WHAT MAKES A CLOCK TICK:

Pendulums

Guide for Parents and Educators

What happens when you make a change to a pendulum?

Length of the pendulum impacts the swing of a pendulum. Students will apply findings to a pendulum they are most familiar with – the swings on their playground or at their local park.

The goal of this lesson is not for students to explain how the pendulum works but to observe the pendulums and use evidence (observation and measurement) to report their results. Students will begin to develop an understanding of the big idea: sometimes changes to a system impact how the entire system works, but not all changes impact how a system works. This activity models for students how to systematically manage changing variables for experiments. Stations will be set up to allow students to change a variable and observe and record what happens.

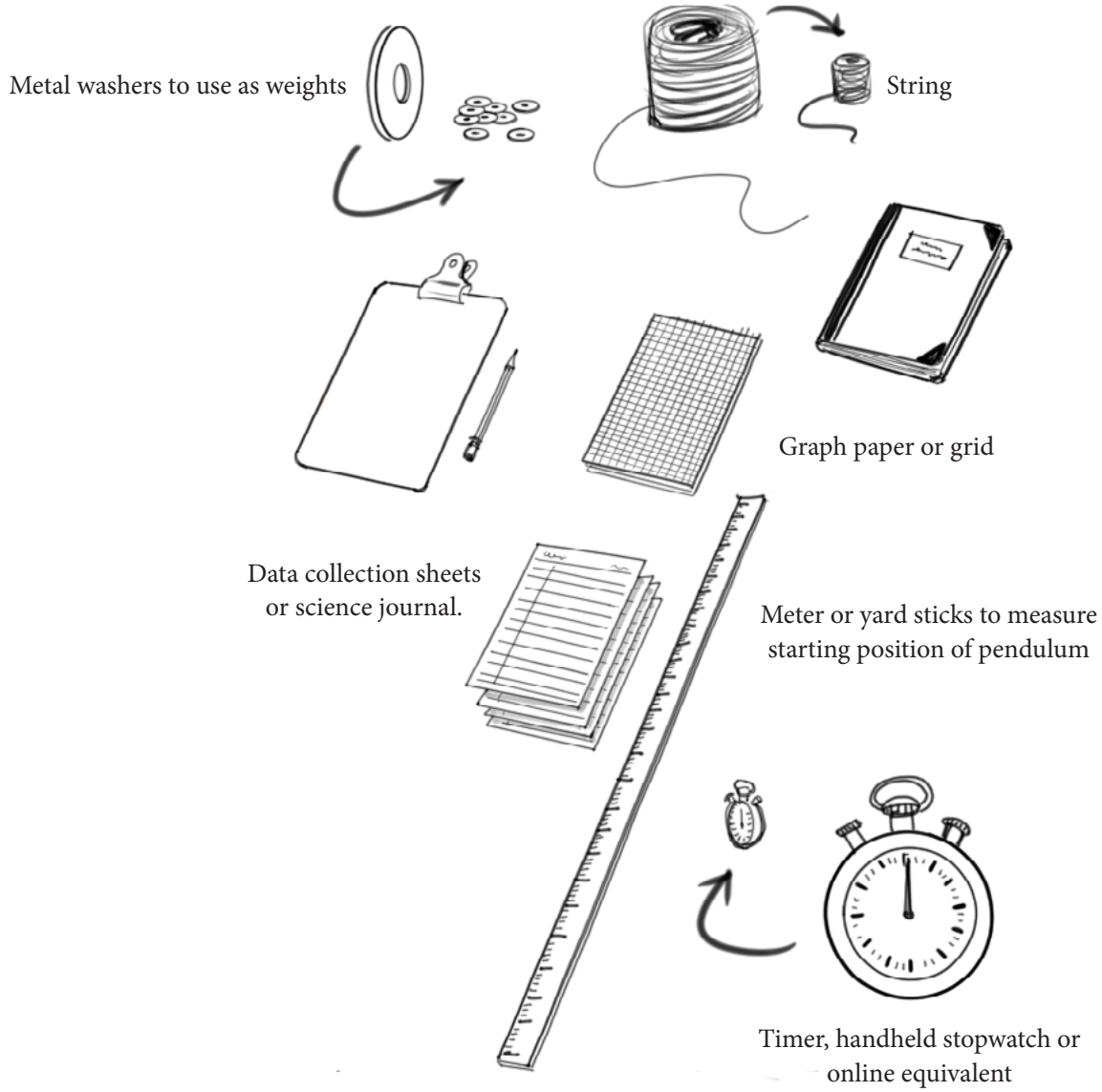
A writing component in this lesson is optional. You may wish to have students make notes and record observations in their science journals.

Objectives

Students will;

- recognize that when a change is made to a system by adding weight or changing length, the patterns observed may also change.
- identify variables and systematic change in the experimental process.
- apply appropriate observation and note-taking skills.
- use data collected to explain results.
- use results to make and support a plausible recommendation for playground swings.

