INTRODUCTION TO NANOTECHNOLOGY EDUCATORS WORKSHOP
January - February 2021

Classroom Resources

Text Resources

- Nanoscale Science: Activities for Grades 6-12, NSTA Press, 2007 (https://my.nsta.org/resource/2596/nanoscale-science-activities-for-grades-6-12)

Introductory Videos

- Nanotechnology Takes Off (https://youtu.be/S4CjZ-OkGDs)
- The Strange New World of Nanoscience (https://youtu.be/70ba1DByUmM)
- Introduction to Nanotechnology - YouTube (https://www.youtube.com/watch?v=8BTGzVScBso&feature=emb_logo)
- Penn State Nanotechnology Applications and Career Knowledge (NACK) Network - YouTube (https://www.youtube.com/watch?v=o5yywKMST0Q&feature=emb_logo)

Paper (2016) that we also shared with participants (full access will need a subscription):

Other Resources:
- NNCI.net (https://nnci.net/resources-educators-k-16)
# Size & Scale

How small is small

- **How to visualize one part per million - Kim Preshoff + The TED-Ed Community** ([Link](https://youtu.be/aa-m8a-jZ0k))
- **Powers of Ten** ([Link](https://www.youtube.com/watch?v=0fKBhvDjuy0))
- **A Boy and His Atom** ([Link](https://youtu.be/oSCX78-8-q0))
- **The Scale of the Universe 2** ([Link](https://youtu.be/uaGEjrADGPA))
- **Scale of the Universe** ([Link](http://scaleofuniverse.com/))
- **Uncertainty Measurements and the Wavelength of Light** ([Link](https://www.nneci.net/ajax/get/node/5292))
- "There's Plenty of Room at the Bottom" ([Link](http://media.wiley.com/product_data/excerpt/53/07803108/0780310853.pdf))
- **Learning Set on Size, Scale, Function and Measurement Systems** ([Link](https://www.nneci.net/sites/default/files/2020-01/Learning%20set%20on%20size%2C%20scale_SG.pdf))

## Size-Dependent Properties

<table>
<thead>
<tr>
<th>Topic</th>
<th>Nano concept</th>
<th>Instructionals</th>
<th>Activities</th>
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<tbody>
<tr>
<td>Electrostatic force dominance</td>
<td>Colloidal particles are on nano scale, too small for gravity to overcome</td>
<td>Video about colloids that explains using size of particles (<a href="https://www.youtube.com/watch?v=XEAlm2zuvc">Link</a>)</td>
<td>Classification of mixtures and particle size activity (NNCI) (<a href="https://www.nneci.net/ajax/get/node/5343">Link</a>)</td>
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<tr>
<td>Electrostatic force dominance</td>
<td>Geckos harness electrostatic forces with nanoscale structures to defy gravity</td>
<td>How do geckos defy gravity? - Eleanor Nelsen (<a href="https://youtu.be/YeSuQm7KfaE">Link</a>)</td>
<td>GeckoMan game (<a href="http://www.coe.neu.edu/Research/geckoman/">Link</a>)</td>
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<tr>
<td>Electrostatic force dominance</td>
<td>Super-hydrophobicity is about harnessing electrostatic forces on</td>
<td>Polar &amp; non-polar (<a href="https://youtu.be/PVL24HAesnc">Link</a>)</td>
<td>Magic Sand Activity (<a href="https://www.nneci.net/ajax/get/node/5372">Link</a>)</td>
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<tr>
<td>Electrostatic force dominance</td>
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<td>Lotus Effect (<a href="https://youtu.be/MFHcSrNRU5E">Link</a>)</td>
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<tr>
<td>Surfaces to control wetting.</td>
<td>Electrostatic force dominance</td>
<td>Surface area to volume ratio</td>
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<td><strong>Nano water guard phenomenon</strong> (<a href="https://youtu.be/z4EYcryEU4">Link</a>)</td>
<td><strong>Drops on surfaces</strong></td>
<td><strong>Activity to teach SA/V trends as objects decrease in size</strong></td>
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<td><strong>Ultra Ever-Dry</strong> (<a href="https://youtu.be/BvTkefJHfC0">Link</a>)</td>
<td><strong>Surface area to volume ratio</strong></td>
<td><strong>What it feels like for a sperm, or how to get around when you are really, really small</strong> (<a href="https://www.wired.com/2011/07/what-it-feels-like-for-a-sperm-or-how-to-get-around-when-you-are-really-really-small/">Link</a>)</td>
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<td><strong>Contact angle</strong> (<a href="https://youtu.be/pk7LcugO3zg">Link</a>)</td>
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<td><strong>Magic Sand phenomenon</strong> (<a href="https://youtu.be/bz1P323bHCo">Link</a>)</td>
<td><strong>Viscosity becomes increasingly dominant in mobility with small size, large SA/V</strong></td>
<td><strong>Styrofoam &amp; salt activity</strong> (Part I) (<a href="https://docs.google.com/document/d/1a7lqjIN_7FJjw51fbgTszmEKlZQD_QpOPVv2NMvRk/edit?usp=sharing">Link</a>)</td>
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<td><strong>Catalysts (catalytic converters in car exhausts, Ag NP covid masks)</strong></td>
<td><strong>Styrofoam &amp; salt activity</strong> (Part II) (<a href="https://docs.google.com/document/d/1a7lqjIN_7FJjw51fbgTszmEKlZQD_QpOPVv2NMvRk/edit?usp=sharing">Link</a>)</td>
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<td><strong>Catalytic converters and nanocatalysts</strong> (<a href="https://www.nnci.net/search/curriculum">Link</a>)</td>
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</table>
| Light matter interactions | Quantum dots | Surface area to volume ratio
Cell size and SA/V - the size of life |
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<td>Light matter interactions</td>
<td>Gold &amp; silver nanoparticles reflect a variety of colors and have a multitude of uses</td>
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<tr>
<td>Light matter interactions</td>
<td>Structural color</td>
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**Surface area to volume ratio**

