RESET | Corrosion of Metals

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TEACHER

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SUBJECT/GRADE LEVEL

Subjects:

Physical Science

Algebra 1

Grade Level:

Middle School

High School

Materials

- Goggles
- Test tubes, 25 x 150 mL -6 per group
- 5 cm piece of steel wool each weighing the same and rolled into a worm shape -6 per group
- Salt packets-restaurant individual packs-6 per group
- Hydrogen peroxide (50 ml per group)
- Distilled water bottle (50 ml per group)
- Test tube rack (one per group)
- 20 cm piece of zinc ribbon (one per group)
- 20 cm piece of magnesium ribbon (one piece per group)
- 20 cm piece of copper wire, 18 gauge (one piece per group)
- 20 cm x 1cm piece of aluminum foil (one piece per group)
- Cooking Spray (one per group)
- Rustoleum Paint any color (one per group)
- Graduated cylinders 5 ml- 2 per group
- Hanging weights (5 identical weights per group)
- Iron ring plus stand (one per group)
- Metric ruler (one per group)
- Timer (one per group)
- Thermometer
- Electronic balance

STANDARDS

Next Generation Science Standards

- MS-PS1-2. Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.
- MS-PS3-1: Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
- MS-PS3-2: Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

- HS-PS1-2. Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties.
- HS-PS2-2: Use mathematical representations to support the claim that the total momentum of a system of objects is conserved when there is no net force on the system.
- HS-PS3-1: Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

Mathematics Standards | Common Core State Standards

- CCSS.MATH.CONTENT.HSA.CED.A.2
    - Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
- CCSS.MATH.CONTENT.HSF.LE.A.1
    - Distinguish between situations that can be modeled with linear functions and with exponential functions.
- CCSS.MATH.CONTENT.HSS.ID.B.6.A
    - Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models.

English Language Arts Standards | Common Core State

- CCSS.ELA-LITERACY.SL.11-12.1.A: Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

LESSON OBJECTIVE(S)

Students will investigate the rate of corrosion to conclude which inhibitors are the most effective at preventing corrosion from occurring and explore variations in tensile strength of different metals.

CAREER CONNECTION(S)

Mentor Background:

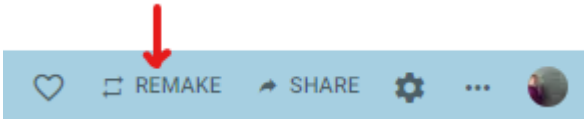
- Kirk Stoffel- Mechanical Engineer: I have been working on armor protection systems for vehicles and personnel for 16 + years and counting. Majority of this work has been and is currently classified. However, portions of my prior work and current projects are unclassified. Those portions are for the most part related to composite materials used in these armor designs. Characterization of these materials (understanding how they perform, why they perform (or don't perform) better, as well as non-ballistic evaluation of these materials. The other project I

can discuss involves insensitive munitions, which means making weapon systems safe for the soldier during times of combat in theater.

- Joseph Labukus- Materials Engineer: My research seeks to understand the degradation mechanisms of many classes of materials(metals, ceramics, plastics) in order to design protection schemes and new materials such as ultralightweight Magnesium Lithium alloys.

STEM Careers: **Metallurgy**, **Engineering** **(mechanical, civil, material)**, **Chemist**

ENGAGEMENT

Classroom	Virtual
Teacher Actions: First, play the following video clip: 1 dead, 7 hurt after Fire Ball ride accident at Ohio State Reminder: Do not tell the students any details of what happened on the carnival ride or how it is related to corrosion. If you want to show a second video clip Deadly accident at Ohio State Fair caused by corrosion that has a news article attached Click here: Ask students to then "think-pair share" what they think could have been the cause of this deadly accident. **Student Actions:** Watch the video of the carnival ride. "Think-Pair-Share" with your table partners or the students around you to compare your reactions to the video and what you think might have caused this accident. Discuss with your class what ideas you came up with with.	**Teacher Actions:** Students will watch the video on the padlet link and you will need to approve their responses to the board. Each student will respond in each column so you will want to read through the responses and look for misconceptions especially within what they think might have caused the accident to occur. Here is the direct link: 1 dead, 7 hurt after Fire Ball ride accident at Ohio State **Student Actions:** Go to this padlet link and watch the video first. Respond with your initial feelings about the video with three emojis and then list one reason you think this accident could have happened. Teachers wishing to make their own copy of the padlet can access the template using either the link above or the QR code below. Once there, to make a copy, you should click "remake" in the top right corner. 

