University of Ruhuna- Faculty of Technology

Bachelor of Biosystems Technology Honours Degree
Level 2 (Semester II) End Semester Examination, December 2022
Academic year 2020/2021

Course Unit: BST 2242 Nanotechnology **Duration: 1 & 1/2 hours**

Instructions to candidates:

Answer only **Three (3)** questions.

Each question should be started with a new page.

1. Titanium dioxide (TiO_2) nanoparticles have a high refractive index (n = 2.4), making them ideal for various applications, including medicines, coatings, inks, plastics, food, cosmetics, and textiles.

   a. Explain briefly the sol-gel synthesis method of TiO_2 nanoparticles.

   (30 marks)

   b. X-ray diffraction (XRD) method can be applied to determine the average particle diameter size (D) of the synthesized TiO_2 nanoparticles based on *the Debye-Scherer formula* (equation 01). Considering the first-order diffraction, Bragg's law (equation 02) estimates Inter planner space (d).

   $D = 0.9\lambda / \beta\cos\theta$ ..... (1)
   $2d \sin\theta = \lambda$ ..... (2)

   Here, λ is the wavelength of the incident beam, θ is the angle of diffraction, β is the FWHM (full width at half maximum) of the reflection peak.

   i. Explain briefly the principle of the XRD method including sample preparation and possible advantages and disadvantages.

   (30 marks)

   ii. The XRD analysis of the prepared sample of TiO_2 nanoparticles was done using an X-ray diffractometer, Cu-Kα X-rays of wavelength (λ) = 0.15406 nm and data was taken for the 2θ. The 2θ values and β values (radian) of the peaks are given in the table. Complete the table.

2θ	θ	cosθ	β	βcosθ	Size(D)/nm
25.270			0.001902		
36.910			0.001884		
55.037			0.001989		
The average size in nm					

(40 marks)

2. Nanoparticles (NPs) are currently used in the diagnosis and treatment of many human diseases, including autoimmune diseases and cancer. However, the cytotoxic effects of NPs on normal cells and living organs is a severely limiting factor that hinders their use in the clinic.

   a. List down the main human exposure pathways to nanoparticles.
   (20 marks)

   b. Discuss briefly the physiochemical factors of nanoparticles that affect cytotoxicity.
   (40 marks)

   c. Explain nano cytotoxicity due to oxidative stress.
   (40 marks)

3. Anthropogenic, combustion-related emissions, including those from fossil fuel and biomass burning for power and heat, are the main sources for a wide array of airborne pollutants, including CO_2, VOCs, SO_x, CO, unburned hydrocarbons, and NO_x.

   a. Discuss briefly potential pathways that release engineered nanoparticles into the environment.
   (40 marks)

   b. In Sri Lanka, Kelani Thissa power plant is playing a key role in supplying electricity by burning fossil fuels. If you are requested to minimize airborne pollutants which release from the power plant, discuss briefly how you apply your nanotechnology knowledge to minimize the airborne pollutants that release into the environment.
   (60 marks)

4. Nanoscale metals are widely used in many fields such as environmental science, medicine, *etc*. Green synthesis is more beneficial than traditional chemical synthesis.

   a. List down the applications of green synthesized Nanoscale Zero-Valent Iron (NZVI).
   (20 marks)

   b. Discuss briefly the advantages of green synthesis compared to chemical and physical methods.
   (20 marks)

   c. Discuss the challenges/limitations towards adopting industrial production and large-scale green synthesized application of nanoscale metals.
   (60 marks)

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