

**ELEMENTARY SCHOOL**

**Sustainable Science**

**Properties of Adhesives:**

**A Sticky Situation**

**Teacher Background and Overview:**

Adhesives are products that are used to bond materials together. Glues and other adhesives are an important part of holding our world together, from construction materials to electronics. However, many of the strongest traditional glues that are used have properties that make them harmful to human health and the environment. Because of this, manufacturers of adhesives have recently become very concerned with aligning their glues to the 12 Principles of Green Chemistry, with some looking to nature for new ideas. Green chemistry provides a set of principles and practices for the intentional design of safer, better performing, and more cost-effective products and processes. In 2007, Columbia Forest Products won the Presidential Award for Green Chemistry for creating an environmentally friendly wood glue that was inspired by the chemistry that allows blue mussels to stick to rocks. By using green chemistry to create new technologies, manufacturers are making exciting new products that are safer and work just as well as—or better than—existing materials!

This unit investigates the properties of adhesives—from strength to environmental impact—through the lenses of green chemistry and biomimicry (the art of taking inspiration from nature in the design of new technologies). Together, these two fields support development of sustainable technologies to help meet the needs of the current population without impacting our ability to provide for the next generation. Throughout the unit, students will explore how nature can provide ideas to scientists and engineers, consider the properties of adhesives, and make their own “greener” glues.

**Additional Resources:**

Adhesives and “Green”: Seeing the Forest Through the Trees. CP Adhesives. <http://www.cpadhesives.com/green-adhesives>

Green Yet Effective: Making Adhesives Strong and Friendly. <http://www.floorbiz.com/BizNews/NPViewArticle.asp?cmd=view&articleid=5167>

**Prerequisite:** Knowledge of mixtures and chemical reactions.

**Lesson Summaries:**

*Lesson 1*

Time Required: 30 minutes

This lesson introduces students to biomimicry, first by decoding and defining the word, then by an interactive matching game that challenges students to think like scientists and engineers when considering different aspects of the natural world.

*Lesson 2*

Time Required: 2x 30-minute class periods + optional 15-minute pre-reading in or out of class

In this lesson, students will evaluate different kinds of tape using the green chemistry criteria. Students will learn about properties of adhesives from a short background reading and the mechanical properties of various tapes using spring scales to measure force. To conclude, students will use the data they have gathered, alongside information on cost and starting materials of each tape, to determine which tape they would recommend.

*Lesson 3*

Time Required: 60 minutes + optional 30-minute pre-reading during ELA time

In this lesson, students will make two different glues using household materials that undergo a chemical reaction when mixed. They will then compare the two glues using the same green chemistry criteria that they used in Lesson 2. This lesson is designed to reinforce their ability to differentiate between mixtures and chemical reactions. Note that Lesson 3 takes longer because of the nature of the experiment and the strong demonstration of concepts.

*Lesson 4*

Time Required: Multi-day project (approx. 5x 30-minute periods) + 45–75 minutes for presentations

This lesson wraps up the unit by having students create an advertisement for their homemade glue. Students will work in groups and present their projects to the class.

**Standards:**

***NGSS***

**5-ESS3-1**Obtain and combine information about ways individual communities use science ideas to protect the Earth’s resources and environment.*Lesson 1,**Lesson 3, Lesson 4*

**5-PS1-3** Make observations and measurements to identify materials based on their properties. *Lesson 2, Lesson 3*

**5-PS1-4** Conduct an investigation to determine whether the mixing of two or more substances results in new substances. *Lesson 3*

**3-5-ETS1-1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. *Lesson 2, Lesson 3, Lesson 4*

**3-5-ETS1-2** Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. *Lesson 3*

***Massachusetts Standards***

*STE*

**5-ESS3-1** Obtain and combine information about ways communities reduce human impact on the Earth’s resources and environment by changing an agricultural, industrial, or community practice or process. *Lesson 1*

**5-PS1-3** Make observations and measurements of substances to describe characteristic

properties of each, including color,hardness, reflectivity, electrical conductivity, thermal conductivity, response to magnetic forces, and solubility**.** *Lesson 2, Lesson 3*

**5-PS1-4** Conduct an experiment to determine whether the mixing of two or more substances results in new substances with new properties (a chemical reaction) or not (a mixture). *Lesson 3*

**5.3-5-ETS3-1(MA)** Use informational text to provide examples of improvements to existing technologies (innovations) and the development of new technologies (inventions). Recognize that technology is any modification of the natural or designed world done to fulfill human needs or wants. *Lesson 1, Lesson 4*

**5.3-5-ETS1-1** Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution. Include potential impacts on people and the natural environment that may limit possible solutions. *Lesson 4*

**5-ESS3-1** Obtain and combine information about ways communities reduce human impact on the Earth’s resources and environment by changing an agricultural, industrial, or community practice or process. *Lesson 3, Lesson 4*

**5-PS1-2** Measure and graph the weights (masses) of substances before and after a reaction or phase change to provide evidence that regardless of the type of change that occurs when heating, cooling, or combining substances, the total weight (mass) of matter is conserved. *Optional – Lesson 3 extension*

*ELA & Literacy*

**RSIT.5.2** Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text. *Lesson 4*

**RSIT.5.3** Explain the relationships or interactions of two or more individuals, events, ideas, or concepts in a historical, scientific, or technical text based on specific information in the text. *Lesson 1, Lesson 4*

**RSFS.5.3** Know and apply grade-level phonics and word analysis skills in decoding words. *Lesson 1*

**WS.5.1** Write opinion pieces on topics or texts, supporting a point of view with reasons and information.*Lesson 3*

**WS.5.2** Write informative/explanatory texts to examine a topic and convey ideas and information clearly.*Lesson 2, Lesson 3, Lesson 4*

**SL.5.1** Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 5 topics and texts, building on others’ ideas and expressing their own clearly. *Lesson 1, Lesson 3*

**SL.5.4** Report on a topic or text or present an opinion, sequencing ideas logically and using appropriate facts and relevant, descriptive details to support main ideas or themes; speak clearly at an understandable pace. *Lesson 4*

**SL.5.5** Include multimedia components (e.g., graphics, sound) and visual displays in presentations when appropriate to enhance the development of main ideas or themes. *Lesson 4*

*Math*

**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. *Lesson 2*

**5.NBT.5** Fluently multiply multi-digit whole numbers using the standard algorithm. *Lesson 2*

**5.NBT.7** Add, subtract, multiply, and divide decimals to hundredths, using concrete models or

drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used. *Lesson 2*