Author: Charlotte M. Trout

| **Background Information** |
| --- |
| **Subject:**Identify the course the unit will be implemented in. | Physics |
| **Grade Band:**Identify the appropriate grade band for the lesson. | 9-12 |
| **Duration:**Identify the time frame for the unit. | 180 – 270 minutes |
| **Overview:**Provide a concise summary of what students will learn in the lesson. It explains the unit’s focus, connection to content, and real world connection.  | Students will apply their understanding of Newton’s laws of dynamics and momentum to the problem of improving sport helmet design. They will analyze different types of sports-related head injuries, analyze the current state of helmet design, and design and conduct an experiment to test model helmet designs. They will use their new knowledge to make recommendations to improve the performance of helmets. A STEM Specialist will be used to reinforce concepts discussed in class and/or to critique students’ presentations. |
| **Background Information:**Identify information or resources that will help teachers understand and facilitate the challenge. | The lesson will allow students to apply their understanding of Newton’s laws and the law of conservation of momentum to the problem of designing safety gear for athletes. The lesson assumes that students have already had classroom experiences with Newton’s laws and the law of conservation of momentum. Information about sports-related head injuries can be found at: <http://www.cdc.gov/concussion/sports/>. The National Science Foundation and the NFL have created a 10-part video series that can supply additional information <http://www.nsf.gov/news/special_reports/football/>. |
| **STEM Specialist Connection:**Describe how a STEM Specialist may be used to enhance the learning experience. STEM Specialist may be found at <http://www.thestemnet.com/> | A STEM Specialist could be used to engage students in STEM-centric learning experiences that:* demonstrate how physics and the engineering design process can be used to develop solutions to problems.
* allows students to analyze and apply current research to their experimental design.
* provides critique of student presentation and/or experimental design.
* extends content knowledge about Newton’s laws and the law of conservation of momentum.
 |
| **Enduring Understanding**:Identify discrete facts or skills to focus on larger concepts, principles, or processes. They are transferable - applicable to new situations within or beyond the subject. | * When two objects collide, there is a force applied to both objects. The size and effect of those forces can be evaluated using the law of conservation of momentum.
* Designed products must meet specific criteria which can include cost as well as performance.
 |
| **Essential Questions:**Identify several open-ended questions to provoke inquiry about the core ideas for the lesson. They are grade-level appropriate questions that prompt intellectual exploration of a topic. | * How can we use our understanding of the law of conservation of momentum to develop safer helmets for athletes?
* How can we use our understanding of the Newton’s laws to develop safer helmets for athletes?
* How can we apply what we learned about designing safer helmets to the design of other safety devices in our lives?
 |
| **Student Outcomes:**Identify the transferable knowledge and skills that students should understand and be able to do when the lesson is completed. Outcomes must align with but not limited to Maryland State Curriculum and/or national standards. | Students will be able to:* apply their understanding of Newton’s law, the law of conservation of momentum, and the engineering design process to develop and test a model of a helmet.
* apply their understanding of Newton’s law and the law of conservation of momentum to the evaluate sports helmet design.
 |
| **Product, Process, Action, Performance, etc.:**Identify what students will produce to demonstrate that they have met the challenge, learned content, and employed 21st century skills. Additionally, identify the audience they will present what they have produced to. | Students will develop a presentation that evaluates sport helmet designs and make recommendations for improvements based on their knowledge of the laws of physics and results from experiments.Students will apply their knowledge of the principle of physics and the engineering design process to create design proposals that improve helmet performance for a sport of their choice.  | **Audience:**[x] Peers [x] Experts / Practitioners [x] Teacher(s)[ ] School Community[ ] Online Community[ ] Other\_\_\_\_\_\_ |
| **Standards Addressed in the Unit:**Identify the Maryland State Curriculum Standards addressed in the unit. | **Next Generation Science Standards:****HS-PS2 Motion and Stability: Forces and Interactions**HS-PS2-3**.** Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.**Maryland Science Core Learning Goals:****Expectation 5.1** The student will know and apply the laws of mechanics to explain the behavior of the physical world.*Indicator 5.1.3* The student will analyze and explain how Newton’s Laws describe changes in an object’s motion.*Indicator 5.1.4* The student will analyze the behavior of forces.*Indicator 5.1.5* The student will analyze systems with regard to the conservation laws.**Common Core Reading in Science and Technical Subjects:**[**RST.11-12.1**](http://www.corestandards.org/ELA-Literacy/RST/11-12/1/) Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.[**RST.11-12.7**](http://www.corestandards.org/ELA-Literacy/RST/11-12/7/) Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.[**RST.11-12.9**](http://www.corestandards.org/ELA-Literacy/RST/11-12/9/) Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible.**Common Core Writing in Science and Technical Subjects:**[**WHST.11-12.1**](http://www.corestandards.org/ELA-Literacy/WHST/11-12/1/) Write arguments focused on discipline-specific content.[**WHST.11-12.2**](http://www.corestandards.org/ELA-Literacy/WHST/11-12/2/) Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes.[**WHST.11-12.9**](http://www.corestandards.org/ELA-Literacy/WHST/11-12/9/) Draw evidence from informational texts to support analysis, reflection, and research. |
| **Suggested Materials and Resources:**Identify materials needed to complete the unit. This includes but is not limited to websites, equipment, PowerPoints, rubrics, worksheets, and answer keys. | Equipment:* Computer lab or computers with internet access
* Projection capability for video
* Raw eggs (check is students have allergies)
* Tape
* Plastic trash bags
 |
| Websites\*:* Head Injuries Websites

