar magnets in various orientations
  - describe the Earth's magnetic field and how it changes with time

Coulomb's Law (5 hours)

- ☐ compare Newton's Law of universal gravitation with Coulomb's Law, and apply both laws quantitatively (328-4)

Electric Circuits (15 hours)

- ☐ apply Ohm's Law to series, parallel, and combination circuits (ACP-3)
  - extend the work-energy theorem to develop the concept of electric potential *energy*
  - define electric potential *difference*
  - describe factors that control electrical resistance
  - define electric current
  - draw a schematic diagram for series, parallel, and simple combination circuits
  - investigate the relationship between voltage rises and voltage drops across circuit elements
  - describe the energy transformations

Electromagnetism and Electromagnetic Induction (5 hours)

- ☐ describe the magnetic field produced by a current in a long, straight conductor, and in a solenoid (328-6)
  - illustrate the use of hand rules
- ☐ analyze qualitatively the forces acting on a moving charge in a uniform magnetic field (328-5)
- ☐ analyze qualitatively electromagnetic induction by both a changing magnetic flux and a moving conductor (328-7)
  - use Lenz's law to predict the directions of induced current
  - describe the construction and operation of step-up and step-down transformers, including ratio of turns and power in power out calculations

Generators and Motors (5 hours) LEVEL 1

- ☐ compare and contrast the ways a motor and generator function, using the principles of electromagnetism (328-9)
- ☐ describe and compare direct current and alternating current (ACP-4)
  - illustrate the third hand rule for motors