Lesson Guide: The Breaker of Molecules: TiO2, Blue Methylene/dye, H20

(Sub title)

Curriculum Alignment to Standards

Arizona Standards:

6: Conduct a controlled investigation using scientific processes (S1, C2, PO3- NEWT)

6: Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and computer logs (S1, C2, PO5- NEWT)

6: Explain how the quality of water affects the quality of life. (S4, C3, PO2- NEWT)

NGSS:

NS. 5-8.1 Science as Inquiry

As a result of activities in grades 5-8, all students should develop--

- *Abilities necessary to do scientific inquiry*
- *Understandings about scientific inquiry*

NS. 5-8.6 Social and Personal Perspectives

As a result of activities in grades 5-8, all students should develop understanding

- *Personal health*
- *Populations, resources, and environments*
- *Natural hazards*
- *Science and technology in society*

ELPS:

Compare and contrast the information gained from experiments, simulations, video or multimedia sources with that gained from reading a text on the same topic. (6 - 8.RST.9)

Produce clear and coherent functional writing (e.g., formal letters, envelopes, procedures, labels, timelines, graphs/tables, experiments, maps, caption, charts, diagrams) in which the development, organization, and style are appropriate to task, purpose, and audience.

(AZ.6 - 8.WHST.4)

CCRS:

6th: Cite textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text. (6.RI.1)

Essential Questions

- What is nanotechnology?
- What is a nanoparticle or nanomaterial?
- What are pros and cons of using nanomaterials with humans and in the environment?
- EXPERIMENT ESSENTIAL QUESTION: Can a nanomaterial such as Food Grade Titanium Dioxide (TiO2) neutralize and break apart molecules of blue methylene when added to water? Does exposure to the sun enhance this process? Could this method potentially be an answer to help cleanse water from pollutants?

Essential Understandings

Students will understand that …

- Students will be able to design and build a water filtration system using natural products such as activated charcoal, sand, soil, and other manufactured products like coffee filters, cotton balls, and cheesecloth.
- Students will be able to visibly see how an engineering nanomaterial can break down molecules in water that has blue methylene added to it. Blue methylene or dye is acting as a pollutant.
- Students will be able to explain pros and cons of using nanomaterials in the environment. What are the risks? What are the benefits?

Terminology

Nanotechnology	**Food Grade**	**Purification**
Nanoparticles	**Engineering**	**Photo-catalyst**
Nanomaterials	**Molecules**	**Solar disinfection**
Titanium dioxide	**Filtration**	

Prerequisites

Students take part in a month long unit called the Water Project which is a Kyrene School District sixth grade lesson that, in collaboration with Arizona State University and Concord Consortium, educates students about the scarcity and importance of water nationwide and globally.
Students are introduced to Arizona's water systems, how Phoenix specifically gets its water, and how our nation is not in a water crisis situation per se like other places worldwide/nationwide. In the USA, we have the luxury of turning on a faucet and clean water appears.
Students are also introduced to water crisis issues of other parts of the world (third world countries- namely Africa). They are exposed to real life images that depict how children and women have to walk miles daily just to get dirty water. Students are exposed to how women and children carry the water they find in trash containers or anything they can use. They read many nonfiction informational texts about the scarcity of water throughout the world.
Building a water filtration system:(Engineering) Using pond water from a local neighborhood, students are challenged to build a water filtration system by working independently first to design their system. They are to sketch their ideas in their interactive engineering notebooks. Thereafter, they share their ideas with members of their group to come up with the best design. Students can use three of nearly eight options for filtration. Some supplies are natural in the environment and some are manufactured. Collaboration then results in their final product and they work together to physically build their systems using cocktail plastic cups and push pins. Once their system in built, and filters are placed within cups, the water is then poured through. Results are compared amongst the class.
Testing the water for pollutants: After the filtration, students test the same pond water for its pH, phosphate, and nitrate levels. Students are taught about the different contaminants and why it could be harmful to the water and harmful if consumed by a living organism. Testing is completed through materials provided by the university. Tablets that would centralize the pollutant are added and students compare their results to color charts provided. Students record their data in their notebooks and comparisons are done again.

Research and read about nanotechnology and nanomaterials and their significance in science.

Instructional Considerations

What type of information should the teacher need before address the lesson?

- What is nanotechnology?
- What are nanoparticles/nanomaterials?
- Why are they used?

Are there any setup requirements or research needs?

- Research: students will read published articles about nanotechnology and Ti02 specifically in preparation for their experiment. Students will also watch a video created by professor Andrew Maynard about nanomaterials and nanotechnology to better enhance their understanding.

