

EDUCATIONAL RESOURCES FOR K-12 EDUCATORS

# 'degrees that work, Nanotechnology'

*Lesson Planning Guide:  
Technology Education Series  
Grade 10*



**Pennsylvania College of Technology**  
**College Information & Community Relations**  
*Roger and Peggy Madigan Library, Rm. 321-339*  
*One College Avenue*  
*Williamsport, PA 17701*  
*(570) 320-2400, ext. 7253*

**‘degrees that work, Nanotechnology’**

Lesson Planning Guide – Technology Education Series

**Unit:** Technological Devices

**Competency:** List and describe the workings of measuring devices used by scientists to measure and rearrange atoms.

**PA Science & Technology Standards Included:** 3.7.10A,B

**Grade Level:** 10<sup>th</sup>

**Approximate Time:** Two to three 45-minute periods.

**Prerequisite Skills**

**Reading, Writing, Speaking and Listening\***

1.4.8/11 Types of Writing

D. Maintain a written record of activities, course work, experience, honors and interests.

**Mathematics\***

2.3.11 Measurement and Estimation

A. Select and use appropriate units and tools to measure to the degree of accuracy required in particular measurement situations.

**Science and Technology\***

3.4.10 Physical Science, Chemistry and Physics

A. Explain concepts about the structure and properties of matter.

**Career Education and Work\***

13.1.8 Career Awareness and Preparation

A. Relate careers to individual interests, abilities, and aptitudes.

B. Relate careers to personal interests, abilities, and aptitudes.

\* Academic Standards, Pennsylvania Department of Education

Competency: List and describe the workings of measuring devices used by scientists to measure and rearrange atoms.

## Performance Standards

Performance Standard	Suggested Evaluation Method
1. Explain how an atomic force microscope (AFM) and a scanning probe microscope (SPM) work, and give an example of their use with 75% accuracy as described by the teacher.	Written test
2. Describe if a career in nanotechnology may or may not be a good option for you with 90% accuracy using information provided by your teacher.	Written report

## Suggested Projects

None

## Multiple Intelligence Types

Verbal/Linguistic

Logical/Mathematical

Bodily/ Kinesthetic

Interpersonal

## Resources

1. Website: Lesson 4: Tools of the Nanosciences, Teacher Materials  
[http://nanosense.sri.com/activities/sizematters/tools/SM\\_Lesson4Teacher.pdf](http://nanosense.sri.com/activities/sizematters/tools/SM_Lesson4Teacher.pdf)
2. Website: Lesson 4: Tools of the Nanosciences, Student Materials  
[http://nanosense.sri.com/activities/sizematters/tools/SM\\_Lesson4Student.pdf](http://nanosense.sri.com/activities/sizematters/tools/SM_Lesson4Student.pdf)
3. PowerPoint Slides: Scanning Probe Microscopy  
[http://nanosense.sri.com/activities/sizematters/tools/SM\\_SPMSlides.ppt](http://nanosense.sri.com/activities/sizematters/tools/SM_SPMSlides.ppt)
4. Website: What is Nanotechnology?  
[www.cneu.psu.edu/resources.html](http://www.cneu.psu.edu/resources.html)
5. Website: Center for Nanotechnology Education & Utilization, Education Programs & Activities  
[www.cneu.psu.edu/edOverview.html](http://www.cneu.psu.edu/edOverview.html)
6. Video: Degrees that work. Nanotechnology  
View or download at [www.pct.edu/degreesthatwork/](http://www.pct.edu/degreesthatwork/)

## Equipment/Materials/Software

1. Measuring Tools: ruler, calipers, micrometers  
Any supplier
2. Black Box Materials: black square box, pencil, magnet probe, cotton swab probe, skewer probe  
Any supplier
3. Computer with Internet access  
Any supplier

Competency: List and describe the workings of measuring devices used by scientists to measure and rearrange atoms.

4. Teacher selected items to measure  
Any supplier
5. Black Boxes with various materials  
Teacher made, see Resource #1
6. Digital Projector  
Any supplier

