University of Guelph Numeracy Project

About Nano

UNIVERSITY of GUELPH

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What is Nano?

- Nano represents one-billionth of a given base measure.
- Nano is a microscopic unit of measure, particularly applicable in the sciences, especially computing, mathematics, chemistry, physics, and biology. At the intersection of these disciplines lies nanoscience and nanotechnology.

Background

- Consider the following example:

  You take a piece of tape and stick it to your tabletop. Suddenly, you shrink to the height of a single nanometre tall. How has your world just changed?

- 30m = 30 billion nm
  2 km = 2000 billion nm

- The wider scientific community uses base measurements in the metric system, such as metres, litres, and grams. For ease in comparison between measures, prefixes are used for differentiation, each representing a different power of 10. Consider the table below:

Prefix	Measurement	Scientific Notation
Kilo-	1000 m	1×10^{3} m
Hecta-	100 m	1×10^{2} m
Deka-	10 m	1×10^{1} m
BASE	1 m	1×10^{0} m
Deci-	0.1m	1×10^{-1}m
Centi-	0.01 m	1×10^{-2} m
Milli-	0.001m	1×10^{-3} m
Micro-	0.000001 m	1×10^{-6} m
Nano-	0.000000001 m	1×10^{-9} m
Pico-	0.000000000001 m	1×10^{-12} m
Femto-	0.000000000000001 m	1×10^{-15} m

- As the preceding table indicates, with a base unit measure of a single metre, 1 billion nanometres are represented. What does this mean practically? We will soon find out more in the proceeding sections.

Biological Implications

- At this scale, it is also foreseeable that breakthroughs in biomedical research could lead to advances in such areas as optometry (e.g. through the development of artificial retinas), otolaryngology (e.g. through the development of artificial ears), and electrical sciences (e.g. molecular wiring). In fact, improvement of electronics through organic means may also result. Afterall, when speaking of change at the atomic level, the repercussions can be astronomical.

- Returning to our example, at a nanometre tall, you would be sufficiently small to man a submarine in a normally-sized human blood stream. In fact, if a blood cell were the size of a shopping mall, then your size would be comparable to that of the coins in the fountain.

- Furthermore, the piece of scotch tape next to you would be the height of the tallest skyscraper you can envision, and would run for what would seem like miles.

- That said, you would also likely have difficulty getting around. As with the hairs Geckos use to adhere to surfaces, which are on the nanoscale themselves, you would likely adhere to surfaces by virtue of weak van der Waals forces.

Physical/Chemical Implications

- At the nano level, behaviours do not adhere to the principles of Newtonian physics, and are best explained by way of quantum mechanics. Of course, this is in agreement with the sentiment that "there are no mysteries in science, only the unknown."

- Physically, when speaking at this level, the increasing miniaturization of technology is likely most tangible. However, consider that not only can computer memory be made to be more efficient, while growing increasingly smaller, but additional achievements are potentially attainable, including: unscratchable paint and/or glasses, CDs engraved on plastic sheets, hydrophobic surfaces, and truly fireproof surfaces.

- At the nano level, the advent of carbon nanotubes has opened a world of possibilities for improved technology. With an acre of these tubes weighing only 4 ounces, and their being as strong as steel (they are able to support a ladybug, which is 1 billion times the weight of a carbon nanotube), they are extremely light weight and surprisingly strong.

- It has been suggested that these nanotubes may revolutionize electronics. However, more practically, their small size represents small amounts of energy expended, flagging it as an ecologically-friendly alternative to current energy means. With this in mind, some have suggested that the technology might be used for the creation of cars consisting of a single solar cell for its body, and decentralized motors operating each wheel individually.

- As a final thought, at the nano level, an obvious implication is the observation and manipulation of particles and atoms. In the formative formation of the brain, self-assembly and self-connection occurs. This

- process represents a spontaneous, but controlled phenomena, with no known discernible properties. As a result, researchers have expressed a desire to discover a potential property underlying the self-assembly of matter, especially for processes that we currently find to be difficult and/or expensive to manipulate ourselves (e.g. silver ions).

Nanoscience/Nanotechnology

- As alluded to earlier, nanoscience is the scientific study of matter and phenomena at the atomic level, found at the intersection of core scientific disciplines, such as mathematics, biology, physics, and chemistry. In these studies, scanning electron microscopes are used to manipulate and observe the structure of the "relief map" by way of electron exchange.

- Nanotechnology, on the other hand, is the technology derived as a benefit of nanoscience, found across a variety of sectors. These include, but are not limited to, agriculture, recreation/sports, aerospace/defence, and energy. If you can dream it up, nanoscience and nanotechnology may eventually provide the solution(s) you need.

Glossary

Nanoscience: The study of structures and phenomena at the atomic level, occurring at the intersection of a variety of disciplines, including mathematics, physics, chemistry, and biology.

Nanotechnology: Technology deriving as a direct benefit of nanoscience.

Scanning Electron Microscope: A crucial tool in conducting research in nanoscience, allowing for the observation and manipulation of structures at the atomic level, by way of the principles of electron transfer.

References

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