I Grade 8 Motion and Forces G64

Content Area: **Science**
Course(s):
Time Period: **Generic Time Period**
Length: **35 Instructional Days**
Status: **Published**

Stage 1: Desired Results

Unit Overview/ Rationale

Students use system and system models and stability and change to understanding ideas related to why some objects will keep moving and why objects fall to the ground. Students apply Newton's third law of motion to related forces to explain the motion of objects. Students also apply an engineering practice and concept to solve a problem caused when objects collide. The crosscutting concepts of system and system models and stability and change provide a framework for understanding the disciplinary core ideas. Students demonstrate proficiency in asking questions, planning and carrying out investigations, designing solutions, engaging in argument from evidence, developing and using models, and constructing explanations and designing solutions. Students are also expected to use these practices to demonstrate understanding of the core ideas.

This unit is based on MS-PS2-1, MS-PS2-2, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, and MS-ETS1-4.

Standards & Indicators

Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. * [Clarification Statement: Examples of practical problems could include the impact of collisions between two cars, between a car and stationary objects, and between a meteor and a space vehicle.] [Assessment Boundary: Assessment is limited to vertical or horizontal interactions in one dimension.] (MS-PS2-1)

Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. [Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [Assessment Boundary: Assessment is limited to forces and changes in motion in onedimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.] (MS-PS2-2)

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. (MS-ETS1-1)

Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. (MS-ETS1-2)

Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. (MS-ETS1-3)

Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. (MSETS1-4)

This unit is based on MS-PS2-1, MS-PS2-2, MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, and MS-ETS1-4

SCI.MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
SCI.MS-PS2-2	Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
SCI.MS-ETS1-4	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.
SCI.MS-PS2-1	Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
SCI.MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Big Ideas - Students will understand that...

Throughout this unit of study, students will be examining and interacting with objects in motion. They will begin this unit by investigating Newton's third law of motion by observing the action/reaction forces involved during a collision. Students will expand their idea of collisions beyond the narrow view of collisions as being an accident in which two or more objects crash into each other. They will learn that scientists' use of the word collision does not refer to the size of the force; instead it describes any interaction between two objects. We want students to understand that a collision can be as small as an ant walking on a blade of grass—that is, that a collision is any touch between two objects, no matter how small or how large the force. Some possible observations may include the action/reaction forces involved in roller skating, skateboarding, moving boxes of different masses, etc. Students will then apply Newton's third law to possible problems and solutions. Some possible investigations could include designing and launching rockets or protecting eggs in a collision. Students then investigate Newton's first and second laws of motion through hands-on activities in which they observe the result of balanced and unbalanced forces on an object's motion. Some examples may include using a seesaw or kicking a ball. In addition, students will observe how an object's motion will change depending upon the mass of the object and the amount of force applied. Activities could include pushing objects of different masses and comparing the forces needed to accelerate the objects. Students will continue their investigation of Newton's third law by participating in an engineering and design problem that will require them to design a solution to a problem involving the motion of two colliding objects. Students could begin by observing collisions. An example of a collision could be an egg in a cart rolling down an incline and colliding with a barrier. Based on their observations of collisions, students will jointly develop and agree upon the design problem that they will focus on. Students will begin by making a clear statement of the problem they are going to attempt to solve. Once students have a clearly stated problem, the teacher will need to provide them with time and opportunity to participate in a short research project where they will gather background information that will help them come up with possible design solutions. Students will need to document their findings, making sure that they cite the resources they use. After students have collected evidence, they can then begin to brainstorm possible solutions. To begin this process, students will need to identify the constraints and criteria for a successful design solution. This would involve them identifying the limits of the design. For example, time, materials, and resources could be some constraints. Students will next identify the criteria for a successful design. For example, one criterion could be that the egg in the collision does not break at all, or that it may crack as long as the contents do not spill out.

After the constraints and criteria have been identified, students can then generate possible solutions. Multiple solutions could be generated. Using the evidence collected during their research, as well as information they have learned as a part of their classroom experience, students can eliminate the solutions that seem least likely to be successful and focus on those that are more likely to be successful. After students have identified the solutions that are most likely to be successful, they will evaluate their competing design solutions using a rubric, checklist, or decision tree to assist them in selecting the design solution they will take into the next phase of the process. Students have reached the stage where they will need to create a model that can be tested. The model could be physical, graphical, mathematical, or it could be a scale model. Students will use the model to collect evidence that will help them determine which of the possible design solutions will be taken into the prototype phase. During the prototype phase, students will create their actual model.

Once students have constructed their devices, they should gather necessary data from tests performed on their design solutions. They will analyze and interpret these data to determine which design best minimizes the force acting upon the egg. For example, the materials of a particular design may be superior and/or the structure of another design may be more successful. Once students have evaluated competing solutions and analyzed and interpreted data, they may then begin to modify their original designs. It is important that students consider the benefits of each design solution. This is when they are deciding whether different parts of their solutions can be combined to maximize efficiency. The final goal is for students to identify the parts of each design solution that best fit their criteria and combine these parts into a design solution that is better than any of its predecessors. Students will then translate this activity to a real world-example in which they see the influence of science, engineering, and technology on society and the natural world.

Essential Questions - What provocative questions will foster inquiry and transfer of learning

What are some ways to describe motion?

How do forces change the motion of objects?

Chapter 1 – Describing Motion

- How does the description of an object's position depend on a reference point?
- How can you describe the position of an object in two dimensions?
- What is the difference between distance and displacement?
- What is speed?
- How can you use a distance-time graph to calculate average speed?

- What are ways velocity can change?
- What are three ways an object can accelerate?
- What does a speed-time graph indicate about an object's motion?

