Big Idea: Size and Scale[1]

(1)- The Big Ideas of Nanoscale Science & Engineering: A Guidebook for Secondary Teachers. S.Y. Stevens, L.M. Sutherland, & J.S. Krajcik, NSTA Press, 2009.

Factors relating to the size and geometry (e.g. size, scale, shape, proportionality, dimensionality) help describe matter and predict its behaviour.

Learning Goals [1]

1. In order to know the size of an object, it is necessary to be able to compare it to a reference object.

2. Some worlds are too small to be seen with the naked eye. These include the micro-, nano-, atomic/molecular worlds. Each of these contain unique representative objects that help define the scale represented by the worlds.

3. The size of an object may be represented in many ways, both qualitative and quantitative. Each representation has advantages and disadvantages depending on the purpose.

4. Changes in scale can affect the way phenomena work and behave.

5. Students will understand that an object's surface area-to-volume ratio depends on its size and shape. [1]

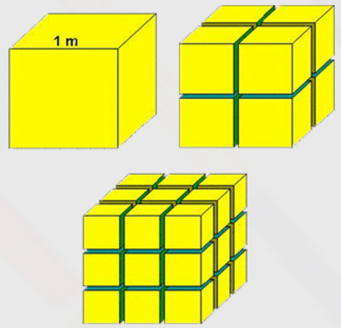


Image from NanoSense www.nanosense.sri.com

Examples

Nanoscale materials have a large percentage of atoms on their surface which can affect their properties. Surface area to volume (SA/V) decreases linearly with increasing size for a given shape but changes disproportionately when the length scale of one dimension is changed. A 10x10x10cm cube may have different properties than a 1x10x100cm rectangle, even though both have a volume of 1000cm3

Pictured: Change in Surface Area on a Divided Cube.

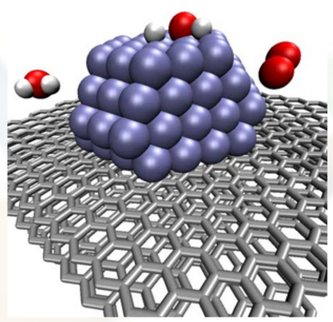


Image University of Wisconsin-Madison College of Engineering press releaase featured 9/2009 at Nanotechnology Now: www.nanotech-now.com/news.cgi?story_id=34743

Cutting-Edge Application

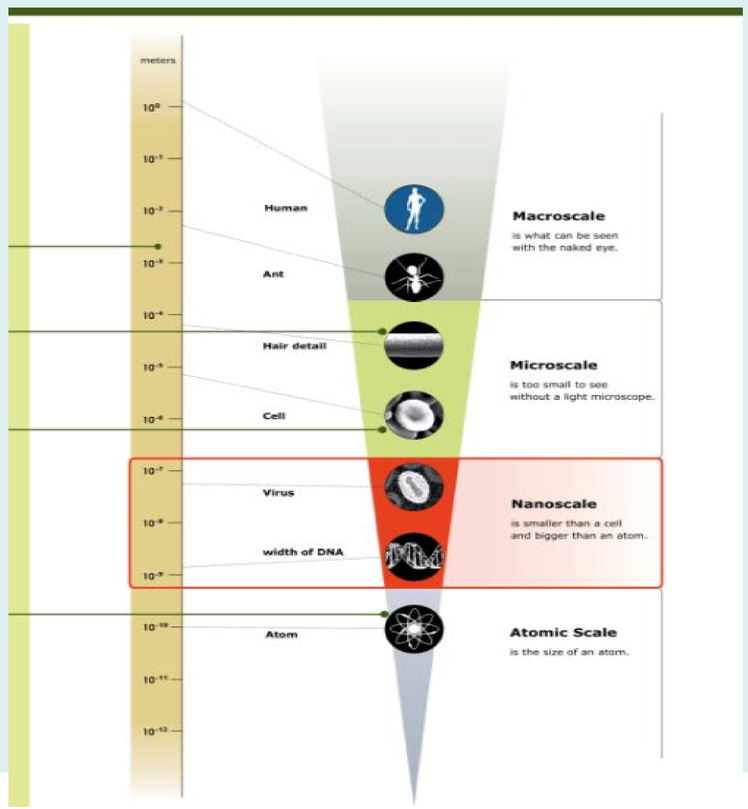
Nanocatalysts have been developed that expose the maximum surface area of the catalyst to the exhaust stream in a car's catalytic converter. These nanocatalysts also minimize the amount of catalyst required, typically expensive platiunum and rhodium. Gold nanoparticles encased in titanium or cerium may offer an efficient (increases oxidation up to 40%) and more cost-effective catalyst for catalytic converters.

Pictured: platinum nanoparticle catalyst on graphite carbon support

Questions to Ponder

How does the two-dimensional size (area) and three-dimensional size (volume) change with respect to changing length scale of one dimension?

Why is there a limit (large or samll) to the size that objects, systems, or models can be? Explain.



Scale Ladder from NiseNet https://www.nisenet.org/catalog/scale-ladder CC BY-NC-SA 3.0 US

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