Name:_____ Date:_____ Class:_____

Student Worksheet

Catalytic Conversions: Guided Inquiry

Safety

Avoid splashing hydrogen peroxide into the eyes or onto other areas of the body. Any spills of calcium chloride on the skin should be immediately flushed with water.

Introduction

Catalysts are in the news! The most valuable part of your car that thieves want to steal is your catalytic converter. Inside a catalytic converter are nanoparticles, which are 10 times smaller than the hair on the eye of a bee. A nanoparticle is on the savle of 1- 100 nanometers. One nanometer is $1x10^{-9}$ meters. Catalysts in the nanoscale range are important because of the greater surface area afforded by nanoparticles. Surface area is known to increase with decreasing particle size (increased surface area to volume ratio) and reaction rates are, in turn, related to surface area. With greater surface area, there is more area with which the chemical agents can react. Nanoparticles allow for greater surface area and therefore faster reactions. Since these particles are so small, researchers

Materials

- 10 ml of alginate-glass MnO_2 mixture
- 30 ml 5% $CaCl_2$ solution
- 3% H_2O_2 solution
- glass stirring rod
- plastic syringe or 1 ml dropping pipette
- petri dish (100mm diameter)
- Vernier caliper
- hand lens or stereomicroscope
- 3" plastic screen or cheesecloth
- tap water
- paper towel
- blank data table (sphere)
- blank data table (cylinder)

Question

What will affect the size and shape of the "nanoparticles" that you will be creating?

Make a Prediction

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Procedure

1. Fill the small plastic cup with $CaCl_2$ solution.
2. Using a plastic syringe or pipette, add drops of the alginate mixture, one at a time, to the solution. Many factors affect the size and shape of the structures. Experiment to discover how to make consistently sized spheres and consistently sized cylinders. You can take a closer look at the alginate structures by using the screen provided to remove them from the solution and to rinse them in water.
3. Once you feel that you understand how to create structures that are of consistent sizes and shapes, use the screen to remove the "practice" structures from your solution. Now try to create 10 spheres similar in size.
4. Remove the alginate structures from the $CaCl_2$ solution using the screen, and rinse them with water.
5. Use the calipers to measure and record the diameter of each of the spheres in the table below.
6. Now place the alginate structures into a petri dish half filled with 3% hydrogen peroxide. Then look at the structures in the dish under greater magnification. Record a description of what you now see (on the table for observations) and identify questions to ask.
7. Repeat steps 3–6, creating cylinders instead. In step 5, also measure and record the length of each of the cylinders on the table below.
8. Return the structures made to the $CaCl_2$ solution; you will use them in the next activity.

Record Your Observations

Use the tables below and on the next page to record the measurements and observations you have made.

Sphere	1	2	3	4	5	6	7	8	9	10
Diameter (mm)										

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Cylinder	1	2	3	4	5	6	7	8	9	10
Diameter (mm)										
Length (mm)										

Alginate structures in H_2O_2	Observations under magnification: What else do you observe? Sketch and describe.

Analyze the Results

1. Show how you calculated the percentage of alginate structures that were the same size. Show all of your work on a separate page.
2. What factors were controlled in this reaction?_____

Draw Conclusions

1. How successful was your group in making alginate structures that are the same size? Justify your success through the percentage of structures that were the same size and shape.
2. What factors affected your ability to be consistent?

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3. Nanoparticles are structures that cannot be seen by an optical microscope. They are too small to be seen within the range of visible light. There are instruments that allow us to image them based on forces at the atomic scale. They are much, much smaller than the structures you made today. What problems may researchers run into when trying to create a batch of nanoparticles that are all the same size and shape?

_____

_____

_____

Student Worksheet or Guide

Title

Materials

- Item 1 (amount)
- 25 mL this
- 25 cm that
-

Make a Prediction

_____For the teacher's guide, provide a sample student prediction here in red._____

_____

___

Conduct an Experiment

1. step 1
2. step 2
3. etc…

Insert drawing or table, if necessary

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Record your Observations

A table or something similar will be provided for students to write down their observations. Please modify this section as necessary. Please provide sample outcomes in the table in red.

	Test 1`	Test 2	Test 3
Control			
Variable			
Variable			
Variable			

Analyze the Results

1. Did you observe what you predicted?

   _____

   If not, how did your observation differ from your prediction?

   _____

   _____

   _____

2. Why was it important to have a control group?

   _____Place a sample answer here for teachers in red_____

   _____

   _____

3. Does your observations leave you with any more questions? Do they enable you to make more predictions? If so, what are they?

   _____Place a sample question and prediction here that students might come up with to help prepare teachers in red_____

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4. Add any other analysis questions, with

Place a sample answer here for teachers in red

Draw Conclusions

5. Example: Based on your results, do you feel that _____? Explain your answer.

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