Sports-Related Head Injuries:<http://www.aans.org/Patient%20Information/Conditions%20and%20Treatments/Sports-Related%20Head%20Injury.aspx>Concussions:* <http://www.cdc.gov/concussion/sports/>
* <http://www.cdc.gov/concussion/HeadsUp/sports_specific.html>
* <http://www.concussiontreatment.com/concussionfacts.html>

Chronic Traumatic Encephalopathy (CTE):* <http://www.bu.edu/cste/about/what-is-cte/>
* <http://www.ninds.nih.gov/news_and_events/proceedings/201212_CTE_workshop_report.htm>

Traumatic Brain Injury:* <http://www.cdc.gov/traumaticbraininjury/>
* <http://www.mayoclinic.com/health/traumatic-brain-injury/DS00552>
* Helmet Design Websites
	+ <http://www.popsci.com/science/article/2012-12/helmet-wars-and-new-helmet-could-protect-us-all>
	+ <http://espn.go.com/racing/story/_/id/8759901/dean-sicking-turns-attention-football-nfl-racing-nascar>
* Newton’s Laws and the Law of Conservation of Momentum Websites
	+ <http://www.physicsclassroom.com/class/momentum/u4l2b.cfm>
	+ <http://www.nsf.gov/news/special_reports/football/>
	+ <http://www.nsf.gov/news/special_reports/football/newtonthirdlaw.jsp>
* Egg Drop Experiments Websites
	+ <http://www.physics.umd.edu/PhysOlympics/egg.htm>
	+ <http://college.cengage.com/education/pbl/project/project3.html>
	+ <http://www.hartnell.edu/physics/physicsolympics/rules/eggdrop.pdf>
	+ <http://web.ysu.edu/gen/stem/Rules_m1840.html#1>
	+ <http://aapt-nes.org/egg-drop-rules/>
* Presentation Rubric: <http://www.bcps.org/offices/lis/models/tips/Assessments/visual.htm>.

