Charlotte Teachers Institute
Collaborative Teacher Education

Getting To The Core, Newton's Third Law: Getting Past The Lyrical Recitation Of The Law, Getting Into The Force Of The Actions And Reactions

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EE Waddell Language Academy

This curriculum unit is recommended for:
7th Grade Science on a modified block schedule

Keywords: physics, Newton's Laws, collision, reactive force, force, motion, middle school project

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis: This unit is designed for middle school students in a modified block schedule. It will take two to three class periods (75 minutes) for the prep work, and the students will complete the project outside class. They will be designing a device to catch a 1,2, or 3-pound kettle weight and keep it from hitting the floor. This is a new project, and will need to be adapted for future years based upon this year's outcomes.

The major goal of this unit is to share a new capstone project for the end of the Physics unit in seventh grade. I find that I am a more of a big picture type of teacher, and the students help with the inquiry process by working out finer details to help refine the project for later years. In the third and fifth grades, students are exposed to ideas of Newton's Three Laws. They are supposed to be able to interpret graphs and explain motion, and how it changes. The goal of a middle school science teacher is to help their students understand how the forces are applied, velocity is related, and how they can apply the concepts to problems. Usually a middle school (early high school) class will do an egg-drop design, or perhaps a catapult project. When interviewed and pressed for the actual applications of the Newton's laws, the students cannot really explain how the project demonstrates Newton's laws. While students may be able to answer standardized test questions, they struggle with a real life application of Newton's laws. The goal of this new project is to try and access more applied results that have more of a concrete meaning for the students.

I plan to teach this unit during the coming year to 150 students in the 7th grade for the 2017-2018 school year. A/B day block schedule, alternate days, 75 minutes per block

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Introduction

EE Waddell Language Academy is located in Charlotte, North Carolina, and is currently a part of the East Learning Community. The middle school population is approximately 450 students, with the seventh grade making up a third of that usually. The seventh grade for the school year 2016-2017 was approximately 32% White, 30% Black, and 25% Hispanic students, the remaining percentages identified as Asian or multi-racial. Approximately 32% identify as Economically Disadvantaged. Eighty-five percent of 5th grades students were at, or above grade level in Science, and the 8th grade was at 82% for the 2016-2017 school year.

EE Waddell is a language magnet school, focusing on language immersion in the elementary grades, and adding additional languages, or secondary languages at the middle school level. This can present challenges when students may not have English vocabulary for every concept; the word "abundant" comes to mind, a quick explanation and they get it. Students are very comfortable with common versus scientific names of concepts and items (they often think in two separate languages). Parents are generally moderately and highly involved in students' achievement.

I see all of the students in the 7th grade. We are on an alternating A/B day schedule. Our students are scheduled for 75-minute blocks throughout the year. The Charlotte Mecklenburg Schools (CMS) pacing guides are provided, but are for 90-minute blocks. My school is a magnet school for language immersion, to reach those goals, some time is removed from the science and social studies classes.

CMS has a Digital Learning initiative that provides a 1-to-1 device while on campus. Currently students use HP Chromebooks. All student work is kept on the student's personal Google Drive, which allows portability through the cloud.

Unit Goals

While students at my school generally come prepared, according to the standardized tests, when pushed for deeper understanding, they seem to default to generalizations accepted by the majority of the population. Students often recite oft-repeated "lyrics" of Newton's first laws. It is noted, and researched in Ghanaian Physics students, that this phenomenon is not only found in an American classroom setting (Antwi 2015,48-49). The science department at my school is made up of teachers who have come into education after a degree or career in a science related field. This is generally not the case in lower secondary (middle) schools. Our focus is to try and pass on a greater understanding of the concepts and methods that will make our students more successful in the high school and beyond setting.

Students in the current digital environment are capable of finding and exploiting resources easy and quickly. It is my concern that under the general culture of standardized testing and focus on earning a grade, that students need to be challenged in a way that they will need to make connections to real world examples. My school has unique time constraints due to the focus on the World Language Magnet portion of the students' curricula. We have very limited contact time, so I have tried to create and use assignments that I can focus a student as much as possible while they are with me, and try and maximize their own learning styles and pathways while they work independently partially in my classroom, and at home.

