Topics in Nanoscience

Assignment-1-23

1. Mention two currently available commercial products where nanoparticles are used. Write the names of the nanoparticles and their characteristics exploited for the application. (2+2+4)
2. Look up the diameter of a silicon atom, in pm. The latest semiconductor chips have fabricated lines as small as 6 nm. How many silicon atoms does this correspond to? (2+3)
3. What are plasmonic particles? Give two examples. (2+1)
4. In the clinical area, PEG-intron^{TM} is used to treat hepatitis C, multiple sclerosis, and HIV/AIDS. PEG-intron^{TM} belongs to which special class and subclass of nanomaterials? (3)
5. QDs are better suited as fluorescent probes than the Alexa Fluor 488 dye under prolonged illumination. Give possible reasons for it. (2)
6. Mention two broad features that arise from the small sizes of nanomaterials and mainly give rise to the unique properties of nanomaterials. (2)
7. When do the 'size effects' begin to appear in materials? (4)
8. Assuming the close-packed full-shell cluster model of atom packing, calculate the (approx.) total number of atoms that will give ~50% of surface atoms. Show the steps of calculations. (6)
9. Define "intensive properties". Mention three intensive properties that do not obey this definition in the case of nanomaterials. (2+2)
10. Calculate the approximate number of atoms that will be at the surface of a spherical particle of radius, 5 nm, having around 8,000 total atoms. (4)
11. Mention at least two classical material properties that become quantized in some nanomaterials. (2)
12. Surface is present in all materials, but why does one see significant effects of the surface in the nanomaterials? (4)
13. Write down the criteria of a high-quality superhydrophobic (ultra-hydrophobic) surface. (4)
14. Compare the Wenzel and Cassie-Baxter models used to explain the superhydrophobicity of a surface. (8)
15. (a) Consider a square array patterned surface that has square pillars of s μm side length and h μm height placed d μm apart. Derive expressions for r, f_1, and f_2 in terms of s, h, and d. (4)

    (b) If the contact angle for the flat surface is measured to be 114°, find the apparent contact angle for the patterned surface according to the Wenzel and the Cassie-Baxter equations. For the Cassie-Baxter equation, assume that the liquid covers the top surfaces of the pillars *completely*. Comment on how hydrophobicity changes with the same surface. Given: $s = 50$ μm, h = 10 μm and d = 150 μm. (4,2)