Roanoke Valley Governor's School for Science and Technology
RVGS Physics

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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.

External standards from Virginia physics Standards of Learning were referenced when reviewing these competencies. To the right of each Enabling Objective is notation indicating alignment with external standards and a relative priority/proficiency rating from A (highest) to D (lowest).

COMPETENCY I

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

Enabling Objectives:

1. Develop a qualitative model	PH.1 C, E
2. Identify dependent and independent variables	PH. 1 A
3. Make and communicate predictions about variable relationships	PH. 1 F
4. Select appropriate measuring devices	PH.1 B
5. Communicate accuracy and precision of measurements related to means and standard deviations	PH. 1 C, E, F
6. Appropriately use significant figures	Exceeds Standard
7. Understand the differences and relationships between dimension and units	Exceeds Standard
8. Understand how to use the metric prefixes	Exceeds Standard
9. Convert between units algebraically	Exceeds Standard
10. Evaluate the resulting units of an algebraic expression	All Standards
11. Graph tabular data	PH. 1 C
12. Qualitatively interpret graphs	PH.1 f
13. Calculate and qualitatively interpret slopes and intercepts of linear graphs	PH.1 C, E
14. Derive algebraic models from linear graphs	PH.1 C, E
15. Qualitatively interpret the story told by the algebraic model	PH.1 C
16. Write a clear summarized communication of a scientific investigation	PH.1 F

COMPENTENCY 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)	Exceeds Standard
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	PH.1 C
3. Create appropriately formatted graphs using Excel/Logger Pro/ Other Graphing Programs	PH.1 C
4. Log onto the RVGS Canvas site and use the resources for that class.	Exceeds Standard
5. Use a computer interface connected to a variety of sensors to collect data for interpretation.	PH.1 B

COMPETENCY III

Students will develop a particle model of constant velocity

Enabling Objectives:

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

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	PH.1 C PH.2 A
2. Contrast motion diagrams of objects travelling with constant velocity and those undergoing constant acceleration	PH.1 C PH.2 A
3. Define instantaneous velocity as the slope of a tangent to a curve at a distinct time in a position vs. time graph.	PH.2 A, B
4. Distinguish between instantaneous and average velocity	PH.2 A
5. Define acceleration with its vector nature	PH.2 A
6. Relate and convert from graphs of position, velocity, and acceleration using basic ideas of calculus from slopes and areas (differentiation and integration)	PH.1 C PH.2 A, B
7. Derive linear and quadratic relationships of uniform acceleration from position and velocity graphs.	PH.1 C, E PH.2 A, B
8. Learn strategies for solving quantitative motion problems using the kinematics equations of uniform acceleration	PH. 2 A, B
9. Apply uniform acceleration concepts to objects undergoing free-fall in one dimension	PH.2 A, B

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

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

COMPETENCY VII

Students will develop a model of impulse and momentum

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

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

COMPETENCY IX

Students will develop a model of Electrical Circuits

1. Develop an understanding of the relationship between Voltage, Current, and Resistance.	PH. 8 B
2. Identify series and parallel circuits and how they affect Voltage, Current, and Resistance	PH. 8 C
3. Identify the components of basic circuits and each parts role within the circuit.	PH. 8 A
4. Demonstrate the ability to measure voltage and current in a circuit.	PH. 8 A, B, C
5. Be able to build circuits from schematics using breadboards, LED's, Resistors, switches	PH. 8 A