Materials and Resources



Standards For Science Content

National Math Science Initiative (NMSI) Science lessons will be aligned with the next generation of multi-state science standards that are currently in development. These standards are being developed around the anchor documents, A Framework for K-12 Science Education, which was produced by the National Research Council. Where applicable, the NMSI science lessons are also aligned to the Common Core Standards for Mathematical Content as well as the Common Core Literacy Standards for Science and Technical Subjects.

Targeted Standards

NEXT GENERATION SCIENCE STANDARDS

4-PS3-a Construct an argument using evidence about the relationship between the change in motion and the change in energy of an object. [Assessment Boundary: No attempt is made to give a precise or quantitative definition of energy. Students should not be assessed on quantitative measures of change.]

Reinforced/Applied Standards Common Core State Standards

W.4.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

W.4.2a Introduce a topic clearly and group related information in paragraphs and sections; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension.

W.4.2b Develop the topic with facts, definitions, concrete details, quotations, or other information and examples related to the topic.

W.4.2c Link ideas within categories of information using words and phrases (e.g., another, for example, also, because).

W.4.2d Use precise language and domain-specific vocabulary to inform about or explain the topic.

W.4.2e Provide a concluding statement or section related to the information or explanation presented.

4.MD.2 Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.

Scientific Practices

The Next Generation Science Standards (NGSS) are designed to engage students in Scientific and Engineering Practices by using Crosscutting Concepts to deepen the students' understanding of Disciplinary Core Ideas. NMSI has developed icons to provide a visual reference for teachers to denote which dimensions students will explore during a given lesson.

NMSI Content Progression Chart

In the spirit of NMSI's goal to connect mathematics across grade levels, the Content Progression Chart demonstrates how specific skills build and develop from third grade through fifth grade. Each column under a grade level lists the concepts and skills that students in that grade should master. Each row illustrates how a specific skill is developed as students advance through their mathematics standards.

3rd Grade Skills/Objectives	4th Grade Skills/Objectives	5th Grade Skills/Objectives
3.MD.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l). Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.	**4.MD.2** Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals, and problems that require expressing measurements given in a larger unit in terms of a smaller unit. Represent measurement quantities using diagrams such as number line diagrams that feature a measurement scale.	**5.MD.1** Convert among different- sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems.

Resources

- Create your own graph paper (http://incompetech.com/graphpaper/plain/)
- Online Stopwatch can be used to count the periods for 30 seconds (http://www.online-stopwatch.com/large-stopwatch/)
- Interactive Pendulum Lab (http://phet.colorado.edu/en/simulation/pendulum-lab)
- Discovery Education – This site has a vast amount of student centered videos by grade level, subject, topic or standard. (https://www.discoveryeducation.com/)
- Britannica for Kids – This site has a wealth of information and interactive activities by grade level, standard and topic. https://kids.britannica.com
- PBS Kids Pendulum Games and Factoids (https://mass.pbslearningmedia.org/resource/phy03.sci.phys.mfw.zpendulum/experimenting-with-a-pendulum/)

Background Information

A pendulum is any object that hangs from a fixed point and is allowed to swing freely. The swing down of the object is caused by the pull of gravity. The swing up of the object is inertia, the tendency of an object to stay in motion. Students experience pendulums in the form of swings on the playground. They may be less familiar with pendulums on clocks. Because the swing of a pendulum is predictable, pendulums have been used to keep time. Students may enjoy learning about the old-fashioned clocks that use pendulums.

The parts of the pendulum: string and bob may be referred to as a system where the parts work together interacting as one complete whole. The bob is the weight (mass) found at the end of the string.

Students at this age find it difficult to distinguish between mass and weight. Weight will be used throughout the lesson. From the Next Generation Science Standards for grade 5 ("Boundary: At this grade level, mass and weight are not distinguished…"), teachers are given the option of using a meter stick or yard stick. While science measurements are often done using the metric system, students at this age would benefit from using the yard stick to become comfortable with tools that measure in fractional units.

Period is a common term used to describe a full swing of the pendulum. This is the movement of the pendulum from the start position to the other side and back again.

The frequency of a pendulum is the number of full swings or periods in a specific length of time. Students will be counting the periods, full swings, in 30 seconds and recording those results.

Students will vary string length to see if changing the length of the string will affect the number of periods in 30 seconds. Longer pendulums have a lower frequency than shorter pendulums. On the playground you may have observed students shortening the chains on the swing by winding them over the top bar of the swing set. Now students will be able to use scientific evidence in the form of measured data to explain why shorter swings are more fun.

If time permits, allow students to change other variables. These could include changing the weight of the bob. Changing the weight of the bob should make no change to the frequency of the pendulum. Challenge students to apply the data from their experiments to the swings on the playground.

Additional Test Suggestions

Invite students to compare how swings would work with weight changes to the pendulum bob.

Repeat the process used in the initial investigation.

Invite students to compare the number of swings when they swing higher. In this exploration students will start the pendulum from different heights finding out if swinging higher means swinging faster.

Repeat the process used in the initial investigation.

References

A Framework for K-12 Science Education

National Research Council. (2012). A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. (pp. 45, 103-138). Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.