Deer Valley Unified School District

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Boulder Creek High School
CTE & Academic Integration

CAREER AND TECHNICAL EDUCATION
BCHS CTE

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Boulder Creek High School **Integrated Academics**

CTE Course: *Intermediate Engineering*

Academic Course(s): *Physics*

Unit Name: *Energy and Power*

Lesson Name: *Mousetrap Cars*

Lesson Synopsis: *Engineering students are given an opportunity to apply knowledge of the concepts energy and power by designing and building a mousetrap car. Mousetrapcars are cars that use only the spring potential energy stored in a single mousetrap for power. Student's will observe the transfer of stored spring potential energy into kinetic energy and eventually to dissipation of that energy as a result of non conservative forces.*

Time Frame:

CTE Course – 1 weeks in class 1 week out of class

Academic Course(s) – 1 weeks in class 1 week out of class

Objectives:

CTE Course –

The student will design and build a mousetrap powered car.
The student will demonstrate knowledge of energy storage and transfer.
The student will evaluate the cars loss of kinetic energy to non conservative forces and develop strategies to improve the car for a 2nd run.

Academic Course(s) –

The student will demonstrate knowledge of energy storage and tranfer.
The student will calculate the work done by non conservative forces.

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 3.1-Use the relationships among energy, work, and power to solve a variety of problems involving mechanical, fluid, electrical, and thermal systemsEngineering 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 3-PO 1. Describe the following ways in which energy is stored in a system:
- *mechanical*
- *electrical*
- *chemical*
- *nuclear*

Strand 5: Concept 3-PO 2. Describe various ways in which energy is transferred from one system to another (e.g., mechanical contact, thermal conduction, electromagnetic radiation.)
Strand 5: Concept 3-PO 3. Recognize that energy is conserved in a closed system.
Strand 5: Concept 3-PO 4. Calculate quantitative relationships associated with the conservation of energy.

Bloom's Taxonomy

☒ Knowledge	☒ Application	☒ Synthesis
☒ Comprehension	☒ Analysis	☒ Evaluation

Resources & Materials:
CTE Course –
Text: Engineering & Technology-Hacker,Burghardt,Fletcher,Gordon,Peruzzi,Prestopnik,Qaissuanee
Mousetrap Car building materials will be provided by students

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 students will be given the challenge of designing and building a car that is powered entirely by a single mousetrap. This car will be tested on efficiency of energy transfer as measured by total distance the car travels.

Input/Modeling
The first phase of this lesson will be spent teaching students the concepts of energy and power. Special attention will be paid to the dissipation of non conservative forces. Student's will calculate energy loss by using the work-kinetic energy theorem and the Law of Conservation of Energy. In addition, students will learn how to calculate the spring constant of an elastic material and will use that knowledge to find the maximum potential energy stored in a mousetrap spring. The 2^{nd} phase will consist of the construction of the car by the students outside the classroom followed by a day of testing for efficiency.

Check for Understanding
The students will demonstrate knowledge of energy concepts by calculating energy loss and will also apply that knowledge to the design of the mousetrap car. Student's will calculate the maximum distance a car would go at nearly 100% efficiency.

Guided Practice
The opportunity for Physics integration into the engineering classroom centers around scientific process of determining the spring constant of the spring which in turn allows the student to calculate the maximum distance their car would travel. The 2^{nd} part of the project will focus on the design fundamentals and construction of the car.

Independent Practice
Students will have several homework assignments that will allow then to understand the Law of Conservation of Energy and the calculation of stored Elastic Potential Energy. Students will also construct the car on their own.

Closure
Students will clear their designs with the teacher prior to construction and will write a final report analyzing the success/failure of their car.

Assessment
The final assessment will consist of testing the car for maximum distsance and efficient transfer of energy.

Learning Structures/Strategies

Sequence

Day 1
Teacher will introduce the concept of energy by demonstrating various types of mechanical energy. Students will participate in several hands on demos showing Gravitational Potential Energy, Kinteic Energy and Elastic Potential Energy. Students will be given a homework assignment that includes identifying types of energy in a system before and after a process takes place.

Day 2
Student's will do a lab activity involving Hooke's Law. The students will design and perform an experiment that will allow them to calculate the spring constant of any spring. Students will use data collecting probes and software as well as data analysis computer software to ultimately calculate the spring constant of the moustrap spring.

Day 3
Students will be given the parameters of the mousetrap construction project. The car must be designed and built based on maximum energy transfer. The students will use the spring constant from the previous day to calculate the potential energy stored in the moustrap spring and will use that to determine the potential distance the car may travel. Students will begin research on mousetrap cars as they begin the design phase.

Day 4-5
Students will begin designing their cars using Solidworks© Engineering software. Their final plan must be approved by the teacher prior to construction.

Day 6-9
Design teams will construct their Mousetrap cars on their own time outside of class.

Day 10
Students will test their mousetrap cars on a smooth hard surface. Distance traveled will be measured in a straight line from the starting point. Using the distance traveled and the previous Potential Energy calculations students can now calculate the efficiency of their cars. Students will write a final report analyzing the success/failure of their cars.