nano@illinois

Research Experiences for Teachers (RET)



It’s About Time

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Description: In this unit students will be discussing the importance of accurate time measurement, how timekeeping technology has evolved over the centuries, and the role that nanotechnology plays in current timekeeping practices.

Learning objectives:

1. Students will describe how timekeeping devices have evolved over time.
2. Students will critique various timekeeping models and identify the advantages and disadvantages of each.
3. Students will define nanotechnology and give examples of current applications in society.
4. Students will design a timekeeping device based on nanotechnology to be utilized on the first manned mission to Mars.

Prerequisite knowledge/skills:

1. Students can define and draw a model of an **atom** including **protons**, **neutrons**, **electrons**, and a **nucleus**.
2. Students can make **claims** and give **evidence** when critiquing models.
3. Students are able to calculate **velocity**
4. Students can define and measure the **wavelength**, **amplitude**, and **frequency** of a wave

Duration: 1-2 weeks

Target grade level(s): Middle School/Early High School

Target subject(s): Physical Science

 Unit Overview

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| Day | Objectives | Activities | Materials |
| 1 | 1) Identify methods of time measurement2) Make quantitative and qualitative observations | 1. Warm-up
2. “The Martian” Observations
3. Timekeeping researchOptional Extension: Evolution of Timekeeping Flipbooks
 | -It’s About Time Unit PowerPoint-[IAT.1: Evolution of Timekeeping Research](https://docs.google.com/document/d/1IKdicJ5_Lrczrr_iZd-XCTtFNxFUBubFye9Fed6wev8/edit?usp=sharing)-How to make a Flipbook video demo: <https://www.nyfa.edu/student-resources/flipbook-animation-techniques-and-examples/>  |
| 2-3 | 1. Define accurate
2. Compare and contrast timekeeping devices
3. Design and construct a simple timekeeping device
 | 1. Warm-up
2. Timekeeping research discussion
3. Timekeeping Device Construction Challenge
 | -It’s About Time Unit PowerPoint-IAT.2: Construction ChallengeHow-to Video for Teachers: Determining the Accuracy of a Clepsydra |
| 4 | 1. Test timekeeping devices and analyze results
2. Critique timekeeping devices
3. Make claims and give evidence about the accuracy of timekeeping devices
 | 1) Warm-up2) Construction Challenge Trials, Critiques & Results Discussion3) Introduction to NanoscaleOptional extension: Device redesign/ rebuild/retest | -It’s About Time Unit PowerPoint-IAT.2: Construction Challenge-Nanoscale information: <http://education.mrsec.wisc.edu/36.htm>  |
| 5-6 | 1. Define and give examples of nanotechnology
2. Define piezoelectric and describe clocks that use this property
 | 1. Warm-up
2. Nanoscale measurement examples
3. Nanotechnology Internet Investigation
4. Nanotechnology research at UIUC
 | -It’s About Time Unit PowerPoint-[IAT.3: Internet Investigation: What is Nanotechnology?](https://docs.google.com/document/d/11O2ZmFa4TrxWBgYgPLNuuBbbEFsz0YFIv6BM7NHAImI/edit?usp=sharing) (Can be used with Nanotechnology at UIUC PowerPoint and the articles at the links below)-Nanotechnology articles online: 1) <http://en.yibada.com/articles/37055/20150607/most-accurate-quantum-thermometer-can-measure-temperature-of-cells.htm> 2) <http://www.livescience.com/48799-miniature-atomic-clock.html>-Nanotechnology at UIUC PowerPoint (see comments section for additional descriptions of slides). |
| 7 | 1) Design and describe applications of Nanotechnology in Space2) Build a model | 1) Complete the Nanotechnology in Space Graphic organizer2) Present projects to classOptional extension: Build a 3D model of a Nanotechnology device | -It’s About Time Unit PowerPoint-Nanotechnology at UIUC PowerPoint (see comments section for additional descriptions of slides).-IAT.4: Nanotechnology in Space Project  |

Alignment with Next Generation Science Standards:

**Science and Engineering Practices:**

* Constructing explanations and designing solutions
* Engaging in argument from evidence
* Obtaining, evaluating, and communicating information

 **Disciplinary Core Ideas:**

* PS2.C: Stability and instability in physical systems
* PS3.B: Conservation of energy & energy transfer
* PS4.C: Information technologies & instrumentation

**Crosscutting Concepts:**

* Systems and System Models
* Structure and Function
* Energy and Matter
* Stability and Change

Background:

This unit was created as a means of integrating lessons on Space, Engineering Practices and current research into an Integrated Physical Science course for high school English language learners. Timekeeping is a universal practice, which lends itself to promoting discussions about accuracy and technology around the world. Handheld devices that utilize electronics for timekeeping are widespread, but many students pause to think about the research and development that made their devices so accessible. Apart from the science concepts including velocity, frequency, and engineering practices, this unit provides activities that are relatable to diverse learners and encourage problem-based learning, collaboration, and creative thinking. A variety of images, video clips, and graphic organizers also make these lessons appropriate for struggling readers and allow for easy differentiation based on the time allotted for each activity.

