

INTRODUCTION TO NANOTECHNOLOGY EDUCATORS WORKSHOP

January - February 2021

Classroom Resources

Text Resources

[Nanotechnology, A Gentle Introduction to the Next Big Idea](https://www.amazon.com/Nanotechnology-Gentle-Introduction-Next-Idea/dp/0131014005) (<https://www.amazon.com/Nanotechnology-Gentle-Introduction-Next-Idea/dp/0131014005>)

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

Introductory Videos

[Nanotechnology Takes Off](https://youtu.be/S4CjZ-OkGDs) (<https://youtu.be/S4CjZ-OkGDs>)

[The Strange New World of Nanoscience](https://youtu.be/70ba1DBUmM) (<https://youtu.be/70ba1DBUmM>)

[Introduction to Nanotechnology - YouTube](https://www.youtube.com/watch?v=8BTGzVScBso&feature=emb_logo) (https://www.youtube.com/watch?v=8BTGzVScBso&feature=emb_logo)

[Innovation Workshop: Nanotechnology, Part 1 — What is Nano? - YouTube](https://www.youtube.com/watch?v=cdZMrcRpq5c&feature=emb_logo)
(https://www.youtube.com/watch?v=cdZMrcRpq5c&feature=emb_logo)

[Innovation Workshop: Nanotechnology — Inside the TechConnect World Innovation Conference - YouTube](https://www.youtube.com/watch?v=1VLHCSMooxk&feature=emb_logo)
(https://www.youtube.com/watch?v=1VLHCSMooxk&feature=emb_logo)

[Penn State Nanotechnology Applications and Career Knowledge \(NACK\) Network - YouTube](https://www.youtube.com/watch?v=o5yywkMST0Q&feature=emb_logo)
(https://www.youtube.com/watch?v=o5yywkMST0Q&feature=emb_logo)

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

[Nanotechnology: CQR \(cqpress.com\)](http://library.cqpress.com/cqresearcher/document.php?id=cqresre2016061000) (<http://library.cqpress.com/cqresearcher/document.php?id=cqresre2016061000>)

Other Resources:

[NNCI.net](https://ncni.net/resources-educators-k-16) (<https://ncni.net/resources-educators-k-16>)

Size & Scale

How small is small

[How to visualize one part per million - Kim Preshoff + The TED-Ed Community](https://youtu.be/aa-m8a-jZ0k) (https://youtu.be/aa-m8a-jZ0k)

[Powers of Ten](https://www.youtube.com/watch?v=0fKBhvDjuy0) (https://www.youtube.com/watch?v=0fKBhvDjuy0)

[A Boy and His Atom](https://youtu.be/oSCX78-8-q0) (https://youtu.be/oSCX78-8-q0)

[The Scale of the Universe 2](https://youtu.be/uaGEjrADGPA) (https://youtu.be/uaGEjrADGPA)

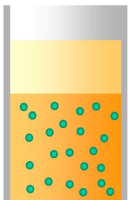
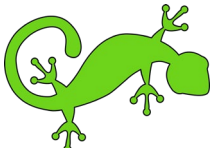
[Scale of the Universe](http://scaleofuniverse.com/) (http://scaleofuniverse.com/)

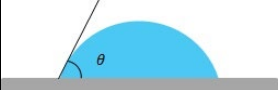
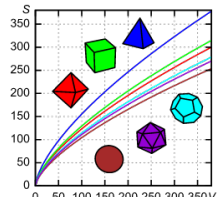
[Uncertainty Measurements and the Wavelength of Light](https://www.nnci.net/ajax/get/node/5292) (https://www.nnci.net/ajax/get/node/5292)

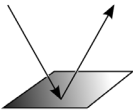
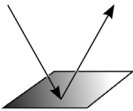
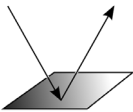
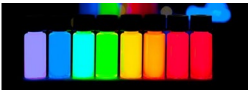
["There's Plenty of Room at the Bottom"](http://media.wiley.com/product_data/excerpt/53/07803108/0780310853.pdf) (http://media.wiley.com/product_data/excerpt/53/07803108/0780310853.pdf)

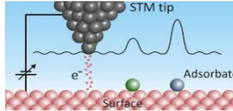
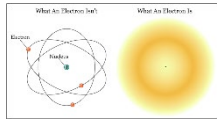
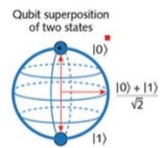
[Learning Set on Size, Scale, Function and Measurement Systems](https://www.nnci.net/sites/default/files/2020-01/Learning%20set%20on%20size%2C%20scale_SG.pdf) (https://www.nnci.net/sites/default/files/2020-01/Learning%20set%20on%20size%2C%20scale_SG.pdf)