Chapter 2 – The Laws of Motion

- What are some contact forces and some non-contact forces?
- What is the law of universal gravitation?
- How does friction affect the motion of two objects sliding past each other?
- What are Newton's Three Laws of Motion?
- How is motion related to balanced and unbalanced forces?
- Why don't the forces in a force pair cancel each other?
- What is the law of conservation of momentum?

Content - Students will know...

- For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength exerts on the first, but in the opposite direction (Newton's third law).
- Models can be used to represent the motion of objects in colliding systems and their interactions, such as inpu as energy and matter flows within systems.
- The uses of technologies and any limitations on their use are driven by individual or societal needs, desires, an scientific research and by differences in such factors as climate, natural resources, and economic conditions.
- The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designe
- Specification of constraints includes consideration of scientific principles and other relevant knowledge, which solutions.
- The change in an object's motion depends on balanced (Newton's first law) and unbalanced forces in a system object's motion depends on the sum of the forces on the object and the mass of the object includes qualitative c changes in motion (Newton's second law); frame of reference; and specification of units
- The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is no
- The greater the mass of the object, the greater the force needed to achieve the same change in motion.

- For any given object, a larger force causes a larger change in motion.
- Explanations of stability and change in natural or designed systems can be constructed by examining the chang different scales

Skills - Students will be able to...

Students who understand the concepts are able to:

- Apply Newton's third law to design a solution to a problem involving the motion of two colliding objects.
- Define a design problem involving the motion of two colliding objects that can be solved through the development of an object, tool, process, or system and that includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.
- Evaluate competing design solutions involving the motion of two colliding objects based on jointly developed and agreed-upon design criteria.
- Develop a model to generate data to test ideas about designed systems, including those representing inputs and outputs.
- Analyze and interpret data to determine similarities and differences in findings.
- Plan an investigation individually and collaboratively to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.
- Design an investigation and identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.
- Make logical and conceptual connections between evidence and explanations.
- Examine the changes over time and forces at different scales to explain the stability and change in designed systems.

Stage 2: Assessment Evidence

A. Finding Distance on a Speed-Time Graph

B. Calculate Average Speed from a Graph

C. Calculate the Acceleration of objects from a chart

D. Completing tasks required at the various Stations

Assessment

A. Students will demonstrate and interpret speed-time graphs.

B. Students will collect data on a rolling ball and determine the average speed by graphing the motion using a distance-time graph.

C. Students will perform a walking activity where they determine the distance they walk in 2s, 4s and in 6s, and then they will graph their results on a distance-time graph.

Stage 3: Learning Plan

Learning Activities

Academic Vocabulary Activities: journals, e-flash cards, puzzles, e-games

Mini-Labs (student engagement)

Launch Labs (teacher and/or student led)

Inquiry Labs (use of inquiry skills)

Interactive technology: classroom presentations, science videos, transparencies, interactive whiteboard activities, online assessments

Language arts strategies: make tables, answer guiding questions, organizing ideas, illustrating ideas, outlines, infer meaning, compare and contrast, make connections

Accommodations for students with IEPs and learning difficulties:

-visual sentence frames using academic vocabulary for discussion

-graphic organizers and sentence starters for literary analysis writing

-Graphic organizers for comparing and contrasting of characters, plot, and theme in order to create a written narrative.

-Graphic organizers/worksheets for book club roles that explains in detail about what each role entails

-Model how to perform specific roles for book clubs

-Use visuals to show important vocabulary for students to make connections

-Have students share their text to text, text to world, and text to self-connections

-One on one teacher support for comprehension and fluency

- Modeling and scaffolding to highlight specific moments, vocabulary, and figurative language, and using context clues to use inference skills

-Show and discuss exemplar writing pieces before students being their own

-Close reading chapters/chunks

-Re-reading key sections for fluency and comprehension

-Colored overlays and reading windows to reduce visual distractions

-Sentence starters for writing assignments

-Vocabulary word banks and strategies (Say it, Define it, Act it)

-Think aloud and Think-Pair-Share

For ELL students:

-visuals for vocabulary

-Word wall

-Additional word work such as illustrating vocabulary and playing vocabulary games

-Partner reading

-Choral reading

-Think-aloud while modeling writing

-Analyze sample summaries before writing

-Color-coded sticky notes for close reading to identify which sticky notes pertain to vocabulary

-Questions about text, etc.

-When students make an error in speaking, answer or restate what they said using the correct form without drawing attention to the mistake.

For gifted students:

-Have students complete extended research projects on a related issue of their choice as it pertains to a content area

-Students perform a written/oral debate on topics related to content

Resources

Glencoe iScience, McGraw Hill, 2012

-Contains an fantastic online component which contains an online textbook, online resources, virtuals teaching reviews, etc.

Paige Keeley Science Probes

BrainPop shorts

"What's Science Got to Do With It" video segments

WebQuests

Video supplements from internet resources

Unit Reflections & Teacher Notes

This is a nice way to ease students into the 8th grade year. There are many hands-on activity opportunites, and through a new stations-led approach, students are able to work at different types of stations to learn information together in their groups, while completing various tasks. (Watch It, Explore It, Read It, Research It, Assess It and Illustrate It are the stations) The students really enjoy this approach, and it keeps them moving and being more interactive throughout the class period. There are also fun virtual labs with the book for designing your own roller coasters where students must use their knowledge of gravity, velocity and forces. (WebQuest) This is a challenge now that we have iPads as flash does not work on the iPads.

Students struggle with use of formulas, so calculators are permitted. There are a lot of formulas related to speed, velocity, acceleration, morce, etc., and students perform based on their math level. Some students grasp the info quickly, while others take a little more time, but as long as formulas and calculators are permitted, they usually do well.