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| **Lesson Title : Surviving a School Shooting** | **Unit #: 1** | **Lesson #: 2** | **Activity #: 3** |
| **Activity Title: Nanotechnology-Folding, Rolling, and Stacking** |

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| **Estimated Lesson Duration:** | **4-5 Class Periods (60 to 70 min each)** |
| **Estimated Activity Duration:** | **1 night of HW before 1 Class Period (60 to 70 min)** |

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| **Setting:** | **Classroom** |

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| **Activity Objectives:**   1. **Students will test how different arrangements of paper (representing carbon nanostructures) result in materials with different strengths by folding, rolling, and stacking origami paper.** 2. **Students will determine which arrangement is the strongest based on confidence intervals.** |

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| **Activity Guiding Questions:**   1. **What is nanotechnology?** 2. **How can we simulate nanotechnology on a larger scale?** 3. **What are the benefits of nanotechnology?** 4. **Can nanotechnology provide lighter and cheaper materials for use in our bullet-proof vest?** 5. **What materials can be used to simulate nanotechnology?** 6. **How can we arrange the materials to determine their strength?** 7. **Is one arrangement stronger than another? How much stronger?** |

| **Next Generation Science Standards (NGSS)** | |
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| **Science and Engineering Practices (Check all that apply)** | **Crosscutting Concepts (Check all that apply)** |
| Asking questions (for science) and defining problems (for engineering) | Patterns |
| Developing and using models | Cause and effect |
| Planning and carrying out investigations | Scale, proportion, and quantity |
| Analyzing and interpreting data | Systems and system models |
| Using mathematics and computational thinking | Energy and matter: Flows, cycles, and conservation |
| Constructing explanations (for science) and designing solutions (for engineering) | Structure and function. |
| Engaging in argument from evidence | Stability and change. |
| Obtaining, evaluating, and communicating information |  |

| **Ohio’s New Learning Standards for Science (ONLS)** |
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| **Expectations for Learning - Cognitive Demands (Check all that apply)** |
| Designing Technological/Engineering Solutions Using Science concepts **(T)** |
| Demonstrating Science Knowledge **(D)** |
| Interpreting and Communicating Science Concepts **(C)** |
| Recalling Accurate Science **(R)** |

| **Common Core State Standards -- Mathematics (CCSS)** | |
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| **Standards for Mathematical Practice (Check all that apply)** | |
| Make sense of problems and persevere in solving them | Useappropriate tools strategically |
| Reason abstractly and quantitatively | Attendto precision |
| Construct viable arguments and critique the reasoning of others | Look for and make use of structure |
| Model with mathematics | Look for and express regularity in repeated reasoning |

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| **Unit Academic Standards (NGSS, ONLS and/or CCSS):**   * CCSS.Math.Content.HSS-IC.A.1 Understand statistics as a process for making inferences about population parameters based on a random sample from that population. * CCSS.Math.Content.HSS-IC.A.2 Decide if a specified model is consistent with results from a given data-generating process, e.g., using simulation. |

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies)   * 1. **This activity was originally created and posted at this site:**   **http://www.sciencebuddies.org/science-fair-projects/project\_ideas/MatlSci\_p042.shtml#summary**   * 1. **See handout for HW. Site to go with handout:** [**http://www.sciencebuddies.org/science-fair-projects/project\_ideas/MatlSci\_p042.shtml#background**](http://www.sciencebuddies.org/science-fair-projects/project_ideas/MatlSci_p042.shtml#background)   2. **See handouts for class activity.**   3. **Supplies: Plastic Disposable Cup, 1-hole Puncher, Curling ribbon (24 in long), Scissors, Origami Paper (7x7 in square or larger, 60 sheets per group), Tape, Chair or Table with Right-Angle Edges, Pennies (250), Optional: Kitchen Scale** |

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| **Teacher Advance Preparation:**  Before the activity begins, the teacher should anticipate the Guiding Questions that students will brainstorm.  **For a more detailed explanation of advance preparation go here:**  **http://www.sciencebuddies.org/science-fair-projects/project\_ideas/MatlSci\_p042.shtml#procedure**   1. Prepare the cups to hold the pennies. 2. Prepare an origami cube for each group (you could have your groups make the cubes, but it could take a lot of class time; or you could have them make the cubes during the previous class period). <http://www.origami-instructions.com/easy-origami-cube.html> 3. Prepare a bag of 250 to 300 pennies for each group. |

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| **Activity Procedures:**   1. Assign HW the night before the day of the activity. See attachment.   Day of the Activity:   1. Guide a short discussion about nanotechnology. Use the questions on the HW attachment. 2. Hand out the Activity sheet. See Attachment. 3. Using the activity sheet: See Attachment 4. Introduce the objective of the activity. 5. Students will brainstorm Guiding Questions to achieve the objective of the activity. 6. Reveal the configurations the groups will use for their experiment along with the type of materials they will use. 7. Students will then work through the experiment to determine which configuration is strongest. 8. Lead a final class discussion about each groups conclusions. |

**Formative Assessments:**

As students are working, ask them the following questions as a formative assessment:

1. Which configuration do you believe will be the strongest? (Before they start testing.)
2. Have any of the results been surprising to you? Explain why?
3. How do you think these configurations will translate to our bullet-proof vest?
4. Do you feel the origami paper is a good way to represent materials that could be used in our bullet-proof vest?
5. What materials are your considering for your bullet-proof vest and how do they relate to your conclusions for this experiment?

**Summative Assessments:**

The summative assessment for this activity will be a 1 page (typed) report that explains the conclusions found by each group. See attachment for questions that should be answered by the report.

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| **Differentiation:**  For students that are not meeting the level set by the standard, I would differentiate by having an extra helper to guide them through the activity. This helper could be a support educator or an advanced student from NHS.  For students that have shown mastery of the standard and are ready to extend beyond this activity, I would recommend that they develop alternate configurations that could be tested (the use of tape or glue, different paper, paper thickness, different materials, new configurations or shapes, etc.) |

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| **Reflection:**  This activity turned out to be the best of the entire Unit. The application of nanotechnology and simulating strength of the statistical application of creating confidence intervals was very effective. Students were able to take their understanding of the math to a higher level and at the same time learn about an exciting and advancing science of nanotechnology.  This is definitely a two day activity. One day to make the origami structures and another to collect the data. |