- **How catalysts work, a nanoscale phenomenon**
  - [How catalysts work, a nanoscale phenomenon](https://www.nnci.net/search/curriculum)
- **Shrink me activity**
  - [Shrink me activity](https://www.nnci.net/sites/default/files/2016-12/Teachers%20Preparation%20Guide.pdf)

**Light matter interactions**

- **What Happens If We Throw an Elephant From a Skyscraper? Life & Size 1**
  - [What Happens If We Throw an Elephant From a Skyscraper? Life & Size 1](https://youtu.be/f7KSlj4Qo0)
- **How to Make an Elephant Explode – The Size of Life 2**
  - [How to Make an Elephant Explode – The Size of Life 2](https://youtu.be/MUWUHf-rzks)

**Structural color**

- **How Animals Hacked The Rainbow And Got Stumped On Blue**
- **Why Is Blue So Rare In Nature?**
  - [Why Is Blue So Rare In Nature?](https://youtu.be/3g246c6Bv58)
- **Measuring Thin Films**
  - [Measuring Thin Films](https://youtu.be/qZgKjZC1uqY)

**Gold & silver nanoparticles reflect a variety of colors and have a multitude of uses**

- **Amazing NanoGold! Why is it red?**
  - [Amazing NanoGold! Why is it red?](https://youtu.be/Emn5vNd6qTc)
- **Researchers develop experimental rapid COVID-19 test using nanoparticle technique: Advanced nanotechnology provides 'naked eye' visual detection of virus in 10 minutes**
  - [Researchers develop experimental rapid COVID-19 test using nanoparticle technique: Advanced nanotechnology provides 'naked eye' visual detection of virus in 10 minutes](https://www.sciencedaily.com/releases/2020/05/200529150643.htm)
- **Creating and Testing Silver Nanoparticle Socks**
  - [Creating and Testing Silver Nanoparticle Socks](https://www.nnci.net/node/5331)
- **Inhibition of Bacteria by Silver Colloid Impregnated Bandages**
  - [Inhibition of Bacteria by Silver Colloid Impregnated Bandages](https://www.nnci.net/node/5333)
- **Spectrophotometry of Metal Nanoparticles**
  - [Spectrophotometry of Metal Nanoparticles](https://www.nnci.net/node/6016)
- **The Effects of Gold and Silver Nanoparticles on Brine Shrimp: A Toxicology Study**
  - [The Effects of Gold and Silver Nanoparticles on Brine Shrimp: A Toxicology Study](https://www.nnci.net/node/5303)

**Light matter interactions**

- **Citrate synthesis of Au nps**
  - [Citrate synthesis of Au nps](https://education.mrsec.wisc.edu/citrate-synthesis-of-gold-nanoparticles/)
- **Synthesis and Characterization of CdSe Quantum Dots**
  - [Synthesis and Characterization of CdSe Quantum Dots](https://www.nnci.net/node/5317)
- **NanoHUB quantum dot lab**
  - [NanoHUB quantum dot lab](https://nanohub.org/resources/450/usage)
- **Quantum Dots: Real-world particles in a box**
  - [Quantum Dots: Real-world particles in a box](https://www.nnci.net/node/5335)
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<td>Quantum effects</td>
<td>Quantum mechanics</td>
<td>wave-particle duality, uncertainty principle (<a href="http://abyss.uoregon.edu/~js/ast123/lectures/lec06.html">http://abyss.uoregon.edu/~js/ast123/lectures/lec06.html</a>)</td>
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<td>How Does a Quantum Computer Work? (<a href="http://youtu.be/g_laVepNDT4">http://youtu.be/g_laVepNDT4</a>)</td>
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<td>Quantum Computers Explained (<a href="https://youtu.be/JhHMJCUmq2">https://youtu.be/JhHMJCUmq2</a>)</td>
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<td>A beginner’s guide to quantum computing (<a href="https://youtu.be/QuR969uMICM">https://youtu.be/QuR969uMICM</a>)</td>
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<td>Quantum Computing and Quantum Supremacy Explained (<a href="https://www.wired.co.uk/article/quantum-computing-explained">https://www.wired.co.uk/article/quantum-computing-explained</a>)</td>
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**Fabrication**

* Nanofabrication Tools: Etching and thin films (https://www.nnci.net/node/6008)
* Wet Etching in Nanofabrication (https://www.nnci.net/node/5319)
Small Scale Stenciling and Sculpting (https://www.nnci.net/node/5310)

Characterization

Mystery Molecules: Identifying Materials with Nanoscale Characterization Tools (https://www.nnci.net/node/5753)
Modeling Scanning Probe Microscopes (SPM) (https://www.nnci.net/node/5657)
Seeing Nano I: Using scanning electron microscopy (SEM) to view nano-size objects (https://www.nnci.net/node/5294)
Seeing Nano II: Using atomic force microscopy to view nano-size objects (https://www.nnci.net/node/5632)

Online news resources for nanoscience and nanotechnology research news

http://www.nano.gov/
https://www.nanowerk.com/
http://www.azonano.com/
http://www.sciencemag.org/
https://www.nature.com/nnano/
http://www.rdmag.com/topics/nanotechnology
http://phys.org/nanotech-news/
http://news.mit.edu/topic/nanotech