**Lesson Plan #1 of Unit #1**

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| **TOPIC/TITLE OF LESSON** | **Visualizing Speed** | |
| **AUTHOR(S)** | **Danielle Reba DiBartolomeo** | |
| **GRADE LEVEL(S)** | **7-12** | |
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| **APPLICABLE PA CORE OR NEXT GENERATION STANDARDS:** | | |
| **3.2.10.B6:** PATTERNS SCALE MODELS CONSTANCY/ CHANGE   Explain how the behavior of matter and energy follow predictable patterns that are defined by laws.  **3.2.10.B7:**   * Compare and contrast scientific theories. * **Know that both direct and indirect observations are used by scientists to study the natural world and universe.** * **Identify questions and concepts that guide scientific investigations.** * **Formulate and revise explanations and models using logic and evidence.** * Recognize and analyze alternative explanations and models.   **3.2.12.B6:** CONSTANCY/CHANGE   Compare and contrast motions of objects using forces and conservation laws. | | |
| **LESSON OBJECTIVES:** | | **ASSESSMENT(S) EVALUATE**  **(formative and/or summative)** |
| **Explain the speed of various objects in terms of time required to cross a football field.**  **Describe the “push” required to make an object of 10 kg travel at the described speed in space.** | | **Student generates mathematical, written and graphical findings**   1. **Prediction graphic** 2. **Time required for fastest object to cross football field** 3. **Location of other objects on diagram**    1. **Usain Bolt**    2. **Walking student**    3. **Running student**    4. **Bugatti Veyron Sport**    5. **SR-71 Blackbird**    6. **Bullet**    7. **NASA object**    8. **Solar system object** 4. **Correct calculations for velocity in classwork and homework** |
| **ACTIVATION OF PRIOR KNOWLEDGE (RTOP #1) ENGAGE** | | |
| **Describe how you calculate speed and velocity.**  **How do calculate speed using acceleration and mass?**  **How do you calculate speed using distance and time?**  **Predict how long would it take \_\_\_\_\_\_\_\_\_\_ to get across the football field.**   1. **Fastest Human** 2. **Fastest Car** 3. **Fastest Plane** 4. **Fastest Object in the solar system**   **Students enter class and record questions, answers and prediction in notebook. Class takes a vote and records class prediction on board and index card. (Index card so that info can be later shared with other classes as a larger prediction data set)**  **Class takes supplies and walks out to football field.** | | |