*\* Throughout the lesson, students are linked to online resources in order to conduct research. The sites have been chosen for their content and grade-level appropriateness. Teachers should preview all websites before introducing the activities to students and adhere to their school system’s policy for internet use.* |
| People, Facilities:* A place on the school grounds where the egg drop can be performed (vertical height of 10-20 feet).
* A STEM Specialists in the field of physics.
 |
| Materials (rubrics, worksheets, PowerPoints, answer keys, etc.):* [Sports-Related Head Injuries Note Sheet](#Sports_Injuries_Note_Sheet)
* [Helmet Design Note Sheet](#Helmet_Design_Note_Sheet)
* Rubrics for some of the egg-drop ideas are found on the websites
* Student portfolios – either computers for an e-version or folders or notebooks
* [Engineering Design Process Planning Worksheet](#Engineering_Design_Planning_Worksheet) (optional)
* Engineering Design Process PowerPoint (optional)
 |

Lesson 1 of 3

**Lesson Overview:** Students will explore the current data regarding sports-related head injuries and current sport helmet design proposals. They will review Newton’s laws of motion and the law of conservation of momentum and relate them to the helmet design issue.

**Duration:** 60 – 90 min

| **Learning Experience** |
| --- |
| **5E Component**Identify the 5E component addressed for the learning experience. The 5E model is not linear. | **Details** | **Science and Engineering Practices** |
| [x] Engagement[ ] Exploration[ ] Explanation[ ] Extension[ ] Evaluation | ***Materials:**** Helmet
* melons
* Computers with internet access
* [Sports-Related Head Injuries Note Sheet](#Sports_Injuries_Note_Sheet)

***Preparation:***Make sure computers are available for students and that the following websites are accessible:Sports-Related Head Injuries:<http://www.aans.org/Patient%20Information/Conditions%20and%20Treatments/Sports-Related%20Head%20Injury.aspx>Concussions:* <http://www.cdc.gov/concussion/sports/>
* <http://www.cdc.gov/concussion/HeadsUp/sports_specific.html>
* <http://www.concussiontreatment.com/concussionfacts.html>

Chronic Traumatic Encephalopathy (CTE):* <http://www.bu.edu/cste/about/what-is-cte/>
* <http://www.ninds.nih.gov/news_and_events/proceedings/201212_CTE_workshop_report.htm>

Traumatic Brain Injury:* <http://www.cdc.gov/traumaticbraininjury/>
* <http://www.mayoclinic.com/health/traumatic-brain-injury/DS00552>

***Facilitation of Learning Experience:***Bring a helmet to class and a small melon. The melon should be able to fit inside of the helmet. Ask students to respond to the following:* Do you think the helmet will protect the melon in a collision? Why or why not?
* Explain the forces that would be absorbed by the helmet in a collision.
* Identify factors that were considered in the design of the helmet.

*Note to teacher: Students may not know the answers to all of these questions/statements. The purpose is for students to begin to critical think about forces and the design process. The teacher can have a student drop the helmet with the melon in it to see if the helmet protects the melon.* Engage students in a brief discussion about sports-related head injuries. Discussion topics include:* Explain what you know about sports-related head injuries including types, causes, symptoms, and prevention.
* There has been a national discussion surrounding sports and head injuries. What has sparked the national discussion and what impact has it had on sports?
* Improvements in technology have led to safer helmet design. Describe what you know about current helmet design for any sport.

Provide students a copy of [Sports-Related Head Injures Note Sheet](#Sports_Injuries_Note_Sheet). Students will follow the directions on the note sheet to conduct research and record information about sports-related head injuries. They can use the websites above or alternative sources. Encourage students to investigate the sport that interests them if it available on the website.Engage students in a discussion to share their research with the class.***Transition:***Inform students that now they will look at some proposals and information about safer helmets. | [x] Asking questions (for science) and defining problems (for engineering)[ ] Developing and using models[ ] Planning and carrying out investigations[x] Analyzing and interpreting data[ ] Using mathematics and computational thinking[ ] Constructing explanations (for science) and designing solutions (for engineering)[ ] Engaging in argument from evidence[x] Obtaining, evaluating, and communicating information |
| [ ] Engagement[x] Exploration[ ] Explanation[ ] Extension[ ] Evaluation | ***Materials:**** Computers with internet access
* [Helmet Design Note Sheet](#Helmet_Design_Note_Sheet)

