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| **Fellow Name:** James Fiorini | **Contact Info:** fiorinjs@mail.uc.edu | **Date:** 11.16.16 |
| **Teacher Name:** John D’Alessandro | **School Name:** St. Xavier HS | **Grade and Class:** Seniors |

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| **Activity Title:** | Toy Cars and Collisions |
| **Estimated Activity Duration:** | 1 day |

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| **Setting:** | Classroom |

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| **Activity Objectives:** |

The student will be able to:

1. Identify inelastic and elastic collisions
2. Recognize the difference between collision types
3. Solve practical problems using:
   1. P = mv
   2. Law of conservation of momentum
      1. 1d, 2 particles

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| **Activity Guiding Questions:** |

1. What is a collision? What are the characteristics of a collision?
2. What real-world purpose does this serve?
3. How can I identify different types of collisions?
4. How can I change one collision to another?
5. What are the pros and cons to different collisions?

| **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):** |

St. Xavier High School Outcomes for Physics

Ohio Department of Education New Learning Standards, Science Standards, pg. 337:

“• Conservation of Energy The total initial energy of the system and the energy entering the system are equal to the total final energy of the system and the energy leaving the system. Although the various forms of energy appear very different, each can be measured in a way that makes it possible to keep track of how much of one form is converted into another. Situations involving energy transformations can be represented with verbal or written descriptions, energy diagrams and mathematical equations. Translations can be made between these representations. The conservation of energy principle applies to any defined system and time interval within a situation or event in which there are no nuclear changes that involve mass-energy equivalency. The system and time interval may be defined to focus on one particular aspect of the event. The defined system and time interval may then be changed to obtain information about different aspects of the same event.”

<http://education.ohio.gov/getattachment/Topics/Ohios-Learning-Standards/Science/ScienceStandards.pdf.aspx>

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| **Materials**: (Link Handouts, Power Points, Resources, Websites, Supplies) |

* Photogate (2x)
* Scale
* Hotwheels car (2x)
* Hotwheels track
* Small magnets (many)
* Tape
* Fishing weights (many)
* printout of assignment (100)

<https://phet.colorado.edu/sims/collision-lab/collision-lab_en.html>

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| **Teacher Advance Preparation:** |

The first lesson in momentum, so the students will have the fundamentals known coming into the lab.

* The activity reviews conservation of energy as studied in class, and students will use theories of energy and momentum to solve problems

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| **Activity Procedures:** |

1. Administer Pre-Test, students will be working independently on this portion
2. After collected, the instructor will show the material presented (High-speed Mars Rover system <http://i.imgur.com/lxERCOo.gifv> and high damping car drop <http://i.imgur.com/UX68xNr.gifv>), and emphasize:
   1. What students are looking at
   2. The force and velocity vectors at all times of the rover’s movement
   3. What movement is desired, and what isn’t
3. Introduce the lab and demonstrate the setup
   1. Using the spare launcher station will show how they will perform tests
   2. Different settings the launcher uses will be shown to display the different results
   3. Quick (not word-for-word) lab review
   4. How the photogates work, as well as how to read the results and calculate them, will be shown
4. Emphasize requirements on lab. Cars must
   1. Roll freely
   2. Not fly off the track in the collision
   3. Not fly off the track in the launch
   4. Not be too close to each other
5. The groups will work as follows:
   1. The students are already assigned to lab pairs, so each test station will have 3-4 pairs to work with
   2. Each station has weights, magnets, cars, and tape pre-issued, as well as the lab sheets
   3. One sheet per lab pair will be turned in
6. Cleanup procedure: students will be in charge of their tidying-up
   1. Each station will have a white piece of paper, folded in quadrants
   2. Each quadrant is labelled as “car”, “magnets”, “weights”, and “waste”, and students will place their supplies there after testing
7. Post-Test – students will complete the lab post-test before leaving, then leave their sheets upon the teacher’s desk

**Formative Assessments:** Link the items in the Activities that will be used as formative assessments.

Checking prepared cars before running them

Checking data received

Checking questions before the final summative questions

**Summative Assessments:** Prepare a Pre-Test and Post-Test with the input of the RET Teacher. This should be a simple 10-12 question assessment tool. These questions will cover the content related to the Standards. The Pre and Post Test will be identical. There may be several summative assessments at the end of this Activity. Besides the Pre and Post Tests, the students might create a product for which this is a rubric developed. The rubric is also a summative assessment tool. Link the assessment tools.

Questions used:

1. What has more energy after the impact, a rubber ball that bounces, or a ball of silly putty sticking to the floor? (circle one)
2. What is safer in an accident: a car with a really hard exoskeleton, or a car with a crushable exoskeleton? (circle one)
3. What is safer in an accident: stopping as fast as possible, or as slowly as possible (provided the speed of stopping only affects you)? (circle one)
4. A collision can include (circle all that apply):
   1. A crane picking up a cell phone
   2. Dropping a cell phone
   3. Plugging in a cell phone
   4. Exploding a cell phone
5. Which of the following is INELASTIC?
   1. A dart hitting a board
   2. Tapping a finger on a desk
   3. Hitting a baseball
   4. Throwing a controller at the floor
6. Which of the following is ELASTIC?
   1. A cornhole bag hitting and sticking on the board
   2. Kicking a football
   3. Grabbing an apple
   4. Tackling a running back

**Results:**

The average percent improvement of the three classes are: class 1 at 3.3%, class 2 with 9.32%, and class 3 had 6.88%. Across the three classes, the second class improved the greatest, while the first’s improvement was marginal. However, the initial scores of the second and third classes were both lower than the first class’s. This could betray a difference in prior knowledge among classes, since all students do not start on the same page. In observation, the second class was the most energetic. While this could mean attention was hard to keep, it also means they were the most interested and inspired in the task.

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| **Differentiation:** Describe how you modified parts of the Lesson to support the needs of different learners.Refer to Activity Template for details. |

Nothing extreme, but some attention issues can arise. I will be trying to make this as active as possible, as there is also a student with writing accommodation. Obviously there is the worksheet, but making sure the students are moving and receiving feedback without just sitting down and filling out a form the whole time can really help engage all of them.

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| **Reflection:** Reflect upon the successes and shortcomings of the Activity. This is done after the Activity is implemented. |

I luckily was able to do this for three classes back-to-back-to-back, so I could modify my procedures and introductions for each class until it was more polished. What I learned from the first class was that my monologue had much to be desired, and as a result the students had trouble with what purpose the magnets served in the experiment. In addition, once we set to work, the photogates used were almost entirely useless. Although I tested all the machines prior to the lab, it seemed maybe two out of eight actually worked. What ended up happening was the students used their phones’ slow-motion camera function, and recorded the collisions as well as the cars’ speed. This enabled them to solve for velocity and complete the lab.

So for the second class, I allowed more quiet time for their formative assessments, went more in-depth with what the purpose of the magnets were, and briefed them on how to use their phones. This class went much more smoothly, but again they did not understand the magnets well. They seemed to all misunderstand that for two trials, the magnets would attract, and for two they would repel.

The third class was the fastest and best with the experiment, because I ended up drawing a diagram on the board, explained the magnets further, and told them what constituted a good trial.