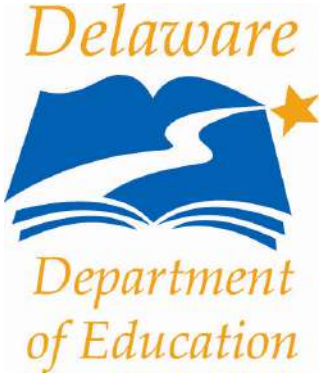
# Delaware Science Coalition


# Grade 5 Motion and Design Unit Template

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*Preface: This unit has been created as a model for teachers in their designing or redesigning of course curricula. It is by no means intended to be inclusive; rather it is meant to be a springboard for teacher thought and creativity. The information we have included represents one possibility for developing a unit based on the Delaware content standards and the Understanding by Design framework and philosophy.*

**Brief Summary of Unit**

**This unit allows students the opportunity to explore the physics of motion and to apply concepts to technological design. Using K'NEX, students design a simple car and investigate how the car moves when pulled by a drop weight system, when carrying a load of a given mass, and when propelled by a rubber band. Next, students investigate friction and car design and how each affects motion. Tire tread and a sail (air resistance) are investigated as design features. Motion of the vehicle when driven by a propeller system is examined. Lastly using engineering problem solving, students engage in ways to meet design specifications.**

## Stage 1: Desired Results
### Delaware Science Content Standards

**Delaware Science Content Standards**

**This course focuses on the Delaware Science Content Standards and Grade Level Expectations in Standards 1 and 3 found on the following web site: http://www.doe.k12.de.us/programs/ci/content_areas/science.shtml**

**Standard 1: The Nature and Application of Science and Technology**

Understandings and Abilities of Scientific Inquiry

Students should know and be able to:

1. Understand that: Scientific investigations involve asking a focused scientific question. Investigations differ depending upon the question being asked.
    - Be able to: Generate focused questions and informed predictions about the natural world.
2. Understand that: Fair test design supports the validity of the investigation. Sometimes it is not possible to know everything that will have an effect on the investigation or control all conditions.
    - Be able to: Design and conduct simple to multi-step investigations in order to test predictions. Keep constant all but the condition being tested.
3. Understand that: The purpose of accurate data collection is to provide evidence to compare with the prediction.
    - Be able to: Accurately collect data using observations, simple tools and equipment. Display and organize data in tables, charts, diagrams, and bar graphs or plots over time. Compare and question results with and from others.

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4. Understand that: The body of scientific knowledge grows as scientists ask questions, conduct investigations, develop explanations and compare results with what is already known.
    - Be able to: Construct a reasonable explanation by analyzing evidence from the data. Revise the explanation after comparing results with other sources or after further investigation.
5. Understand that: The purpose of communicating is to share and justify results. Scientists communicate their results to others, including the details that allow others to replicate the results.
    - Be able to: Communicate procedures, data, and explanations to a variety of audiences. Justify the results by using evidence to form an argument.
6. Understand that: The use of mathematics, reading, writing, and technology are important in conducting scientific inquiries.
    - Be able to: Use mathematics, reading, writing, and technology when conducting scientific inquiries.

Science, Technology, and Society
Students should know that:

1. Science and technology are related. Technology provides the tools needed for science to investigate questions and may provide solutions to society's problems, wants, or needs. Not all technological solutions are effective, uniformly beneficial, or equally available to everyone.

**Standard 3: Energy and Its Effects**
Forms and Sources of Energy
Students should know that:

2. The energy of a moving object depends on its speed. Faster moving objects have more energy than slower moving objects.

Students should be able to:

- Identify that the energy of a moving object depends upon its speed. Give examples of how an object's energy of motion increases when the object's speed increases.

Students should know that:

3. Energy can be stored in an elastic material when it is stretched.

Students should be able to:

- Describe how energy can be stored in an elastic object or material by stretching it. Use diagrams to describe ways that the energy stored in a stretched object can be used to make objects move.

Forces and the Transfer of Energy
Students should know that:

1. Force is any push or pull exerted by one object on another. Some forces (e.g., magnetic forces and gravity) can make things move without touching them.

