

# Deer Valley Unified School District



Deer Valley  
Unified School District

Boulder Creek High School  
CTE & Academic Integration



Team Leader: Michelle Coots  
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**CTE Course:** *Intermediate Engineering*

**Academic Course(s):** *AP Physics*

**Unit Name:** *Materials and Materials Processing*

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**Lesson Name:** *Bridge Building Project*

**Lesson Synopsis:** *Engineering students are given an opportunity to apply knowledge of the concepts stress and strain by designing and building a bridge entirely out of craft sticks. Student's will have an opportunity to explore, test, and evaluate the sticks for compression and tensile strength. Using this hands on analysis of the building materials the students will use bridge design software to design a bridge to meet the needs of the "customer".*

**Time Frame:**

*CTE Course – 2 weeks*

*Academic Course(s) – 2 Weeks*

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**Objectives:**

*CTE Course –*

*The student will evaluate the strength of craft sticks.*

*The student will design and build a bridge that will be tested for strength.*

*Academic Course(s) –*

*The student will collect and analyze stress data for the craft sticks.*

*The student will use design data provided from the bridge building software to evaluate the strength of their design prior to building.*

**Standards:**

*CTE Course –*

*Engineering Sciences: PO 2.1-Apply a structured approach to solving problems including: defining a problem (including customer needs), brainstorming, researching and generating ideas, identifying criteria and constraints, exploring possibilities, making a model (physical, mathematical, conceptual), evaluating the solution using standards and specifications (i.e., testing), and communicating results*

*Engineering Sciences: PO 2.6-Develop and implement a plan for a project (i.e., time, materials, resources, and steps)*

*Engineering Sciences: PO 3.4-Identify relevant chemical, environmental, mechanical (tension, compression, torque), electrical, and physical properties of materials used in engineering projects*

*Engineering Sciences: PO 4.1-Apply appropriate data collection and analysis methods to display data (graphs, tables, formulas, and words)*

*Engineering Sciences: PO 4.5-Apply mathematical concepts to modeling*

*Academic Course(s) –*

*Strand 1: Concept 2-PO 3. Design an appropriate protocol (written plan of action) for testing a hypothesis:*

- Identify dependent and independent variables in a controlled investigation.*
- Determine an appropriate method for data collection (e.g., using balances, thermometers, microscopes, spectrophotometer, using qualitative changes).*
- Determine an appropriate method for recording data (e.g., notes, sketches, photographs, videos, journals (logs), charts, computers/calculators).*

*Strand 1: Concept 2-PO 5. Record observations, notes, sketches, questions, and ideas using tools such as journals, charts, graphs, and computers.*

*Strand 5: Concept 1-PO 1. Describe substances based on their physical properties.*

*Strand 5: Concept 2-PO 9. Represent the force conditions required to maintain static equilibrium.*

**Bloom's Taxonomy**

Knowledge  
 Comprehension

Application  
 Analysis

Synthesis  
 Evaluation

**Resources & Materials:**

*CTE Course –*

*Westpoint Bridge Construction Software (<http://bridgecontest.usma.edu/>)*

*PC with Microsoft Excel*

*Bridge Building materials (craft sticks and white glue)*

*Text: Engineering & Technology-Hacker,Burghardt,Fletcher,Gordon,Peruzzi,Prestopnik,Qaissuanee*

*Academic Course(s) –*

*Text: College Physics-Serway,Vuillel*

**Prerequisite Learning:**

*CTE Course –*

*\*Data collection with appropriate units*

*\*Knowledge of design process*

*Academic Course(s) –*

*\*Graphical analysis*

*\*Definition of mass, weight*

**Learning Structures/Strategies****CTE Course****Set for Interest**

Engineering "design teams (students)" are approached by the "customer(teacher)" and asked to build a bridge. This bridge will be built entirely out of craft sticks and white craft glue. The bridge will need to meet specific criteria and will be tested for strength.

**Input/Modeling**

The initial phase(1 week) of this 2 week project requires the design team to first learn the difference between stress and strain as well as the difference between compression and tension. During this process the teams will begin designing bridges using the Westpoint Bridge Design software. By the end of the 1<sup>st</sup> week the design teams will begin construction and will test bridges at the end of the 2<sup>nd</sup> week.

**Check for Understanding**

The teacher will have each design team pass an initial quiz regarding the preliminary knowledge needed to begin the design phase. Students will demonstrate comprehension of the terms stress, strain, compression, and tension and will have experimented with the craft sticks in a lab setting prior to designing their bridge.

**Guided Practice**

The opportunity for Physics integration into the engineering classroom centers around scientific process of testing the materials prior to construction then applying that knowledge to design and construction of the bridge. The students will see demonstrations in class of various materials that are brittle, ductile, elastic, etc. They will then have hands on experience in testing the strength of the sticks in various ways.

**Independent Practice**

Students will have several homework assignments that will allow them to understand the form and function of bridges as well as homework involving the calculation of stress, strain, Young's modulus etc.

**Closure**

Design teams will have an opportunity to present their bridge designs to the class and explain/defend their ideas. They will discuss the bridge in terms of construction design, cost (number of sticks), desired outcome, etc.

**Assessment**

The final assessment will consist of 2 parts. The first part will consist of the presentation from the design team and the second part will be the testing of the bridge.

**Learning Structures/Strategies****Sequence****Day 1**

Teacher will introduce the unit by presenting the ideas of stress versus strain. Several demonstrations using everyday materials can be used as well as a Powerpoint presentation with definitions. Using Chapter 9 from the College Physics text the teacher will define and demonstrate compression, tension, elasticity, ductile, shearing, and Young's modulus. Students will be given conceptual questions from the Text on page 313 and mathematical problems from page 314.

**Day 2**

A student centered discussion will take place using whiteboards. Students will discuss the conceptual problems and show their work regarding the math solutions. The students will then be led in a discussion by the teacher regarding the structure and strength of a craft stick. They will be encouraged to discuss possible ways to test the strength of the stick under tension and compression forces. They will break into design teams and begin their own testing of craft sticks in preparation for designing a bridge.

**Day 3**

Students will be given the parameters for the bridge design including number of sticks (cost), max and min lengths, max and min heights, max and min weight, etc. These parameters may change from year to year if the class is entering a nationally sponsored contest. Design teams will begin using the Westpoint Bridge software to begin designing their bridge.

**Day 4-5**

Design teams finish designing their bridge and prepare for construction. Designs must be approved by the teacher prior to the start of construction.

**Day 6-8**

Design teams will construct their craft stick bridge and prepare to present their designs to the class.

**Day 9**

Design teams will present their bridge designs to the class.

**Day 10**

All bridges will be tested and results recorded.