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| **TEACHING AND LEARNING APPROACHES EXPLORE, EXPLAIN, EXTEND** | |
| **WHAT IS THE TEACHER DOING?**  **RTOP (# 2-10; #9-12; #21-25** | **WHAT ARE STUDENTS DOING?**  **RTOP (#11-19)** |
| 1. **Teacher reviews difference between speed and velocity.** 2. **Discuss why the football field is a good model to measure distance** 3. **Model measuring speed with predicting problems metacognition.** 4. **Talk about safety** 5. **Students released to collect data** 6. **Students begin data analysis** 7. **Data analysis share-out** 8. **Teacher models using bullet as fastest object and using results to predict where other objects are.** 9. **Student teams use a rubric to rate their experiment** | 1. **Students record two formulas, specify that difference is whether there is a vector/direction** 2. **Students record 3 predicted pros and cons for using the football field as a model** 3. **Students pass out supplies and determine roles** 4. **Students write safety rules** 5. **Data collection Runner volunteers line up Data students disperse down football field (1 per runner at various distances) 6 runners means teams of six at different distances. Race is run and students turn in data as runner, meters, color of runner and time to data manager. Walker volunteers line up. Data students line up 1 per walker at various distances. Race is walked and students turn in data as walker, meters, color of walker, and time to data manager 2.** 6. **Data manager 1 and 2 input class data into computers. Create spreadsheets that identifies average speed and speed for each contestant.  Team colors separate to begin making calculations for cards at lab table. All tables have “research data” Usain Bolt, Bugatti Veyron Sport and SR-71 Blackbird. Different tables will get different bullets, solar system objects and NASA objects. If possible, teams self select from a complete list, writing their mission on a shared Google doc or the whiteboard. Teams annotate research and locate important data, calculate speed and order objects based on speed.**   [**http://www.theatlantic.com/photo/2015/07/the-voyage-of-new-horizons-jupiter-pluto-and-beyond/398408/**](http://www.theatlantic.com/photo/2015/07/the-voyage-of-new-horizons-jupiter-pluto-and-beyond/398408/)  [**https://www.nasa.gov/missions**](https://www.nasa.gov/missions)   1. **Data Manager 1 and 2 present data and share to Google folder for students to access at home. Colors present data for research. Data is added to folder. Students brainstorm something they think is faster and slower than the data points given.** 2. **Students select fastest object and using the time it takes to cross a football field, predict where the other objects will be. Students fill in a graph paper diagram of the football field with objects. Students add in starred prediction for two brainstormed objects.** 3. **Student teams use a rubric to rate their experiment**  * **Data table** * **Graphic** * **Paragraph** * **Discussion of prediction** * **Questions created** * **Next Steps: what you would change** |
| **WRAP UP RTOP (#14) EXTEND** | |
| **Students will get a list from Wikipedia and discuss where these objects might fall on the model of the football field.** [**https://en.wikipedia.org/wiki/List\_of\_vehicle\_speed\_records**](https://en.wikipedia.org/wiki/List_of_vehicle_speed_records)  **Discussion questions:**  **Pros and cons of everyone having the same fastest object.**  **Pros and cons of everyone having the same slowest object**  **Pros and cons of using a football field as distance**  **Pros and cons of using speed vs. acceleration**  **What was most startling**  **Compare and contrast your results to your prediction**  **Compare and contrast to the class prediction**  **Create two new questions**  **Describe what you might try next**  **Homework:**  **Imagine if each of these objects had a mass of 10kg. Using your understanding of Newton’s Laws, and a rocket that accelerates the object at 10 m/s2, how long does the rocket have to push to get the object to move at the specified speed?**  **Web research: what other “pushes” can NASA scientists use to make an object change direction or move faster? What is complicated about these “pushes”?**  [**http://www.nasa.gov/mission\_pages/newhorizons/news/jupiter\_system.html**](http://www.nasa.gov/mission_pages/newhorizons/news/jupiter_system.html)  [**http://www.nasa.gov/centers/glenn/technology/Ion\_Propulsion1.html**](http://www.nasa.gov/centers/glenn/technology/Ion_Propulsion1.html)  [**http://www.nasa.gov/centers/glenn/technology/warp/ipspaper\_prt.htm**](http://www.nasa.gov/centers/glenn/technology/warp/ipspaper_prt.htm)  **Finish lab report using this information and rubric and share to official submission folder on google drive.** | |

Refer to the RED text in the headings to see how the 5 E’s correspond to the lesson plan components. It is the teacher’s prerogative where extension activities are addressed.

**Rubric for Lesson Plan #1 of Unit #1**

***Instruction: Use the rubric below to review your lesson against the indicators listed below. Consider how someone unfamiliar with your unit would rate your work. Place a checkmark in the appropriate rating box.***

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| **RTOP**  **Indicator** | **Indicator Description** | **Thoroughly**  **Addressed** | **Adequately Addressed** | **Some Evidence** | **No Evidence** |
| \_ | Aligned with PA Core or Next Generation Science Standards | **x** |  |  |  |
| \_ | Strong correlation between lesson objectives and assessment methods |  | **x** |  |  |
| \_ | Incorporates NASA content and/or resources within the lesson | x |  |  |  |
| \_ | Integrates available technology | **x** |  |  |  |
| #1 | Provides opportunities to help students to activate prior knowledge | **x** |  |  |  |
| #2 | Structures lesson to engage students as members of a learning community | **x** |  |  |  |
| #4, #5 | Utilizes a problem based/inquiry learning model in which students make predictions, estimations and /or hypotheses with a means for testing them |  | **x** |  |  |
| #12, 14 | Describes structured activities requiring student exploration, self-assessment, elaboration and reflection |  |  |  |  |
| #11, 16 | Indicates how students will use a variety of means to represent phenomena |  | **x** |  |  |
| #10 | Connects with other content discipline and/or real world phenomena |  | **x** |  |  |
|  | Incorporates the use of modeling, guided practice and independent practice |  | **x** |  |  |
|  | Identifies and/or provides an authentic real-world problem relevant to the students for them to solve | **x** |  |  |  |
|  | Addresses each of the 5 E’s—engage, explore, explain, extend, and evaluate | **x** |  |  |  |