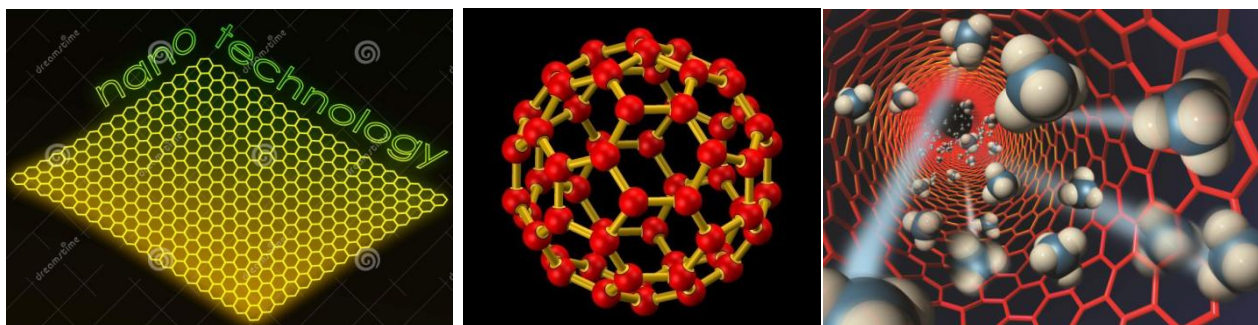


## ACTIVITY TO INTRODUCE NANOTECHNOLOGY



The aims of this activity are:

1. to convey the idea that it is impossible to create things as small as you want and that the top-down approach, commonly used in technology, is not applicable below certain sizes;
2. to demonstrate that the total surface area of an object increases by cutting it in smaller and smaller pieces, while the total volume remains constant.

This activity is therefore useful to stress the two following points.

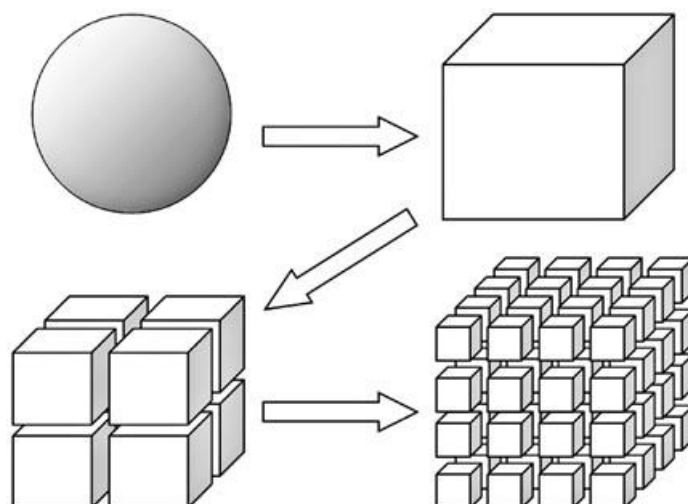
The first one, concerning the request to construct smaller and smaller cubes by using a sheet of paper, enables to introduce how to tackle nanotechnology and to stress the effectiveness of the bottom-up approach to construct devices of nanometer size. In fact students realize that they are unable to create very small cubes and, therefore, that alternative ways to miniaturization have to be considered. The teacher by recalling that molecules can interact together to give bigger molecules will introduce nanodevices. Examples of nanodevices that can be easily used at school are nanosensors; a particularly simple and appealing nanosensor is the luminescent system haemoglobin-luminol, which finds application in forensic analysis.

The second point, concerning the request to compare the total surfaces when a cube is cut in smaller cubes, allows students (i) to observe that the dimensions of the cubes affect the total surfaces area, while the entire volume remains constant, and (ii) to consider that the dimensions affect the surface area to volume ratio as shown in figures 1 and 2. This last consideration is important to discuss with the students the properties of nanomaterials, e.g., nanoparticles, and to stress that such properties are actually related to their very small size which results in an incredibly vast surface.

Divisions of the cube-side	Number of cubes
$2 \times 2 \times 2$	$2^3 = 8$
$3 \times 3 \times 3$	$3^3 = 27$
$4 \times 4 \times 4$	$4^3 = 64$
$5 \times 5 \times 5$	$5^3 = 125$
$6 \times 6 \times 6$	$6^3 = 216$
$7 \times 7 \times 7$	$7^3 = 343$
$8 \times 8 \times 8$	$8^3 = 512$
$9 \times 9 \times 9$	$9^3 = 729$
$10 \times 10 \times 10$	$10^3 = 1000$



**Figure 1:** The number of cubes increases splitting the side of the original cube



**Figure 2:** The surface area changes when the same volume has different shapes

At the end of the activity students are requested to fill the following sheet and the results are discussed in the classroom.

**Questions that students will answer at the end of the activity**

Name..... date..... class.....

Have you ever heard of nanotechnology before? YES NO

If yes, explain when and concerning what:

Explain what “nano” means in scientific contexts:

Write the name of something that has the dimension of some nanometers: