Course: Physics & Technology Grade Level: 11

PVRHS CURRICULUM MAP

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STAGE 1 – DESIRED RESULTS

Subject: Physics & Technology

Teacher/Designer: Koenig/ Kennedy

A Year-Long Project Based Curriculum with Embedded Stepping Mini-projects. Each semester will contain between 3-7 mini-projects, each spanning between 1-4 weeks.

State standards addressed (verbatim):

HS-PS2-1.	**Analyze data to support the claim that Newton's second law of motion describes the mathematical relationship among the net force on a macroscopic object, its mass, and its acceleration.** [Clarification Statement: Examples of data could include tables or graphs of position or velocity as a functio of time for objects subject to a net unbalanced force, such as a falling object, an object rolling down a ramp, or a moving object being pulled by a constant force.] [*Assessment Boundary: Assessment is limited to one-dimensional motion and to macroscopic objects moving at non-relativistic speeds.*]
HS-PS2-6	**Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.*** [Clarification Statement: Emphasis is on the attractive and repulsive forces that determine the functioning of the material. Examples could include why electrically conductive materials are often made of metal, flexible but durable materials are made up of long chained molecules, and pharmaceuticals are designed to interact with specific receptors.] [*Assessment Boundary: Assessment is limited to provided molecular structures of specific designed materials.*]
HS-ETS1-2.	**Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering**
HS-ETS1-3.	**Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.**

International Technology and Engineering Educators Association (ITEEA)

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Technological Literacy Standards

(from http://www.iteea.org/TAA/Publications/TAA_Publications.html)

- **Standard 3:** Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.
- **Standard 8:** Students will develop an understanding of the attributes of design.
- **Standard 9:** Students will develop an understanding of engineering design.
- **Standard 10:** Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.
- **Standard 11:** Students will develop abilities to apply the design process.

The International Society for Technology in Education (ISTE)

National Educational Technology Standards (NETS)

(from https://www.iste.org/Content/NavigationMenu/NETS/ForStudents/2007Standards/NETS_for_Students_2007_Standards.pdf)

- **Standard 1: Creativity and Innovation**
- Students demonstrate creative thinking, construct knowledge, and develop innovative products and processes using technology.
- Students:

a. apply existing knowledge to generate new ideas, products, or processes.
b. create original works as a means of personal or group expression.
c. use models and simulations to explore complex systems and issues.
d. identify trends and forecast possibilities.

- **Standard 3: Research and Information Fluency**
- Students apply digital tools to gather, evaluate, and use information.
- Students:

a. evaluate and select information sources and digital tools based on the appropriateness to specific tasks.

- **Standard 4: Critical Thinking, Problem Solving, and Decision Making**
- Students use critical thinking skills to plan and conduct research, manage projects, solve problems, and make informed decisions using appropriate digital tools and resources.
- Students:

a. identify and define authentic problems and significant questions for investigation.
b. plan and manage activities to develop a solution or complete a project.

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1. use multiple processes and diverse perspectives to explore alternative solutions.

- **Standard 6: Technology Operations and Concepts**
- Students demonstrate a sound understanding of technology concepts, systems, and operations.
- Students:

a. select and use applications effectively and productively.

b. troubleshoot systems and applications.

Essential Questions (3-4) in provocative, student-friendly language:

- What characterizes a structure?
- What characterizes a system?
- What is the purpose(s) of a bridge?
- What is the purpose(s) of a scale model?
- What is a resource?
- What is meant by "design process" (proto-typing)?
- What is Technology?
- What does it mean to be an organized student?

Big Ideas/ Enduring Understandings: ***Students will understand that…***

- Resources are limited.
- Problems exist that need to be solved.
- There are four fundamental forces that exist in nature.
- The Design Process (loop) is a method for solving problems.
- Prototypes or iterations are used to communicate solutions (picture is worth a thousand words).
- Newton's Laws of Motion can be used to solve problems involving forces.
- For every problem solved a new problem may be unexpectedly created (cause/effect).
- Multiple forces can act concurrently on an object.
- Technology education is the study of the designed world.
- Organization is necessary to be successful in studying and working within science and the designed world.

Commented [1]: We need something pertaining to structures here to answer the essential question about structures.