***Preparation:***Make sure the computers are available and can access the following sites:* <http://news.nationalgeographic.com/news/2013/13/130202-football-concussions-nfl-super-bowl-safety-head-injuries-health/>
* <http://www.popsci.com/science/article/2012-12/helmet-wars-and-new-helmet-could-protect-us-all>
* <http://espn.go.com/racing/story/_/id/8759901/dean-sicking-turns-attention-football-nfl-racing-nascar>

These are suggested sites. Based on time and class policy, the instructor may encourage students to find additional information. Always insist that students evaluate the source of this information.***Facilitation of Learning Experience:***Have the students conduct research about helmet design, both current and proposed. Suggested websites are above. Students will take notes on the [helmet design note sheet](#Helmet_Design_Note_Sheet) and add the note sheet to their portfolio.***Transition:***Inform students that now they will consider the concussion and helmet issue from the laws of physics. | [ ] Asking questions (for science) and defining problems (for engineering)[ ] Developing and using models[ ] Planning and carrying out investigations[x] Analyzing and interpreting data[ ] Using mathematics and computational thinking[ ] Constructing explanations (for science) and designing solutions (for engineering)[ ] Engaging in argument from evidence[x] Obtaining, evaluating, and communicating information |
| [ ] Engagement[ ] Exploration[x] Explanation[ ] Extension[ ] Evaluation | ***Materials:**** Textbook or reading material for Newton’s laws and the law of conservation of momentum. A website that could be used is: <http://www.physicsclassroom.com/class/momentum/u4l2b.cfm>
* Computer with projection capabilities and access to the video:

<http://www.nsf.gov/news/special_reports/football/newtonthirdlaw.jsp>***Preparation:***Make sure reading materials are available. If planning on using the [physics classroom website](http://www.physicsclassroom.com/class/momentum/u4l2b.cfm), make sure computers with internet access are available. Have a computer with projector set-up and the video ready to play.***Facilitation of Learning Experience:***Lead a discussion that reviews Newton’s third law and the conservation of momentum. Have students’ access prior knowledge and lab experiences. As required, refer them to texts. Show the [NSF video](http://www.nsf.gov/news/special_reports/football/newtonthirdlaw.jsp) to facilitate the discussion and focus it on football helmets. Potential discussion topics include:* conservation of momentum
* elastic vs. inelastic collisions
* Newton’s third law

Finally, have students return to their portfolios and summarize the relationship of the physics principles discussed in class to the design of safer helmets. ***Transition:***Inform students that in the next lesson they will use their knowledge of the conservation of momentum Newton’s third law, and the engineering design process to construct a safety device.  | [ ] Asking questions (for science) and defining problems (for engineering)[ ] Developing and using models[ ] Planning and carrying out investigations[ ] Analyzing and interpreting data[ ] Using mathematics and computational thinking[x] Constructing explanations (for science) and designing solutions (for engineering)[ ] Engaging in argument from evidence[x] Obtaining, evaluating, and communicating information |

|  |
| --- |
| **Supporting Information** |
| **Interventions/Enrichments**Identify interventions and enrichments for diverse learners. | Struggling Learners* Instructors can create teams based upon ability, learning style, or other appropriate criteria, so all students can contribute equally.
* Frequent meetings with each team to determine needs, answer questions, and assess progress may help structure work time.
* Provide access to computers with word-processing programs for students to type their notes.
* Provide resources to define and/or pronounce difficult vocabulary.
* Provide additional time for work.
 |
| English Language Learners* Strategies to help English Language Learners are similar to those listed above.
* Provide resources to define and/or pronounce difficult vocabulary. A native language dictionary may also be beneficial.
* Use visuals (pictures displayed on a document camera or PowerPoint presentation), when appropriate.
* Read directions and documents aloud to students, when appropriate.
 |
| Gifted and Talented* The instructor should foster independent thinking and collaboration among the teams. No one student should take over the work for the entire team.
* Higher level thinking questions should be asked throughout the lesson with the expectation of responses that are thoughtful and elaborate.
* Sample documents should be used at the instructors’ discretion.
 |

