

University of Canterbury

End of Year Examination 2008

Prescription Number(s): CHEM 410

Paper Title: Nanotechnology

Time Allowed: TWO HOURS

Number of pages: FOUR

This paper is divided into TWO sections.

Answer **TWO** questions; **ONE** question from each section.

TURN OVER

SECTION A

(Answer **ONE** question from this section)

1. Artificial nanopores and natural ion channels (for example, gramicidin) have been investigated as elements in sensing systems.
 - (a) Briefly comment on the general advantages and disadvantages of artificial nanopores compared with natural ion channels for application as sensing elements.
 - (b) For a system based on **either** artificial nanopores **or** gramicidin ion channels, describe in detail how the sensing element is fabricated.
 - (c) For the system chosen in (b), describe how the sensor functions. Outline the types of analytes that have been, or could be, sensed. Include in your answer an explanation of how the sensor is changed for detection of different analytes.
 - (d) Outline the limitations of the sensor described in (b). Suggest how these limitations might be overcome or reduced, or how an alternative format based on the same sensing element (i.e. artificial nanopores or ion channels) might be more successful.

2. Nanoparticles are frequently used in the detection strategies of affinity biosensors.
 - (a) Define the terms **biosensor** and **affinity biosensor**.
 - (b) Describe the different ways in which nanoparticles can be used in affinity-based molecular recognition to enable detection (or improved detection) of the analyte. You should include descriptions of specific sensing strategies that are used in commercially available sensors, or are under development. Indicate particular advantages and limitations of the sensing strategies you describe.

TURN OVER

SECTION B

(Answer **ONE** question from this section)

3. (a) (i) Name three unique properties of metal nanoparticles and explain the importance of these properties using bulk metals for contrast and comparison.
- (ii) Give an account of the favorable properties of support immobilized nanoparticles as catalysts.
- (iii) Explain why immobilization of metal nanoparticles on supports is often required in order to produce active catalysts.
- (b) (i) Give examples of 0-D, 1-D and 3-D nanostructured materials.
- (ii) Using 0 to 3-D classification, describe a nanostructured catalyst system consisting of an ordered porous support material with metal nanoparticles immobilized inside long and narrow channel-like pores of the support. Assume that the overall dimensions of the support particles are in the micrometre range.
4. (a) (i) Explain the concepts that underpin top-down and bottom-up approaches towards fabrication of nanostructured materials.
- (ii) Comment on the long-term future prospects of each approach in (i), using Moore's law and hierarchical self-assembly within natural systems to illustrate your argument.
- (b) (i) Explain the difference between intrinsic and extrinsic defects.
- (ii) Can one create a material without intrinsic defects? Explain.
- (iii) The phrase "perfecting imperfection" refers to which type of defects? Give an example.
- (iv) Why is ultra-high purity Si required to make doped semiconductors?

END OF PAPER