



KENYATTA UNIVERSITY
UNIVERSITY EXAMINATIONS 2022-2023
FIRST SEMESTER EXAMINATIONS FOR THE DEGREE OF PETROLEUM
ENGINEERING
EPL 100 MATERIAL SCIENCE

INSTRUCTIONS:

1. This paper contains FIVE questions
2. Answer Question ONE any other TWO questions.

Useful information

N_A (Avogadro's number) = 6.023×10^{23} atoms/mol

QUESTION ONE COMPULSORY (30 marks)

a) Describe the terms as used in material science and engineering:

- | | |
|---------------------------|----------|
| (i) Tenacity | (1 mark) |
| (ii) Viscoelasticity | (1 mark) |
| (iii) Dielectric strength | (1 mark) |
| (iv) Thermal endurance | (1 mark) |
| (v) Cullet | (1 mark) |

b) (i) show that the atomic packing factor for the unit cell in fig 1. Below is 0.74 (6 marks)

(ii) What would this crystal structure be called? (1 mark)

(iii) to which crystal system does it belong? (1 mark)

(iv) Sketch and name the other representations of this unit cell (2 marks)

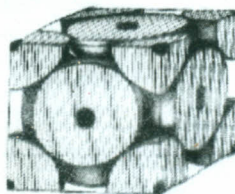


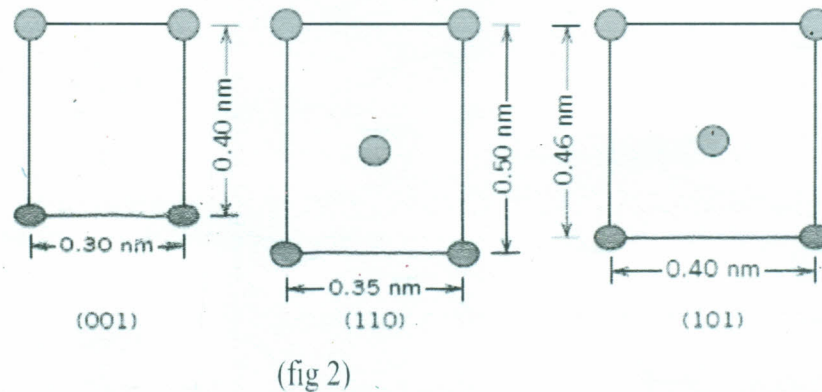
Fig. 1

c) With the aid of a diagram, determine that 6 whole atoms are associated with the HCP structure. (6 marks)

- d) Niobium has an atomic radius of 0.1430nm and a density of 8.57g/cm³. Determine whether it has an FCC or BCC crystal structure (5 marks)
- e) Describe magnetic particle inspection (4 marks)

QUESTION TWO (20 marks)

- a. Enumerate advantages of ceramic materials (5 marks)
- b) State three properties of glass (3 marks)
- c) Figure 2 below are shown three different crystallographic planes for a unit cell of a hypothetical metal: The circles represent atoms.
- To what crystal system does the unit cell belong (1 mark)
 - What would this crystal structure be called? (1 mark)
 - If the density of this metal is 8.95g/cm³, determine its atomic weight (6 marks)



- d) State two uses of Lime and Potassium carbonate in the manufacturing of glass (4 marks)

QUESTIONS THREE (20 marks)

- a) To which crystal structures do the following materials belong?
- Iron (α -phase) (1 mark)
 - Chromium (1 mark)
 - Cobalt (1 mark)
 - Molybdenum (1 mark)
- b) Give a comparison between plastic and elastic deformation (5 marks)
- c) Magnesium has an HCP crystal structure, an HCP crystal structure, a c/a ratio of 1.624 and a density of 1.74g/cm³. Compute the atomic radius of Mg (7 marks)
- d) State four uses of acrylics (4 marks)

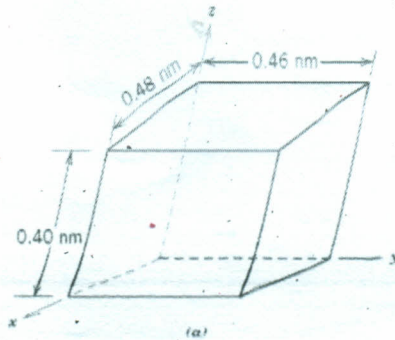
QUESTION FOUR (20 marks)

- a) For a ternary system, temperature is also a variable. What is the maximum number of phases that may be present for a ternary system, assuming that pressure is held constant (4 marks)
- b) A glass sample has a crack length of $4.2\mu\text{m}$. If the Young's modulus of the glass is 70GN/m^2 and the specific energy is 1.1J/m^2 estimate its fracture strength and compare it with its Young's modulus (5 marks)
- c) Define the following terms:
- (i) Proportional limit (1 mark)
 - (ii) Plastic deformation (1 mark)
 - (iii) Flame hardening (1 mark)
 - (iv) Newer ceramics (1 mark)
 - (v) Smart material (1 mark)
- d) With the aid of a diagram show for the body centred cubic crystal structure has a maximum packing of 68% (6 marks)

QUESTION FIVE (20 MARKS)

- a) Explain the magnetic particle inspection testing of metals (5 marks)
- b) Describe the following heat treatment processes
- (i) Case hardening (4 marks)
 - (ii) Gas carburizing (4 marks)

For the unit cell shown in the accompanying sketch (a), locate the point having coordinates $\frac{1}{4} \frac{1}{2} \frac{1}{2}$.



- (5 marks)
- c) Sketch and name the two representations of the HCP crystal structure (2 marks)