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| **Lesson Title : Surviving a School Shooting** | **Unit #: 1** | **Lesson #: 2** | **Activity #: 4** |
| **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:** | **2 Class Periods (60 to 70 min)** |

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

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| **Activity Objectives:**   1. **Students will test different Non-Newtonian fluids to determine which is best at stopping a projectile.** 2. **Students will determine which Non-Newtonian fluid is the strongest based on hypothesis tests.** |

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| **Activity Guiding Questions:**   1. **What are Non-Newtonian fluids?** 2. **What Non-Newtonian fluids could we make in the classroom?** 3. **What materials are need to make particular Non-Newtonian fluids?** 4. **Which NN fluids could be used for our bullet-proof vest?** 5. **How will the NN fluids be contained in our bullet-proof vest?** 6. **How can we measure the strength of each NN fluid?** 7. **How strong does the NN fluid need to be in order to stop a projectile?** 8. **What is the speed of a bullet at impact?** 9. **How will we simulate a bullet at impact?** |

| **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. **Videos used as an introduction:**   [**http://youtu.be/D-wxnID2q4A**](http://youtu.be/D-wxnID2q4A)  [**http://youtu.be/G1Op\_1yG6lQ**](http://youtu.be/G1Op_1yG6lQ)  [**http://youtu.be/bLiNHqwgWaQ**](http://youtu.be/bLiNHqwgWaQ)   * 1. **See handouts for class activity.**   2. **Supplies: Non-Newtonian Fluids (Glurch, Bulk Silly Putty, Gummy Bear Mix, Ooblek, Food Coloring Optional), Screwdriver, Powerful Earth Magnets, Drinking Straws, Small Projectiles of some kind.** |

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| **Teacher Advance Preparation:**  Before the activity day:  The teacher should anticipate the types of data that students will/can collect for each of the experiments in order to provide guidance when the groups “get stuck”.  **For a more detailed explanation of advance preparation go here:**   1. The teacher will need to prepare the NN fluids before the activity day.   Making Oobleck - <http://www.livescience.com/21536-oobleck-recipe.html>  Making Glurch - <http://toysinthedryer.com/glurch-or-slime/>  Silly Putty - <http://www.crayolastore.com/category/sillyputty/sillyputty-reg-bulk>  Gummy Bear Mix - <http://www.food.com/recipe/gummy-bears-15145> |

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| **Activity Procedures:**   1. Optional: A day or two before the “day of experiments”, it would be very cool to create a large amount of Oobleck and put it in a large tub of some sort. Then let the students run across the fluid to show that they won’t sink. 2. If you cannot do #1 above, then show the students a video that demonstrates the properties of Oobleck.   [**http://youtu.be/D-wxnID2q4A**](http://youtu.be/D-wxnID2q4A)  [**http://youtu.be/G1Op\_1yG6lQ**](http://youtu.be/G1Op_1yG6lQ)  [**http://youtu.be/bLiNHqwgWaQ**](http://youtu.be/bLiNHqwgWaQ)   1. Pass out the Activity 4 Student Handout: The Final Four – A Tournament of Non-Newtonian Fluids   Note: You may want to pass this out the day before you start the testing or the day you show the videos above. This will give the students the opportunity to brainstorm what type of data they will collect during the experiments. If you decide to do this, you could also introduce the students to the types of NN fluids they will be experimenting with.   1. Provide each team with an appropriate amount of each NN fluid for their experiments. 2. Turn the students loose on their experiments. Let them know that they do not have to go in the order on the handout, but I would suggest that they save Experiment #5 for last and maybe even give a full day for just Experiment #5. 3. The Challenge: Finally students will make their bullet proof vests using all the data they collected from the activities.   Instructions:   1. Your “vest” should be no smaller than a 5” x 5” square, nor larger than a 10” x 10” square. 2. Your vest must not be thicker than 2 inches.   Note: Depending on how you pace this activity, it could take between 2 and 4 class periods. |

**Formative Assessments:**

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

1. What type of data are you collecting for each experiment? Why? Were there any types of data you thought about collecting, but decided against? Why?
2. For each experiment, ask students, “Who is your winner? How did you come to that decision?”
3. For each experiment, ask students, “How do you think this relates back to our challenge?”

**Summative Assessments:**

There will be two summative assessments for this activity:

1. The “Final Conclusions” page of the handout will be graded. Were the teams conclusions valid and did the team support their conclusions with statistics?
2. An additional assessment will be handed out that asks each student to create a confidence interval of their choice (proportions or means) based on any set of data they collected during the activity.

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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 use an additional NN fluid for their experiments or they could create an additional experiment of their choice. |

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| **Reflection:**  This was a great activity but one that takes a lot of planning on the teachers part.  The “hook” of having a big tub of oobleck to run on was a success. The students are amazed by the properties of the oobleck and love playing/experimenting with it. Each of the experiments in the activity were good, but if there was one I would replace, it would be the “sitting ball” test. There really wasn’t much to observe for that experiment.  The creativity of the students shined in this activity as they combined the materials for their custom experiment. I heard students say things like, “this is so cool”, “I was surprised by that”, “this is the best activity I’ve ever had in a math class”, and “I can’t believe what this is capable of”. The application of Non-Newtonian fluids to stop a projectile enhanced student interest. And we all know that the more interested you are in something, the more invested you become.  The final bullet-proof materials and creations were very creative with some more effective than others.  Finally, the nail gun proved to be a pretty good “test” of the bullet-proof creations, but I think a projectile with more power would make this activity better. |