Preparation time: Varies based on the size of the class. Apart from making copies of student handouts the teacher will need to acquire recycled materials (plastic bottles, cardboard, etc.), scissors, tape, sand (a 50 lb. bag will be more than enough), and food coloring (a few drops per liter of water).

Preparation notes for materials and chemicals: The graphic organizers work well as electronic documents. Students will need access to the Internet when completing background research.

Safety: Students should handle instruments carefully when cutting materials and handling glassware.

Waste disposal: No special disposal is required.

**Materials/supplies/equipment needed with example source listed/pricing/CAS # and contact information**

Empty 2 Liter Bottles (2 per group of students; reuse empty soda bottles)
1 roll of duct taper per group ($2 for a 15 foot roll at Menards; to save costs groups can share tape)

1 50lb. bag of play sand for the class ($3.77 per bag at Menards)
1 box of food coloring ($3.50 for 2.72oz at Wal-Mart; to save costs 1-1oz bottle is sufficient for the class)

Optional:
Timekeeping: Explore the History and Science of Telling Time (Build It Yourself)
By Linda Formichelli and W. Eric Martin
**ISBN-13:** 978-1619301368
$20.02 on Amazon.com

This book provides historical information on different types of timekeeping devices and also gives step by step instructions for constructing various devices.

**Procedure/activity**

 **Day 1:**
1) Introduce unit with clips from ”The Martian” (2015)
NASA’s rendezvous plan: <https://www.insidescience.org/content/inside-spaceflight-martian/3251> (~1.5 min)

For a higher-thrill clip show the Rescue sequence at the end of the film <https://www.youtube.com/watch?v=tij72Ejo2lU> (~5 min)

2) Discuss the importance of accurate timekeeping in the clip.

-Students give examples from their daily lives.
Additional online sources for Background on “The Martian”

“The Martian” Internet Movie Database <http://www.imdb.com/title/tt3659388/>
“Epic Space Rescues” <https://www.youtube.com/watch?v=ft3p2C6oO30>
“Your Brain on Mars” <https://www.youtube.com/watch?v=Y19fwDEfQ8E>

3) Student Research- How has timekeeping evolved over time?
Use the website: <http://nrich.maths.org/6070> “A Brief History of Time Measurement”
-Students work in groups to complete the **Evolution of Timekeeping Graphic Organizer (IAT.1)**-Students present their findings to the class

***Optional Extension:***
1) Demonstrate a flipbook

2) Students work with partners to illustrate a flipbook that demonstrates the construction, use, and failures of a historical timekeeping device of their choice.

-Students can reference their notes from the **Evolution of Timekeeping Graphic Organizer (IAT.1)**

3) Students present their flipbooks to their peers.

  **Day 2-3:**

# 1) Warm- Discuss accuracy of timekeeping devices. Prompt students to consider the necessity of accurate devices based on location and activity (Ex: Do farmers need to know exactly what time it is when they are in the fields?)2) Have students do a jigsaw to share research from the Evolution of Timekeeping Graphic Organizer (IAT.1) If they need additional information they can also watch the video at the link below:

# Review various timekeeping devices throughout history with “A Brief History of Timekeeping” Video <http://wn.com/a_brief_history_of_timekeeping> (~ 3 min)3) Students work in groups to build a historical timekeeping device using the IAT.2: Construction Challenge worksheet. They will also create a labeled diagram detailing the structures and functions of their device. The class should be divided so that approximately half of the groups are doing the Sand Timer and half are building the Clepsydra so there are different devices for comparison(Note: Construction time may vary greatly depending on the number of students in the classroom. If some groups finish faster than others have them build a second model of the device but challenge them to change one aspect of it so that it is more accurate than their first model. They can present both the class and discuss the changes they made.)

4) Student groups demonstrate their timekeeping devices to the class and discuss the advantages and disadvantages of each device.

5) Students discuss a way to improve the accuracy of each device by changing 1-2 materials used in its construction. This provides a good connection to the use of NGSS’ Science and Engineering Practices in the classroom. Discuss the steps that modern engineers follow when completing a project.