Lesson 2 of 3

Lesson Overview: Students will use the engineering design process to develop a device to transport a raw egg from a height to the floor. They will evaluate their device and compare the activity to the design of sports helmets.

Duration: 60 minutes

| **Learning Experience** |
| --- |
| **5E Component**Identify the 5E component addressed for the learning experience. The 5E model is not linear. | **Details** | **Science and Engineering Practices** |
| [ ] Engagement[x] Exploration[ ] Explanation[ ] Extension[ ] Evaluation | ***Materials:**** raw eggs
* plastic trash bags
* masking tape
* [Engineering Design Process Planning Worksheet (Optional)](#Engineering_Design_Planning_Worksheet)
* Engineering Design Process Planning Guide PowerPoint (Optional Instructional Resource)

The remaining materials depend on the structure of the challenge. Some samples are:* <http://www.physics.umd.edu/PhysOlympics/egg.htm>
* <http://college.cengage.com/education/pbl/project/project3.html>
* <http://www.hartnell.edu/physics/physicsolympics/rules/eggdrop.pdf>
* <http://web.ysu.edu/gen/stem/Rules_m1840.html#1>
* <http://aapt-nes.org/egg-drop-rules/>

***Preparation:*** Decide which egg drop challenge will be used and have the materials ready. Also decide how teams will be determined.Secure a place for dropping the eggs and, if inside, protect flooring with sheets of plastic in the drop zone. Plastic trash bags work well.***Facilitation of Learning Experience****:*Divide the class into teams of 2-3 students each. Inform students that they must design a device that will protect a raw egg from a collision. Carefully explain the rules of the challenge and the goal. The goal should include some criteria that relate to cost of materials as well as safe transport of the egg. Remind students about the engineering design process. Students can use the [Engineering Design Process Planning Guide Worksheet](#Engineering_Design_Planning_Worksheet) as a tool to plan their experiment. Additionally, the Engineering Design Process PowerPoint can be used to explain this process to students. Monitor team work during the construction phase and provide time reminders. When time is up, insist that construction stops and begin the testing phase.***Transition:***Students will be asked to discuss their design, engage in failure analysis, and identify opportunities for improvement.  | [x] Asking questions (for science) and defining problems (for engineering)[ ] Developing and using models[x] Planning and carrying out investigations[ ] Analyzing and interpreting data[ ] Using mathematics and computational thinking[x] Constructing explanations (for science) and designing solutions (for engineering)[ ] Engaging in argument from evidence[ ] Obtaining, evaluating, and communicating information |
| [ ] Engagement[ ] Exploration[x] Explanation[ ] Extension[ ] Evaluation | ***Materials:**** Results from the egg drop challenge
* Student summaries of their design

