



Grade 8 Science - Unit 1 - Forces and Motion

Unit Focus

By performing several investigations that demonstrate the laws of physics, students will develop an understanding of the forces that are at work everyday in their lives. Students will begin the unit by being challenged to create a working roller coaster that meets a set of requirements. As students engage in hands-on, inquiry-based experiences they will uncover not only how their roller coaster demonstrates the laws of physics in its performance, but also how our world operates according to these laws. In order to engage in, and quantify how Newton's Laws impact the world around us, students will apply their understanding of math and graphical analysis to solve physics problems and communicate experimental results. Students will demonstrate their understanding of Newton's Laws in regards to forces and motion when they complete a Mars Mission task to design, construct, test and revise a rover and lander. At the end of the unit, students will tie together all of the concepts they have investigated as they complete their final unit model to demonstrate their level of understanding of the concepts taught in the unit, and answer content and design process related questions.

Stage 1: Desired Results - Key Understandings

Standard(s)	Transfer	
<p>Next Generation Science Standards Performance Expectations: Middle School Physical Sciences</p> <ul style="list-style-type: none"> Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects. (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. (MS-PS2-2) Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects. (MS-PS2-4) Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object. (MS-PS3-1) Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system. (MS-PS3-2) <p>Madison Public Schools Profile of a Graduate</p> <ul style="list-style-type: none"> Design: Engaging in a process to refine a product for an intended audience and purpose. (POG.2.2) 	<p><i>Students will be able to independently use their learning to...</i></p> <p>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.</p>	
	Meaning	
	Understanding(s)	Essential Question(s)
<p><i>Students will understand that...</i></p> <p>U1 Objects possess a potential energy that is dependent upon their position and gravitational force.</p> <p>U2 The motion of an object can be determined and/or predicted by using its position, velocity, and acceleration.</p> <p>U3 Objects in motion remain in straight-line motion at constant speed, and objects at rest remain at rest unless acted upon by unbalanced forces. (Newton's 1st law).</p> <p>U4 The acceleration of an object depends upon its mass and the net force acting on it. (Newton's 2nd Law)</p> <p>U5 Forces between objects come in pairs that are equal in magnitude but opposite in direction (Newton's 3rd law)</p> <p>U6 Established knowledge provides the foundation for future scientific and engineering advances.</p> <p>U7 There is an attractive gravitational force between any two objects that is dependent on their masses and distance between them.</p> <p>U8 Kinetic energy increases as an object's speed or mass increases, and this relationship can be visualized and analyzed using graphs to make predictions about energy in motion.</p>	<p><i>Students will keep considering...</i></p> <p>Q1 How do forces affect the motion of objects, and what role does mass play in those changes?</p> <p>Q2 How does the motion or position of an object affect the amount of kinetic or potential energy it has?</p> <p>Q3 Why do objects exert equal and opposite forces during a collision, and how can this concept help us design equipment that is both safe and effective?</p> <p>Q4 What factors influence the strength of gravitational attraction between objects?</p>	

Stage 1: Desired Results - Key Understandings

- Collective Intelligence: Working respectfully and responsibly with others, exchanging and evaluating ideas to achieve a common objective. (POG.3.1)

Acquisition of Knowledge and Skill

Knowledge

Students will know...

- K1** The total energy within a system is conserved.
- K2** Newton’s Third Law states that forces always come in pairs: for every action force, there is an equal and opposite reaction force.
- K3** When two objects collide, they exert equal and opposite forces on each other that affect their motion.
- K4** An object’s motion changes when the total (net) force acting on it is not zero.
- K5** The change in an object’s motion depends on both the total force acting on it and the object’s mass.
- K6** The greater the mass of an object, the greater the force needed to achieve the same change in motion.
- K7** Gravitational forces are always attractive and act between any two objects with mass having an impact on potential energy.
- K8** In order to detect motion, objects must be compared to a designated frame of reference.
- K9** The strength of gravitational attraction increases with the masses of the objects and decreases as the distance between them increases.
- K10** Kinetic energy is the energy of motion and increases when an object’s speed or mass increases.
- K11** Graphs can show the relationships between mass, speed, and kinetic energy.
- K12** How acceleration and velocity combine to impact the movement of object (speed up, slow down).
- K13** Potential energy is stored energy that depends on the position or arrangement of objects (e.g., height above the ground or the stretch of a spring).
- K14** When the distance or position between objects changes (such as moving two magnets closer), the amount of potential energy in the system changes.
- K15** Scientific Literacy Terminology: potential energy, kinetic energy, motion, point of reference, speed, constant speed, average speed, position-time graph, slope, force, friction, gravity, inertia, mass, acceleration, balanced/ unbalanced forces, net force, circular motion.

Skill(s)

Students will be skilled at...

- S1** Planning and conducting investigations to explore Newton’s Laws of Motion, identifying variables, and collecting and analyzing data.
- S2** Interpreting graphs to describe the relationships among position, velocity, and acceleration.
- S3** Conducting simple experiments that show and explain how forces work to change the motion of an object.
- S4** Using mathematical equations to solve force and motion problems.
- S5** Planning and conducting an experiment to investigate the effects of mass, surface texture and pressure on the amount of friction between objects.
- S6** Applying their understanding of Physics to create a functional roller coaster.
- S7** Developing and using models to explain how changes in object arrangement affect stored potential energy.