

Teacher's Guide:

Pause # 1

Hello. First of all, let me thank you for agreeing to do this and I hope you and your students will enjoy this lesson plan and find it useful. This is only some suggested discussions or small experiments that can be done during the pauses with the students. Hopefully this will help you out in terms of leading the class. First of all, the material that we're going to cover within the whole lesson is regarding the size concept and how it will affect the properties of matter. I am sure that your students do have a sense of the words big and small and for the size concept in general. However, the limits regarding size might not be very clear. During the pause it will be helpful to ask the students to list what they think the smallest objects in their opinion and also the biggest objects. Some might think that some things are the smallest e.g. sand particles; some might go further and enlist cells. Then you can go down to large molecules then small ones, atoms, protons, neutrons, electrons or even photons....

Also for big objects, some might mention mountains, earth, the sun or the universe. These discussions and listings will make them realize that there is a continuous spectrum of sizes big and small. And for the comparison between object, you can talk about the scale and methods of measuring length and sizes. An emphasis on the units will be a very good thing especially sub-divisions e.g. millimeter, micrometer, nanometer and angstrom, and multiplications e.g. kilometer, light year and so on.

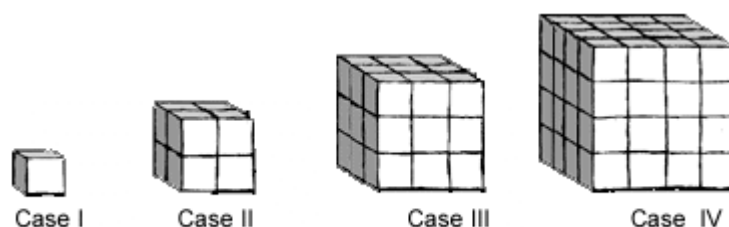
Pause # 2

In this pause, it will be very helpful to talk about how does size affect the behavior of things. For example large and tall kids are in general very strong so they tend to be involved in sports. The size of something is important since size affects what it can do and how it reacts

to its environment. You can compare between an elephant and a mouse and see the differences in their behavior since everyone knows the size difference between them. Then we can go further to smaller objects like insects. All living things that we have been comparing so far consist of cells. The difference is the number of these cells. So we can say that cells are very small. But these cells contain so many things such as proteins, sugars and many other things and also many reactions are taking place in the cell. Since reactions in order to happen a collision between reactants should take place (reactants must meet in order to react) so size is very important. And that's why it was essential for cells to be small, so reactants can collide efficiently and produce products.

Pause # 3

In order to show how smaller sizes have larger surface area, you can have different cubes. These can be made of carton or paper. Make only small cubes and you can construct big cubes from the small ones as shown in the figure below.



And construct the following table on the board

Parameter	Case I	Case II	Case III	Case IV
Length (L)	1	2	3	4
Face Area (L ²)	1	4	9	16
Volume (L ³)	1	8	27	64
Surface Area (6 x L ²)	6	24	54	96
Area/Volume	6	3	2	1.5

From this table you can see that there is a relation between size and ratio of surface area to volume. And the smaller the size is, the larger this ratio will be which means more chance for interaction with the environment. Also there is a relationship between the size and surface area per specific amount, which is also explained in the video. Off course, particles can have different shapes and mainly they are spherical, so I made my calculations for spheres rather than cubes. But cubes will be easier for the students to understand then we can discuss spheres.

Pause # 4

You can do the same calculations for spheres with radius 1 nm, small molecules such as water which has a radius of ~2.8 Angstrom.