Objectives

CMS uses a pacing guide built on the North Carolina Essential Standards in Science. I try to imbed the simpler concepts in harder to grasp ones. I generally have those simpler ideas incorporated into rubrics, or within other assignments that I have borrowed from my textbook, or created myself. Please see Appendix 1 for appropriate North Carolina State Standards.

During this capstone project I plan on having the students interact with the following concepts:

- Questioning the difference between velocity and speed.
- Defining the difference between constant velocity and acceleration.
- Creating concrete examples of constant and changing velocity (Newton's 1st and 2nd Laws)
- Being able to identify, create, and analyze examples of Newton's Third Law.
- Communicating findings and learning with peers.

Scientific Content: Background for Teachers

Vocabulary:

- acceleration – any change in velocity.
- balanced force – two forces with equal strength acting an on object at the same time. When balanced forces are present, objects will either keep moving without a change in velocity or they will remain still. (Newton's First Law of Motion)
- force – a push or a pull. Forces tend to change the state of rest or motion of an object.
- friction – the force between two objects interacting, in opposite directions of motion, converts kinetic energy usually into thermal energy.
- gravity – attractive force between two objects (Newton's Law of Gravitation)
- inertia - a property of an object that is related to its mass - moving objects tend to stay moving and motionless objects remain motionless. (Newton's First Law of Motion)
- mass – the amount of matter an object has – commonly called "weight" by students, but mass is a more accurate term, as weight is the magnitude of the force on the mass due to gravity.

- motion – the changing position of an object.
- relative speed – the speed of an object when compared to a reference point or another object.
- speed – how fast an object is changing positions.
- unbalanced force - two forces with unequal strength acting an on object at the same time. When unbalanced forces are present, objects will accelerate (change speed, direction, or both) (Newton's Second Law of Motion)
- velocity – speed in a given direction, vector.
- weight – how much gravity is pulling down on an object.

A great place to check personal understanding for the Newton's three laws, is with Kahn Academy (see Appendix for reference). A bit of background on Newton's history, his publishing of *Principia* with its explanations of the laws, and his impact upon the scientific community is also a good place to start students (Bynum, 2012).

Newton's First Law of Motion: Students generally can recite the phrase, "Objects at rest, stay at rest; and objects in motion stay in motion". While this shows a basic understanding, it needs to be expanded upon to mention that if all forces are balanced, then there isn't any acceleration (change in speed, direction, or both). A goal of prior units before this curriculum unit is to change the general mantra, into, "Objects remain with Constant Velocity, until acted upon by an unbalanced force". The Physics Classroom (Henderson, 2017) provides good insight, and examples and animations for better understanding.

Newton's Second Law of Motion: "Unbalanced forces cause a change in motion". Students usually refer to this as speeding up, or slowing down in a linear fashion. Velocity of an object is a vector, meaning it has both a magnitude (speed) and a direction (This is a great time to add in a quick clip of the villain Vector from Despicable Me #1). Students generally can agree that a car could go around a NASCAR track with cruise control on, but not feel that there was acceleration, due to the fact that speed remains constant. The velocity however, does not remain constant since the car is constantly changing direction. Usually it is not a very difficult step to combine the change in speed and direction when talking about acceleration. The Physics Classroom (Henderson, 2017) has interactive Concept Builders, and examples with animations that can help provide a variety of examples and animations that can help both inexperienced teachers and students alike.

Newton's Third Law of Motion: "Every action has an equal and opposite reaction". **This is the focus of my curriculum unit**. Students generally can recite this very easily, but the majority of the time they confuse the scientific concept with "Cause and Effect" concepts in Language Arts or Social Studies. Given a catapult model, the common example of the 3rd law is, "When I pull the lever back, that is the action, and when I release it, it throws the projectile, that is my opposite reaction". This is the beginning of student understanding, that those forces are in opposite directions, but that the forces described by the student are not instantaneously acting on the object, but in a chronological sequence. The opposing forces are the interaction of the objects, not the if/then statement. The primary force is the pushing of the lever, but the opposite and equal force of Newton's Third Law is the pushing back of the lever against the student's finger. An example of the student sitting in a chair, and the chair pushing back up to keep the student from accelerating downwards due to gravity.