EXPLORATION

Classroom	Virtual
Teacher Actions: Students will be exploring the corrosion of stainless steel with different coverings meant to prevent corrosion. This will allow students to explore different things that are used in the real world to prevent corrosion. Though this lab is set up for students to either work alone or in groups, it will lead to their ability to see how corrosion begins to change the appearance of the metals. For further exploration- students could also measure the ductility or tensile strength of these metals by comparing them back to the control, Student activity: Exploring Corrosion of Metals **Student Actions:** Click on the following link Exploring Corrosion of Metals and follow your teacher's instructions whether to work alone or with a group work through the lab.	**Teacher Actions:** Students will not be able to complete the lab on their own but will watch a demo of the lab the teacher is doing over Zoom or google meets- Another idea for virtual learning would be a lab kit to send home with students to complete showing the before and after so that they can get clear observations of each situation and complete the lab sheet. Here is a link to the virtual lesson: Exploring Corrosion of Metals **Student Actions:** Click on the following link Exploring Corrosion of Metals and make observations of what happened at each step. Record your data and answer the questions. Compare the types of coverings and decide which best protected the metal inside. Answer all the questions and submit your finished document to your instructor.

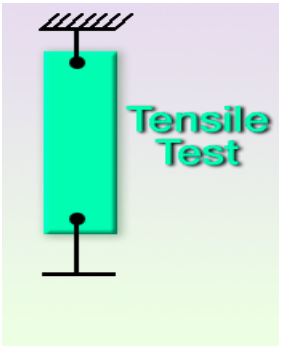
EXPLANATION

Science Classroom	Science Virtual
Teacher Actions: Students can either be teacher led or student led through the following presentation. Have students check their work when completed on this nearpod activity Presentation: Corrosion Student Actions: Work through the following presentation Corrosion and make note of any questions that you have about the presentation.	Teacher Actions: Be available to answer questions as students work through the presentation Presentation: Corrosion Then share a link with students for them to check their learning with this nearpod activity: Student Actions: Work through the following presentation Corrosion and make note of any questions that you have about the presentation.

Math Classroom	Math Virtual
Teacher Actions: Lesson Topic: Rate of Change and slope Using data collected during the exploration, the teacher will plot the sample data points to demonstrate a relationship between two quantities (example: mass and time). This can be done on a white board, tablet, etc (Sample Lesson). Demonstrate the connection between results of the lab and "steepness" of the slopes. Have students calculate unit rate. **Extension:** With the shared data, the teacher can review central tendencies (mean, median, mode), and box and whisker plots. Group the students so that one group is assigned to each trial. Each group should create a box and whisker plot for their assigned 15 minute trial. If the students need a review, the teacher should demonstrate with the "control" data. The teacher should use the box and whisker plots to show how the size of	**Teacher Actions:** Lesson Topic: Rate of Change and slope The teacher should download the Explain Everything presentation. Based on what the teacher prefers, the teacher may choose how he or she wants to present the information to the students. Open Collaboration: Students and teachers can move through slides and whiteboard together freely. (Students can move objects and write on screen) Presentation: Teacher explains and the audience follows. (This option will require the teacher to move objects and draw). The teacher should have data from the lab readily available (based on whether students were able to collect their own data or watched a virtual lab). The teacher should prompt students to choose two quantities to graph (suggested: time and mass or time and temperature). The teacher should then demonstrate how to choose a scale (if students do not know how to do this already)