***Preparation:***The room should be arranged to facilitate discussion***Facilitation of Learning Experience:***If students have not already done so, ask them to describe, in writing, their design and how it was supposed to protect the egg in terms of Newton’s third law and the law of conservation of momentum. In addition, have them summarize how well it worked.After allowing a few minutes for writing, lead a general discussion of the results. What worked and what didn’t? How do the laws of physics explain the results?***Transition:***In the final portion of the lesson, students should compare the egg drop (collision in one direction) with the collisions that athletes might experience. | [ ] Asking questions (for science) and defining problems (for engineering)[ ] Developing and using models[ ] Planning and carrying out investigations[x] Analyzing and interpreting data[ ] Using mathematics and computational thinking[x] Constructing explanations (for science) and designing solutions (for engineering)[x] Engaging in argument from evidence[ ] Obtaining, evaluating, and communicating information |
| [ ] Engagement[ ] Exploration[ ] Explanation[ ] Extension[x] Evaluation | ***Materials:***Student summaries of their design.***Preparation:***The room should be arranged to facilitate discussion***Facilitation of Learning Experience:***Guide the students in a discussion to compare the egg drop to athletic collisions. Specifically, how is designing a container for the egg like designing a helmet and how is it different? Be sure that they focus on the physics.***Transition:***In tomorrow’s lesson, students will have a chance to look again at current helmet design as well as proposed improvements, evaluate those designs and make suggestions. | [ ] Asking questions (for science) and defining problems (for engineering)[x] Developing and using models[ ] Planning and carrying out investigations[ ] Analyzing and interpreting data[ ] Using mathematics and computational thinking[ ] Constructing explanations (for science) and designing solutions (for engineering)[ ] Engaging in argument from evidence[x] Obtaining, evaluating, and communicating information |

|  |
| --- |
| **Supporting Information** |
| **Interventions/Enrichments**Identify interventions and enrichments for diverse learners. | Struggling Learners* Instructors can create teams based upon ability, learning style, or other appropriate criteria, so all students can contribute equally.
* Frequent meetings with each team to determine needs, answer questions, and assess progress may help structure work time.
* Provide access to computers with word-processing programs for students to type their notes and design results.
* Provide resources to define and/or pronounce difficult vocabulary.
* Provide additional time for work.
 |
| English Language Learners* Strategies to help English Language Learners are similar to those listed above.
* Provide resources to define and/or pronounce difficult vocabulary. A native language dictionary may also be beneficial.
* Use visuals (pictures displayed on a document camera or PowerPoint presentation), when appropriate.
* Read directions and documents aloud to students, when appropriate.
 |
| Gifted and Talented* The instructor should foster independent thinking and collaboration among the teams. No one student should take over the work for the entire team.
* Higher level thinking questions should be asked throughout the lesson with the expectation of responses that are thoughtful and elaborate.
* Sample documents should be used at the instructors’ discretion.
 |

Lesson 3 of 3

Lesson Overview: Students will now combine their knowledge and experiences to create an evaluation and recommendations for safer helmets.

Duration: 60 minutes

| **Learning Experience** |
| --- |
| **5E Component**Identify the 5E component addressed for the learning experience. The 5E model is not linear. | **Details** | **Science and Engineering Practices** |
| [ ] Engagement[ ] Exploration[ ] Explanation[ ] Extension[x] Evaluation | ***Materials:**** Student portfolios
* Computers with access to internet

***Preparation:***Make sure portfolios and computers are available***Facilitation of Learning Experience:***Have the students work in teams to design safer football helmets. Students must justify their design using the principles of physics. Pose the following questions to students:* How will the new helmets prevent or mitigate injuries?
* Can the new design eliminate injury? Why or why not?
* What is the largest challenge remaining? How can you address this challenge?

Students should prepare a design proposal for their new designs. Student designs will be peer reviewed by classmates. Provide students the opportunity to modify designs based off of feedback. A STEM Specialist could be used at this point in the lesson to critique the design of student work.***Transition:*** Ask the students, what about other sports? | [ ] Asking questions (for science) and defining problems (for engineering)[ ] Developing and using models[ ] Planning and carrying out investigations[ ] Analyzing and interpreting data[ ] Using mathematics and computational thinking[ ] Constructing explanations (for science) and designing solutions (for engineering)[x] Engaging in argument from evidence[x] Obtaining, evaluating, and communicating information |
| [ ] Engagement[ ] Exploration[ ] Explanation[x] Extension[ ] Evaluation | ***Materials:**** Student portfolios
* Computers with access to internet