Size-Dependent Properties

Topic	Nano concept	Instructionals	Activities
Electrostatic force dominance  Anna Bearne (CC BY 3.0)	Colloidal particles are on nano scale, too small for gravity to overcome  CC0 1.0 Universal Public Domain	Video about colloids that explains using size of particles (https://www.youtube.com/watch?v=XEAiLm2zuvv)	Classification of mixtures and particle size activity (NNCI) (https://www.nnci.net/ajax/get/node/5343) Classification virtual activity Ice Cream Break with Nanoscience: Nucleation and Colloid Suspensions (https://docs.google.com/presentation/d/1b_RJhkBimxjhpDQzEOMxBZ-lag_knQIY2M8NzRgv_CY/edit?usp=sharing)
Electrostatic force dominance  Anna Bearne (CC BY 3.0)	Geckos harness electrostatic forces with nanoscale structures to defy gravity  CC0 Public Domain	How do geckos defy gravity? - Eleanor Nelsen (https://youtu.be/YeSuQm7KfaE) Gecko Tape (https://web.stanford.edu/group/mota/education/Physics%2087N%20Final%20Projects/Group%20Gamma/gecko.htm) Human climbing with efficiently scaled gecko-inspired dry adhesives (https://royalsocietypublishing.org/doi/full/10.1098/rsif.2014.0675)	GeckoMan game (http://www.coe.neu.edu/Research/geckoman/)
Electrostatic force dominance	Super-hydrophobicity is about harnessing electrostatic forces on	Polar & non-polar (https://youtu.be/PVL24HAesnc) Lotus Effect (https://youtu.be/MFHcSrNRU5E)	Magic Sand Activity (https://www.nnci.net/ajax/get/node/5372)

	surfaces to control wetting.  CC BY-SA 3.0	• Nano water guard phenomenon (https://youtu.be/z4EFycryEU4) • Ultra Ever-Dry (https://youtu.be/BvTkefJHfC0) • Contact angle (https://youtu.be/pk7LcugO3zg) • Magic Sand phenomenon (https://youtu.be/bz1P323bHCo)	• The Water Race: Hydrophobic & Hydrophilic Surfaces (https://www.nnci.net/ajax/get/node/5326)
Electrostatic force dominance 	Drops on surfaces  CC0 1.0 Universal Public Domain		• Exploring surface area of polymers using contact angle estimation (https://www.nnci.net/ajax/get/node/6018)
Surface area to volume ratio  Gautam Arora (CC BY 3.0)	Activity to teach SA/V trends as objects decrease in size  CC0 1.0 Universal Public Domain		• Surface Area-to-Volume Ratio of Nanoparticles (NNCI) (https://www.nnci.net/ajax/get/node/5328)
Surface area to volume ratio 	Viscosity becomes increasingly dominant in mobility with small size, large SA/V  CC0 Public Domain	• What it feels like for a sperm, or how to get around when you are really, really small (https://www.wired.com/2011/07/what-it-feels-like-for-a-sperm-or-how-to-get-around-when-you-are-really-really-small/)	• Styrofoam & salt activity (Part I) (https://docs.google.com/document/d/1a7lqjIN_7FJjw51fbgTsmzEIKIZQD_QpOPVvv2NMvRk/edit?usp=sharing) • Stokes' Law and Viscosity Lab (https://docs.google.com/document/d/1E8IEB7kTIBVWYInID0dGosThXig6WFVPwjymFnjaUwQ/edit?usp=sharing)
Surface area to volume ratio 	Catalysts (catalytic converters in car exhausts, Ag NP covid masks)		• Styrofoam & salt activity (Part II) (https://docs.google.com/document/d/1a7lqjIN_7FJjw51fbgTsmzEIKIZQD_QpOPVvv2NMvRk/edit?usp=sharing) • Catalytic converters and nanocatalysts (https://www.nnci.net/search/curriculum)