Are there common misconceptions students may have?

- They will be challenged in their understanding about nanotechnology since it is such a foreign concept and difficult to grasp being that these materials and particles are so small.
- Will certain nanomaterials be dangerous to use or even consume?
- What are the risks or the benefits of using nanomaterials?
- How do we know that the water is safe to consume?

Materials

- Food grade Ti02
- 16.9oz plastic bottles
- Aluminum foil
- Cotton balls
- Coffee filters
- Sand
- Activated charcoal
- Plastic bottles or tubing for constructing new filtration (IF TIME)

Day 1: (20 minutes) Brainstorm a problem and a solution

- Have students brainstorm ways they think they could make the water crisis better. How could they solve the issue of not having clean water in certain parts of the world? What are things they need to think about when making their choice of how to solve the problem? What would the risks and benefits of their choice be?
- Students will share ideas. Class discussion about how difficult it can be to solve a problem to something because of the consequences- good or bad.

Day 1: (20-30 minutes) What is nanotechnology?

- Student Investigation-
- Small video clip created by Andrew Maynard PHD at ASU about nanotechnology innovation, nanomaterials, and risk vs. benefits of nanotechnology.
    - Students will be given a small section of reading that introduces nanotechnology and why it is used in science. They will use a Venn Diagram to compare risks and benefits as described in their reading of nanoparticle/nanomaterial use.
    - Students will share their results with partners.
    - Students will be introduced to foods that have Ti02 within them. This will help to build life relevance and help them make a connection to Ti02 and foods/products they sometimes consume/use.
- Questions:
    - Why do scientists think nanotechnology is good to use? Why can it be harmful?
    - Why is it used in foods and other products?
    - What makes nanotechnology so appealing to use?

Day 2: (50 minutes) TI02 and Blue Methylene/ Food Dye investigation

- Students have now been introduced to nanotechnology and nanoparticles. In groups of four, students will be given experiment supplies of a clear plastic cup, Food Grade Ti02 (1-2g- powdered), 1g of Blue Methylene or one drop of food dye and regular drinking water.
    - Telling students: Up to this point we have studied water, how we get water here in Arizona, and learned that there are places in the world that do have access to clean drinking water. You have even brainstormed ways that you could fix the water crisis in a third world country. Do you think there is a nanomaterial that we could use that would cleanse a pollutant in water that could be consumed by humans? Would it completely destroy the pollutant? For your investigation/experiment I want you answer this question before we begin
        - EXPERIMENT ESSENTIAL QUESTION: Can a nanomaterial such as Food Grade Titanium Dioxide (Ti02) neutralize and break apart molecules of blue methylene or food dye when added to water? Do you think it will break it down completely? Not break it down at all? How will the water change when exposed to sunlight and without sunlight?
- Students will sketch a drawing or take a picture of the water in the cup before the Blue Methylene/Dye is added, after it is added, and after Ti02 is added. Students will do this in a step by step process as a class. All of this will be done in the classroom. Once Ti02 is added, students will describe their observations in their engineering notebooks. Students will go outside and place their water in sunlight and observe what occurs.
- After the Ti02 is added and exposed to sun and left out to be observed for about 10 minutes, students will return to class to describe their results and thoughts. How much did the water change?
- Teacher at this point exposes water that was not exposed to sunlight (wrapped in foil) and the water that was left under normal lighting in classroom which will prove Ti02 as photo-catalyst. Students make comparisons between exposed and non-exposed water. Students share remarks.

Day 3: Elaborate (20-50) How clear is our water?

- Lets compare our water amongst all groups. Have students look and compare different cups. Are there similarities? Differences?
- Would you drink the water based on its clarity? Why or why not?
- How could we make the water more clear? Could we build another filter? Would it have to be as elaborate or could we use one material to make the water clearer? How would we build it?
- Have students explain how they would filter this water and what they would use to filter? They can only use one filter of supplies provided: activated charcoal, coffee filters, and cotton balls, sand.
- Have students make another filter and record results
- Compare as a class.
- IF TIME: how could we make the water more clear? We need to filter out the Ti02. Let's construct a mini filter and see how it would work out and what our water will be like when it passes through.

Science Evaluate (10 minutes) What did we learn about nanotechnology and its uses to clean water?

Using your data you recorded and any observations, do you think this nanomaterial Ti02 could cleanse water freely from all pollutants? Why or why not? What are some things to consider when using the Ti02? Students write their answers in their notebooks as an assessment. Have them think back to day 1 and their notes about having a problem and solving it and the consequences of that choice. Have them add thoughts about this given the investigation.