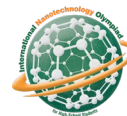


International Nanotechnology Olympiad

# Sample Questions





In the name of God

International Nanotechnology Olympiad sample questions

1. Suppose you start with a sheet of paper that is 10 centimeters long. You repeatedly cut the current piece in half, keeping one half and discarding the other. Approximately how many cuts are required to reduce the length to less than 100 nanometers?

1. 2,000,000
2. 2,000
3. 200
4. 20

2. Proteins are crucial biological nanomaterials found within living organisms. The process of protein synthesis is most analogous to which of the following physical phenomena?

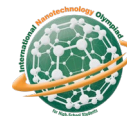
1. The diffusion of a perfume's scent throughout a room
2. The dispersion of colored ink particles in a glass of water
3. The spontaneous upward movement of water through plant vessels to supply the top leaves and stems
4. The formation of sugar crystals on a string placed in a saturated sugar solution.

3. How is the structural order of nanoparticles affected as their size decreases?

1. The long-range structural order gradually decreases.
2. The material's unit cell becomes larger.
3. The material retains its bulk crystal structure.
4. The crystal planes within the material expand.

4. In a one-gram sample, which of the following materials has the highest ratio of covalent bonds to carbon atoms?

1. Diamond
2. Fullerene
3. Carbon nanotube
4. It depends on the number of carbon atoms in the structure.



**5. Consider an object carrying a net electrical charge, isolated within an insulating environment. If this object is fragmented into numerous nanoparticles such that the original charge is distributed among them, how do the total charge of the resulting nanoparticle collection and their surface charge density compare to the respective values for the original object?**

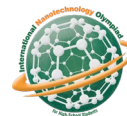
- 1. The total charge decreases, and the surface charge density remains constant.**
- 2. The total charge remains the same, and the surface charge density increases.**
- 3. The total charge remains the same, and the surface charge density decreases.**
- 4. The total charge increases, and the surface charge density remains constant.**

**6. What is the primary phenomenon responsible for the change in the color of nanoparticles as their size decreases?**

- 1. A reduction in electron cloud density**
- 2. A decrease in the lattice constant and a change in crystal structure**
- 3. An increase in the surface area to volume ratio of the particle**
- 4. The splitting and modification of the energy band structure**

**7. What are the primary strategies employed by nature to construct structures, and in contrast, what are those typically used in large-scale industrial manufacturing?**

- 1. Bottom-up, Top-down**
- 2. Top-down, Bottom-up**
- 3. Bottom-up, Bottom-up**
- 4. Top-down, Top-down**



8. Over time, living organisms have evolved specific spontaneous processes to harness natural forces and organize the activity of intracellular components—essentially forming natural self-assembling systems. Given the stability of these components and their sensitivity to temperature changes, which of the following interactions plays a key role in this self-assembly process?

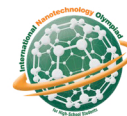
1. Covalent bonds, metallic bonds, ionic bonds
2. Hydrogen bonds, metallic bonds, van der Waals forces
3. Covalent bonds, van der Waals forces, capillary action
4. Hydrogen bonds, van der Waals forces, capillary action

9. Which of the following nanocatalyst shapes is most likely to exhibit the highest efficiency in chemical reactions?

1. A cube with sides measuring 10 centimeters.
2. A sphere with a diameter of 10 centimeters.
3. A cylinder with a high length-to-diameter ratio.
4. The geometric shape of a nanocatalyst does not significantly impact reaction efficiency.

10. In the production of a specific quantity of methanol from carbon monoxide and hydrogen gases, a cubic catalyst with a side length of 10 centimeters (nickel metal on an alumina substrate) is employed. If the same quantity of methanol were produced using a spherical nanostructured catalyst with a diameter of 10 centimeters, what would be the mass of this nanocatalyst? (The density of the conventional catalyst is  $0.01 \text{ g/cm}^3$ .)

1. 5.23 grams
2. 10 grams
3. The mass can be considered approximately equal.
4. The mass decreases significantly.



## Answer Sheet:

1. (A) (B) (C) ●

2. (A) (B) (C) ●

3. ● (B) (C) (D)

4. ● (B) (C) (D)

5. (A) (B) ● (D)

6. (A) (B) (C) ●

7. ● (B) (C) (D)

8. (A) (B) (C) ●

9. (A) (B) (C) ●

10. (A) (B) (C) ●