

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

Faculty of Industrial Technology

Department of Technical Teacher Education

Bachelor of Education Honours Degree

MATERIALS SCIENCE - TTE 0139

Bridging Examination

January 2011

Instructions

1. Examination length is **3hrs**.
2. Each question carries twenty (**25**) marks and there are five (**5**) questions in total.
3. Answer any four questions.

Question 1

- a. Sketch FCC, BCC, and HCP unit cells and for each give a metal of that structure. [15]
- b. Copper has an atomic radius of 0.128 nm, an FCC crystal structure with a lattice parameter of 0.362 nm, and an atomic weight of 63.5 g/mol. Compute its theoretical density given that Avogadro's constant is 6.02×10^{23} atoms/g.mol. [5]
- c. Show for the face-centred cubic crystal structure that the unit cell edge length a and the atomic diameter d are related through

$$a = d\sqrt{2}$$

[5]

Question 2

- a. Explain the concept of strain hardening. [5]
- b. The commercial use of steels exceeds that of any other engineering material. Is it necessary to do heat treatment of steels? [5]
- c. Discuss the stages of an annealing heat treatment cycle, with specific reference to the changes in mechanical properties, and grain structure and size. [15]

Question 3

- a. Figure Q4 in Appendix A is a schematic illustration of one primary bonding type found in materials.
- i. Give the name of this bond and the materials that exhibit this type of bonding. [3]
 - ii. Explain the properties of these materials that are a result of this bonding. [7]
 - iii. Make a neat sketch of an almost similar type of atomic bond and explain how it is formed and its nature. [9]
- b. Polymers have low melting points and densities. How is this related to the atomic bonding? [6]

Question 4

- a. Define a phase. [4]
- b. Given in Table Q5 in Appendix A are the solidus and liquidus temperatures for the copper (Cu) - nickel (Ni) system. Construct on graph paper the phase diagram for this system and label each region. [10]
- c. For an alloy with a nominal composition of 45% copper – 55% nickel determine
- i. The phases present at 1290°C. [3]
 - ii. The amounts of these phases [8]

Question 5

- a. Explain why we study materials. [5]
- b. Materials are classified into four main groups. Write a brief but concise discussion on each of the four classes, with specific reference to the typical properties and applications. [20]

End of exam

Appendix A

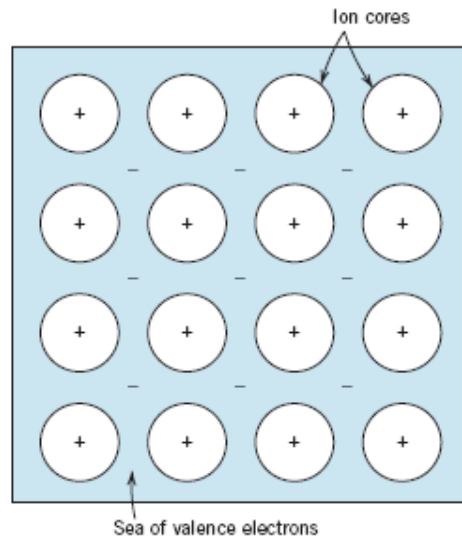


Figure Q4

Table Q5

Composition Weight % (Ni)	Solidus Temperature (°C)	Liquidus Temperature (°C)
0	1085	1085
20	1160	1197
40	1240	1280
60	1313	1350
80	1380	1405
90	1420	1435
100	1453	1453