

Names: _____

Ultraviolet Radiation and TiO₂ Nanoparticles: What do they do?

Activity 1.

Students will work in teams. An assigned team leader will operate the UV lamp powered by AA batteries. All team members are required to wear gloves and safety splash goggles for the following activities. Do not look directly into the lamp or lasers!

Procedures:

- A. Fill a microcentrifuge tube with 0.5 mL of AgNO₃ and H₂O solution using dropper pipet.
- B. Using another **new** pipet, transfer 0.5 ml of CH₃OH into the microcentrifuge tube with the solution from A. Close the lid and mix the solution by gently shaking the tube.
- C. Transfer **three drops** of above solution from step B (CH₃OH, AgNO₃ and H₂O solution) into each of the three depressions in the spot plate.
- D. Now, using another new dropper pipet, transfer two drops of the nanoparticle solution (TiO₂) into the second depression and third depression of the spot plate. Using a clean toothpick for each depression gently stir the spot plate to mix the solution in each of the depression.
 1. Observe all three depressions for 120 seconds under classroom light: Record your observations for each depression.

E. Now **cover the third depression** with the black fabric.

Place the **first and second depression** under a handheld UV lamp. Switch on the UV lamp. Record the color of each solution you observe at 20 second intervals for 80 seconds in the chart below.

Complete the following time vs color of the solution in the *first depression* using the coded color scale bellow. **Please turn off UV light when checking the color of the solution.**



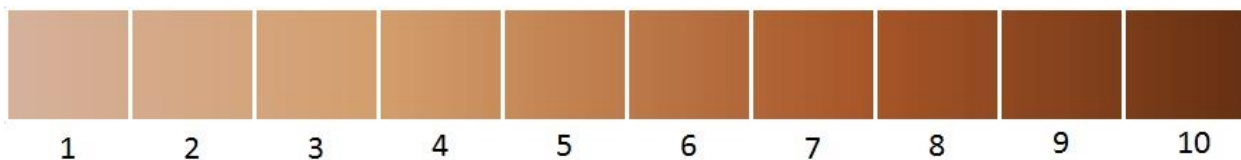
Time vs Color change of TiO_2 Solution in **depression 1**

If there is no change (NC) or the color is off the scale use (NS)

Record the color changes by using the code number shown in above color scale.

0 sec	20 sec	40 sec	60 sec	80 sec

Complete the following time vs color of the solution for depression two using the coded color scale below. **Please turn off UV light when checking the color of the solution.**



Time vs Color change of TiO₂ Solution in **depression 2**

Record the color changes by using the code number shown in above color scale.

0 sec	20 sec	40 sec	60 sec	80 sec

G. Remove the black rubberized fabric on top of the **third depression**. What's the color of the solution in this depression? _____

What do you expect will happen if you turn the UV lamp on the uncovered third depression?
_____ Try it. What were your results?

Complete the Following:

1. What was the purpose of irradiating the methanol and silver nitrate and water solution in the first depression of the spot plate?
2. What substances were the same in all three spot plate depression solutions? Why was the third depression covered with black rubberized fabric?
3. What changes did you observe when looking at the solution in the second depression, (including TiO₂, silver nitrate, water, and methanol solution) under UV light? How does it compare to the silver nitrate, water, and methanol solution under UV light in the first depression?
4. What do you think caused the changes you found in the second depression solution on spot plate?

5. What questions do you have about the results you found? What do you think would happen if you took the solutions out into sunlight? How would you develop an investigation to answer your question(s)?

6. Look at your Time vs Color Change Data. What do you notice about the changes in color for each solution over the time period? Explain

7. What are the two variables needed for the color change in the reaction?

8. What would a balanced equation for the reaction look like?

9. Would the reaction occur without TiO_2 ? How do you know?

10. Would the reaction occur without UV radiation? Explain

11. A catalyst is a substance that speeds up a reaction without being consumed by the reaction. Is there a catalyst involved in this reaction? If so, what do you think it is? What is your reasoning?