Strategies for Learning

Table Groups
Students are grouped by table teams in my room. I change these teams as necessary for student engagement and success. Groups last usually for several weeks to a whole quarter. Middle school students like consistency and to be challenged. I do however allow flexible grouping when students create group projects.

Flexible Grouping
I allow students to choose whom to work with in groups, and they can choose to work as an individual. For this project, any students who work in a group will still provide their own device. Designs can be identical in a group, there are usually enough variations in attention to details and materials to have students evaluate the minor differences, compared to the major differences between groups.

Science Reading Assignments
These are in support of my Language Arts colleague. Students generally are not fond of reading informational text. Articles and book assignments can offer different challenges to students. They work on these in their table groups.

Discussion Lessons
Each day class begins with discussion lessons. These can start with open ended or multiple-choice questions. These allow for formative assessment before students begin research and designing projects. Students are allowed to work in groups and use resources to answer these questions. This allows students a varied pacing, but does keep them on a timeline that allows for success in the project.

Learning Experiences

The main focus of this unit is on the development of an understanding of Newton's Third Law through real world example, simulations and independent practice and finally a student-designed project. I have provided the handouts for the project that I give to students in Appendix 2.

The project will consist of students creating a device to catch a kettle bell weight (possibly 3 different weights), and stop it just before it hits some sort of material or target that can possibly qualitatively record the severity of the impact. I plan on using a zip-lock bag with Smarties Candies laid flat. The effect of the weight on the candy will mark if the weight impacted with great force, or landed gently. Distance of the weight from the ground will also be measured. The goal is to get close to the target without hitting it.

Lesson 1: Connections to real life.

Examples of NASCAR crash barriers, seatbelts, highway speed arrestors, and barriers from bicycle racing. I will use videos and simulations for student engagement and simulations from The University of Colorado Boulder for physics review. I will start with simulations for acceleration and balanced forces. This may take differing amounts of time based upon the students' prior knowledge and resources available. It is important to keep in mind the students' context that they need to connect to the information that they are trying to access to gain a deeper understanding.

Objective:

1. Given examples of forces interacting, students will be able to identify locations, and directions of Newton's First and Second Laws, and begin to identify the difference between Newton's Third Law and "Cause and Effect". Students will create a group poster highlighting personal examples, generic wording, and a "scientific, nerdy" version of each of Newton's three laws.
    a. Students will have access to textbook and internet resources for reading informational text.
        i. The Physics Classroom (see references for links to website)
        ii. Prior units and interactive assignments, teacher made. (see Appendix 2 for links and descriptions of resources used in class)
    b. Teacher created documents may be added or substituted according to personalized learning plans or required differentiation.
    c. Students should be able to answer the following questions
        i. What will happen when object A applies a force to object B?
        ii. What happens when an object at rest or in motion experiences an unbalanced force?
        iii. What causes an object to accelerate?
        iv. What happens when two unbalanced forces act on an object?
        v. What kinds of forces can act on an object?

Materials and Technologies needed:

- Teacher created worksheets, see Appendix 2
- Online articles (The Physics Classroom, PHET University of Colorado. Please see references for web site information.)
- Reading Study Guide materials and textbook (accessible via teacher's personal website, please see the end of Appendix 2 for link to files)
- Chromebooks (issued by district, or personal devices)

<u>Lesson Procedures</u>: (What the teacher will do)

- Teacher will direct whole group to objectives, and circulate within small groups to facilitate understanding and assist in students' real world connections.
- Teacher will provide background resources at appropriate levels for student understanding.

Independent Practice:

- Given examples of Newton's Laws, students will be able to identify which laws are being observed when given directed questions
- Students will provide personal examples, connected to school related topics when asked to demonstrate a specific law. Students do this on "Newton's Three Laws Applications" worksheet provided and linked in folder in Appendix 2.
- Students will be able to identify which law is demonstrated when presented scenarios.

