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| **Title** | **Analyzing Speed from Different Modalities** |
| **Introduction** | Everything in the universe undergoes some type of motion. Even when one stands still, the earth is still in motion. It rotates around our sun and the sun moves within our galaxy. **Mechanics** is the term that is used by scientists to refer to motion and forces that cause motion. Forces are responsible for all types of motion. So the speed or velocity of an object can be impacted by forces. **Speed** is the distance an object moves divided by the time it takes for that object to move. For example, a car’s speed is 80km/hour. **Velocity** is speed in a given direction. **Acceleration** is the measurement of the change in velocity in a certain time. Its units could be 16m/s2 to indicate the rate of change of an object. So velocities can increase or decrease over time, thus changing acceleration. The acceleration can be affected by the **mass** of an object, that is, the amount of matter in an object. Mass can be measured in grams, ounces, pounds or kilograms.  Students will use the TI Sensor pad to analyze speed and acceleration from a variety of chosen movements (walking forward, running, skipping, jogging, jump roping, walking backwards, walking heel-to-toe, hop, skip, or crawl). They will save and upload graphs that they will compare with other students in the class or other types of movements.  The classroom time will be spent among the proper use and testing of the TI sensor pad, brainstorming for additional movements, and testing and analyzing of data used with the Engineering Design Process.  This project is designed so that students take charge of their learning. In order to complete their project, they conduct research independently, brainstorm possible solutions, choose their sensor for the task, test their hypotheses and analyze data collected from the experiment, modify procedures and retest as needed. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \*1 Physics 4 Kids-<http://www.physics4kids.com/files/motion_force.html>  Additional resources  HOT Science Labs (go to p.27) -<http://science.dadeschools.net/Instructional%20Resources%202012-2013/Science%20Hands-on%20Activities/HOT%20Science%20Labs%20-%20Physical%20Science%202012-2013.pdf> |
| **Real Science Application** | An **unbalanced force** acting on an object changes its speed or direction of motion, or both. The change in motion (**direction or speed**) of an object is proportional to the applied force and inversely proportional to the mass. All motion is relative to whatever **frame of reference** is chosen, for there is no motionless frame from which to judge all motion. **Friction** is a force that opposes motion between two surfaces that are in contact. The amount of friction depends on factors such as the roughness of the surfaces and the force pushing the surfaces together. Newton's law describes the relationship between gravitational force, mass, and distance. An object will not start moving until a force acts upon it. An object will stay in motion forever unless an unbalanced force acts upon it. **Inertia** is the tendency of objects to resist any change in motion. Likewise, inertia is the reason a moving object stays in motion with the same velocity unless a force changes its speed or direction or both. Note: Newton's Laws should not be memorized at this age. Rather, the principles which underpin the Laws ought to be well understood.  NOTE: (The above information was adapted from CMAPP, but this link has similar information.) <http://idahoptv.org/sciencetrek/topics/force_and_motion/facts.cfm>    The ASSIST Program goals include the creation of wearable devices that collect data regarding the health of an individual using energy from the body to fuel the device. In this experiment students are collecting data from the TI Sensor Pad to compare the different forms of motion from group members. Many individuals have incorporated wearable technology in their daily lives through the use of fitness trackers. Some trackers are used for motion (walking, steps, running, bicycling, jogging even swimming); others record sleep hours, heart rate, pulse. Some have alarms built-in, incoming phone and texts alerts and display medals when milestones are achieved (ex. 5,000 steps) and have been achieved. These devices are marketed to increase physical fitness through feedback and motivation. These devices can contain sensors to monitor the heart, exercise, sleep, body temperature, oxygen saturation, blood pressure, activity level and calories burned- while monitoring the wearers’ daily trends. \*1  Trends are important for providing doctors long-term data that will show any patterns that may cause concern, which would not otherwise show up in a brief 15-20 minutes doctor’s visit. Sensors can also be used to monitor animal movement. For years, sensors have provided clues to the habitats in which animals migrate, their diets, and their interactions with other species in those environments. This data has led to understanding population influences and the results associated with these changes. Humans have also made lifestyle modifications to decrease the negative impacts on the affected populations, both directly and indirectly. Some changes include the response to diet, exercise, habitat, sleep, friends, work, stress and environmental hazards. \*2    \*1 <http://www.analog.com/library/analogdialogue/archives/48-12/wearable_electronics.html>  \*2 http://www.housing.ucsb.edu/dining/nutrition-blog/what-influences-our-lifestyle-choices |

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| **Curriculum Alignment** | This section contains the curriculum alignment of the lesson to the North Carolina NC Essential Standards science or Math, and the Next Generation Science NGSS) or Common Core Math   |  |  |  |  | | --- | --- | --- | --- | | Content Area | Grade Level | NC Essential Standards | NGSS | | Human Body | 7th | 7.TT.1 Use technology and other resources for assigned tasks. | |  |  | | --- | --- | |  | **1.** HS-ETS1-1.Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants. | | |  |  | 7.RP.1 Apply the Engineering Design Process to complete tasks. | HS-ETS2 Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering. | |  |  | 7.P.1. Understand motion, the effects of forces on motion and the graphical representations of motion. | HS-ETS3Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. | |  |  | 7.P.2  Understand motion, the effects of forces on motion and the graphical representations of motion. | HS-ETS4 Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem. | |
| **Learning Outcomes** | Students will explain that motion can be defined and measured.  Students will demonstrate how forces affect motion.  Students will represent and analyze motion graphically.  Students will explain and illustrate how energy can be transferred, transformed, and or conserved.  Students will complete an experiment while incorporating technology in the Engineering Design Process. |
| **Time Required and Location** | 55-minute class periods  Lessons will be conducted in the classroom, computer lab and hallway outside of teacher’s classroom. |
| **Materials Needed** | Teacher List:   * TI Sensor Tag * Digital presentation for Speed Topic included in lesson * Digital copy of Sample Data worksheet for collecting Sensor Tag Data using smartphone or tablet * TI Sensor Tag how-to presentation included in lesson * Kahoot Vocabulary Review game link (kahoot.it) * Google Drive for posting documents * Padlett for students comments(created by teacher)   Student List:   * TI Sensor Tags 1 per group of 3 to 4 students * Device for collecting Sensor Tag data (phone, ipad, etc.) * Recording devices (computer, or notebook, pen / pencil, chart) * Lab Sheet 1 per student (designed by students, including data sheet) * Graph paper * Sample Data Worksheet 1 per student * 1 ruler per group of 3 to 4 students * Extra batteries |
| **Safety** | Safety Rules and Precautions   1. Students are to behave in an appropriate manner that does not cause harm to themselves or others. No horse-playing, throwing items or pranks are permitted. 2. Students should read the lab procedure and safety rules prior to conducting the lab. Students are encouraged to ask questions before the lab of anything that appears confusing. 3. Students should not start the lab until permission is granted by the teacher. Unauthorized investigations are prohibited. 4. Students are expected to handle the equipment with care. Do not throw or drop the TI Sensor Pad. Return the equipment to the teacher before departure from the class. 5. No foods, liquids or gum are allowed in the science lab, hallway or computer lab. 6. Report any accidents to your teacher at once. 7. Students are to maintain a reasonable amount of order and organization at their lab station and outside and place book bags in the storage area (away from the lab area) when completing labs. 8. Students should carry equipment properly. 9. Students should maintain a sense of purpose (stay focused on the task at hand) and use appropriate voice levels when working in groups. 10. Students should remain with their group unless retrieving items; not visit other groups or engage in conversation with other students outside of their group. 11. Student Hallway Rules   a. Students work with an inside voice to complete the lab activity. (No  yelling, screaming or laughing in a disruptive manner will be  tolerated due to other nearby classrooms.)  b. Students should not run down the hall, or play at the water  fountain or disturb other classrooms.  c. exercise caution when walking with pencils while other students are  walking in the vicinity of one’s lab areas |
