



UNIVERSITY OF GHANA

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BSC. ENGINEERING

FIRST SEMESTER EXAMINATIONS: 2018/2019

DEPARTMENT OF BIOMEDICAL ENGINEERING

BMEN 305: BIOMATERIALS (3 CREDITS)

INSTRUCTIONS:

PLEASE ATTEMPT ALL QUESTIONS. MAKE SURE YOUR ANSWERS ARE DIRECTLY RELATED TO THE SCENARIO DESCRIBED.

TIME ALLOWED: TWO AND HALF (2½) HOURS

Assume a new material, *Vibranium*, has been discovered. The material is purported to be stronger than any material known; it can withstand high impact forces, has shape-memory properties and is exceptionally lightweight. Due to the extraordinary properties of the material, a Biomedical Engineer is considering the material for the design of two different products, a protective suit to be worn by military personnel and a bone implant. Answer the ensuing questions regarding the choice of *Vibranium* for the design projects.

1. a. What is a shape-memory material? [3 marks]
- b. Based on the purported properties of *Vibranium*, describe the expected structure of the material. Focus on the arrangement of atoms and bonds present. [7 marks]
- c. Based on your answer to (b), is *Vibranium* expected to be a metal, ceramic or polymer? Justify your answer. [10 marks]
- d. List with explanation, 5 critical materials properties to be possessed by a material that is to be used for external protection by military personnel going for combat (combat gear). [10 marks]
- e. List with explanation, 5 critical materials properties to be possessed by a material that is to be used for an internal fixation device (bone implant). Explain your answer. [10 marks]

2. For each of the design projects (military combat gear and internal bone fixation device),
- Describe briefly an appropriate *in vitro* test for biocompatibility and state the shortcomings of the test. [10 marks]
 - Describe in detail, an acceptable local host response to *Vibranium*,
 - 15 minutes after first contact of the material with the host.
 - 12 months after first contact of the material with the host.[20 marks]
3. The biomedical engineer designs the product in Figure 1 below as the bone fixation implant, using *Vibranium*.
- Assuming *Vibranium* is a metal, describe three (3) distinct problems likely to arise from the design upon implantation. [12 marks]
 - For each of the problems in (a) suggest a solution. [12 marks]
 - How would your answer in (a) change if *Vibranium* were a non-degradable polymer? [6 marks]

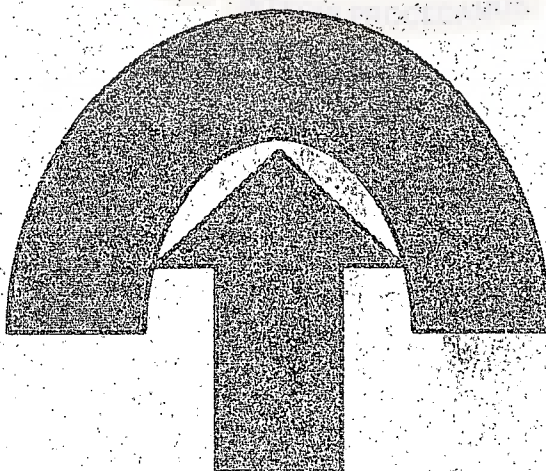


Figure 1: Lateral view of the *Vibranium* bone implant.