Physics and Engineering - Unit 1 - Modeling and the Engineering Process

Unit Focus

During this introductory unit, students will begin to apply the Engineering Design Process and principles of physics to a variety of modeling activities. Students will explore these concepts through laboratory activities as well as computer simulations as they learn the MatLab software program. This program is widely-used at the college level to allow students to create and test models through online simulations. Students can simulate tests, gather data and use this data to revise their models, develop a deeper understanding of the principles of physics and learn the underlying patterns and relationships that govern the study of physics. Specifically, students will apply their experience to predict the rate of fall of a set of "non-ideal" objects, simulating the work done by NASA and SpaceX when designing spacecraft.

Stage 1: Desired Results - Key Understandings

Standard(s)

Next Generation Science Standards (DCI)
Science: 11

- Both physical models and computers can be used in various ways to aid in the engineering design process. Computers are useful for a variety of purposes, such as running simulations to test different ways of solving a problem or to see which one is most efficient or economical; and in making a persuasive presentation to a client about how a given design will meet his or her needs. *ETS1.9.B2*
- Criteria may need to be broken down into simpler ones that can be approached systematically, and decisions about the priority of certain criteria over others (trade-offs) may be needed. *ETS1.9.C1*
- Newton's second law accurately predicts changes in the motion of macroscopic objects. *PS2.9.A1*

NGSS/NSTA Science & Engineering Practices
NGSS Science & Engineering Practices: 9-12

- Ask questions to determine relationships, including quantitative relationships, between independent and dependent variables. *SE.9-12.1.3*

Transfer

T1 Create models to explore complex systems, show mastery of key science concepts, and/or develop solutions through creation of a product open to testing and redesign.
T2 Analyze qualitative and quantitative data to interpret patterns, draw conclusions, and/or make predictions.

Meaning

Understanding(s)	Essential Question(s)
U1 Collection of accurate data is crucial to creating a successful revision of the original model. **U2** Translation from the ideal world to the real world involves model building and iteration **U3** Engineers use test or simulation data to determine if a model needs revision and to inform the needed revisions.	**Q1** How do I use tools and materials to carry out my test? How do I collect and record quality data? **Q2** Based on current information, how do I develop a testable design? **Q3** What do the results tell me? What patterns do I see or what conclusions can I draw?

Acquisition of Knowledge and Skill

Knowledge	Skill(s)
K1 When forces are balanced, a falling object will reach a constant velocity (terminal velocity) **K2** Velocity and acceleration are interdependent where drag is present **K3** Computer simulations can be utilized to approximate solutions of complex equations	**S1** Writing and modifying programs to model real world behavior **S2** Building a conceptual model of a scenario and translating that model into computer code **S3** Refining models based on data collected from experimentation **S4** Optimizing system design based on computer simulation and real world data

Stage 1: Desired Results - Key Understandings		
• Ask and/or evaluate questions that challenge the premise(s) of an argument, the interpretation of a data set, or the suitability of the design. *SE.9-12.1.7* • Design a test of a model to ascertain its reliability. *SE.9-12.2.2* **Madison Public Schools Profile of a Graduate** *Critical Thinking* • Analyzing: Examining information/data/evidence from multiple sources to identify possible underlying assumptions, patterns, and relationships in order to make inferences. (POG.1.2) *Collaboration/Communication* • Product Creation: Effectively use a medium to communicate important information. (POG.3.2)		