Teacher's Preparatory Guide

The Bigger the Better-Not Always True – Exploring Size Effect on Chemical Reaction Times

Purpose
Many physical characteristics effect how matter reacts with other matter. Size does matter. This lesson will explore the reaction time of different size grains of salt when added to soda water. The objective is to determine if surface area affects reactivity time.

Time required:
One 50 minute class period

Level:
Upper elementary to middle school
Groups of 3 students

Teacher Background

The more finely divided the solid is, the faster the reaction happens. A powdered solid will *normally* produce a faster reaction than if the same mass is present as a single lump. The powdered solid has a greater surface area than the single lump. This causes an increase in the number of collisions per second which increases the rate of reaction. In nanoscale science and engineering scientist and engineers utilize the fact that size is important in chemical reactions. They know that reaction rates increase as the size of the material decreases. This is because as the substance decreases in size its surface to volume ration increases creating a greater area for the substance to react with the surrounding material. To learn more about the importance of size and scale in nanotechnology check out the NanoSense unit – *Size Matters* at:
http://nanosense.org/activities/sizematters/index.html

For additional information go to:
www.purchon.com/chemistry/rates.htm
http://www.docbrown.info/page03/3_31rates.htm

Materials (per group)

3 - 100 mL graduated cylinders

1 L soda water

5 - 10 g (approx) each of rock salt, sea salt, and table salt

Timer or stopwatch

Weigh dishes or similar to hold salts

Developed by Kaye Sheets
Development and distribution partially funded by the National Science Foundation

NNIN Document: NNIN-1058
Rev: 08/2008

Advance Preparation
Measure the rock salt first since it will vary in weight and it is necessary for all weights to be equivalent. Then obtain an equivalent weight of the other salts.

Safety Information
Goggles are required for this activity. If graduated cylinders are glass, make sure students are cautioned about breakage.

Directions for the Activity

1. Make a chart of physical characteristics that students know will affect rate of reaction. (Temperature, pressure, concentration, size of molecules) Explain that today's activity will investigate how molecular size effects rate of change.
2. Hand out student guide sheets.

Procedure (from Student Activity Guide)

1. Pour 75 mL of soda water in each cylinder. Label the cylinders as rock, sea and table.
2. Simultaneously place the appropriate salts in each cylinder.
3. Observe the reaction time of each. Record how long it takes for each salt to fully dissolve in the soda water.

Cleanup:

Make sure that students are aware of where to dispose of materials at the end of the activity. Salts should be diluted with ample water.

Worksheet (with answers)

Worksheet with answers follows after National Science Education Standards.

Assessment
Questions:
1. Since the mass of each sample is the same, what could have made the difference in the rate of change? (Since the mass of each sample is the same the only variable is the size o the crystals. The increased surface area of the table salt allows many more reactive sites for the soda and salt to react, releasing more CO2.
2. If you were to take Alka seltzer and water in film canisters or pill bottles to make "rockets" would it make a difference if you used the whole Alka seltzer tablet or if you crushed it? (The crushed tablet has more surface area so it may go the highest)

Resources:
To learn more about nanotechnology, here are some web sites with educational resources:
http://www.education.nnin.org
http://mrsec.wisc.edu/Edetc/modules/index.html
http://nsec.wisc.edu/
http://www.nanoed.vt.edu/links.htm

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National Science Education Standards
Standard B

Structure of atoms
Structure and properties of matter
Chemical reactions
Motion and forces
Interactions of energy and matter

Student Worksheet or Guide

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Make a Prediction

Students are to determine if molecular size affects rate of change. Some students will say yes, other students will disagree.

Conduct an Experiment

1. Pour 75 mL of soda water in each cylinder. Label the cylinders as rock, sea and table.

2. Simultaneously place the appropriate salts in each cylinder.

3. Observe the reaction times of each. Record the time it takes for each salt to dissolve in the soda water on the table below.

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Record your Observations

	Rock	Sea	Table
Amount of soda water	**75 mL**	**75 mL**	**75 mL**
Amount of salt	**Between 5-10 g**	**Between 5-10 g**	**Between 5-10 g**
Reaction time	**Times will vary**	**Times will vary**	**Times will vary**

Analyze the Results

1. Did you observe what you predicted? Explain -

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

2. Would it be important to have a control group? Which of the salts would you use as a control group? Why?

   Table - it dissolves the fastest and is the easiest to observe

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

   Sample question may be 'Does it have to be soda water?' Would it work different if other liquids were used?

4. How do you think this activity would have gone if you had salts that were "nano" is size? Nanosized particles are on the scale of 10^{-9} well beyond the visible range which your salts are in.

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Students should be able to give a response based on their observations from activity. They should be able to sugest that the smaller the size the faster the reaction time. Nano would be the fastest because of high surface to volume ratio.

Draw Conclusions

5. If you were to take Alka Seltzer and water in film canisters or pill bottles to make "rockets" would it make a difference if you used the whole Alka Seltzer tablet or if you crushed it? (The crushed tablet has more surface area so it would react faster and make the rocket go the highest). For younger student they should be able to note that the smaller the sixe of the material the fasater the reaction.

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