12. A photocatalyst is one that is triggered by light or radiation. Now consider TiO_2 and UV radiation. What is the relationship?

Elaborate Rubric

Criteria	7	5	3	1	Score
Sets up and describes the solutions for the tests.	Includes all aspects of the design. Set up is appropriate. Describes the solutions for testing	Includes most aspects of the design. Set up has few minor errors. Describes the solutions for testing with few errors	Includes some aspects of the design. Set up has several errors. Describes the solutions for testing with some errors	Includes few aspects of the design. Set up is not appropriate. Few descriptions of the solutions for testing	
Creates a labeled table, records findings for each laser and includes the wavelengths of light emitted by each laser	Creates a labeled table, records ALL findings for each laser in a table. Includes the wavelengths of light emitted by each laser	Creates a labeled table, records findings for each laser in a table. May have minor errors. Includes the wavelengths of light emitted by each laser	Creates a labeled table, records findings for each laser in a table. (may have major errors/omissions). Includes the wavelengths of light emitted by each laser	Records few findings for each laser in a table (may have many error/omissions). Include the wavelengths of light emitted by each laser	
Draws appropriate conclusions using evidence to support the conclusion.	Draws appropriate conclusions using evidence to clearly support the conclusion.	Draws appropriate conclusions with some minor errors with evidence to support the conclusion.	Draws appropriate conclusions with several errors; some evidence missing to support the conclusion.	Lacks appropriate conclusions has missing or inaccurate evidence to support the conclusion.	
				total	

Evaluation Rubric:

Criteria	7	5	3	1	Score
Describes how to identify the coated side of glass.	Describes how to identify the coated side of glass.	Describes how to identify the coated side of glass (minor errors in description)	Describes how to identify the coated side of glass. (several errors in description)	Describes how to identify the coated side of glass but includes many missing elements and inaccuracies.	
Explanation includes appropriate use, definitions or descriptions of the following: photocatalyst, (TiO ₂), nanoparticle, visible spectrum, ultraviolet radiation,	Explanation Includes ALL terms with correct definitions, descriptions and appropriate usage of terms noted in the criteria.	Explanation Includes 5 terms with correct definitions, descriptions and appropriate usage of terms noted in the criteria	Explanation Includes 3 with correct definitions, descriptions and appropriate usage of terms noted in the criteria	Explanation Includes 1 correct definition, descriptions or appropriate usage of terms noted in the criteria	
Equation includes a labeled and balanced equation	Equation completed with accurate labels	Equation completed but has minor errors	Equation completed but has major errors	Equation is incomplete or has many omissions	
					Total

Chemical Preparation and Materials List

Chemical #1: Purchase silver nitrate solution commercially

Chemical #2: Methanol: commercial available >99% methanol 25 ml

Chemical #3: TiO₂ Solution: Weight 10 mg TiO₂ nanoparticles (solid powder), and add 20 ml of water to make suspension of TiO₂ particles.

List of Supplies per Team:

Local stores:

- Plastic sheet to cover table top for experiment (Cut large 15 x15 inch plastic sheets from garbage bags)
- Black out cloth or plastic (5 x5 in square)
- Timer or stop watch (available at local stores)
- Measurement cup (at least one, plastic is fine)

Science Materials Supplier:

- Goggles (for all students)
- 3 to 5 pipettes (plastic is fine; there are three chemicals, thus a minimum of 3 pipettes is required per experiment)
- 2 centrifuge tubes attached lids (plastic is fine; provides means of rough measurement and to shake gently for complete mixture)
- Chemical solutions (3): silver nitrate solution, methanol, and TiO₂ solution
- Wet well plate (depression plates)
- Ultra violet lamp and batteries (*This can be done outside but the timing is difficult to record as the change occurs rapidly*).
- Color strip for color coding (laminated colored activity sheet strips) or print the entire sheet with a color printer.