A list of factual knowledge to be taught – ***Students will know…***

- 7 resources of technology [time, materials, knowledge, people, tool/equipment, capital, energy]
- Four conventionally accepted fundamental interactions, gravitational, electromagnetic, strong nuclear, and weak nuclear.
- Different types of forices: field force, contact force, tension force, compression force, frictional force, spring force, or gravitational force.
- Identify a restoring force.
- Identify the 9 steps associated with our problem solving design loop.
- Definition of Inertia (Newton's 1st law language).
- Definition of Newton's 2nd Law of Motion
- Definition of Newton's 3rd Law of Motion (action/reaction)

- Mathematical representation of Newton's 1st , 2nd, & 3rd Laws of Motion.
- Mathematical representation of Torque.
- Free body diagrams.
- Definition of Technology (the study of the Human-made world)
- The 4 outcomes to any technological solution: expected/desired, expected/undesired, unexpected/desired, unexpected/undesired.
- The difference between prototypes and models.

A list of skills to be taught or reinforced (including habits of mind) – *Students will be able to…*

- Safely and accurately manipulate resources while minimizing waste.
- Conduct investigations to analyze and calculate the forces that act on a structure. Present findings in organized data tables and graphical representation.
- Calculate the Net Force acting on an object and determine the Net Force through the use the Newton's laws of motion to solve problems.
- Make a claim supported by evidence about the magnitude and direction of a net force that causes an object to change it's state of motion.
- Classify forces according to the agents that cause them.
- Make claims about the factors that a affect the stability of an object.
- Communicate both verbally and in written form with teammates.
- Productively achieve the common goal while recognizing individual strengths and weakness and leverage each to help the group meet its goal.
- Safely use appropriate tools when necessary.
- Learn that sequencing in fabrication is critical.
- Design alternative solutions through the creation of prototypes.
- Construct prototypes and models. (using a 3-D printer)
- Analyze the use of different construction material in the development of prototypes.
- Organization

STAGE 2 – ASSESSMENT EVIDENCE

Assessments (Quizzes, tests, and a performance task to assess student mastery formatively and summatively, including an exemplar of proficient student work and a scoring guide for the performance task):

- Group Portfolio [completed design loop components] [see rubric]
- Oral presentation [see rubric]
- "Bridge Model/Prototype/Artifact" [see rubric]
- Project displayed at "Parents' Nights"
- Quizzes: Newton's Laws of Motion
  - Torque & Rotation
- Unit Assessment on all topics covered in big ideas, factual knowledge, and Investigations on static and dynamic systems.
  - Constant velocity & Constant acceleration

- Force table (statics)
- Bridge component testing: compression & tension.

- Investigations on Torque and angular motion.
  - Balanced and Unbalanced torques (moment arms).
  - Design and fabricate a Mobile.

Sample Performance Task [TLA]

Goal: To design & fabricate scale bridge components to withstand the greatest compression and tension testing.

Role: Structural Engineers/Bridge Developers

Audience: Classmates ,Teacher, guest(s)/professionals.

Situation:
- Students will be provided a variety of materials in order to determine the structural integrity of each. (vellum, loose-leaf, copier paper, file folder)
- Students will be given all the equipment that ***can*** be used to carry out their design & fabrication of the bridge components to be tested.
- Using the design process, each group will design and fabricate a bridge..

Product:
TLA, will include but is not not limited to the following components:
- Laboratory Skill Assessment:
- Each group member will produce hand-drawn sketch(s) for initial design concepts. *(Deep Dive video clip ABC Nightline).*
- Sample of all physically tested bridge components.
- Lab report outlining their experimental protocol, data collection and analysis, and conclusion using the Claim, Evidence, & Reasoning (CER) method.

Standards/Criteria of Success: A rubric based on the above product components will be used to assess the TLA.

Sample Performance Task [Presentation Model]

Goal: To construct a scale model of the groups proposed bridge and bridge site.

Role: Structural Engineers/Bridge Developers

Audience: Classmates ,Teacher, guest(s)/parents/guardians.

Situation:
- Students are to design and fabricate a scale model of a bridge replicating the group's solution to the given crossing.
- The model will incorporate all components necessary for a detailed presentation of the structure and its surrounding settings.
- The model will detail all considerations that will exhibit the proposed appearance of the final structure in its environmental setting.

- Students will be provided all the materials (but not limited to) that ***can*** be used to carry out their design & fabrication of the bridge & bridge site model.
- Students are expected to utilize acquired skills and knowledge in the model design and fabrication, drawing on information & practices from: field trips, professional guest speakers, & class lecture/activities. [Ex. TLA's, lab reports, video, etc.]

Product: Physical scale model, written report and presentation.

Standards/Criteria of Success: A rubric based on the above product components as well as craftsmanship and timeliness will be used to assess the project.

