MODULE 4-HOW DO WE SEE NANOPARTICLES?

RESULT: R1/T1.3. LESSON PLAN

NANOWARE

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Lesson Information

Title**:** How do we see nanoparticles?

Subject**:** Visualization and Analysis Methods for Nanoparticles

Grades**:** 9-12

Brief Description**:** Students will learn visualization and analysis methods for nanoparticles, describing different methods and understanding their operational principles in high school.

Objectives**:** Students will be able to:

- explain the limits of vision of the human eye,
- describe what is the purpose of using the light microscope and its operational principles,
- describe why we cannot visualize atoms using the light microscope,
- explain visualization methods we can use to visualize atoms and nanoparticles.

Duration: 6 lessons in total (3 lessons for theory and video watching and 3 lessons for activities-one lesson is 40 minutes)

Lesson Procedure

This lesson introduces the concept of visualization and analysis methods of nanoparticles, describing different methods and understanding their operational principles. It is expected that, after this lesson, students will understand the size of nanoparticles and the limits of vision of the human eye, students will explore relative size, and the idea that cells are quite big when compared to nanomaterials. In addition, students can tell different techniques such as SEM, TEM, AFM, and STM used to image nanoparticles, and they can tell the differences among all microscopic methods.

In the beginning, ask students if they ever had any interest and did some research about nanotechnology, and what they got about it. The following questions can be asked to measure students' prior knowledge and to reveal their alternative conceptions, if any:

- Who has heard of the metric system of measurement?
- What is the metric system? (The metric system is a decimalized system of measurement based on ten)
- What is the smallest thing you can think of? (atoms, electrons, molecules).

- What is a nanometer?
- How many nanometers are in one meter? (1,000,000,000nm)
- Can you tell which objects are manmade and which ones are made by nature?

One of the purposes of asking these questions is to reveal their alternative conceptions of the metric system. One of the most common is not realizing the connection between the relative and absolute sizes of two objects. Another one is the idea that cells are the smallest objects in existence.

Activity 1: Nanotechnology Video

Students will watch a video introducing nanotechnology.

Materials Needed

- Video platform

Activity Procedure

Show students a video introducing nanotechnology to get their attention (https://www.youtube.com/watch?v=j_wQgy97Pi4) and discuss with the students why nano scientists work with such small particles.

Activity 2: How big it is!

Students will visualize the order of numerical properties of objects from the nanoscale to the visible scale using exponents and decimals. Students will make size comparisons of objects and they will develop an understanding of how small a nanometer is in comparison to common objects through this activity.

Materials Needed

- Student Handouts
- Calculator

Activity Procedure

For this activity, students work in groups of 4 or 5. Then, show to the students the following figure about the metric system.

Latin prefix w/meter	Measure as an exponent	Measure as a number	Common Expression
Terameter	10^{12}	1,000,000,000,000	One Trillion
Gigameter	10^{9}	1,000,000,000	One Billion
Megameter	10^{6}	1,000,000	One Million
Kilometer	10^{3}	1,000	One Thousand
METER	**10^{1}**	**1**	**One**
Milimeter	10^{-3}	0.001	One Thousandth
Micrometer	10^{-6}	0.000001	One Millionth
Nanometer	10^{-9}	0.000000001	One Billionth
Picameter	10^{-12}	0.00000000001	One Trillionth

Source: file:///C:/Users/Zeha/OneDrive/Desktop/NANOWARE/size%20and%20scale%20teacher%209-11v3-1.pdf

Ask the students following questions.

1. Which prefix in the table represents the smallest number?
2. How many decimeters does it take to make one meter?
3. Look at the table. What do you think one-thousandth of a meter is called?
4. What do you think one-millionth of a meter is called?
5. What do you think one billionth of a meter is called?
6. What is the average height of your group members?
7. What is your group member's height in centimetres?
8. If you wanted to find your group member's height in millimetres, how much would you multiply their original height by?
9. What is your group member's height in millimetres?
10. If you wanted to find your group member's height in nanometers, how much would you multiply their original height by?
11. What is your group member's height in nanometers?

Explain to students that there is an enormous scale from high mountains to red blood cells in our world and our universe, from the solar system to disease and disease-causing bacteria. The table above contains some of the measurements of the International System of Units (SI).

Activity 3: Light and Electron Microscope Videos

Materials Needed

- Video platform

Activity Procedure

Depending on the age group, first, students will watch videos on how the light microscope works (ages 9-12: https://www.youtube.com/watch?v=tVcEEw6qbBQ, ages 13-17: https://www.youtube.com/watch?v=FnOvLEaC4gg).

In addition, students will watch videos on the working principle of SEM, TEM and Cry-SEM microscopes (https://www.youtube.com/watch?v=GY9lfO-tVfE, https://www.youtube.com/watch?v=a0G7iyz4McM,

https://www.youtube.com/watch?v=Qq8DO-4BnIY).

They will also watch a video about the award-winning images taken under the SEM microscope (https://www.youtube.com/watch?v=ZyXrtODhJEA).

They will watch the video about how to prepare stained temporary mount of onion peel for light microscope application (https://www.youtube.com/watch?v=6gIneqf6pYU).

After watching the videos, ask the students the following questions;

1. How does the light microscope work?
2. What are the parts of the equipment? and What does each piece do?
3. With which device do we see objects that we cannot see using a light microscope?
4. What do you think about SEM?
5. What do you think about TEM?
6. What do you think about Cryo-SEM?

At the end of the discussion, explain to students that there is some kind of microscope to observe objects which are smaller than a micrometre. Mention to students that because we can see these objects and understand them scientifically, we can produce nanotechnological products.

Activity 4: Observing Samples Using Light Microscope

Materials Needed

- Video platform
- Light microscope
- Onion
- Coloring material

Activity Procedure

First, students will watch the video about how to prepare stained temporary mount of onion peel for light microscope application (https://www.youtube.com/watch?v=6gIneqf6pYU).

For this activity, students work in groups of 4 or 5.

After practice, ask the students following questions:

1. What processes do you use to see the onion peel under the light microscope?
2. At what magnification do you get the best view?
3. How to describe onion peel cells by looking at the image?
4. Do you see all the organelles of onion peel cells? Why?
5. Which microscope do you use to see all the organelles of onion peel cells? Why?

At the end of the discussion, explain to the students which microscopes we should choose according to the size of the objects.