Lesson 2: Define Project/ Research

Define parameters of the project. Parameters include: size, materials, weight, and target objective (to not crush the candy). Important factor of this day is to discuss the reasons for parameters (limitations: time, cost, intended users). Please see Appendix 2 for student handouts.

Objective:

1. Student will be aware of constraints, and reasons for those constraints. Students will understand the connections of those constraints to real world examples.
2. Students will be made aware of grading, and requirements for success on project.

Lesson 3: Research and Design.

This is the focus of the project, for students to gain practical, and personal experience of the forces created when "launching" the crusher project. Students get time in class with technology and teacher assistance to design and research ideas. Students are encouraged to look at other project ideas (e.g.: Egg Drop / catching devices) to incorporate design elements and concepts. Please see student handouts in Appendix 2 for plans for student "rough draft"

Objective:

1. Student will have researched other physics projects to develop ideas for designing project.
2. Teacher will reconnect with Lesson 1 for conceptual basis of project.
3. Students will be made aware of grading, and requirements for success on project.

Lesson 4: Research, Design and Rough Drafts due.

Preliminary plans due on teacher designed rough draft planning guide. Please see Appendix 2 for rough draft worksheet. Students should provide highlighted parts of other projects that they think that they can use in developing their Crusher design.

Lesson 5: Check-In (two weeks out)

This could be a check in, with students turning in data tables, submitting pictures of testing, or video of prototype testing. I plan on having two alternatives relative to curriculum/ year-end timing

1. prototyping and independent testing report (this is more ideal, usually an optional portion, or extra credit)
2. just have students turn in final projects, while not ideal, allows for continuing with other curriculum while students work.

Lesson 6: Final projects due and drop/destruction day.

Use data tables. I generally keep track of the two best in each class to reward with pizza. I hand out the final review on this day. Depending on students, it can be due in one or two class periods.

Lesson 7: Assessment

Final written and mathematical assessment due. (see Appendix 2)

Appendix 1

State Standards

- **7.P.1 Understand motion, the effects of forces on motion and the graphical representations of motion.**
  - **7.P.1.1** *Explain how the motion of an object can be described by its position, direction of motion, and speed with respect to some other object.*
  - **7.P.1.2** *Explain the effects of balanced and unbalanced forces acting on an object (including friction, gravity and magnets).*
- **7.P.2 Understand forms of energy, energy transfer and transformation and conservation in mechanical systems.**
  - **7.P.2.1** *Explain how kinetic and potential energy contribute to the mechanical energy of an object.*
  - **7.P.2.2** *Explain how energy can be transformed from one form to another (specifically potential energy and kinetic energy) using a model or diagram of a moving object (roller coaster, pendulum, or cars on ramps as examples).*
  - **7.P.2.3** *Recognize that energy can be transferred from one system to another when two objects push or pull on each other over a distance (work) and electrical circuits require a complete loop through which an electrical current can pass.*
  - **7.P.2.4** *Explain how simple machines such as inclined planes, pulleys, levers and wheel and axels are used to create mechanical advantage and increase efficiency.*

Appendix 2

All following pdf documents may be accessed from link to my Google Drive Folder that follows.

Balay
Grade 7 Science

Name: ______________________________ Date: ________ Block:____________

Crusher Project

Students will create a device to stop a mass from crushing a target substance (probably smarties candies). We will be applying all of Newton's laws, Friction, Gravity, and the concepts of simple machines. Students will construct a device out of recycled materials. Students will work on devices at home and meet design benchmarks for full credit on the project. Students will have an in-class competition for effectiveness (stopping mass closest to targets, surviving multiple impacts). Students may collaborate on design and assist each other in construction, but MUST present their own, individual project for classroom competition/consideration.

Standards

- Differentiate between weight and mass; weight is the amount of gravitational pull on an object
- Explain how the motion of an object can be described by its position, direction of motion, and speed.
- Graph and interpret distance vs. time graphs for constant speed.
- Identify examples of where Newton's three laws can be shown in your design (from start to launch)
- Differentiate between potential and kinetic energy, and note where energy is transferred.
- Mechanical Advantage provided by variety of simple machines, if applicable.