**Day 4:**
1) If students need to finish testing/presenting and critiquing their devices use today as a partial catch- up day.

2) If finished with the Construction Challenge students can start exploring Nanotechnology. The warm-up challenges them to think about scale.

3) As a pre-assessment students can create a concept map to determine what Nanotechnology is and how it is relevant to their lives. Refer them to this site for background reading and activities they can explore: Nanoscale information: <http://education.mrsec.wisc.edu/36.htm>

**Day 5:**

1) The warm-up will revisit scale and ask students to think about measuring things we cannot easily see. Answers may vary greatly but should mention DNA molecules and atoms.

2) Students will complete the internet investigation below with partners. This works very well as an electronic document that students can edit online (such as Google Docs.)
[IAT.3: Internet Investigation: What is Nanotechnology?](https://docs.google.com/document/d/11O2ZmFa4TrxWBgYgPLNuuBbbEFsz0YFIv6BM7NHAImI/edit?usp=sharing)

To help students find information more quickly provide these links below:

-Nanotechnology articles online:
1) <http://en.yibada.com/articles/37055/20150607/most-accurate-quantum-thermometer-can-measure-temperature-of-cells.htm>
2) <http://www.livescience.com/48799-miniature-atomic-clock.html>

Another helpful source that provides information on current and future applications is <http://www.nanowerk.com/n_neatstuff.php>

3) Leave time at the end of class for each pair to share something that they discovered about Nanotechnology.

**Day 6:**

1) At the beginning of class ask students how researchers are using Nanotechnology.

2) Discuss the Nanotechnology at UIUC PowerPoint (see comments section for additional descriptions of slides). Key takeaway: Nanotechnology is cheaper than current technologies and allows for many advances in technology for scientists and consumers.

3) Introduce the IAT.4: Nanotechnology in Space Project. Students may need blank paper to sketch their ideas.

**Day 7:**

1) Students Present projects to class after finishing the IAT.4 Nanotechnology in Space Project.
2) Discuss- Could Mark Watney use this technology on Mars? Why or why not?

Optional extension:
Build a 3D model of a Nanotechnology device. Allow students to use recycled materials to build and label a 3D model. For additional rigor challenge them to draw and label a scaled diagram of how large the device would be in real life.

Links to the research articles and other resources in order of their use in the unit:

1) Clips from “The Martian”
i) NASA’s rendezvous plan: <https://www.insidescience.org/content/inside-spaceflight-martian/3251>
ii) Rescue Sequence: <https://www.youtube.com/watch?v=tij72Ejo2lU>

2) Additional online sources for Background on “The Martian”
i) “The Martian” Internet Movie Database <http://www.imdb.com/title/tt3659388/>
ii) “Epic Space Rescues” <https://www.youtube.com/watch?v=ft3p2C6oO30>
iii) “Your Brain on Mars” <https://www.youtube.com/watch?v=Y19fwDEfQ8E>

3) A Brief History of Time Measurement <http://nrich.maths.org/6070>

4) How to make a Flipbook video demo: <https://www.nyfa.edu/student-resources/flipbook-animation-techniques-and-examples/>

5) Nanoscale information: <http://education.mrsec.wisc.edu/36.htm>

6) Nanotechnology articles online:
i) <http://en.yibada.com/articles/37055/20150607/most-accurate-quantum-thermometer-can-measure-temperature-of-cells.htm>
ii) <http://www.livescience.com/48799-miniature-atomic-clock.html>

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The *nano@illinois* Research Experience for Teachers (RET) at the University of Illinois at Urbana-Champaign (from 2014-2017) exposes a diverse set of in-service and pre-service science, technology, engineering, and mathematics (STEM) teachers and community college faculty from across the nation to cutting-edge research in nanotechnology. The RET focuses on recruiting underrepresented minority populations (focused on ethnicity, geography, disability, and veteran status) including women and will target teachers from high-need areas, including inner city, rural, low-income, and those with significant URM students. Participants conduct research over 6 weeks in world-class labs with 4 follow-up sessions during the school year.

Teacher professional development opportunities includes teacher-focused lectures, mentoring, networking, poster sessions, ethics seminars, hands-on modules, STEM education issues, career choices, and resources for implementing a nano lab and curriculum. Teachers will develop modules to be disseminated widely and present their results. High-quality follow-up sessions and evaluation will be infused.

The nano@illinois Research Experiences for Teachers (RET) is managed by the University of Illinois Center for Nanoscale Science Technology.

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