| **Student Prior Knowledge** | These activities are created as part of the unit on motion and forces. Students should be knowledgeable with safety rules (although they will reviewed again), the Engineering Design Process components, and motion vocabulary (such as speed, distance, time. temperature and acceleration). |
| **Teacher Preparations** | * Review presentation media for how-to lessons on use of TI Sensor Tags prior to lab day. * Note: If the motion app/accelerometer is not working, the firmware may need to be updated. This may happen automatically between the cellular device and the TI-Sensor Tag * If desired select and create graphs for samples and TI Sensor Tag display, otherwise review sample data and graphs provided in lesson * Display the objectives of the lessons * Reserve the computer lab for three days * Get permission to install app on school devices or have students install the app on their own devices. * Remind students to bring their devices and connect to the school’s wi-fi prior to presentation day make sure students have TI Sensor Tag app loaded * Assign students to groups; make sure at least one student has a device with the TI Sensor Tag app installed. (Students will define roles and responsibilities in the group.) * Prepare a list of those students who need to pair up with others and adjust seating assignment. * Assign computer lab seating chart. (Lab partners sit together.) * Set up free kahoot.it account and become familiar with leading a “kahoot”. * [Kahoot for teachers](https://getkahoot.com/)  (Teachers set up a free account, and set up questions prior to the class. Alternative: Students can create kahoots on a teacher- created generic account. * [Kahoot for students](https://kahoot.it/#/) (Students enter the game pin from the teacher’s page.) |
| **Activities** | Outline: Motion and Forces Unit  Discussion of Motion and Forces, relevant vocabulary  Day 1: Objective: To determine prior vocabulary knowledge  1. [Vocabulary Sort](http://www.readwritethink.org/professional-development/strategy-guides/introducing-ideas-vocabulary-with-30953.html) Strategy of 10 words (Explanation: Students sort words based on their meaning / relationship.)  2. Think, Pair, Share Strategy: Students pair up with a buddy and explain their categories.  3. [KWL](https://www.eduplace.com/graphicorganizer/pdf/kwl.pdf): Students glue these words in their interactive notebook under the appropriate headings leaving space for definitions if needed. If students know all the words, the teacher can have them /draw pictures or add examples for each word.  Day 2 & 3: [Marble Motion Lab](http://it.pinellas.k12.fl.us/Teachers3/gurianb/files/AD5483E493EE4299BDAF1BABAD473540.pdf) with 8 books.  Objective: To determine speed using distance and time.  1. Students set up in teams; begin lab & collect data.  2. Students create a graph based on their data. (Day 3)  Day 4 Graphical Analysis of Data (Describing motion),  Objective: To analyze graph for trends  1. Students examine the graph for trends.  2. Students answer analysis questions  3. Student groups report out to the class.  Day 5, 6, 7: TI Sensor Pad: An Overview, loading software onto personal devices and use of the device, and motion lab completion. Discussion of results and presentation of lab to classmates. (Location: Computer Lab)  Day 5: Objectives: Students with Smartphones will :   1. be issued a TI-Sensor Tag device 2. be directed and/or assisted to load the app onto the phone.   [TI Sensor Tag](http://makezine.com/2013/04/18/teardown-of-the-ti-sensortag/): An Overview, loading software onto personal  devices   1. open the app and explore the use of the accelerometer / motion program     \*Note: If more than one device is operated in close vicinity of others, users may see them all on their device screens. It may be necessary to put distance between the devices to connect to the correct one.  Day 6. Objectives: Students will:   1. practice the use of device while completing a lab with a partner. 2. acquaint themselves with the working the TI-Sensor Tag device motion sensor/ accelerometer their and cellular devices.   <http://processors.wiki.ti.com/index.php/SensorTag_User_Guide>  Day 7. Objectives: Students will explore:   1. Pair TI-Sensor Tag with cellular devices 2. Complete experiment to explore motion. 3. Collect data according to the lab directions. 4. Analyze data 5. Discussion of results and presentation of lab to classmates.   Day 8. Objectives: Students will:  1. Identify problems that were encountered  2. Brainstorm possible solutions to problems  3. Repeat the lab with the new solutions.  4. Analyze the outcome / results  5. Present their findings to the whole group.  Days 9. Match the Graph. Students will create an experiment using the Engineering Design Process. They will take the graph that is produced from the TI Sensor Tag and share it with a lab partner.  Day 10. Partners must evaluate the graph for speed factors (increase, decrease or constant) and attempt to recreate it with his / her own motion and sensor. The two graphs will be compared in a classroom presentation. (Location: The hallway outside of the classroom)  Day 11. Students will analyze a [motion graph handout](http://camillasenior.homestead.com/motion_graphs.pdf)  to learn about different speed examples.  **Engage:** Ask students to play [Kahoot](https://kahoot.it/#/) for vocabulary word review as they come in the door. (The teacher can check attendance and / or homework while students are completing the warm-up.) Students who enter late will join a member or team in progress. {5 min.}  **Explore:** Students are presented with a [motion graph handout](http://camillasenior.homestead.com/motion_graphs.pdf) for examination. It is displayed on the projector screen for all students to see as well. Individually, students should determine what type of speed occurs at each section of the graph (speed increases, decreases or remains constant) and for each example. Students turn to a neighbor and discuss answers. Students are encouraged to provide reasoning for their responses. Students are randomly chosen and polled to explain the different parts of the graph and different graphs  **Explain:** Students will be asked to create a motion graph. They have the option to walk forward, walk backwards, skip, jog, or run. First, students should walk from one end of the hallway to the other and count by paces (or strides) to get their distance. They will record the distance traveled by the number of paces or strides. They will generate a graph with the TI Sensor Tag and save it to exchange with their buddy. To save the picture, students will take a screen shot from their phone. They can then text this people o their bud  **Elaborate** Each student will use their partner’s graph to calculate speed and then attempt to recreate another graph as close to the partner’s graph as possible on the TI Sensor Tag. Students are encouraged to use stopwatches to identify checkpoints and calculate the corresponding instantaneous speeds to match the graph. These two graphs will be compared for accuracy. Students will report their findings to the class in a presentation type formation (like PPT).  Questions for Graphical Analysis  Directions: **Identify** the **speeds** at different intervals for **you** and **your partner’s** graphs.   1. Is your partner's graph **increasing** or decreasing? 2. Is there a **point** on the graph where your partner's motion **stopped** completely? 3. **Label** all of this on your partner's graph with the transparency overlay. 4. Now use this information to **create a graph** as close to as possible as the graph of your partner.   Extensions:   1. What are some sources of error in this experiment? 2. What are some ways to increase the accuracy when duplicating your partner’s graph? 3. Problem: I wish we could display the graph from the TI Sensor tag program that is generated on your phone concurrently while creating a new graph from the partner’s attempt to match your own. Is there a way that we can do something similar to this? (Possible answer: the teacher can split the computer screen and post the pictures on the screen after students have finished creating their graphs.)   Students will draft their responses to the question while others complete their lab? The teacher will examine preliminary responses and ask questions for clarification. |
| **Assessment** | The students will be graded on their correct labeling and analysis of their partner’s graph and responses to the questions. (The graph should be labeled with distance, time and speed markers.) |