Constraints:

- Size: 12 inches cubic (12x12x12 inches). ALL DEVICES MUST BE ABLE TO SIT ON A LAP ON A BUS.
- Mass will start a beginning height, and will move higher for subsequent rounds.
- All students will participate in the first round, with devices capable of continuing moving on. STUDENTS WILL BE ELIGIBLE FOR FULL CREDIT FOR SURVIVING FIRST ROUND AND NOT CRUSHING TARGET MATERIAL; SECOND ROUND, OR FURTHER, IS OPTIONAL.
- Materials: All recycled materials (minimal purchase of materials)
  - **NO METAL FRAMEWORK OR WELDING!**
  - **NO FOOD PRODUCTS OTHER THAN TARGET CANDIES**

Problem or Need

Construct a device capable of stopping a kettle bell weight from hitting and/or crushing target Smartie Candies. Devices should find inspiration from crash barriers, bullet-proof vests, car bumpers, safety nets, or other objects designed to arrest motion or redirect force. School Egg Drop projects may be considered for design ideas.

Step 1: Research

Research Force Arrestors, Crash Barriers, and other school projects. **EASY BIB FOR WEBSITE DOCUMENTATION Required (copy link and use MLA8).** Bibliography will be due on CANVAS. Pictures from the internet are cited with WLA8 format

Step 2: Design

Students will need to turn in preliminary drawings (by hand) and materials lists by TBA, for A block; and TBA for B block. This assignment is on paper. Time is allowed in class.

Step 3: Build

Student will document their building and design. This will allow for them to adjust and identify possible weaknesses along the process. Students will be asked to upload pictures of their materials, designs, and testing in CANVAS.

Step 4: Drop Day

Students need to bring in projects for drops on TBA

Step 5: Communicate your Solution

Project Reflection: Students will have exit assessments on the designs they used and saw classmates use. They will need to think about possible solutions to issues, changes in designs, and improvements for future years' projects.

Crusher Project Materials and Rough Draft Design.

Materials List: This is a planned list, things you would like to scavenge for recycled materials. You may, or may not use most or many of these items. You need to plan on what to look for.

1. ______________________________
2. ______________________________
3. ______________________________
4. ______________________________
5. ______________________________
6. ______________________________
7. ______________________________
8. ______________________________

Plan: How do you think it will look?

Top Views. You may copy and paste a pics below Think of components that may be used in your Crusher design. Get close ups of parts.	Side Views. You may copy and paste a pics below Think of components that may be used in your Crusher design. Get close ups of parts.

Questions:

1. Why did you choose to attempt this design (think about the other designs you chose NOT to do)?
2. What about this design do you think will be the most challenging? (materials, complex design, adding in enough simple machines)?
3. Why do you not want to convert all of the potential energy of the mass into kinetic?
4. Where will the energy go that was converted to kinetic energy when the mass comes to a complete stop?

	5	7	9	10
Effort & Creativity (2x)	Device is incomplete or just thrown together	Device appears poorly constructed or slipshod. – "Parts are a hot mess, but somehow manage to work together."	Device appears well constructed – "Parts are well chosen and integrated effectively."	Device appears well constructed AND shows evidence of detailed work, craftsmanship, innovation – "WOW! Should we patent this?"
Weight	Device over 3 times target weight	Device between 2 & 3 times target weight.	Device between 1 & 2 times target weight	Device at, or under prescribed weight
Distance to target	Over 6 inches away, or crushes target candy	Mass is between 3 & 6 inches of target	Mass is between 1 & 3 inches of target	Mass comes within 1 inch of hitting target with final drop (can stop at 1 drop)
Target Candy Condition	Target impacted and device not immediately rebuild-able	Untouched/ unbroken, target outside 6 inches-OR-target impacted	Untouched/ unbroken, target within 6 inches	Untouched/unbroken, target within 3 inches
Total				

	5	7	9	10
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Target Candy Condition	Target impacted and device not immediately rebuild-able	Untouched/ unbroken, target outside 6 inches-OR-target impacted	Untouched/ unbroken, target within 6 inches	Untouched/unbroken, target within 3 inches
Total				

Newton's 3 Laws Applications

Use the same picture for all of the Newton's laws. Find one that allows you to show off what you know for each law, but all in one pic. You will only focus on one law at time. DO NOT TRY TO DO ALL THREE LAWS AT THE SAME TIME, focus on showing MULTIPLE examples of each law on one pic.

