Teacher's Preparatory Guide

The Surface Area-to-Volume Ratio of Nanoparticles: Part II

Purpose This inquiry-based lab should be used immediately after doing the *Surface Area-to-Volume Ratio of Nanoparticles* lab, using the same clay samples as before.

Time required One 50-minute class periods or one 90-minute block day

Level Middle school or High school

Safety Information None

National Science Content Standards

Content Standard A

- Abilities necessary to do scientific inquiry

Content Standard B

- Structure and properties of matter
- Chemical reactions

Teacher Background Follow the link below for an easy-to-read article about how surface-to-volume ratio and nanoparticle catalysts may help fuel automobiles.
http://www.memagazine.org/nanoapr05/spheres/spheres.html
This link is a short, sweet article explaining the introduction in the student worksheet:
http://www.guardian.co.uk/uk_news/story/0,3604,1291039,00.html

Materials (the same as in part I of this lab)

- 8.5 inch × 11 inch sheet of waxed paper
- modeling clay, the size of a walnut
- metric ruler
- calipers, with metric markings
- pencil
- calculator

Advance Preparation To assist students with calculating their design, print and distribute surface area and volume formulas from the link below (non-calculus):
http://www.math.com/tables/geometry/index.htm Alternatively, if the student has had calculus, you can use formulas from this link: http://mathworld.wolfram.com/SurfaceArea.html

Cleanup Dispose of wax paper. Store the modeling clay for another use.

Developed by Manuel Casillas and the Board of Regents UCSB
Development and distribution partially funded by the National Science Foundation

NNIN Document: NNIN-1111
Rev: 12/07

Student Worksheet

The Surface Area-to-Volume Ratio of Nanoparticles: Part II

Materials

- 8.5 inch × 11 inch sheet of waxed paper
- modeling clay, the size of a walnut
- metric ruler
- calipers, with metric markings
- pencil
- calculator

January 16, 2008

Dear Team:
Thank you for your recommendation on what shape might work best for our nanoparticle catalyst. Trouble is, the nickel isn't reacting as much as we would like.

Please design a prototype for a new shape of particle that would get the greatest surface area-to-volume ratio. Show us, through calculations, why your shape is better than the ones we gave you.

Just so you know, you are in competition with other teams working on the same project. The best design will get a percentage from our profits!

Sincerely,

John Turner, CEO
Hydrogen Fuel, Inc.

Question Which shape would be the most reactive?

Make a Prediction *Example prediction: I think that a tortilla rolled into a cylinder would be more reactive, because it will have a larger surface area-to-volume ratio.*

NNIN Document: NNIN-1111
Rev: 12/07

Procedure

1. Using the same clay as you used in Part I of this lab, design a new shape with the clay that would be even more reactive than your recommendation in Part I.

Record Your Observations

2. Draw your shape on the back of this page.
3. Label all parts of your drawing.
4. Measure any factors (radius, height, width, etc.) that would contribute to surface area. Make your own data table on the back of this page. Record your measurements there.

Example answer: a rolled-up tortilla (a hollow cylinder)

Shape	Diameter (cm)	Length (cm)	Width (cm)	Height (cm)
Tortilla	*14.7*			*0.2*

Analyze the Results

5. Calculate the surface area of your shape.
6. Calculate the volume of your shape.
7. Calculate the surface area-to-volume ratio of your shape .
8. Be sure to show all of the formulas you used and the calculations you made.

Shape	Surface area (cm^2)	Volume (cm^3)	Ratio $\frac{\text{Surface Area}}{\text{Volume}}$
Tortilla	*348.47 cm^2*	*33.49 cm^3*	*10.40*

Draw Conclusions

9. Explain why your shape is more reactive than the shapes in Part I.

Students should demonstrate through their calculations that their surface area-to-volume ratio is higher than those in Part I of this lab.

Assessment *Students should be able to correctly calculate surface area, volume, and the ratio of surface area/volume based on their measurements used in the "Record your Observations" table.*