| **Extension Activities (Optional)** | Choose a question and complete the response. Links are provided for your ease of research.   1. What are your views regarding speed limits on interstate highways? View the links and express your opinions.   <http://www.nytimes.com/1998/10/21/automobiles/in-the-debate-over-speed-there-are-few-facts-no-limits.html>  <http://www.pennlive.com/midstate/index.ssf/2014/07/70_mph_speed_limit_pros_and_co.html>   1. How do radar detection devices work? What is your advice for someone speeding?   <http://www.autoblog.com/2009/04/08/speed-traps>   1. What are some common dangers with speeding?   <http://www.popcenter.org/problems/speeding/print/>  <http://www.popcenter.org/library/researcherprojects/Speeding.pdf> |
| **Modification** | Modifications  Gifted and talented classification, and/or English language learners.  Modifications should include:   1. Paired with a buddy who can help with instructions, notes, assignments and keeping organized during class. 2. Google Translate or a dual-language app will be used where possible 3. Extra time to complete assignments or provided less items to complete 4. Modified or alternative assessments.   Classroom adaptations   1. Preferential seating to benefit the student, free from distractions. 2. Short breaks after completing tasks. 3. Squeeze balls or tools to help with fidgety students. 4. A quiet area free from distractions for testing or studying 5. Focus cues from the teacher 6. Teacher keeps a notebook for student organization 7. A student agenda for parents and students to initial daily. 8. Hand signals for comprehension check-ups during the lesson. 9. Computers to read aloud information to the students   Gifted students will be given enrichment activities |
| **Alternative Assessments** | Students will be given the option to watch a flipped classroom video, complete work problems, complete the Marble Motion Lab and write a summary regarding motion or competing elements of a Tic Tac Toe. Other interactive simulated labs include Gizmos found on the explorelearning.com website. Questions accompany each lab. Modifications will include limiting the number of questions for completion. |
| **References** | This section contains a consistent and properly annotated list of publications related to the research focus for this module.  \*1 Physics 4 Kids-<http://www.physics4kids.com/files/motion_force.html>  Additional resources  HOT Science Labs (go to p.27) -<http://science.dadeschools.net/Instructional%20Resources%202012-2013/Science%20Hands-on%20Activities/HOT%20Science%20Labs%20-%20Physical%20Science%202012-2013.pdf>  <http://idahoptv.org/sciencetrek/topics/force_and_motion/facts.cfm>  <https://getkahoot.com/>  <https://kahoot.it/#/>  <http://www.edutopia.org/blog/vocabulary-instruction-teaching-tips-rebecca-alber>  Vocabulary sort [(description](http://www.readwritethink.org/professional-development/strategy-guides/introducing-ideas-vocabulary-with-30953.html))  <http://www.readwritethink.org/professional-development/strategy-guides/introducing-ideas-vocabulary-with-30953.html>  <https://www.eduplace.com/graphicorganizer/pdf/kwl.pdf>  <http://it.pinellas.k12.fl.us/Teachers3/gurianb/files/AD5483E493EE4299BDAF1BABAD473540.pdf>  Information about the accelerometer <http://processors.wiki.ti.com/index.php/SensorTag_User_Guide#Sensors_2> |
| **Comments** | * You will need batteries with repeated use of the Sensor Tags * The firmware requires an updated to make the accelerometer work properly * The lab was written to help students develop or improve graphing skills. |
| **Author Information** | Esta Lampkin, 2015-2016 Kenan Fellow  Zebulon Gifted and Talented Magnet Middle School  Subjects Taught: 7th Grade Science, Nanotechnology& Robotics Elective  Teacher of 20+ years  elampkin@wcpss.net  Mentor: Dr. Jess Jur, Assistant Professor, NCSU, Textiles & Nanotechnology, Materials Engineering  National Board Certified 2009, |

One Health Challenge / Scoring Rubric

*Note: A score point of 0 is only awarded if the element is missing.*

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| ***Product*** | ***Description*** | ***Highly Proficient*** | ***Proficient*** | ***Developing Proficiency*** |
| ***Research*** |  | ***3 points*** | ***2 point*** | ***1 points*** |
| **Problem Selection** | The problem your group selected is:   * relevant to today’s healthcare concerns * measureable * related to One Health | Contains exemplary work within the category.  Meets 3 bulleted points well. | Contains good or average work within the category.  Meets 1 to 2 bulleted points well. | Contains below average work within the category.  Meets none of the bulleted points well. |