1. State Newton's First Law in terms of velocity:

Restate here:

   a. Insert a picture of something that you can show an example of Newton's 1st Law (YOU NEED TO USE "INSERT DRAWING" AND ADD TEXT AND ARROWS OF WHERE THE FORCES ARE AND EXPLAIN)

Insert drawing here:

2. State Newton's Second Law in terms of velocity:

Restate here:

   a. Insert a picture of something that you can show an example of Newton's 2nd Law (YOU NEED TO USE "INSERT DRAWING" AND ADD TEXT AND ARROWS OF WHERE THE FORCES ARE AND EXPLAIN)

Insert drawing here:

3. State Newton's Third Law in terms of forces (keep direction of forces in mind)

Restate here:

   a. Insert a picture of something that you can show an example of Newton's 3rd Law (YOU NEED TO USE "INSERT DRAWING" AND ADD TEXT AND ARROWS OF WHERE THE FORCES ARE AND EXPLAIN)

Insert drawing here:

Crusher Project Materials and Final Design

Materials List: please list all of your building supplies and material used to hold device together, you may leave out any materials or supplies used solely for aesthetics (to make it look good)

1. ____
2. ____
3. ____
4. ____
5. ____
6. ____

Plan: How did it look? (you may insert pictures of your design, or draw by hand or digitally)

Top View	Side View

Data Table: document final height of masses (qualitative) at different heights. Not all masses or heights may be used in final drop. Students may use this format in their personal trials when testing their designs.

Height\ Mass	Mass #1 _______	Mass #2 _______	Mass #3 _______
0.5 meters above			
1 meter above			
1.5 meters above			
2 meters above			

Questions:

1. Why did you choose to attempt this design?
   (think about the other designs you chose NOT to do)?

2. What about this design was the most challenging?

3. What is the potential energy of the starting mass? Remember to show your work. Please calculate for all possible masses and heights listed.

Height\ Mass	**Mass #1 _______**	**Mass #2 _______**	**Mass #3 _______**
0.5 meters above			
1 meter above			
1.5 meters above			
2 meters above			

4. How much energy did your device absorb? Calculate the difference in potential energy for the data collected above and starting PE calculated in #3

Height\ Mass	**Mass #1 _______**	**Mass #2 _______**	**Mass #3 _______**
0.5 meters above			
1 meter above			
1.5 meters above			
2 meters above			

5. What was the Kinetic Energy of the different expected masses at the point of impact? Consider the idea of Mechanical Energy being KE + PE

Height\ Mass	Mass #1 _______	Mass #2 _______	Mass #3 _______
0.5 meters above			
1 meter above			
1.5 meters above			
2 meters above			

6. Calculate the speed of the mass at time of impact for the lightest mass at 1.5 meters above the target.

7. After your first drop, did your device seem to be able to be useful again? Why or why not?

8. Why would it be a good idea for a device to be reusable immediately? What would be a real world example for this?

9. What advice would you give to future students on how to be successful in this project? (Not design ideas)

10. If you could change something about the project for the teacher, what would it be?

Answer Key:

A. Student should have a list of materials
B. Student should have top and side views of their device, may be hand drawn, computer drawn, or photos inserted.
C. Data of height of device after drop. Information should be in cm above the floor, from the bottom of the device (all measurements should be from bottom of device)