***Preparation:***Make sure portfolios and computers are available***Facilitation of Learning Experience****:*Divide the class into groups based on interest. Have them look at the safety equipment used in another sport. Each group should use the knowledge they have acquired in this unit to evaluate that equipment and make recommendations for improvements to prevent injuries. Each group will prepare a short presentation of their evaluation and recommendations. These presentations could be evaluated by other groups, the instructor, or a STEM Specialist. The class could develop a rubric for evaluation. Examples of rubrics can be found at: <http://www.bcps.org/offices/lis/models/tips/Assessments/visual.htm>.***Transition:***Inform the class that a STEM Specialist in the field of physics will visit the class to reinforce physics concepts discussed in class. Encourage students to develop questions to ask the STEM Specialist. | [x] Asking questions (for science) and defining problems (for engineering)[ ] Developing and using models[ ] Planning and carrying out investigations[ ] Analyzing and interpreting data[ ] Using mathematics and computational thinking[x] Constructing explanations (for science) and designing solutions (for engineering)[ ] Engaging in argument from evidence[x] Obtaining, evaluating, and communicating information |
| [ ] Engagement[ ] Exploration[ ] Explanation[x] Extension[ ] Evaluation | ***Materials:***Technology needs of the STEM Specialist***Preparation:***Contact the STEM Specialist in advance to review your plans for the lesson and explain his/her role. A description of the ability level of the students, as well as some of the prior knowledge your students may have of Newton’s laws and the conservation of momentum. Prepare a list of questions to direct the learning experience with the STEM Specialist or have students prepare some questions in advance. ***Facilitation of Learning Experience:***The STEM Specialist will engage students in a learning experience that demonstrates how the laws of physics can be used to mitigate or prevent injuries.  | [ ] Asking questions (for science) and defining problems (for engineering)[ ] Developing and using models[ ] Planning and carrying out investigations[ ] Analyzing and interpreting data[ ] Using mathematics and computational thinking[ ] Constructing explanations (for science) and designing solutions (for engineering)[ ] Engaging in argument from evidence[x] Obtaining, evaluating, and communicating information |

|  |
| --- |
| **Supporting Information** |
| **Interventions/Enrichments**Identify interventions and enrichments for diverse learners. | Struggling Learners* Instructors can create teams based upon ability, learning style, or other appropriate criteria, so all students can contribute equally.
* Frequent meetings with each team to determine needs, answer questions, and assess progress may help structure work time.
* Provide access to computers with word-processing programs for students to type their notes and evaluations.
* Provide resources to define and/or pronounce difficult vocabulary.
* Provide additional time for work.
 |
| English Language Learners* Strategies to help English Language Learners are similar to those listed above.
* Provide resources to define and/or pronounce difficult vocabulary. A native language dictionary may also be beneficial.
* Use visuals (pictures displayed on a document camera or PowerPoint presentation), when appropriate.
* Read directions and documents aloud to students, when appropriate.
 |
| Gifted and Talented* The instructor should foster independent thinking and collaboration among the teams. No one student should take over the work for the entire team.
* Higher level thinking questions should be asked throughout the lesson with the expectation of responses that are thoughtful and elaborate.
* Sample documents should be used at the instructors’ discretion.
 |

Name: Date:

**Sports-Related Head Injuries**

Directions: Circle the sports-related injury from the list below that you will conduct research on.