STAGE 3 – LEARNING PLAN

Summary of Learning Activities (Lectures, mini-lessons, readalouds, independent reading, films, website exploration, discussions, dialogues, debates, partner or small-group work, student presentations, reports, journals, reflections, in-class assessments, written reports, essays, research, and homework):

- Projects (i.e. TLAs & Model Construction)
- Field Trips (i.e. Bridge, Model Museum, etc.)
- Guest Speakers (i.e. landscape architect, structural engineer, etc.)
- Readings (i.e. "The Organized Student")
- Demos/Discussions
- Lab Activities and Reports/Engineering Log
- Teacher-Led Practice Sets
- Independent Practice Sets
- Class Discussions

Lesson Topics: (Physics)
<u>Dynamics- Newton's Laws of Motion</u>

- Units
- Force
- Vectors
- Vector components (sin, cos, tan), Pythagorean Theorem
- Newton's First law of motion
- Mass
- Newton's Second law of motion

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- Newton's Third law of motion
- Weight-the Force of Gravity; and the Normal Force
- Elastic Force- Restoring Force
- Graphing & Interpreting Data (Interpretation of Spring Constant)
- Concurrent & Parallel Forces
- Free Body Diagrams-Solving Problems with Newton's Laws (Tension & Compression Forces)
- Force of Friction & Coefficient of friction (Interpretation of coefficient of Friction)

Rotational Motion

- Torque
- Center of Gravity vs. Geometric center
- Rotational Dynamics; Torque and Rotational Inertia

Static Equilibrium

- Conditions for Static Equilibrium
- Solving Static Problems
- Method of Joint
- Stability and Balance
- Elasticity; Stress and Strain
- Spanning Spaces with Arches and Domes

Lesson Topics: (Technology)

Introduction

Class requirements – overview of course
Course proficiencies
General class procedures
Evaluations – grading policy
Using rubrics
Define Technology, innovation & invention
Categories of Technology – Physical, Informational, Biological
Reading of '*The Organized Student.*'

Design & Problem Solving Process – Overview of the Problem Solving Design Loop

Science vs. Technology – Natural World vs. Human-made world
Problem Identification
Design Brief (Resources) along with Constraints
Research to acquire information / knowledge to help solve problem and
See if a patent currently exists for your solution & market research / viability
Alternate Solutions – rough sketches initially, orthographic drawing, CAD, Inventor
Choosing a Solution – from 'T' charts listing pro's and con's for each idea
Development – construct an experiment for the
Building a prototype / Modeling
Testing your device / gathering data
Redesign / Reimplementation
Documentation
Keeping portfolios (electronic/digital & three ring binder) and design logs

Identifying Problems and Opportunities

What is a technological problem?
Source of problems

Commented [2]: We need to add the topics for Technology Education lessons here

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Situation description
Solution statements

Resources of Technology
Time
People
Energy and Power
Information or Knowledge – either you have or need to learn/find
Capital (money)
Tools and Equipment (Safely)
Materials
Other Criteria – size, maximum material amounts, etc.
Renewable & non-renewable resources

Research Methods
Sources of Information – Source Documents vs Wikipedia
People
Books, Magazines, Newspapers, DVD's, YouTube search, Google search

Alternate Solutions
Brainstorming rules and techniques
Morphological Chart
Synetics
Sketching
Isometric / Orthographic projection
Two-point perspective
Shade and shadow

Design Criteria
Efficiency
Economy
Safety
Aesthetics
Ergonomics
Ethics
Human Factors
Choosing Solutions
Attribute Matrix

Impacts of Inventions and Technology
Expected – Desired
Expected – Undesired
Unexpected – Desired
Unexpected – Undesired
Effects on Society

Development
What is a model?
Materials that go into model making
Scaling techniques and using a scale
Multi-view sketching and drawing
CAD – 2D Autodesk AutoCAD, Autodesk Inventor

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Prototyping
- Processes
- Materials
- Lab Safety – personal and group safety
- Eye protection and ear protection
- Power tool demonstration, modeling correct usage, written test, machine usage

Testing, Evaluation and Presenting Results
- Introduction to statistics
- Charts and graphs
- Evaluation reports
- Information graphics
- Use of color – design techniques

Culminating Activity
- Structures: Structural Systems, Technological Structures, Forces, Structural Components

Calculating and Testing Loads
- Technology Learning Activity (TLA)
- Evaluation (Rubric)
- Procedure