1. Answers vary, should be introspective
2. Answers vary
3. PE= mgh, where PE= potential energy, m= mass, g= 9.8 m/s^2, h= height
4. Energy absorbed can be calculated by subtracting final PE from original PE, $PE_{absorbed} = PE_{initial} - PE_{final}$ not all boxes in table may be used.
5. Mechanical Energy = Potential Energy + Kinetic Energy,
   a. $ME_{original} = PE_{original} + KE_{original}$ where $KE_{original} = 0$
   b. $ME_{original} = ME_{impact}$ so
   c. $PE_{original} = ME_{impact}$
   d. $ME_{impact} = PE_{impact} + KE_{impact}$
   e. Substitute $PE_{original} = ME_{impact}$ to get $PE_{original} = PE_{impact} + KE_{impact}$
   f. Now use $KE_{impact} = PE_{original} - PE_{impact}$
6. Kinetic Energy = ½ mv^2
   a. Using data from #5 above
   b. square root of velocity = square root of (2xKE/mass)
7. Student answers will vary
8. Student answers will vary, but should make connection to some sort of crash barrier or bumper
9. Student answers will vary
10. Student answers will vary.

My Google Drive folder with the above files (docx, pdf, and Google files available) may be accessed at this address.
https://drive.google.com/drive/folders/1Chdwtsqg8onkv6DK4kaGP5uZKpoiI1up?usp=sharing

Lesson Resources Prior to Crusher Project start.

Videos and quick questions for Newton's Laws. I present these through my LMS (CANVAS), but could also be done through Google Forms and Classroom. These questions are designed to be quick formative assessments, the videos are imbedded in the form and the quiz graded as an informal grade. They are given as prerequisite material for the project. Students choose one video, attempt questions, can reassess and watch other video (setting within CANVAS)

1. First Law
    a. Videos
        i. "Science of NFL Football" from the National Science Foundation
            1. https://youtu.be/08BFCZJDn9w
        ii. "Newton's 1st Law James River High School NewtonFirstJohn Christian" by JMU Physics Video Contest
            1. https://youtu.be/pWcfcLKWk9c
        iii. Questions
            1. What is the best way to restate Newton's First Law of Motion?
                a. <u>Objects keep moving with the same motion unless acted upon.</u>
                b. Objects move at random, unless I say so.
                c. Objects move when acted upon by gravity.
                d. If you place an action on an object, it will still move the same.
            2. What should remain the same if Newton's First Law applies to an object?
                a. <u>Velocity</u>
                b. Speed
                c. Location
                d. Time
            3. Newton's First Law is also known as?
                a. Gravity
                b. Momentum
                c. <u>Inertia</u>
                d. Velocity
2. Second Law
    a. Videos
        i. "Science of NFL Football" from the National Science Foundation
            1. https://youtu.be/qu_P4lbmV_I
        ii. "Dance With Newton's Laws" by <u>sciencefilmsusc</u>
            1. https://youtu.be/wmtjTMl3_Rg

   - iii. Questions
      1. For Newton’s Second Law to NOT apply, what won’t happen?
         - a. Stays moving the same
         - b. Stops
         - c. Changes speed
         - d. Changes direction
      2. Why would an object accelerate? (pick most correct answer)
         - a. Gravity is in full effect!
         - b. Your science teacher and math teacher are pulling on it the same from either side.
         - c. All forces are balanced.
         - d. Forces are unbalanced.
      3. What is the formula for Force with relation to mass and acceleration?
         - a. F=m/a
         - b. m=a/F
         - c. F=ma
         - d. F=a/m

3. Third Law
   - a. Videos
      - i. "Science of NFL Football" from the National Science Foundation
         1. https://youtu.be/e1lzB36aHD4
      - ii. “Newton’s Third Law in Dance” by jbabydancer
         1. https://youtu.be/LWkK6Zt388A\
      - iii. Questions
         1. According to Newton's 3rd Law, what is equal?
            - a. All actions
            - b. All reactions
            - c. An action and reaction are not equal
            - d. A reaction to an action
         2. What is the relationship between the action and reaction?
            - a. They are equal, but going in opposite directions
            - b. They are equal, and going in the same direction
            - c. They are NOT equal, but going in opposite directions
            - d. They are equal, and are going parallel to one another.

References and Resources

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