1. Concussions
2. Chronic Traumatic Encephalopathy (CTE)
3. Traumatic Brain Injury

Record notes for the selected sports-related head injury in each category. Identify your sources below or on the back.

|  |  |
| --- | --- |
| **Definition** | **Symptoms and Diagnostic Test** |
| **Causes** | **Prevention** |

**Interesting Facts:**

**Sources:**

Name: Date:

**Helmet Design Note Sheet**

Directions: Conduct research on three different helmet designs for the same sport. Identify your sources on the back of this sheet.

|  |  |
| --- | --- |
| **Sport** |  |
| **Picture of Helmet** |  |  |  |
| **Safety Features** |  |  |  |
| **How is the proposed design going to reduce injury?** |  |  |  |

**Sources:**

|  |
| --- |
| **Engineering Design Process Planning Worksheet** |
| NAME: |  | TEAM MEMBERS: |  |
| DATE STARTED: |  | DUE DATE: |  |
| **DEFINE THE PROBLEM**What is the problem you are trying to solve? |
| Problem Statement:Design Brief: |
| **BRAINSTORMING**In the space below generate a mind-map of all of the possible concepts and ideas that need to be explored in developing a solution to your problem. Remember there should be no limitations at this point, so be creative! |
|  |
| **RESEARCH & GENERATE IDEAS**In the space below, answer the questions and document your research. Be sure to include proper citations! |
| What are the mathematics concepts required to create a solution to this problem?What are the science concepts required to create a solution to this problem?What have others done to address this problem?What other ideas do you have?Notes:APA Citations: |
| **IDENTIFYING CRITERIA & CONSTRAINTS**List what has to happen to solve the problem and constraints that you have. (people, time, materials, capital…) |
|  |
| **EXPLORE DIFFERENT POSSIBILITIES**Reflect on your brainstorming and research notes. Generate at least three designs that you feel meet the criteria and constraints in the space below. |
|  |  |  |
| **SELECT AN APPROACH**Create a decision matrix to select the best approach to the problem. |
|

|  |  |  |  |
| --- | --- | --- | --- |
| Constraint/criteria 1 | Constraint/criteria 2 | Constraint/criteria 3 | Total |
| Sketch 1 |  |  |  |  |
| Sketch 2 |  |  |  |  |
| Sketch 3 |  |  |  |  |
| Enter the constraints of the project in the first row.Score each sketch for each constraint. + = 3 pts., √=2 pts., - = 1 pt.Total the rows and circle the highest score. |
| Explanatory Writing* Create an explanation on why the selected design is the best solution to the problem.
* This explanatory writing must be based on logic, facts, and data.
* Your explanation must be well written and make use of the references from your research
 |

 |
| **DEVELOP A DESIGN PROPOSAL**Take your highest scoring design and create working drawings (sketches with dimensions, so that you could build your project). Do not forget to add a list of materials! |
|  |
| **MAKE A MODEL OR PROTOTYPE**In the space below, document (using digital pictures) your construction of the model/prototype. Be sure to include a picture of the final model/prototype. |
|  |  |
|  |  |
| **TEST & EVALUATE**As you create your solution, you will perform tests to make sure that the solution is meeting the needs of the given problem. If you solution does not work, you may need to repeat the previous steps of the Engineering Design Process, until you find a functional design. In the space below, document the type of test you conducted and the results. |
| 1. What data will you collect to evaluate your design?
2. How will you collect the data?
3. What are the math concepts that you will have to use in recording and analyzing your design?
4. What mathematical tools will you use to collect and analyze your test data?
5. List the mathematical formulas will you need for testing your design?

|  |  |
| --- | --- |
| Test Description | Test Results |
|  |  |
|  |  |
|  |  |

 |
| **REFINE THE DESIGN**Based on your tests, propose refinements to the design and construction of the problem solution in the space below. Include pictures of your improved design. |
|  |
| **CREATE OR MAKE IT**If time allows, modify your model/prototype as proposed in refining the design. What additional steps would be necessary to produce this solution for mass production? |
|  |
| **COMMUNICATE RESULTS**An engineer must be able to communicate his or her work. You can be the most brilliant engineer but if you cannot successfully communicate your ideas with others, then your ideas are useless. Explain the process you took to develop your solution and create an argument on why your design is the best solution to the problem or why it is not. This argument must be based on logic, facts, and data. A valid argument also provides the facts and data for the opposing argument. Your argument must be well written and make use of the references from your research and testing results. |