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Students should be able to:

- Demonstrate and explain how forces of different sizes and directions can produce different kinds of changes in the motion of an object.

Students should know that:

2. The speeds of two or more objects can be compared (i.e., faster, slower) by measuring the distance traveled in a given unit of time, or by measuring the time needed to travel a fixed distance.

Students should be able to:

- Use rulers, meter sticks, tapes, and watches to measure the distance objects travel in a given period of time, and how much time it takes for an object to travel a certain distance. Organize the measurements in tables, and construct graphs based on the measurements. Reach qualitative conclusions about the speeds of the objects (faster versus slower).

Students should know that:

3. A force must be applied to change the speed of a moving object or change its direction of motion. Larger forces will create greater changes in an object's speed in a given unit of time.

Students should know that:

4. Pushing and pulling forces can be used to transfer energy from one object to another.

**Big Ideas**

- **Observe** an object's movement and describe the **changes** in motion.
- Construct **models** to observe **patterns** of motion.
- Conduct **investigations** to recognize that force can change the speed of an object.
- Energy may be stored in **materials** with elastic **properties.**
- **Interactions** of materials affect the motion of an object.
- Design investigations that modify a **control** to meet specific **conditions**.

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**Unit Enduring Understandings**

Students will understand that…

- Moving objects have energy. Faster moving objects have more energy than slower moving objects.
- Energy can be stored in a twisted rubber band. This energy can make things move.
- Changes in the motion of an object can be produced by different sized forces.
- Changes in the motion of an object can be produced by forces from different directions.
- Speed is the amount of distance traveled over a certain amount of time.
- Speeds of objects can be compared (faster, slower) through knowing the distance and time.

**Unit Essential Question(s)**

- What happens to the energy in a system — where does this energy come from, how is it changed within the system, and where does it ultimately go? How does the flow of energy affect the materials in the system?
- How do we know that things have energy?
- How can energy be transferred from one material to another? What happens to a material when energy is transferred to it?

**Knowledge & Skills**

**Students will know:**

- **Technical drawings ensure close similarity among the finished products.**
- **Technical drawings can be used to convey a particular design to others.**
- **A pulling force may cause a vehicle to move in the direction of the pull.**
- **In a drop-weight system that pulls a car, an increase in the pulling force increases the car speed.**
- **A force must be applied to change the motion of a vehicle. In a drop-weight system, the force that stops the vehicle's motion is the force of the bookend.**
- **Mass is the amount of material in an object whereas weight is the force of gravity acting on the mass.**
- **The load on a vehicle is a force that acts in a downward direction (when placed on the vehicle).**
- **In a drop-weight system, the load acts to slow the motion of the vehicle.**
- **A twisted rubber band stores energy that can be used to move a vehicle. The greater the stored energy, the greater the potential motion of the vehicle.**
- **Scientists conduct multiple trials to ensure that the results are not flawed.**
- **Understand that friction can both aid and slow the motion of a vehicle.**

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- **Air resistance slows a vehicle's movement.**
- **A propeller creates a force that changes the motion of a vehicle. The energy to turn the propeller comes from the stored elastic energy of a rubber band.**

**Students will be able to:**

- **Draw (top view and side view) and label the parts of the vehicle.**
- **Build a vehicle following a technical drawing.**
- **Compare own drawings to technical drawings.**
- **Use a drop-weight system to pull a vehicle.**
- **Compare the motion of the vehicle with the amount of mass added to the drop-weight system.**
- **Follow simple steps in an investigation.**
- **Record observations and collect data.**
- **Use data to draw conclusions.**
- **Predict how load (mass) will affect motion.**
- **Investigate the effects of load on motion.**
- **Accurately measure time in seconds and distance in centimeters.**
- **Given a problem, design, plan, and implement a solution.**
- **Investigate the motion of cars when powered by rubber band energy.**
- **Conduct multiple trials of each investigation.**
- **Investigate ways to increase or decrease the friction on a vehicle and describe the resulting motion.**
- **Investigate how a propeller changes the motion of a vehicle.**