### Suggested Learning Sequence

Strategy	Outline	Resources/Equipment
<b>Performance Standard 1</b>		
Introduction/ Review	<p>Review with the students basic tools used with measurement systems. Discuss the term “accuracy”:</p> <ul style="list-style-type: none"> <li>• “How close is it?” .001, .0001, .000000001</li> <li>• Is it within a hair width?</li> <li>• How do we perform accurate measurement?</li> </ul> <p>Introduce students to:</p> <ul style="list-style-type: none"> <li>• Atomic Force Microscope (AFM)</li> <li>• Scanning Probe Microscope (SPM)</li> </ul> <p><b>Related Academic Skills:</b> 3.7.10A</p>	Resource #1
Reading Assignment/ Presentation	<p>The night before starting this lesson have students read <u>Seeing and Building Small Things</u>. Give a PowerPoint presentation about the Scanning Probe Microscope. Highlight the AFM and SPM and the relationship between new tools and the ability to gather new data and to innovate using new technologies. Ask students, “How do we see and move things around that are very small?”</p>	Resource #1 Resource #2 Resource #3
Review/ Demonstration	<p>Review with the students how to identify and use basic measuring tools:</p> <ul style="list-style-type: none"> <li>• ruler: 1/16” – 1/64”</li> <li>• Vernier caliper</li> <li>• outside micrometer: .001” - .0001”</li> <li>• nano size: .000000001</li> </ul> <p>Compare and contrast “standard” measurement to nano size particles. Demonstrate the Black Box Activity to the class.</p> <p>The idea is to get students thinking about how scanning microscopes give us a picture of the surface of atoms. Show the use of different probes to determine the layout of objects on the bottom of the black box.</p>	Resource #1 Resource #2 Equipment #1 Equipment #2 Equipment #3
Activity	<p>In teams of two, have students measure and record the size of selected materials. Inform students that the accuracy of the measurement is very critical.</p>	Resource #2 Equipment #1 Equipment #4 Equipment #5

Competency: List and describe the workings of measuring devices used by scientists to measure and rearrange atoms.

	<p>Have the teams complete the Black Box activity as demonstrated. At the conclusion of the activity have each team present their findings to the class:</p> <ul style="list-style-type: none"> <li>• drawings/sketches, accuracy</li> <li>• describe the technique used</li> <li>• point out the difficulties</li> </ul> <p>Have teams hand in the written work for evaluation.  <b>Related Academic Skills:</b> 3.2.10C; 3.7.10A,B  <b>Related SCANS/Soft Skills:</b> Interpersonal A; Information C; Technology B</p>	
Evaluation	Administer the written quiz on the <u>Seeing and Building Small Things</u> lesson. Score the quiz using the answers given in the <u>Teacher Materials</u> document.	Resource #1 Resource #2
<b>Performance Standard 2</b>		
Introduction	<p>Define and explain to the class what Nanotechnology includes:</p> <ul style="list-style-type: none"> <li>• Nanotechnology</li> <li>• Personal Nanofactories</li> <li>• Mechanochemistry</li> <li>• Nanofabrication</li> <li>• Nanometer</li> </ul>	Resource #4 Equipment #3
Presentation	<p>Discuss how Nanotechnology could fit into the students' career plan:</p> <p style="text-align: center;">Skills</p> <ul style="list-style-type: none"> <li>• Oral &amp; written communication skills</li> <li>• Chemistry</li> <li>• Math</li> <li>• Way things work</li> <li>• Study skills</li> </ul> <p>Have students think about their career plans, specifically as they pertain to individual and personal:</p> <ul style="list-style-type: none"> <li>• Training/education</li> <li>• Interests/abilities</li> <li>• Career goals</li> </ul> <p>Talk with them, answer questions and ask them questions. Discuss the impact of Nanotechnology to future processes e.g.; medical semi-conductors. Talk about how students are trained for employment:</p> <ul style="list-style-type: none"> <li>• Capstone</li> <li>• Certificate degree</li> <li>• Associate degree</li> <li>• Baccalaureate degree</li> </ul>	Resource #5 Equipment #3 Equipment #6
Activity	Have students watch the DVD "Degrees that Work – Nanotechnology". Remind them as they watch the DVD that they could be "Mark Atwater".	Resource #6 Equipment #3 Equipment #6

Competency: List and describe the workings of measuring devices used by scientists to measure and rearrange atoms.

Assessment	<p>At the conclusion of the unit, have each student write a report on whether nanotechnology could be a possible career choice for them. Have them explain why or why not focusing on their individual and personal interests and abilities.</p> <p>Evaluate the reports on the correctness of the information and correlations and using the PA scoring rubric for written pieces.</p> <p><b>Related Academic Skills:</b> 1.4.8B: 1.5.8A-F; 13.1.8A,B</p> <p><b>Related SCANS/Soft Skills:</b> Information C,D; Thinking B</p>	
------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--

### Related SCANS/Soft Skills

#### Resources

None

#### Interpersonal

A. Participates as Member of a Team

#### Information

C. Interprets and Communicates Information

D. Uses Computer to Process Information.

#### Systems

None

#### Technology

B. Applies Technology to Task – Understands overall intent and proper procedures for setup and operation of equipment.

#### Thinking Skills

B. Decision Making – specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative

#### Personal Qualities

None

### Related Worksite/Work Based Activities

None

### Additional Resources

1. Video: Nanotechnology Modules  
[www.cneu.psu.edu/edtoolsvideos.html](http://www.cneu.psu.edu/edtoolsvideos.html)

---

This planning guide was written by Robert Tule, retired Technology Education Teacher, Muncy, PA.