| **Solution Research** | The solution:   * solves the problem that your group selected * the solution is created for a targeted audience * the solution is well researched and students can defend their design solution | Contains exemplary work within the category.  Meets 3 bulleted points well. | Contains good or average work within the category.  Meets 1 to 2 bulleted points well. | Contains below average work within the category.  Meets none of the bulleted points well. |
| ***Design*** |  |  |  |  |
| **Feasibility** | The product design works well:   * in the chosen environment * as a sensor on a wearable device * to transmit data (if necessary) in a manner conducive to the technological needs, existing infrastructure, and surroundings * \*\*\****High school only***\*\*\* as a proposed solution for your given problem. The product functions as intended and collects the necessary data to provide a solution to your chosen problem. | Contains exemplary work within the category.  Meets 3 or more bulleted points well. | Contains good or average work within the category.  Meets 1 to 2 bulleted points well. | Contains below average work within the category.  Meets none of the bulleted points well. |
| **Wearability** | The product is able to:   * withstand the movements, temperatures, and fluids found in the environment it is located * be made out of a material that is the least obtrusive for the highest percentage of people (i.e. it is not made out of a material that has many known allergens) * generally comfortable and not too bulky to wear | Contains exemplary work within the category.  Meets 3 bulleted points well. | Contains good or average work within the category.  Meets 1 to 2 bulleted points well. | Contains below average work within the category.  Meets none of the bulleted points well. |
| **Aesthetics** | The product designed considers:   * cultural sensitivity of the area in which the design will be distributed * stylish considerations including whether or not it is visually appealing * designs that reflect a target age and gender group OR are neutral (e.g. bright colors for children, one-size-fits-all sizes, etc.) | Contains exemplary work within the category.  Meets 3 bulleted points well. | Contains good or average work within the category.  Meets 1 to 2 bulleted points well. | Contains below average work within the category.  Meets none of the bulleted points well. |
| **Sensor placement** | The product designed= considers:   * Body location/s that would collect and transmit the most data (i.e. a hydration sensor would be placed on the inner arm) * Body location/s that maximize comfort and minimize discomfort for the wearer * Body location/s that are minimally invasive unless designed specifically for that location (e.g. a sensor in teeth). | Contains exemplary work within the category.  Meets 3 bulleted points well. | Contains good or average work within the category.  Meets 1 to 2 bulleted points well. | Contains below average work within the category.  Meets none of the bulleted points well. |
| **Power** | The product designed is powered by:   * an appropriate type of power (i.e. plutonium for a wearable sensor is too powerful and unsafe) * a power source/s is easily accessible in the selected location or desired market * a method that provides a lengthy lifespan for the product | Contains exemplary work within the category.  Meets 3 bulleted points well. | Contains good or average work within the category.  Meets 1 to 2 bulleted points well. | Contains below average work within the category.  Meets none of the bulleted points well. |
| ***Poster*** | ***Description*** | ***Highly Proficient*** | ***Proficient*** | ***Developing Proficiency*** |
| **Instructions** | The poster contains instructions that are:   * concise on how to use the device * written for the targeted audiences (consider literacy levels or age appropriate words and language) * graphics and designs that aid the user in understanding how to use and maintain the product | Contains exemplary work within the category.  Meets 3 bulleted points well. | Contains good or average work within the category.  Meets 1 to 2 bulleted points well. | Contains below average work within the category.  Meets none of the bulleted points well. |
| **Background Information** | The poster explains:   * how this health issue relates to One Health * how the device is powered and why this type was chosen * how to use the device and the lifespan of the device | Contains exemplary work within the category.  Meets 3 bulleted points well. | Contains good or average work within the category.  Meets 1 to 2 bulleted points well. | Contains below average work within the category.  Meets none of the bulleted points well. |