## Stage 2: Assessment Evidence
**(Design Assessments To Guide Instruction)**

**Suggested Performance Task(s)**

**This Motion and Design unit is assessed through the use of an end-of-unit summative assessment. This assessment is intended to uncover student misconceptions which will then direct instruction. Both the student guide and teacher directions and rubrics are included. To access the end-of-unit summative assessment, go to the website listed below. Click on the Delaware Science**

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**Comprehensive Assessment Program.**

http://www.doe.k12.de.us/programs/ci/content_areas/science.shtml

**Key Transfer Ideas:**

1. Unbalanced forces initiate and influence movement.
2. Data can be used to describe the effects of forces on the movement of a vehicle.
3. Data sets can be analyzed to determine which set best meets given requirements.
4. The greater the amount of force, the greater the change in motion (i.e., the vehicle travels a greater distance in a certain amount of time).
5. Air resistance acts to slow the movement of a vehicle.

Student Expectations:

- Identify the stored energy in a twisted rubber band as the source of energy that can cause a vehicle to move.
- Explain how the motion of a vehicle is affected by more twists of the rubber band (greater stored elastic energy) or increased load (downward acting force).
- Interpret data and determine which data set best meets the established criteria.

**Other Evidence**

Student worksheets are completed throughout the unit and may be used as formative assessment.

**Student Self-Assessment and Reflection**

This unit contains a student self assessment that is intended to uncover understanding of concepts as well as attitudes and feelings towards the investigations.

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## Stage 3: Learning Plan
**(Design Learning Activities To Align with Goals and Assessments)**

**Key learning events needed to achieve unit goals**

**The National Science Resource Center. *STC: Motion and Design.* Washing ton D.C. 2002.**

**Lesson 1: Students record and share their ideas and questions about Motion and Design. Students design and build a vehicle to meet requirements given.**

**Lesson 2: Students draw a record of their vehicle from Lesson 1. Students build a vehicle by following a 2 view technical drawing. Students compare their record with the technical drawing.**

**Lesson 3: Students set up a system to pull their vehicles and compare and discuss how the motion of their vehicle changes when more or less weight on a string is used to pull them.**

**Lesson 4: Students add blocks to their vehicles to investigate the effects of a load on motion.**

**Lesson 5: Students design vehicles and systems to pull the vehicles to meet requirements and apply previously collected data to design their system. Students read about the Lunar Rover.**

**Lesson 6: Students try to move their vehicle using rubber band energy. Students then evaluate the design of the vehicle and discuss the results of their evaluations.**

**Lesson 7: Students predict and investigate how variations in rubber band energy affect the distance their vehicles travel and record the results and discuss the patterns.**

**Lesson 8: Students discuss what they know about friction and evaluate design features that reduce or increase friction on vehicles propelled by a rubber band. Students then share what they observed and the role of friction in their vehicles' motion.**

**Lesson 9: Students adapt their vehicles to hold a cardboard sail and make observations about how the sail would influence the vehicle's motion and discuss these observations.**

**Lesson 10: Students test how air resistance influences a vehicle's motion and discuss and compare results. Students also discuss**

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**real world objects designed to minimize air resistance and read about a woman who drag races.**

**Lesson 11: Students discuss design features about propeller-driven vehicles and build one from a technical drawing and discuss the observations.**

**Lesson 12: Students will discuss the motion and design of their propeller-driven vehicles and compare these features and then design changes for their propeller-driven vehicles that will not affect performance.**

**Lesson 13: Students determine the cost of their propeller-driven vehicles and modify their vehicles to reduce costs. Students also discuss trade-offs involving cost, performance and appearance.**

**Lesson 14: Students plan a final design challenge and present their plans to the class.**

**Resources & Teaching Tips**

- **What text/print/media/kit/web resources best support this unit?**
  - **Force and Motion by Newbridge Publishing**
  - **United Streaming.com**
  - **Fossweb.com**
  - **Field Trip to Dover Air Force Base Museum**
- **What tips to teachers of the unit can you offer about likely rough spots/student misunderstandings and performance weaknesses, and how to troubleshoot those issues?**

**Accommodation/Differentiation ideas and tips**

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