			• How catalysts work, a nanoscale phenomenon (https://www.nnci.net/search/curriculum)
Surface area to volume ratio 	Cell size and SA/V - the size of life	• What Happens If We Throw an Elephant From a Skyscraper? Life & Size 1 (https://youtu.be/f7KSfjv4Oq0) • How to Make an Elephant Explode – The Size of Life 2 (https://youtu.be/MUWUHF-rzks)	• Shrink me activity (https://www.nnci.net/sites/default/files/2016-12/Teachers%20Preparation%20Guide.pdf)
Light matter interactions  Klaus-Dieter Keller, CC BY 3.0, via Wikimedia Commons	Structural color 	• How Animals Hacked The Rainbow And Got Stumped On Blue (https://www.npr.org/sections/health-shots/2014/11/12/347736896/how-animals-hacked-the-rainbow-and-got-stumped-on-blue) • Why Is Blue So Rare In Nature? (https://youtu.be/3g246c6Bv58) • Measuring Thin Films (https://youtu.be/qZgKjZC1uqY)	
Light matter interactions 	Gold & silver nanoparticles reflect a variety of colors and have a multitude of uses 	• Amazing NanoGold! Why is it red? (https://youtu.be/MsnfvNd6qTc) • 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/2020/05/20200529150643.htm)	• Citrate synthesis of Au nps (MRSEC) (https://education.mrsec.wisc.edu/citrate-synthesis-of-gold-nanoparticles/) • Creating and Testing Silver Nanoparticle Socks (https://www.nnci.net/node/5331) • Inhibition of Bacteria by Silver Colloid Impregnated Bandages (https://www.nnci.net/node/5333) • Silver nanoparticle synthesis, spectroscopy, and bacterial growth (https://www.nnci.net/node/5330) • Spectrophotometry of Metal Nanoparticles (https://www.nnci.net/node/6016) • The Effects of Gold and Silver Nanoparticles on Brine Shrimp: A Toxicology Study (https://www.nnci.net/node/5303)
Light matter interactions 	Quantum dots 	• What are quantum dots? (https://www.nanowerk.com/what_are_quantum_dots.php) • Color by Size: Quantum Dots (https://youtu.be/dhRIHF1DENI) • What is quantum dot? (https://youtu.be/z7aqJpKfPC0)	• NanoHUB quantum dot lab (https://nanohub.org/resources/450/usage) • Quantum Dots: Real-world particles in a box (https://www.nnci.net/node/5335) • Synthesis and Characterization of CdSe Quantum Dots (https://www.nnci.net/node/5317)

		• Biophotonics (https://www.bioopticsworld.com/biophotonics-tools/article/16430482/hybrid-gold-nanoparticles-could-pair-cancer-imaging-therapy)	• Turning Fruit Juice into Graphene Quantum Dots (https://www.nnci.net/node/5652)
Quantum effects  Marco Petrucci, (CC BY 3.0)	Quantum tunneling and STM 	• Quantum Tunneling (http://abyss.uoregon.edu/~js/glossary/quantum_tunneling.html) • Quantum Tunneling and the Uncertainty Principle - Quantum Theory and the Uncertainty Principle (http://www.physicsoftheuniverse.com/topics_quantum_uncertainty.html)	
Quantum effects 	Quantum mechanics 	• wave-particle duality, uncertainty principle (http://abyss.uoregon.edu/~js/ast123/lectures/lec06.html)	
Quantum effects 	Quantum computing 	• Quantum Computing 101 (https://uwaterloo.ca/institute-for-quantum-computing/quantum-computing-101#Quantum-vs-classical) • Quantum Supremacy & AI, with Stephen Fry. (https://www.youtube.com/watch?v=92Ntk4niqPo) • How Does a Quantum Computer Work? (http://youtu.be/g_laVepNDT4) • Quantum Computers Explained (https://youtu.be/JhHMJCUMq2) • A beginner's guide to quantum computing (https://youtu.be/QuR969uMICM) • Quantum Computing Expert Explains One Concept in 5 Levels of Difficulty (https://youtu.be/OWJCfOvochA) • Quantum Computing and Quantum Supremacy, Explained (https://www.wired.co.uk/article/quantum-computing-explained)	• Website: Quantum Computing: Tomorrow's computing today (https://www.ibm.com/quantum-computing/)

Fabrication

[Nanofabrication Tools: Etching and thin films](https://www.nnci.net/node/6008) (<https://www.nnci.net/node/6008>)

[Wet Etching in Nanofabrication](https://www.nnci.net/node/5319) (<https://www.nnci.net/node/5319>)

[Small Scale Stenciling and Sculpting](https://www.nnci.net/node/5310) (https://www.nnci.net/node/5310)

Characterization

[Mystery Molecules: Identifying Materials with Nanoscale Characterization Tools](https://www.nnci.net/node/5753) (https://www.nnci.net/node/5753)

[Modeling Scanning Probe Microscopes \(SPM\)](https://www.nnci.net/node/5657) (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) (https://www.nnci.net/node/5294)

[Seeing Nano II: Using atomic force microscopy to view nano-size objects](https://www.nnci.net/node/5632) (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>

<https://www.iom3.org/news/all-news.html>

<http://phys.org/nanotech-news/>

https://www.sciencedaily.com/news/matter_energy/nanotechnology/

<http://news.mit.edu/topic/nanotech>