a box varies, even though it represents 25% of the data. This learning is cross-curricular to the idea of precision and sources of error in the science classroom. This is also a good time to demonstrate how outliers greatly affect the results (both the linear pattern on the original graph and the length of each of the quartile boxes). **Student Actions:** Students will be given a graph (whiteboard, paper, tablet, etc.) to graph the data from each of their trials. They will then calculate the rate of change for their data and input it into a shared google sheet. (Template: Class Spreadsheet). With this shared data, students should calculate the average corrosion rate for each trial and plot that on a class graph. Students are also encouraged to calculate other central tendencies. **Extension:** Students should calculate the Q1, Q2, Q3 based on the assigned data. They should then construct a box and whisker plot.	and how to graph the data for one of the test tubes. The teacher should then demonstrate how to determine the **rate of change** and explain how this is also known as **slope**. The teacher should then prompt the students to graph the data for the 6 test tubes (copying the graph from the "template" slide onto their own slide in the presentation). Prompt the students to choose a different color for each test tube. After graphing the data, they should then calculate the rate of change for each trial. From there, the students can organize the rates for each trial and draw conclusions. Once the students have completed this, the teacher should prompt them to put their data in the shared spreadsheet and the class can calculate the average corrosion rates. **Student Actions:** Students will follow the teacher presentation and ask/note questions that they have. They will create their own graphs of the data and determine the slopes for each of their trials. To conclude the lesson, they will input their data into a shared spreadsheet.

ELABORATION

Classroom	Virtual
Teacher Actions: **Tensile strength of metals** Students will use the concepts that they learned about corrosion to discover new characteristics of metals when related to tensile strength and calculate stress and strain on metals. **Make sure that you test your metals ahead of time to make sure the weights and setup work based on your materials on hand. Note: some metals will stretch noticeably more than others, making the measurements easier.** 1. Gather the same five metals as previously used in the lab with corrosion. Measure the length, width and thickness of each piece. Record your data. 2. Punch two holes at each end of the sheet metal. If you are using wire make sure you secure it very tightly at the top so there is no slipping. 3. Using a ring stand or another method your teacher shows you hang one end of your material from a solid point that does not move, then you can hang weights/spring scale on the other end. 4. Add one weight. 5. Wait one minute and remeasure (only the length). 6. Then add an additional weight. Set your timer for another minute. Remeasure only the length. 7. Add another weight and continue measuring length each minute until you have added all 5 weights.  At the conclusion of the lab, the teacher should share how a tensile tester works to measure	**Teacher Actions:** **Tensile strength of metals** Students will not be able to complete the lab on their own but will watch a demo of the lab the teacher is doing over zoom or google meets- Another idea for virtual learning would be a lab kit to send home with students to complete showing the before and after so that they can get clear observations of each situations and complete the lab sheet. **Student Actions:** Click on the following link **Tensile strength of metals** and make observations of what happened at each step. Record your data and answer the questions. Answer all the questions and submit your finished document to your instructor.

metal strength and why the types of metals are important. Some links are given below. Climbing Carabiner Testing Real World Application Extensometer (Seeing the math) **Optional:** If the school is close to a university or lab that has a tensile tester, the teacher could take the students there to test various metals, instead of using the setup described above. **Student Actions:** Fill out the following worksheet Tensile strength of metals as you work through the following activity.	

EVALUATION

Classroom	Virtual
Teacher Actions: Summative assessment Quiz Corrosion and Tensile Strength (doc) can be printed or used virtually as a google form. Reminder: Make a copy for your own use in your classroom so you receive your own data.. Alternative Summative assessment idea: **(use this method for math classroom instead of corrosion google form given above)** Have students design and run their own lab testing other variables using their knowledge of corrosion and tensile strength. Approve any plans for safety concerns before allowing students to test their hypothesis. **Student Actions:** Students will take the quiz Quiz Corrosion and Tensile Strength (doc) and submit to the instructor for feedback. **Alternative Summative assessment idea:** Design and run your own lab testing other variables using your knowledge of corrosion and tensile strength. Write a hypothesis, procedure and submit to your instructor for approval. Once approved, run the test and write your observations in your data table and analyse your results. Explain them in a conclusion statement and submit to your instructor.	**Teacher Actions:** Summative assessment Quiz Corrosion and Tensile Strength (doc) can be printed or used virtually as a google form. Reminder: Make a copy for your own use in your classroom so you receive your own data.. Alternative Summative assessment idea: Have students design and run their own lab testing other variables using their knowledge of corrosion and tensile strength. If this is to be achieved at home it is best that they use other materials to test or different temperatures etc. You may wish they submit their plan first before proceeding with testing for double checking any safety concerns, **Student Actions:** Design and run your own lab testing other variables using your knowledge of corrosion and tensile strength. Write a hypothesis, procedure and submit to your instructor for approval. Once approved, run the test and write your observations in your data table and analyse your results. Explain them in a conclusion statement and submit to your instructor.

REFERENCES

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