

Roanoke Valley Governor's School for Science and Technology
RVGS Physics
Competency List, 2018-2019

August 22, 2018

RVGS Physics is the introductory science course for all first-years students. Topics include motion, forces, momentum, work, and energy. A focused approach allows students to develop a deep factual, conceptual, mathematical, and procedural knowledge of fundamental physics concepts. Skills in technology, statistics, data collection, and experimentation are reinforced by lab activities throughout the course. The primary goals of the course are to improve problem solving skills, correct basic preconceptions about physics, and build a “big picture” foundation for future higher level science courses

This course is taught using best practices in gifted education. Each competency is aligned with Hockett's five principles of gifted education:

Gifted Education Principles:

(Hockett, J.A. (2009) “Curriculum for Highly Able Learners That Conforms to General Education and Gifted Education Quality Indicators.” *Journal of Education for the Gifted*. Vol. 32, No. 3, p. 394-440)

1. High-quality curriculum for gifted learners uses a conceptual approach to organize or explore content that is discipline based and integrative.
2. High-quality curriculum for gifted learners pursues advanced levels of understanding beyond the general education curriculum through abstraction, depth, breadth, and complexity.
3. High-quality curriculum for gifted learners asks students to use processes and materials that approximate those of an expert, disciplinarian, or practicing professional.
4. High-quality curriculum for gifted learners emphasizes problems, products, and performances that are true to life, and outcomes that are transformational.
5. High-quality curriculum for gifted learners is flexible enough to accommodate self-directed learning fueled by student interests, adjustments for pacing, and variety.

COMPETENCY I

Students will apply certain basic skills to represent and communicate scientific concepts

Enabling Objectives:

1. Develop a qualitative model
2. Identify dependent and independent variables
3. Make and communicate predictions about variable relationships
4. Select appropriate measuring devices
5. Communicate accuracy and precision of measurements related to means and standard deviations
6. Appropriately use significant figures

7. Understand the differences and relationships between dimension and units
8. Understand how to use the metric prefixes
9. Convert between units algebraically
10. Evaluate the resulting units of an algebraic expression
11. Graph tabular data
12. Qualitatively interpret graphs
13. Calculate and qualitatively interpret slopes and intercepts of linear graphs
14. Derive algebraic models from linear graphs
15. Qualitatively interpret the story told by the algebraic model
16. Write a clear summarized communication of a scientific investigation

COMPETENCY II

Students will be able to use technology effectively in RVGS Physics

Enabling Objectives:

1. Create word-processed document by controlling:
 - a) formatting (e.g. fonts, margins, text-wrapping, subscripts, superscripts, tables)
 - b) graphics (e.g. graphs, equations)
 - c) saves and prints (e.g file format, pdf, file location)
2. Create spreadsheets by controlling:
 - a) formats of the cell (e.g. font format, type (e.g. number), orientation)
 - b) formulas, including macros
 - c) graphs of data
3. Create appropriately formatted graphs using Excel/Logger Pro
4. Log onto the RVGS Moodle site, enroll in a class, and use the resources for that class.
5. Use a computer interface connected to a variety of sensors to collect data for interpretation.

COMPETENCY III

Students will develop a particle model of constant velocity

Enabling Objectives:

1. Choose origin and positive direction for a system
2. Define motion relative to frame of reference
3. Distinguish between vector and scalar concepts
4. Derive linear relationships of constant velocity position graphs
5. Connect constant velocity to Newton's First Law of motion
6. Connect motion graphs and vectors
7. Relate graphical, algebraic and diagrammatic representations of constant velocity
8. Use appropriate units for kinematical properties through the use of dimensional analysis

COMPETENCY IV

Students will develop a particle model of uniform acceleration

Enabling Objectives:

1. Contrast graphs of objects travelling with constant velocity and those undergoing constant acceleration
2. Contrast motion diagrams of objects travelling with constant velocity and those undergoing constant acceleration
3. Define instantaneous velocity as the slope of a tangent to a curve at a distinct time in a position vs. time graph.

4. Distinguish between instantaneous and average velocity
5. Define acceleration with its vector nature
6. Relate and convert from graphs of position, velocity, and acceleration using basic ideas of calculus from slopes and areas (differentiation and integration)
7. Derive linear and quadratic relationships of uniform acceleration from position and velocity graphs.
8. Learn strategies for solving quantitative motion problems using the kinematics equations of uniform acceleration
9. Apply uniform acceleration concepts to objects undergoing free-fall in one dimension

COMPETENCY V

Students will develop a free particle model of inertia and force interactions.

Enabling Objectives:

1. Develop the notion that force is required to change velocity, not to produce motion via Newton's First Law
2. Recognize that constant velocity does not require an explanation
3. Identify specific forces acting on an object
4. Draw and use accurate free-body diagrams
5. Understand the connection between unbalanced forces, inertia and acceleration via Newton's Second Law
6. Learn and apply strategies for solving quantitative force and motion problems
7. Identify action/reaction pairs of forces as an application of Newton's third law.
8. Convert between graphs of Force and graphs of motion

COMPETENCY VI

Students will develop a two dimensional particle model of motion.

1. Relate and convert graphs of position, velocity, and acceleration in two dimensions simultaneously.
2. Solve problems involving uniform acceleration in one dimension and constant velocity in another
3. Contrast motion diagrams involving uniform acceleration in one and two dimensions
4. Apply to two dimensional free fall and projectile motion problems
5. Apply to two dimensional circular motion problems
6. Distinguish between speed and velocity in terms of circular motion
7. Identify centripetal acceleration as the radial component of an acceleration of an object moving in a circle

COMPETENCY VII

Students will develop a model of impulse and momentum

1. Apply previous reasoning from the new perspective of *impulse* and *momentum*
2. Learn what is meant by an isolated system
3. Distinguish between momentum and velocity as well as impulse and force
4. Identify inelastic collisions and isolated systems
5. Convert between Impulse, momentum, force, and motion graphs of two objects.
6. Learn and apply strategies for solving quantitative problems using the conservation of momentum

7. Understand how impulse is the action necessary to change the momentum of an isolated system

COMPETENCY VIII

Students will develop a model of work and energy

1. Develop a concept of energy in terms of its transformation within and transfer to and from an isolated system to its environment
2. Develop a concept of potential energy in terms of work done by conservative forces (gravitational, spring, and electrostatic)
3. Apply conservation of energy to elastic collisions
4. Learn and apply strategies for solving quantitative problems using the conservation of energy
5. Identify if work is being done to an isolated system
6. Identify internal and external forces with respect to an isolated system
7. Define power as the rate of energy transfer