

OLLSCOIL NA hÉIREANN
The National University of Ireland

National University of Ireland, Galway

Trinity Examinations, 2000/01

First Year Mechanical and Biomedical Engineering Examination

INTRODUCTION TO MATERIALS

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Attempt Four Questions

You must attempt Question 1 (26 marks) and three other questions (18 marks each)

Total 80 marks Time Allowed: 2 Hrs.

Table of Characteristics of Selected Elements attached.

- 1(a) Sketch the (112), (110) and (111) planes on a Body-Centered-Cubic (BCC) unit cell. (5)
- (b) For BCC molybdenum (Mo), calculate the planar density (atoms/nm²) of the (112), (110) and (111) planes. Which plane will exhibit plastic slip first and why? (12)
- (c) In which direction will the first plane slip? What is the atomic density of this direction (atoms/nm)? (4)
- (d) Calculate, from first principles, the volume occupied by 5.0 Kg of Molybdenum. (5)
- 2(a) Define the following mechanical properties and describe a test for measuring each property
- (i) Elastic Modulus
 - (ii) Poisson's Ratio
 - (iii) Proof Strength
 - (iv) Impact Toughness
 - (v) Hardness
- (10)
- (b) What are the major factors influencing the crystal structure of ceramics? Give one example each of AX and A_mX_p structures. Draw each structure. (8)

3(a) (i) Discuss and compare thermoplastic and thermosetting polymers in terms of their formation, processing, mechanical properties and other properties. (6)

(ii) What factors influence the percentage crystallinity of thermoplastic polymers? Explain the importance of the glass transition temperature (T_g) and the melt temperature (T_m). (6)

(b) Calculate the number average (\bar{M}_N) and weight average molecular weights (\bar{M}_w) for a polymer blend composed of the following six fractions:

Mol. Weight (g/mol)	1400	2020	4100	7500	9010	10450
Weight (g)	0.01	0.5	1.2	0.95	0.2	0.05

Which properties of the polymer do increase in the weight-average molecular weight (\bar{M}_w) influence most? (6)

4(a) Explain the phenomenon of dendritic solidification of metals. What influence does cooling rate have on the crystal structure of metals? (6)

(b) Describe investment casting of metals. (6)

(c) Describe the selective laser sintering (SLS) rapid prototyping process

5(a) Explain the following terms:

In-Vitro Testing, Prosthesis, Biomaterial (5)

(b) List and explain the main requirements of Biomaterials and Medical Devices. (6)

(c) What are the main advantages of polymer-matrix composites? (7)
Discuss the main classes of fibres used with polymer composites and their relative advantages and disadvantages.